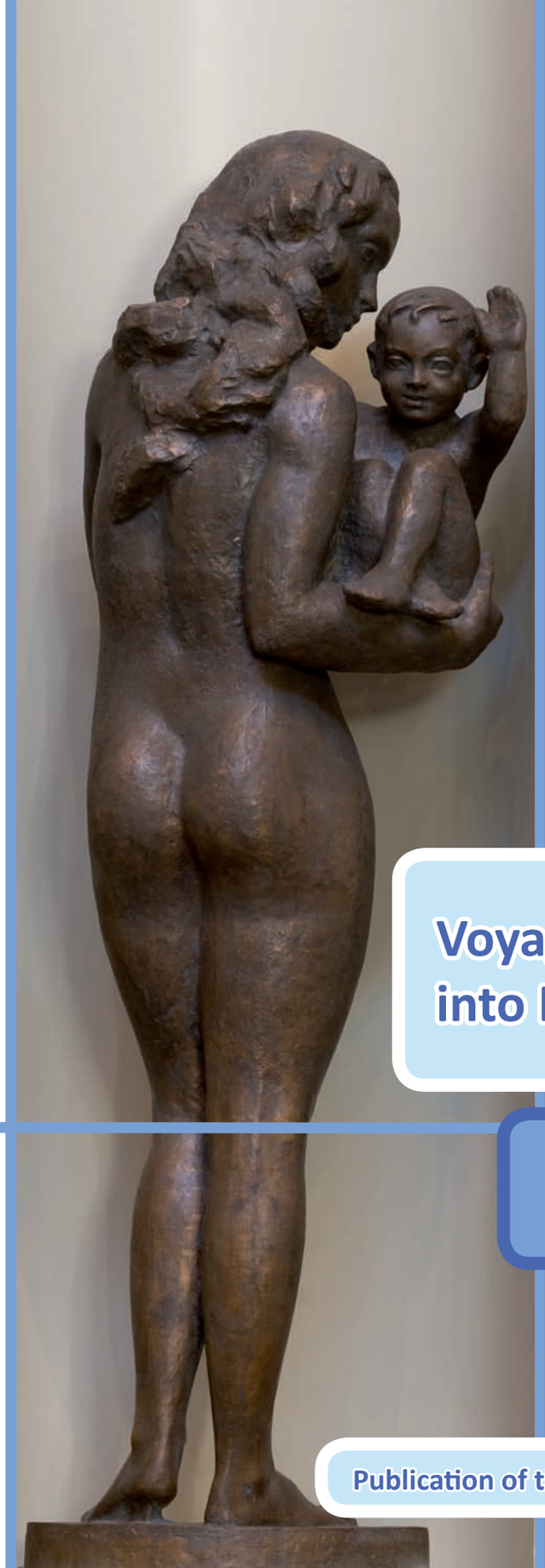

Voyages of Exploration into Biopolicy

Osmo Kuusi, Sirpa Kurppa
and Jussi Pakkasvirta (Eds.)

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Publication of the Committee for the Future 8/2011

VOYAGES OF EXPLORATION INTO BIOPOLICY

Challenges facing and perspectives on Finnish biopolicy in a global framework 2010-2050

Summary

Osmo Kuusi, Sirpa Kurppa
and Jussi Pakkasvirta (Eds.)

Publication of the Committee for the Future 8/2011

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About the English version of the report: "Löytöretkiä biopolitiikkaan, Suomen biopolitiikan haasteita ja näkökulmia globaaleissa puitteissa 2010-2030"

The Report was originally published in Finnish in February 2010. The English version includes only the Forewords of the report, Contents, Position adopted by the Committee for the Future on Finnish biopolicy based on the report and two final chapters of the report. Osmo Kuusi has modified the final chapters to take into account that the earlier chapters are not included to the English version. He has also made some additions to the text based on the developments after the publication of the original Finnish book.

Helsinki 15.4.2011

Osmo Kuusi

To the Reader

The future report for this parliamentary term deals with climate change. The Committee for the Future decided at the beginning of its term to launch a project of proactive and determined work on the theme of the report and chose, in simplified terms, forests, water and food as its first subjects of study.

The study broadened and deepened as the work progressed towards visions of the future of biopolicy. Now all of you have the opportunity to assess the result.

In addition to the members of the Committee, representatives of other Eduskunta committees and, in the broadly-based steering group, a considerable number of researchers and other experts in the field contributed to producing the report. The project was meritoriously led by Representative Kyösti Karjula.

My warmest thanks to all of you who participated in the work!

The Committee for the Future will continue deliberation of the theme at a plenary session discussion in the near future. Work on the future report will be continued with formal hearings to consult experts. The report will be completed in early autumn.

I hope this report will be read by lots of you and that it will prompt a lively and fruitful discourse on the lines that Finnish biopolicy should follow in the future.

Marja Tiura

Chair of the Committee for the Future

Foreword

The need for a anticipation project dealing with the global future of forests, nutrition and fresh water was recognised early on in the parliamentary term, in the spring of 2007. Radical changes in the forest industry, an energy and food crisis as well as climate and environmental challenges opened a perspective revealing the inescapability of anticipation the biopolicy of the future. The anticipation task has been challenging. Many of the reviews of agriculture, forestry and foodstuffs production conducted in recent times have been entirely national in scope or applied only to the EU. In this work, we have consciously tried to open up a global perspective. This is crystallised in the title of this final report: Voyages of Exploration into Biopolicy – Challenges Facing and Perspectives on Finnish Biopolicy in a Global Framework 2010-2050.

A preliminary report published in spring 2008 concentrated on an examination of the forest sector. The significance of forests for the prospering of our country has been major. Immediately after the Second World War, about 25 million cubic metres of firewood was cut using human labour assisted by horses. The rate of growth of the forests was not sufficient to satisfy the strongly increased demand for timber by the construction sector. In the course of the decades, the pulp and paper industry has meant a key channel for the use of wood. The forest industry has provided an excellent growth substrate for also the Finnish metal and mechanical engineering industry. Even some of the electronic industry's innovations can trace their roots back to the forest industry. For our country, utilisation of forests has become one sectoral cluster with advanced know-how.

This sector of key importance to Finland has undergone a profound upheaval in the past 10-15 years. The centre of gravity in demand for pulp and paper has shifted to Asia and production has decisively gained strength in South America. At the same time, demand for products of the pulp and paper industry has declined in Europe. In new production units in South America, for example, pulp manufacturing costs are about half what they are in Finland.

The most recent major investment in the chemical forest industry in Finland was in 1994. In recent years, investments by forest industry companies of Finnish origin in production facilities and land acquisition have been in South America: Uruguay, Brazil and Chile. As a consequence of this, the larger part of these companies' employees are in production facilities outside our country's borders. Over the same period, several production facilities in Finland have been closed down.

Parallel to this, globalisation has been strongly reflected also in the foodstuffs economy, where the effect has been the opposite from the perspective of production and markets. The Finnish foodstuffs industry has concentrated primarily on serving the domestic market. Export opportunities have even narrowed in thinking on the future. By contrast, food imports have increased 3 – 4-fold in the past 15 years. It is noteworthy that a considerable part of the increased imports have come from outside the EU.

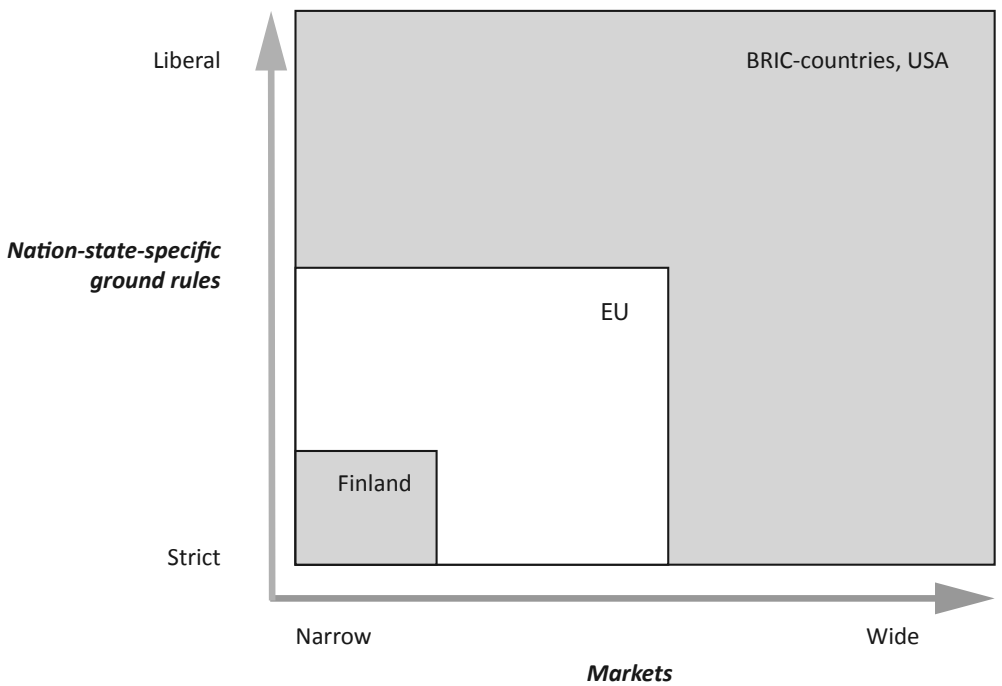
An examination of this anticipation project reinforces the view that in terms of its natural resources endowment relative to population Finland is an exceptionally wealthy country.

The soil offers favourable conditions for diversified production of biomasses, to provide fibres, wooden structures, chemicals, nutrition and energy. The forests' growth potential is excellent. At the moment, an annual growth increment of about 100 million cubic metres is possible. In addition, an abundance of water resources accentuates our strong position.

In this period of transition, strengthening of Finnish biopolicy and of our country's bioeconomy are seeking new ways of acting and new innovations. It is a big challenge also for existing and new companies in the bio-sector. Climate change, local acceptability, the adequacy of world food production, protection of biodiversity and Finland's special interests as well as Finnish employment are factors that are seeking balanced contents.

A global examination opens interesting perspectives, of which I shall highlight two special ones: first, that production is being polarised between a large-scale and capital-intensive agribusiness model and a labour- and competence-intensive small-scale production model. These models compete in production of food, fibres and energy in all of the important bioproducer countries. It is mainly the small-scale production model that accounts for local employment. The second perspective that I shall highlight has to do with the ground rules that are specific to companies and nation-states. The success factor that will be indisputably the clearest in the future is high-level competence founded on customer- and demand-centred research and development.

The difference between the agribusiness model and the small-scale production model is dealt with in greater detail in the introduction section of the report. The question of ground rules that are specific to companies and nation-states has been given less attention. The following diagram articulates this totality:



The EU has been trying to act as a global trendsetter for climate and energy policy. However, the Copenhagen climate conference revealed the different paces at which progress is being made in different parts of the world. The EU had to be content with a negotiated outcome that was clearly more modest than it would have wanted. The pace of climate and energy policy was determined in practice by the BRIC countries (Brazil, Russia, India and China) and the United States, which have not been prepared for binding emission reductions.

Capital-intensive global companies in various sector have assumed an overwhelming position when decisions on where to locate production are made. They assess, besides the region's market potential, also the ground rules set by different nation-states and economic regions, especially looked at in the light of their opportunities for action. The success-related choices that global companies make are detached from the success of individual nation-states and also from democratic decision-making power. This characteristic feature of globalisation makes increasingly rapid transfers of know-how and technology possible. This means in practice that, for example, StoraEnso and UPM are global companies in the forest sector and the decisions they make are not bound to the solutions that an individual nation-state, such as Finland, arrives at.

Secondly, countries that are growing strongly as actors in biopolicy, such as Brazil and Uruguay, have made political decisions creating ground rules that have strengthened companies' interest in and willingness to operate in the nation-states in question.

This opens up an especially challenging vista for Finland's and the EU's biopolicy and for development of the ground rules in our own operating environment. Indeed, it can be asked whether sufficiently competitive conditions for bioeconomy companies have been ensured in Finland and the European Union. In recent years, strong growth in biopolicy and also in the rest of the economy has taken place in countries outside the EU.

The conclusions outlined in the extensive anticipation report include a compilation of 12 challenges and perspectives; and an effort to find better solutions to these than has currently been possible must be included in Finnish biopolicy in the future. Finland can assume a role as a pioneer in a sustainable, company-powered bioeconomy. This presupposes courageous political choices and decisions founded on foresight. It is especially important that through decisions by the State space is foresightedly created for new openings and markets for new innovations. In its time, the Nordic decision to go with the NMT mobile system created the foundation on which today's data-transmission industry emerged. Now comparable breakthroughs are needed in the bioenergy and environmental technology and wood construction sectors.

On the national level it is important that we find in biopolicy a balance that contains the prerequisites for success in the development work done by both large-scale global corporations and innovative small companies to create new products and services.

Accomplishing this report has been a demanding and extensive cooperative effort. In addition to Representatives, several dozen Finnish and international experts representing the forest, foodstuffs and water sectors participated in the work. I thank the experts who contributed to the project and especially Docent Osmo Kuusi, who bore the main responsibil-

ity for writing it, and the other authors, Professor Sirpa Kurppa and Docent Jussi Pakkasvirta. Your inputs have been decisive.

The members of the steering group have been Members of the Finnish Parliament Kyösti Karjula (Chair), Marko Asell (Deputy Chair), Tarja Filatov, Liisa Jaakonsaari, Harri Jaskari, Anneli Kiljunen, Anne Kalmari, Matti Kangas, Timo Kaunisto, Jouko Laxell, Marjo Matikainen-Kallström, Juha Mieto, Mats Nylund, Lauri Oinonen, Sirpa Paatero, Sanna Perkiö, Petri Pihlajaniemi, Erkki Pulliainen, Kari Rajamäki, Pirkko Ruohonen-Lerner, Jouko Skinnari, Marja Tiura, Pentti Tiusanen, Pekka Vilkuna, Anne-Mari Virolainen, Ulla-Maj Wideroos and Jyrki Yrttiaho.

The following persons participated in the work of the expert group. All of them influenced, in a variety of ways, the content of the report. Those whose names are marked with an asterisk are the persons mentioned in footnotes as the authors of various sections or the suppliers of key material used in the sections: Acting Director Jyrki Aakkula, (MTT Agrifood Research Finland), Adviser Hannu Eerola (Ministry for Foreign Affairs), Professor Martti Esala (MTT Agrifood Research Finland), Managing Director Christine Hagström-Näsi (Metsäklusteri Oy), Professor-Emeritus Pertti Harstela (Finnish Forest Research Institute Metla)*, Professor Juha Helenius (University of Helsinki), Risto Isomäki*, writer, Director Markku Kanninen, (Centre for International Forest Research CIFOR), Professor Pekka Kauppi (University of Helsinki)*, Markus Kröger, MA (University of Helsinki)*, Professor Sirpa Kurppa (MTT Agrifood Research Finland)*, Professor Katri Kärkkäinen (Finnish Forest Research Institute Metla)*, Economist Kalle Laaksonen (Pellervo Economic Research PTT), Professor-Emeritus Ossi V Lindqvist (University of Kuopio)*, Professor Anssi Niskanen (University of Joensuu), Docent Jussi Pakkasvirta (University of Helsinki)*, Director Pasi Rikkonen (MTT Agrifood Research Finland), Professor-Emeritus Pentti K. Räsänen (University of Helsinki)*, Professor Seppo Salminen (University of Turku)* and Docent Jussi Tammisola (University of Helsinki)*.

Anticipation work is a responsible and visionary way of exercising influence. Through the scenarios outlined in this anticipation report we are consciously opening different paths to a challenging and inspiring voyage of discovery into the realm of biopolitics. At its best, it will engender a discourse, decisions and creative activities, which will be reflected in a centrally important way in the future success of Finland.

This anticipation report will also create a background for parliamentary deliberation of the Government report on climate and energy policy; in conjunction with this deliberation, especially energy alternatives will acquire more detailed contents.

Lumijoki 30.01.2010

Kyösti Karjula

Representative

Chair of the Steering Group

Contents

Position adopted by the Committee for the Future on Finnish biopolicy

Scenarios for Finnish biopolicy up to 2030

The vision of Finnish biopolicy

In photosynthesis plants and algae bind carbon dioxide from the air into their structures with the aid of water and various nutrients. Alongside organic nature, also more generally the carbon cycle in nature is based centrally on photosynthesis, because fossil fuels are likewise the result of earlier photosynthesis processes.

An increasing level of greenhouse gases in the atmosphere can be interpreted as a change or disturbance in the world's photosynthesis-based biosystems. The world's biosystems merge to form a system that spans the globe, because the carbon dioxide and another important greenhouse gas, methane, that enter the atmosphere spread from their emission sources to every part of the planet. Thus global biopolicy and combating climate change are closely intertwined with each other.

The Committee for the Future takes the view that the following vision can be set for Finnish biopolicy with a perspective extending to beyond the year 2030:

A biopolicy managed on a global level and Finnish biopolicy as a part of it form the core area of management of climate change. Combined in global biopolicy are combating climate change, safeguarding the world's supply of nutrition and protection of species diversity. Finnish biopolicy must be a means of especially preventing global warming, but it must operate in a way that does not lead to a weakening of employment and livelihood in Finland nor to a famine catastrophe in any country of the world. Protection of species diversity and improving the conditions of people living in developing countries are also important objectives.

In this statement of position the Committee for the Future concentrates especially on the challenges that bioproduction will face in Finland up to the year 2030. Stances have been crystallised into twelve challenges, which are derived from a SWOT (strengths-weaknesses-opportunities-threats) analysis of Finnish biopolicy that has been condensed into a single page.

The challenges faced when acting in an international operating environment are examined in the statement of position after the theses and SWOT table in the section “Finnish biopolicy in an international environment”.

However, the Committee does not adopt a position on these special challenges for Finnish biopolicy, which are associated with the alternative scenarios for the development of the global biosector that are outlined in the evaluation report.

Twelve key challenges facing Finnish bioproduction in the period up to 2030

As its vision, based on an examination of the strengths, weaknesses, opportunities and threats associated with the Finnish biosector as well as on an assessment of the development opportunities for Finland’s global operating environment, the Committee takes the view that Finnish biopolicy should aspire to the following by 2030.

1. The Finns will in 2030 be among the world’s most competent experts in relation to forests and wood. It must be ensured through training and research that the Finns are in the world vanguard in, among other things, reliable evaluation of carbon sinks; manufacturing and maintaining machinery and equipment for the forest sector; manufacturing special packaging products and papers; microbiological utilisation of valuable components of wood; as well as in applications of nano and gene technology in the forest sector.

2. Finland’s annual wood growth increment, which is currently around 100 million cubic metres, must in 2030 be used in a balanced way to benefit employment in our country and prevent climate change.

Towards this purpose:

- Usilisation of wood resources should be assessed creatively and fresh-mindedly without committing ourselves solely to earlier modes of use.
- The importance that forests and products made of wood have in Finland and globally as sinks and stores of carbon dioxide and other greenhouse gases must be studied in greater detail that heretofore.
- Finland must commit only to sinks-related conventions that are justified when examined globally against the background of the approximately 70-year cycle of Finnish forest nature. Wood resources must be utilised in a way that motivates promotion of good management of forests.
- A development programme concentrating on increasing the size of forest holdings must be made, taking especially urban-dwellers who own forests into consideration. To promote wood circulation, consideration should be given to, for example, new taxation-based means as well as solutions that promote forest management and wood sales.
- Forest resources data must be utilised better than at present in wood procurement and wood procurement practices. The right wood must be put to the right use; in other words, there must be an ability to channel wood in the correct proportions for use by the chemical and mechanical wood-processing sectors or the energy industry.

3. The socio-economic strengths and weaknesses of northern wood material relative to woods grown in tropical and sub-tropical regions must be reliably studied.

- The socio-economic advantageousness of using especially birch in the manufacture of pulp and its chemical ancillary products compared with wood produced in tropical or sub-tropical regions, especially eucalyptus, must be evaluated.
- What possibilities Finnish wood and Finnish production facilities offer for making special pulp grades and whether substituting for the use of waste paper with virgin pulp is justified for environmental reasons must be studied. One reason could be, for example, that ethanol is made from waste paper.
- If raw materials from northern forests prove socio-economically competitive in the manufacture of pulp and its chemical ancillary products, the means by which especially Finnish companies or those with Finnish backgrounds can be influenced to use more domestically-sourced wood raw material in the manufacture of pulp must be studied.

4. Building with wood must be made a national strength in Finland by the year 2030. Towards this purpose:

- Building with wood and training and research in the wood products sector must be strengthened.
- Structural wood must be favoured in public building.
- The use of wood in basic renovation of buildings must be promoted, inter alia by using wooden structures as additional insulation.
- Finland must actively offer its expertise to create construction standards for multi-storey buildings within an EU framework, in such a way that building with wood becomes easier to do.
- Building regulations must be revised to favour the use of wood. A point of departure that must especially be adopted in this is the carbon-binding properties of wood structures compared with buildings made from concrete elements. The overall advantageousness from the perspective of combating climate change of living in wooden houses as well as the demands of healthy housing must be taken into consideration in the requirements set for insulating buildings.

5. Packagings will be a key opportunity for large-scale use of wood-based materials in 2030. Through research, product development and official regulations, the aim should be to ensure that by 2030 the overwhelming majority of of plastic packagings will have been replaced by wood- or pulp-based products. Packagings that use intelligent information technology and are optimised in their overall ecological effects must be developed as a special Finnish strength.

6. The Committee for the Future takes the view that in 2030 bioenergy must be one central way of utilising Finland's wood resources and cropland. With a perspective up to 2020, this presupposes Finland already having made a commitment to the EU concerning the proportion of our total national energy consumption that renewable energy represents. In the production of liquid biofuels Finnish raw materials will face tough competition from raw materials produced in the tropics. In 2030 liquid biofuels made from Finnish biomass will be competing with those made using, among other things, algae, sugarcane and the fruits of the jatropha bush.

- The demands that the EU makes, sensible use of forest growth and cropland as well as Finland's security of supply with regard to energy production presuppose that utilisation of biomasses in energy production must be supported on a long-term basis, if necessary using the means that taxation provides.
- Adequate research and development funding for the production of liquid biofuels from domestic wood and peat must be ensured. Before large-cale production is begun, the environmental impacts and socio-economic advantageousness of this production compared with raw materials for liquid biofuels from outside our country's borders must be assessed.

7. Management of water resources is a key challenge for the world's bioproduction. Finnish industry has developed into a very efficient purifier of water and recycler of the water it uses in its processes. Water-related competence must be an important strength of Finnish exports in 2030.

- Finnish water-related competence must be developed by means of training and research that promotes it.
- The high level of competence that the Finns possess must be broadened from purification techniques for organic material to general management of water resources such as purifying community wastewaters, more efficient use of sources of freshwater and desalinising saltwater to make it suitable for irrigation.
- Pure water as virtual water bound up in products must be elevated to the status of one of the supporting legs of Finnish bioproduction. It must be emphasised when marketing bioproducts that Finnish water is managed fairly and according to a high technical standard. A fact that must also be highlighted is that Finland will continue to be one of the countries where clean water is not a scarcity factor. Thus, viewed from an international perspective, it also makes sense for bioproducts requiring a lot of water to be made in Finland.

8. Climate change and changing demand for food in the world will markedly alter the conditions in which the Finnish foodstuffs industry will have to operate in the period up to 2030.

- Since food security has become a very challenging problem in the world, it is important to ensure that the food supply in Finland functions well.
- The Finnish foodstuffs economy must be based on a high level of competence in all value chains and especially in key sectors like milk and meat production. Research and product development are needed in relation to, among other things, processing bio raw materials into products that positively influence health.
- The soil structure and drainage techniques must be developed from the perspective of better use of water and nutrient resources. The possibilities of soil as a carbon sink must likewise be determined and utilised. Raising livestock in conditions of good water resources and supply is a special strength for Finland.
- Special attention must be paid to customers' expectations with regard to food. By means of special ambassadors of culinary culture, Finnish food's image as something that is tasty and respects natural values must be reinforced. The school in Finland is a good reference point also for developing Finnish food education. Finnish production should avail itself of growing markets for additive-free food that keeps well and still tastes good.

- Competent organic food production must be developed as a strength for Finland.
- The status of locally-sourced food must be strengthened in the domestic foodstuffs chain.

9. Management of plant protein production is of very essential importance from the perspective of the security of the food supply in Finland. In particular, attention must be paid to the food supply for monogastric (single-stomached) animals – pigs and chickens. It is currently 80% dependent on imported protein fodder. There must be a conscious concentration on developing protein sources that suit northern conditions. Economically viable means of separating the protein-richer parts of biomasses (e.g. grain) and using them for protein production must be sought. Combined production of protein and bio-ethanol is a good example of this.

10. Competence in new biotechnology as the ability to read organisms' genomes from DNA is increasing at a speed that can be compared to the pace of development of information technology in the past three decades. Inter-species transfer of genes can also be done in an increasingly trustful way.

- It is important to be prepared for a situation in which competence in new biotechnology in 2030 will be on a completely different level than what it was in 2009. For example, it may be possible in 2030 to manufacture inexpensive artificial meat from animal stem cells in a solution of nutrients.
- Opportunities of the new biotechnology in plant production must be assessed and the significance of genetic engineering in non-food production, fodder production and foodstuffs production must be clarified.

11. The global challenges of climate change, the world food supply and protecting biodiversity are dealt in international cooperation. It is important that Finland is actively exercising influence in international negotiations and participating in intergovernmental agreements through the EU or within the frameworks of various international organisations. However, it is increasingly important that globally-operating companies behave responsibly and that each and every Finn understands that he or she bears a share of the responsibility for solving global problems.

12. Finland's nature offers major opportunities in the forms of both biomaterials and unique environments. The Finnish bio-sector in the future must be one of high competence. It should have an international orientation and enthuse talented young people. Many futures researchers have anticipated that the information society will be followed by the bio-society. Let Finland be in the vanguard of responsibly and sustainably bringing it into being!

Table: Finnish bioproduction's key strengths, weaknesses, threats and opportunities.

STRENGTHS	OPPORTUNITIES
Sustainably managed forest resources that are strong in their wood material and are increasing by about 100 million cubic metres a year. Forest road network. Diverse and interesting nature. Sustainable water economy and water-related competence. Finland is one of the few countries in the world where availability of freshwater does not constitute a key constraint on bioproduction. A high level of know-how in chemical processing of wood; in manufacturing and maintaining machinery and equipment; as well as in research methods and and expertise in relation to the world's forest resources and forest markets. A competent foodstuffs economy and especially good expertise in some sectors (such as milk and meat production) A well-functioning society and administration, the honesty of officials can be relied on.	Utilisation in a global framework of the world's best forest- and wood-related know-how: advisory services, competence in conducting inventories, reliable evaluation of carbon sinks, special packagings and papers, microbiological utilisation of the most valuable components of wood, nano and gene technology applications. Utilisation of entire forest growth increment and new growth methods: • Making building with wood a national forte, development of standards and regulations that favour building with wood. • Wood- and peat-based biofuels. • Cogeneration of electricity and heat using bioenergy. • Forest management based on constant growth and excessively dense stands of trees. Purity and sustainability as the foundations of the Finnish bio-brand and marketing: • Cultivation on nature's terms, organic large-scale production. • Livestock raising in a country with good water resources and supply. • Water farming in reliction or coastal grassland areas. Multiple use of forests, tourism and recreation. • Sustainable exploitation of fish stocks in inland water bodies and the sea, biodiesel from fish.

WEAKNESSES	THREATS
Settlement that is sparse, although it still covers the whole country, and long distances, natural annual growth of trees slow.	Dwindling demand for Finnish paper and pulp as European demand declines and eucalyptus replaces other fibre materials.
Lack of venture capital for small companies, ideas, boldness and competence, funding provided by Tekes (the Finnish Funding Agency for Technology and Innovation) is not an incentive to enterprise.	Increasing natural catastrophes: storms, deluges, floods, new diseases and destructive insects.
Wood procurement excessively controlled by fibre-producing big companies.	Taking care of natural resources becomes unprofitable. Forest renewal and precommercial thinning are neglected.
Competence in relation to wood products weak on all levels and actors in the sector are poorly networked.	Management to increase forest growth can become detrimental if in emission quotas the tree growth for a particular year is taken for emission reductions demanded.
Lack of appreciation for natural production and a low level of competence in the absence of training and research.	Excessively stringent energy and fire regulations become an impediment to building with wood.
Large retail chains' purchasing policy, local bioproduction is not included sufficiently in range sold.	Spread of a genetically engineered algae or plant species into the environment.

Finnish biopolicy in an international environment

In its biopolicy Finland must not be limited only to activities taking place within the borders of our own country. The Committee for the Future emphasises the challenges to Finnish activities that are coming from especially the world's tropical and sub-tropical regions. Oversight of Finland's national interests and our national biopolicy must be carried out in a linkage with the challenges of sustainable development in these regions. In practice, biopolicy in a global environment can be implemented in many ways: as EU climate policy, as development cooperation policy, as foreign trade policy, by influencing the ethical operating principles according to which partly state-owned companies are managed, and so on.

Development towards the vision will be promoted by especially favouring and increasing the efficiency of small-scale cultivation based essentially on numerous mutually complementary plant species and human labour in tropical and sub-tropical regions. Especially with preservation of species diversity in mind, protecting rain forests is an essential objective associated with this policy.

Cultivation that ensures a local food supply and provides employment, but is much more efficient compared with current practices can solve the enormous social problems associated with populations that would concentrate in the slums of large cities in developing countries. Employment-generating cultivation must be supported with all of the means that science and technology and especially new biotechnology offer. Nor should the possibilities that rapidly developing genetic engineering offers be left unused in this.

It is not desirable for land in tropical and sub-tropical regions to be used to a substantially greater degree than at present to cultivate food plants in large monoculture expanses. Although these forms of cultivation can increase crops, using land in this way can eliminate the prerequisites for more efficient small-scale farming. Genetically modified varieties resistant to the herbicide glyphosate must not be favoured, especially in those cases where their cultivation leads directly or indirectly to destruction of rainforests and rural populations migrating to cities.

Tree plantations are likewise a threat to the small-scale cultivation that is aspired to. Something that must be especially taken into consideration in how growing eucalyptus and other tropical trees is viewed is, in addition to combating climate change, the way that solutions will affect employment in Finland. Eucalyptus plantations threaten employment in Finland by weakening the position of Finnish wood and especially birch as a raw material for pulp. On the other hand, it is important that Finnish companies providing employment in the global forest sector remain competitive. To prevent the competitiveness of the forest industry of Finnish origin and of the Finnish manufacturers of the machines and equipment that the forest sector needs from being jeopardised, it is acceptable for eucalyptus plantations and the pulp combinates associated with them to be increased, provided the following conditions are locally in force:

- - It can be convincingly demonstrated that the plantations can substantially increase the amount of carbon dioxide and other greenhouse gases that are removed from the atmosphere and stored.
- - The plantations do not directly or indirectly threaten existing rain forests or areas that are to be allowed to return to rain forest.
- - The plantations do not endanger key resources in the area, i.e. the supply of water or nutrients, or else those affected by the reduction in supply receive fair compensation.
- - The plantations and the industrial operations based on them provide extra employment for poor local people or at least do not reduce the poor people's level of employment so that a moderate standard of living is jeopardised.
- - The plantations and the industrial operations based on them do not, through the large subsidies and tax concessions they receive, promote unhealthy competition between countries in the support they give companies.

The demands set are more easily achievable by cultivating tropical pines than with eucalyptus. Tropical pines store carbon during their growth period for longer than eucalyptus. Wood products made from tropical pines also bind carbon more permanently than those made from eucalyptus. Their contribution to local employment is likewise greater than is the case with eucalyptus. Markets for wood products are also more local than those for fibre-based products and thus do not threaten the competitiveness of production in Finland to the same extent as eucalyptus does.

The threat of rain forests being cleared must be reduced through economic incentives which support employment for and the livelihoods of people in the threatened rain forest area. An especially good method is one in which, with the consent of those who own the rain forests, those who exploit them are paid to continue using them in accordance with principles of sustainable development and protect them from illegal logging.

Livestock raising on large areas of land has both its good and its bad sides. When done in a traditional way, it does not consume large amounts of natural resources. It also employs more people in tropical regions than growing soybeans or maize on extensive unploughed areas that are sprayed with the herbicide glyphosate. The very large areas of land that livestock raising in the tropics, and especially Brazil, demands are a problem. With world food production threatened in the next few decades and combating climate change demanding significant production of biofuels, increasing attention will have to be paid to growing consumption of meat in the world. From the perspective of combating climate change, the methane emissions caused by livestock raising are a major problem. Meat production should at least take place to an increasing extent in places where the natural prerequisites for it are, thanks to ample availability of water and pastures that grow well, good. Finland is one of the countries where, as climate change advances, the future would appear to offer especially good conditions for livestock raising.

In order for biofuels to be able to become globally an important means of combating climate change, their production would have to be made very considerably more efficient. In tropical and sub-tropical regions, the most promising raw materials for liquid biofuels with a perspective up to the year 2030 would appear to be algae, sugarcane and the jatropha plant.

Algae have long been studied as a source of diesel, especially in the USA. In principle, the area of a basin in which the algae needed to produce a tonne of oil grow is about a tenth or even a hundredth of the area that oil palms need to produce the same amount of oil. There are still a lot of technical difficulties associated with using algae as a source of bio-oil, but rapidly advancing biotechnology provides grounds to believe that success will be achieved by 2030. A special advantage of algae is that they can be grown also in saline water. Especially genetically modified algae could be a superior source of biofuels in the future. They could also develop into a decisively important way of capturing carbon dioxide when coal is burned. However, associated with an alga that proliferates efficiently in saline water is the major risk of its managing to proliferate uncontrolledly in the seas. An efficiently proliferating alga could affect the world's ecosystems in a way that would be very difficult to redress.

Sugarcane is a highly polyploidy plant, meaning that the ten chromosomes in its genome appear in the plant copies five or even fourteen times. It is extremely difficult to develop a plant of this kind using traditional cross-breeding methods. Thus it is not surprising that in recent years it is just this plant that it has been possible to develop especially much using gene transfers. A general assessment presented is that with genetically modified sugarcane it has been possible to double the ethanol yield in 15 years. The jatropha bush, which thrives in arid regions and produces bio-oil, can be made more productive by means of gene modification.

Any bio-fuels that are produced in Finland in 2030 will probably compete with especially the above-mentioned ones produced in tropical and sub-tropical regions. One core question of Finnish biopolicy is whether Finnish sources of biofuels can be developed into alternatives that compete on an equal footing with these fuels. Of decisive importance from the perspective of competitiveness is how the cellulose and lignin that plants and especially trees contain can be converted into fuels in a way that makes economic sense. This must

be striven for using all of the means that science offers, also promoting the use in Finland of genetic modification for this purpose.

An image of purity is strongly associated with Finnish bioproduction in the world. It is advisable to use this perception in the near future when Finnish bioproduction is being developed. It is likewise an good idea to take promotion of organic cultivation as one of the key objectives of Finnish national biopolicy.

Suspicions that the hereditary material in genetically moderated food plants will spread to plants cultivated by conventional means and especially to organically grown ones will have to be rebutted over the next few years. However, it is important that a high level of competence in new plant biotechnology is retained in Finland. Finnish bioproduction must also be in accordance with sustainable development based on scientific knowledge rather than just mental pictures. For example, we shall have to be prepared for a situation where already in the 2020s it is possible to do genetic modification very precisely so that the change in the DNA chain is made in precisely the intended place in the genome. That way, it will be possible by means of genetic modification to copy exactly what happens when plants cross-breed.

At the latest around 2030, but possibly already a lot earlier, there will be a need for a thorough assessment of what new lines must be staked out for sophisticated biotechnology and gene technology in Finnish bio-policy. It is possible that developing biotechnology will make gene technology such an ”everyday matter” that developing plant species by means of genetic modification to give them a better ability to cope with diseases, drought, salinity and low availability of nutrients will no longer arouse more suspicions than does striving for the same goals with today’s cross breeding-based methods. For safety reasons, it would be advisable to adopt gene technology in biofuels production first, then in the production of fodders that are not used as human food and only in the final stage on an extensive scale to produce foodstuffs that people eat.

Helsinki, 5 February 2010

The following participated in the Committee’s deliberation of the matter:
Chair Marja Tiura /National Coalition
Deputy Chair Jyrki Kasvi /Greens
members: Mikko Alatalo /Finnish Centre
Marko Asell /Social Democrats
Harri Jaskari / National Coalition
Kyösti Karjula / Finnish Centre
Miapetra Kumpula-Natri / Social Democrats
Jouko Laxell / National Coalition
Päivi Lipponen / Social Democrats
Marjo Matikainen-Kallström / National Coalition
Mats Nylund /Swedish People’s Party
Sirpa Paatero / Social Democrats
Lyly Rajala / National Coalition
Kimmo Tiilikainen / Finnish Centre
Pertti Virtanen /True Finns
Jyrki Yrttiaho /Left Alliance

Global scenarios for bioproduction and management of climate change

10 Challenges facing and perspectives on Finnish biopolicy[1]

10.1 What is meant by "futures map" for Finnish biopolicy?

A key objective of this evaluation report has been to open a view on the opportunities for and threats to Finnish biopolicy in a global operating environment. The report examines factors that centrally influence the future of the global biosector, i.e. drivers of the future. Some of them are very difficult to influence through Finnish actions. However, the overwhelming majority of the drivers of the future are of such a nature that Finland and the Finns are playing a role in influencing their development. Although the Finns cannot on their own decisively influence these factors, it is very important that they are making our own contribution to promoting their positive development. Since also the Finns will be affected by the solutions that are found to humankind's serious problems, the Finns' actions cannot be limited to measures that affect only our country's internal development.

In some respects, the downplaying of the Finns' responsibility is especially distorting. This applies in particular to exercising influence in the global forest sector. Forest companies with Finnish backgrounds have made major investments in Brazil, Uruguay and China in the past ten years. They have even been among the biggest landowners in Uruguay since Stora-Enso's most recent acquisitions there. Stora-Enso is also an important land-user in Brazil. That country's vast and sparsely populated land area and its especially large freshwater resources give it a very important position in safeguarding a food supply for the world population of the future. For the same reasons and because of the Amazon rain forest, Brazil also has a singularly important role in efforts to mitigate climate change with the aid of vegetation and especially forests.

It is important that the Finns have a shared view of what matters when they are acting in the global biosector. Five key objectives for the Finns' actions in the biosector outside Finland's borders were recognised in Chapter 1 of the report:

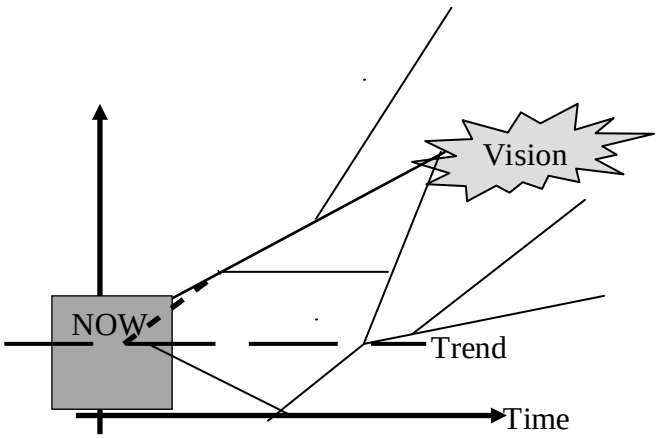
- Acceptability of the policy from a local point of view
- Impacts of the policy on climate change
- Impacts of the policy on the world's food security

1 This chapter is written by Osmo Kuusi

- Impacts of the policy on biodiversity
- How the policy promotes Finland's national special interests and especially the employment of Finns.

A shared view or vision of what should be achieved when Finns operate in the global bio-sector can be established by weighting and analysing these objectives and the routes along which progress in the desired directions can be made. A futures map is needed for this. The key elements of this map are illustrated in Diagram 10.1 (viz. Kamppinen et al. 2002).

Diagram 10.1. Scenario pathways and vision on the futures map



The pathways along which to advance from the present situation towards the vision are outlined on the futures map. The lines in the diagram indicate special paths that lead in the direction of the vision or past it. The term that futures researchers use for the pathways is "scenario".

"Scenario" was originally a term used in the film industry. In its original meaning it refers to the director's copy of the movie manuscript. The concept established itself in futures research from the late 1960s onwards. Herman Kahn and Anthony Wiener were among the first to use it. According to their definition (Kahn – Wiener 1967 p. 6):

> Scenarios are hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision-points. They answer two kinds of questions: (1) precisely how might some hypothetical situation come about, step by step? and (2) what alternatives exist, for each actor, at each step, for preventing, diverting, or facilitating the process?

Kahn's and Wiener's characterisation is a fairly good description of how futures researchers nowadays use scenarios. Indeed, it can even be regarded as more successful than most of the more detailed definitions formulated after it.

The scenarios help decision makers in their choices of route towards the vision. The following of a scenario path that seems to go towards the vision is a reasonable choice in the near future. However, the following of this path is often not a possible or reasonable choice in

the more distant future. In the diagram, when one has followed the road map of the scenario to the end of the dotted line, the world is no longer the same as in the ”now” situation. For example, obstacles that hinder the following of the scenario path have appeared. There are often also reasons for changing the place of the vision based on unanticipated developments.

Advancing towards the future in this complex world can be compared to sailing on a stormy sea. If one is only able to follow the wind, one has to accept the trend or the “business as usual” scenario, even if it does not lead towards the vision. Even if one actively strives towards the vision, the “winds of development” or megatrends can take one in a direction that is very far from the vision aspired to. In order to be even to some extent prepared for such situations, it is also important to include in the futures map scenario paths that do not go towards the vision.

The four greenhouse gas emission scenarios published by the Government of Finland in 2009 are an example of the futures map where all discussed scenarios reach the vision (Government future report 2009). The vision was that the Finnish greenhouse gas emissions in 2050 will be no more than 20% of the 2009 level. According to the vision, the whole world is also committed through national programmes to ensuring that the average global temperature does not increase by more than 2°C by 2050.

The basic features of the four scenarios were characterised in the following futures table.

The Government’s scenarios certainly well highlight the choices that will have to be made with respect to consumption behaviour, energy production, as well as the regional placement of production and housing in order to meet the national objective. However, they are of rather little assistance in a situation in which the world has strayed or drifted far from the paths leading in the direction of the global vision.

The mitigation of the climate change presupposes worldwide cooperation. Even if we assume that the conclusions of the report of the Intergovernmental Panel on Climate Change (IPCC) are valid (IPCC 2007) it might take long time before the key actors of the world are ready to accept them. This conclusion is clear based on Copenhagen and Cancun summits in 2010.

In particular the realistic scenario has to take into account the risk of “carbon leakage”. Any scenario has to indicate how detrimental leakages are to be avoided. One possible story can be based on severe sanctions for the leakers. However, if carbon leakages are economically and socially very advantageous for the leakers, it is unlikely that sanctions will easily be agreed to and at least they will be circumvented in many ways. Other possible stories might be based especially on changing technologies, lifestyles or socio-economic institutions.

Table 10.1. The Government's scenarios (Government future report 2009)

	A. Efficiency revolution	B. Sustainable everyday kilometre	C. Better on own resources	D. Technology decides
guiding principle	eco-efficiency	local services	self-sufficiency	industrial Finland
business structure	services-preponderance clearly increased	services-preponderance increased	services-preponderance slightly increased	similar to present
community structure	concentrated	highly concentrated	dispersed	dispersed in urban regions
passenger traffic performance	declined	declined clearly	at present level	grown
final consumption of energy	halved	declined by 1/4	declined by 1/3	at present level
share of renewable energy	1/1	2/3	4/5	3/5
use of nuclear power	ended	grown	declined	grown clearly

Whatever the case, technological, institutional and attitudinal change must be global. At least change must happen in the countries that account for the vast bulk of emissions. Change also needs to happen in countries that currently produce few emissions relative to their population. Namely, large carbon leakages to them could negate the efforts of those who act responsibly. From the global perspective, it is also fairly questionable if the pioneers take care of their carbon emission cuts in a way that they cannot recommend to other countries. This applies in particular to substantially increasing nuclear power capacity, i.e. the Finnish Government's fourth scenario. If developing countries were to begin building a nuclear power capacity along the lines of the scenario, it is quite probable that a nuclear disaster would take place somewhere. This seems even more reasonable after the 2011 catastrophe in Japan. In addition to carelessness concerning earthquakes and tsunamis, e.g. terror attacks could pose serious threats in the future.

The aim in the futures map in the report is to look at the future possibilities for Finnish biopolicy more broadly than the Finnish Government's vision and scenario pathways. In particular two sets of material have served as the points of departure in drawing the map. One is based on interviews with 26 of the members of the Finnish parliament. Interviews are used to outline Finland's national vision for action in the global biosector. In fact, this report contains two visions based on this material. One is the vision, derived directly from the interviews, for which the author of this chapter is responsible. The other is contained in the statement of position in the beginning of the report by the Committee for the Future. The results of the interviews were used as one starting point also in drafting this vision.

The vision derived from the interviews defines a preferred area in the futures map for the Finnish biopolicy. The map is given by four scenarios of global development. The scenarios have been built by updating those outlined in the UN Millennium Ecosystem Assessment (Carpenter et al. 2005).

10.2 Central objectives when operating in the global biosector

Osmo Kuusi conducted the interviews underlying the national biopolicy vision in the autumn of 2009. The interviews took about one hour each and comprised the following parts:

- Key objectives for Finnish biopolicy when operating in a global environment
- Land-use solutions in tropical and subtropical regions and especially in Brazil and Uruguay in 2030
- Plant cultivation and breeding in 2030
- SWOT analysis for national biopolicy 2030+, adapting to and influencing the development of the global operating environment.

The basic group of interviewees comprised the MPs of the steering group for the Forests-Food-Water project, who were appointed by the various Eduskunta committees when the project was getting under way in the autumn of 2007. All of them were offered the opportunity to be interviewed and 20 of the 24 accepted. The group of interviewees was supplemented with six representatives from different parties to ensure that the composition of the group corresponded well to the relative strengths of the various parliamentary parties.

Table 10.2. Representatives interviewed for the vision by party affiliation

Centre Party	7
National Coalition	5
Social Democrats	6
Left Alliance	2
Greens	2
Swedish People's Party	2
Christian Democrats	1
True Finns	1

The Representatives interviewed were, in alphabetical order, Marko Asell, Tarja Filatov, Harri Jaskari, Pekka Haavisto, Toini Kankaanniemi, Anne Kalmari, Matti Kangas, Kyösti Karjula, Jyrki Kasvi, Timo Kaunisto, Anneli Kiljunen, Jouko Laxell, Juha Mieto, Mats Nylund, Lauri Oinonen, Sirpa Paatero, Petri Pihlajaniemi, Kari Rajamäki, Jouko Skinnari, Kimmo Tiilikainen, Marja Tiura, Pentti Tiusanen, Pekka Vilkuna, Anne-Mari Virolainen, Pertti Virtanen and Ulla-Maj Wideroos.

A lot of the MPs came from the Committee for the Future, as well as from the Agriculture and Forestry Committee of the Eduskunta. The interviewees evidently adopted stances based on their personal view rather than on their party's line. In some cases, MPs from the same party in terms of their evaluations were even the furthest from each other among the entire group of respondents.

The Argument Delphi technique (Kuusi 1999) was loosely used in the interviews. MPs' numerical judgements were put to the test of anonymous arguments obtained from other MPs. The numerical judgments of other participants were not revealed during the interviews. Judging by the wide variance in responses, the arguments of other interviewees did not orient views too much in the same direction. Honest opinions were sought also through promises that the replies to the questions will be handled confidentially and that the results will be presented only as applying to groups of at least three persons.

The interviewees first evaluated how Finland in its international activities should emphasise five key objectives of global biopolicy. The interviewees were asked to divide 100 points of importance between the key future challenges recognised in the anticipation project (Table 1).

Before answering, the roles of different policies were discussed. The development cooperation policy is inclined to improve the living conditions of disadvantaged populations in the target countries. Recently also the challenges of climate policy and biodiversity are stressed. The development of climate policy proper has taken place mainly under the leadership of the EU and largely separate from development cooperation policy. Export promotion, on the other hand, has often been carried out almost entirely from the perspective of Finland's national benefit, i.e., putting it simply, with the employment of the Finns in mind. The role of different policies was concretised by referring to recent activities of Finns in Brazil and Uruguay. Especially the activities of forest companies with Finnish backgrounds were discussed.

Table 10.3. Key objectives of biopolicy to be implemented by Finland in a global environment up to the year 2030, dividing 100 importance points between five objectives.

	Evaluations			
	Average	Median	Range	Variance as deviations from the two most-supported adjoining categories
1. Acceptability of actions by Finns or companies with Finnish backgrounds from a local, e.g. Brazilian, point of view	15.6	15	5-60	12%
2. Mitigation of climate change	24.45	22.5	10-50	33%
3. Effects on world food supply	20.00	20	10-40	31%
4. Protection of biodiversity	17.30	15	5-50	12%
5. Advantageousness from perspective of Finland's special interests (inter alia Finnish employment)	22.65	20	0-65	50%

For the purpose of evaluating the variance, the responses have been placed in the categories 0, 5-10, 15-20, 25-30, 35-40, 45-50, and over 50. The percentage shown reveals the proportion of all respondents who deviate from the two most-supported adjoining categories.

When the criterion used is the average of evaluations, the degrees of emphasis that the interviewees placed on the key objectives of global biopolicy were similar, even surprisingly so. Based on the median responses, mitigation of climate change was the long-term objective considered most important. Immediately on its heels came advantageousness from the perspective of Finland's national interests, i.e. mainly Finnish employment, as well as the world food supply. Actions to protect biodiversity as well as acceptability from a local point of view were interpreted as being less important, but still fairly essential.

Although the evaluations on average did not differ particularly much from each other, there were very large differences between individual respondents. This is revealed by the broad range of the evaluations as well as the even distribution of the responses throughout the scale, especially with respect to emphasising Finland's special national interests, i.e. mainly the objective of employing Finns.

A central explanation for the major differences in the responses were the interviewees' different interpretations of what is the most critical factor when trying to influence five objectives that are linked to each other. To probe the different interpretations, reasons were especially elicited from those heavily emphasising some particular objective. The reasons that were heard are outlined in the following:

Those who especially emphasised local acceptance

- It is essential to find a solution to the problem of the landless and growing urban slums in developing countries through local solutions. Only that way will it also be possible to bring the world's food problems and climate change under control and safeguard Finland's national interests as well.
- Every country's right to decide its own affairs must be stressed. This applies just as much to Brazil as to Finland. Thus, it is crucial to ensure when operating in the international arena that we have the local population's approval. Finland's national interests and those of the local population must be reconciled in such a way that climate change, the world food supply and protection of biodiversity are taken into account as well.

Those who especially stressed mitigating climate change

- Climate change is humankind's greatest shared challenge, one that can be dealt with only through determined international cooperation. Because climate change affects all, it can also become a project that unites humankind. Even from the point of view of Finland's own interests, we should focus on the developing technological and lifestyle-based solutions to climate change.
- Mitigation of climate change and, associated with this, safeguarding biodiversity must be the basic starting point when we act in the international arena. Safeguarding a food supply globally is, in turn, a human right that should not be compromised on, either, in conjunction with this. These objectives must be harmonised with local conditions. Environmental technology and a strong concentration on environmental questions are also over the long term the best national policy. It is important to awaken on the level of the individual a sense of responsibility for solving global environmental and food problems.

- Climate change is the most important challenge. It is essential to place it clearly ahead of short-term emphasis on safeguarding the world food supply, because from the perspective of mitigating climate change, only a part of the poorest are really in a central position: mainly those who are destroying forests. What must be stressed in every country is its own long-term food production and other bioproduction. That way, both the world's food supply will be safeguarded and greenhouse gases captured from the atmosphere.
- By stressing the importance of mitigating climate change, solving a central global problem can be combined with our national long-term interest, especially in the forest sector. It is particularly important to emphasise forest growth and products made from wood as a way of mitigating climate change.
- It must not be accepted that the growth of Finnish forests will cease and they will become no more than a poorly utilised carbon store.
- Mitigating climate change must be combined with supporting the local population and ensuring a supply of food for it. By acting that way, we can also influence one key factor in the background of ecological crises: uncontrolled population growth in developing countries.

Those who especially stressed the world food supply

- The hungry are not motivated to mitigate climate change. Without safeguarding the food supply at the same time, mitigating climate change will easily be perceived in developing countries as just another way of exploiting them.
- The world food supply is becoming seriously endangered, as was stressed at the FAO conference in 2008. Land must be used more efficiently both in the tropics and in Finland. Again, genetic modification must be used to add efficiency to food production. If a lot of additional cropland is cleared, climatic conditions could change and the advance of the greenhouse phenomenon could be more difficult to prevent.
- Cropland now being used for food production must not be diverted to biofuel production. Production of these fuels must be concentrated in areas where it does not compete with food production, and this must be done using inter alia genetic modification.

Those who especially stressed protection of biodiversity

- A fundamental challenge in global biopolicy is to keep the soil fertile. This can be done by avoiding one-sided use of land and promoting diversified cultivation of local varieties. When Finns are operating in the biosector outside our country's borders, they must above all solve major global problems and not strive to obtain special advantages for Finland. Solving global problems will also be to Finland's benefit.
- The most important challenge facing the world now is that of preserving tropical rain forests. They are key maintainers of climatic equilibrium in the world. From the perspective of the global ecological balance, it is very important to preserve the diversity of species in them. It is very difficult to restore a felled rain forest to its original level of species diversity. Mountain rain forests are especially endangered.

- Finland must take responsible world citizenship as its guiding star. Climate change, the world food supply and preserving species diversity are three closely intertwined objectives. Compromising on one will inevitably lead to problems with the others as well.

Those who especially stressed national interests, i.e. mainly safeguarding Finnish employment

- Industrial production in Finland and our exports are in serious crisis. Forest companies and information technology companies operating in Finland are succeeding internationally, but their operations are producing fewer and fewer jobs in Finland. Pulp and paper production are leaving Finland, although the profitability difference between the production in Finland and in tropical countries is only rather marginal. Fortunately, the loss of pulp production is offset to some degree by manufacturing machinery and equipment for the forest sector, as well as exports of services. Employment in Finland should be put at the centre of our policy also when Finns operate in Brazil and other tropical and subtropical regions.
- Industrial production in Finland is in a crisis the depth of which is not yet fully comprehended. Although large companies with Finnish backgrounds are cutting jobs in Finland, a dichotomy between them and Finnish society should not be created. If we keep our level of competence good, especially in our key sectors, Finns will find jobs also in the future. Manufacturing machinery and equipment associated with the forest industry as well as services relating to management, advisory services and maintenance can be preserved in our country even if pulp and paper manufacturing declines here. There must also be an active search for new successful products both in the forest sector and elsewhere.
- Finland should not act naively in mitigating climate change. The large EU countries act completely inconsistently in this respect. For example, in Germany, the use of brown coal as a source of energy is still being subsidised. China and Sweden are acquiring land areas in developing countries to safeguard their national interest in the biosector.
- If other countries do not actively set about mitigating climate change, there is no point in Finland doing so.

The different interpretations can be condensed into the following controversial issues:

1. Should there be a special concentration on mitigating climate change so that the world's food supply is safeguarded or, by contrast, should food be ensured for as many people as possible so that they would also become motivated to mitigate climate change?
2. To what extent do the mitigation of climate change and safeguarding the world food supply run in the same direction as objectives? Should the first priority groups for food supply be those who are most critical from the perspective of mitigation of climate change (e.g. poor people living near rain forests)?
3. Is it most important to safeguard especially essential ecosystems like rain forests?
4. Is it especially important to let locals decide how to use their own bio-resources?
5. Are the Finnish economy and the welfare society in such a crisis that the Finns' employment and livelihood must be taken care of first?

10.3 How should land be used in the world's tropical and subtropical regions?

The interviewees were asked how they preferred different uses of land in the world's tropical and subtropical regions up to 2030. After this, they were asked to evaluate on a scale of 0-10 how forcefully development should be promoted in the direction they wanted. A zero on the scale meant that promotion did not matter and a 10 that it should be very forceful. Once again, special attention was paid to the arguments presented in support of views, particularly in the cases of those who presented unusually exceptional views.

The interviewees' preferences concerning land use are presented in two tables. One table describes preferences concerning agribusiness, small-scale farming and forest conservation. The other table examines the most promising production methods of biofuels in tropical and subtropical regions up to 2030. The importance points for supporters of any land use have been presented as positives and those of opponents as negatives.

Questions 1-4, on the one hand, and question 5, on the other, were intended to elicit the interviewees' evaluations of the tension between the agribusiness and the small-scale farming that employs people and currently provides a meagre livelihood to them. With the exception of one interviewee, the respondents came out in support of small-scale cultivation. As a general rule, the attitude was very positive, as the median value 8 reveals. There was no systematic difference between the parties concerning this issue. The few stances that deviated from the others can be interpreted as representing individual views.

Agribusiness based agriculture is a main reason for rapidly growing cities and their slums in developing countries. This is a very questionable development trend because the megacities of the developing countries will hardly be able to provide enough reasonable work for an immigrating rural population. Social problems will become increasing more serious in the metropolitan slums even if the agribusiness improves the efficiency of food production.

Many MPs stressed the need to increase the efficiency of small-scale garden-type cultivation. Some mentioned that genetic engineering might improve the efficiency of small-scale production. The interviewer referred to the Green Revolution of the 1960s and 1970s, which saved India from famine. Many MPs shared the views of M. S. Swaminathan, who has been called "the father of the Green Revolution in India". He has suggested that famine in India can now be avoided only by combining small scale agriculture with the possibilities of new biotechnology. The ideas of this old Gandhian plant breeder and the work of the agricultural research foundation that he heads will be discussed in more detail in subchapter 11.6 and in the updated UN Millennium scenarios. An interviewee stressed that the advantages of large-scale production can be achieved with small-scale farming, if small farmers are able to combine their efforts. A possibility mentioned was a major public or private buyer of small farmers' products that also promotes advanced cultivation methods. Certificates for socially responsible production also provide a way of promoting demand for small farmers' products.

Table 10.4. Evaluations of plantation cultivation (agribusiness), small-scale farming and forest conservation with a perspective up to 2030

	Evaluations			
	Average	Median	Range	Variance as deviations from the three most-supported categories
1. Eucalyptus plantations	-5.1	-5	2 – (-10)	17%
2. Pine plantations	1.4	4	9 – (-7)	35%
3. Large-scale and heavily mechanised monoculture cultivation of food plants (e.g. soybeans)	-1.1	-3	8 – (-10)	35%
4. Plantations for raising meat livestock	-0.6	-1	8 – (-10)	52%
5. Small-scale cultivation based essentially on many mutually complementary plant species and human labour	7.7	8	10 – (-1)	4%
6. Paying compensation to the local population for protecting forests and especially rain forests (e.g. REDD+ projects)	7.8	8	10 - 5	0%

To facilitate calculation of the variance, the responses are grouped into the categories 10–8, 7-5, 4-2, 1- (-1), -2 - (-4), -5- (-7) and -8 – (-10). The percentage figure reveals the share of all respondents who deviated from the three most-supported categories.

A few interviewees were, however, of the opinion that it might be difficult to make small-scale cultivation more efficient. This was stressed in particular by a respondent who evaluated increasing small-scale cultivation as a slightly negative course of development. In his view, stepping up the efficiency of agribusiness cultivation is a better solution.

Of the various forms of agribusiness, the attitude adopted towards eucalyptus plantations was on average the most negative. Only two interviewees suggested that having more of these would be a slightly positive development. The reasons presented in support of a negative view of eucalyptus plantations were the fact that they compete with small-scale cultivation, the large amount of increasingly scarce water resources that eucalyptus uses, as well as competition with Nordic birch as a raw material for pulp. However, eucalyptus trees are highly effective sinks of CO2. Another advantage of eucalyptus plantations mentioned was the employment in Finland based on exported harvesting machines, as well as new equipment for pulp and paper mills.

The interviewees adopted a clearly more positive attitude to pine plantations than to eucalyptus ones. Both the average value for the replies and their median were slightly in favour of more pine plantations. The views were, however, more scattered than in the case of eucalyptus. There were no clear differences between the political parties in the average stances. By contrast, differences between stances within parties were fairly substantial.

The main argument of those who were ready to accept pine plantations was that pine products are more permanent stores of carbon than products using eucalyptus. It was also considered that the position of the Finnish birch pulp improves if land is used more for pine plantations and less for eucalyptus plantations. The critics stressed the general problems

of the agribusiness, too. Some were also of the opinion that Finnish pulp production would not by any means be saved by a changeover from growing eucalyptus towards growing more pine. They considered that Finnish birch has permanently lost its competitiveness as a raw material for pulp. That was assessed as being the case especially because the use of paper is constantly dwindling due to new information technology and the Internet. Although the markets for pine are more local than the markets for eucalyptus pulp, there exists in any case, however, some competition between tropical pine and Finnish wood products.

Agribusiness in food production was examined with special reference to large soybean and maize plantations. They are typically based on glyphosate resistant GM plants in Brazil and elsewhere in the tropical and subtropical regions. The attitude to agribusiness producing food plants divided opinions rather a lot, although the majority took at least a slightly negative attitude towards it. The main reason for a negative assessment was the adverse effects of the agribusiness on small-scale agriculture. Besides the questionable migration of rural populations to urban slums, unemployed small farmers have been used in the destruction of rain forests by the big cattle breeders. The argument presented in favour of a permissive stance was above all the constantly growing food requirement in the world. Some MPs considered that a more effective food agribusiness is needed for that purpose.

Ranches producing livestock for meat divided opinions almost evenly between supporters and opponents. In Brazil and Uruguay, pasture has been the overwhelmingly the most important use of agricultural land. Those most critical of livestock raising strongly emphasised the need to limit meat production in the world. Freeing land from meat production, which demands a lot of water and other resources, creates the prerequisites for other bioproduction. Some took the view that in the future Finland, thanks to abundant water resources and pasture with grass that is growing faster as a result of global warming, will enjoy an advantage in livestock raising compared to tropical countries and especially Brazil.

Those adopting the most positive attitude to livestock raising saw livestock raising for meat as a traditional and established form of production in South America that does not consume a lot of natural resources. However, some of those who adopted a positive attitude were of the opinion that also making meat livestock production in South America more efficient would be a positive development from the perspective of the world food situation.

The destruction of rain forests and converting of land for cultivation is an ongoing process in Latin America, Indonesia and Africa, despite many promises to the contrary. To stop it, one way would be to pay compensation to the countries and population groups involved. The interviewees were nearly unanimous in regarding the launch of a conservation programme of this kind.

We are able to compare the judgments of the MPs with the real situation two years after the interviews. Concerning the mitigation of climate change, reducing emissions from deforestation is the issue where the global community has been most active. This conclusion is evident based on the 2010 United Nations Climate Change Conference in Cancún, Mexico, from 29 November to 10 December 2010.

The Cancun agreement set different duties for the developing countries and the developed countries in terms of global forest policy. It encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities:

a. Reducing emissions from deforestation;
b. Reducing emissions from forest degradation;
c. Conservation of forest carbon stocks;
d. Sustainable management of forest;
e. Enhancement of forest carbon stocks.

The agreement requested developing country Parties aiming to undertake activities referred to above, in the context of the provision of adequate and predictable support, including financial resources and technical and technological support to developing country Parties, in accordance with national circumstances and respective capabilities, to develop the following elements:

a. A national strategy or action plan;
b. A national forest reference emission level and/or forest reference level 6 or, if appropriate, as an interim measure, subnational forest reference emission levels and/or forest reference levels, in accordance with national circumstances;
c. A robust and transparent national forest monitoring system for the monitoring and reporting of the activities referred to in paragraph 70 above, with, if appropriate, subnational monitoring and reporting as an interim measure, in accordance with national circumstances,
d. A system for providing information on how the safeguards referred to in annex I to this decision are being addressed and respected throughout the implementation of the activities referred to in paragraph 70, while respecting sovereignty.

The Cancun meeting resulted in the collective commitment of the developed country Parties to take more seriously into account the climate change impacts of their own forests. Besides that, the developed countries reached a collective commitment concerning the resources given to developing countries for forestry and investments through international institutions. It was decided that the allocated resources in the period 2010 – 2012 would be USD 30 billion, with a balanced allocation between adaptation to the climate change and its mitigation. Funding for adaptation will be prioritised for the most vulnerable developing countries, e.g. small island developing States and Africa.

In the longer term, the developed countries accepted a goal of mobilizing jointly USD 100 billion per year by 2020 to address the needs of developing countries. The Cancun summit decided to establish the Green Climate Fund, to be designated as an operating entity of the financial management of allocated resources. The Fund shall be governed by a board of 24 members comprising an equal number of members from developing and developed country Parties. Representation from developing country Parties shall include representatives from relevant United Nations regional groupings and representatives from small island developing States and the least developed countries.

The practical programme for reducing emissions from deforestation and conservation of forest carbon stocks has been the REDD+ programme. (Reducing Emissions from Deforestation and forest Degradation in developing countries). The programme was launched in

September 2008 to assist developing countries to prepare and implement national REDD+ strategies. REDD programmes in different countries have received both governmental and voluntary contributions. In practice, the truly allocated resources have still been very limited – millions instead of billions of dollars - with one exception. Norway has promised $1 billion for the REDD process in Indonesia. In March 2011, the Indonesian Congress sent a delegation to Norway to clarify several clauses in the Letter of Intent outlining the terms for receiving the money.

The obstacles of the practical implementation of REDD programmes are not easy to overcome. The Ministry of Forestry of Indonesia has estimated that the state has lost a total of US$17.54 billion as a result of the companies illegally destroying the forest in just one province of Indonesia. Taking into account the big economic interests connected with forest areas, it is not surprising that Brazil has not been ready to accept any safeguards that risk its national sovereignty in the REDD related discussions. Perhaps the most difficult problem is the threat to forests posed by fire. The success of reductions in carbon emissions by avoiding deforestation depends on harmonising REDD with policies to limit fire incidence not only in the Brazilian Amazon, but also in other rainforest nations in South America, Africa and Asia.

In order to proceed in the REDD process one has to accept the economic realities of those countries that have benefited from the deforestation – and also from forest fires. The comment by Hadi Daryanto, secretary-general of the Ministry of Forestry of Indonesia in October 2010 is illustrative:

> There is $10bn coming in from palm oil, $4bn from pulp and paper [in Indonesia], and the people who work in these concessions are many, so we cannot just stop it all or the IMF will collapse us as an economy. So please be wise about this, who will pay for that? Europe and the US have a financial crisis and who is going to help us just for the sake of climate change? Nobody. We were told to democratise and this is the price of democracy. Climate change is the price of democracy. Indonesia is trying to be a good boy, but we can't paint the sky for you.

10.4 Attitudes to various forms of plant breeding

The most controversial issue concerning the global biosector is the use of new biotechnology and especially the use of genetic engineering. This issue resulted in highly scattered judgments from the interviewed Members of Parliament.

The interviewees were first asked to adopt a stance on organic cultivation shielded by safety buffer zones in order to avoid "gene contamination" by GM plants. With three exceptions, the interviewees were positively disposed to protecting organic cultivation with these zones. One who took a dissident view was very vehemently opposed to organic cultivation, seeing it as being founded on anti-scientific arguments. According to another, its efficiency is not adequate. The Prime Minister of Finland in 2009, Matti Vanhanen had suggested that the whole of Finland should be declared a GMO-free area. The interviewees were told that evaluating the importance of organic cultivation shielded by safety buffer zones as 9 or 10 would be construed as supporting Vanhanen's initiative. Based on this cri-

terion about a third of the respondents were of this view. Most supporters of the initiative were from the Centre Party or the Greens.

Second, the future of the present mainstream breeding practice - represented by Boreal Kasvinjalostus Oy in Finland - was evaluated. No one adopted a negative stance on this operational model and the majority of interviewees were very positively disposed towards it. This is revealed by the median value 8 and the narrow range of the responses.

Table 10.5. Plant breeding and development methods with a perspective up to 2030

	Evaluations			
	Average	Median	Range	Variance as deviations from the three most-supported adjacent categories
1. Organic cultivation protected by broad buffer zones or GM-free zones from "gene contamination"	5.5	7	10 – (-10)	18%
2. Use of traditional cross-breeding methods in plant breeding supported by monitoring of DNA transfers and propagating plants by cloning	6.6	8	10 – (3)	0%
3. Few but extensively cultivated plants that have been genetically modified to tolerate crop protection agents (especially glyphosate-tolerant soybeans) or plants that produce their own protection agents (especially Bt cotton)	-0.5	-2	10 – (-9)	45%
4. Many kinds of genetically modified plants produced with the aid of the 2030 level of know-how to have a better tolerance to diseases, drought, salinity and paucity of nutrients	3.9	5	10 – (-8)	23%
5. Genetic modification in cattle feed production	1.7	4	10 – (-10)	48%
6. Genetic modification in production of bioenergy and bio-oils (especially algae, sugarcane, jatropha and northern energy trees (e.g. associated with REDD processes)	3.2	6	10 – (-10)	29%

In calculating the variance the responses have been grouped in the categories 10-8, 7-5, 4-2, 1- (-1), -2 - (-4), -5- (-7) and -8 – (-10). The percentage reveals the share of respondents who deviated from the three most-supported adjacent categories.

The genetic engineering of plants in a perspective up to 2030 was divided into four application classes. The interviewees' attitudes concerning genetic engineering differed considerably. The most fervent opponent rejected all modes of application with an evaluation of at least -6. On the other hand, at least one of the most ardent proponents accorded each form of genetic modification an importance value of 10. The most ardent proponents saw in genetic modification a key solution model in the face of the food crisis threatening the world and climate change. To some opponents, on the other hand, it manifested itself as a major threat to inter alia species' diversity.

The first category of genetic engineering was focused on the applications in extensive use in the United States, South America, India and China. This line of the applications in 2030 promotes monoculture agriculture focusing on the tolerance of weed-control agents (now especially glyphosate) as well as plants' ability to produce chemicals to protect themselves from insect pests (now e.g. *Bt* cotton). The Monsanto Company has long dominated the development and marketing of these genetically modified plants.

Opinions were divided fairly sharply within party groups but rather little between them concerning this first-generation form of genetic engineering. The median respondent of the whole panel was slightly negatively disposed to this form of cultivation. An interviewee representing a strong negative stance considered that the development of resistant populations of insects will be a big problem. This has already been the problem with the existing GM varieties that produce Bt toxin.

The second application class of the genetic engineering was inspired much by the philosophy of "the father of the Green Revolution in India", M. S. Swaminathan. It also took into account the technical advances in gene technology in the perspective of 2030 (e.g. future prospects of zinc finger nucleases). More strict and controlled methods of genetic engineering open opportunities for simplified approval procedures, at least for some GM plants. If a GM plant has only those kinds of features that are in principle achievable without genetic engineering, it is reasonable to make its acceptance radically easier than now. The acceptance would be still easier if the developed GM plant were to be left for free use.

Radically easier approval procedures would make true the vision of Swaminathan that genetic engineering will be used also on only locally promising plant variants and commercially less interesting plants (e.g. sweet potato). In this way, applications can be broadened from resisting weeds, plant diseases and pest insects to making plants better suited to their growth in specific environments. By having a little better ability to cope with drought, salinity and scarcity of various nutrients, plants do not decisively improve their competitiveness relative to other plants. The result is reflected first of all in less use of resources per unit produced.

The interviewees' attitudes to the above kind of genetic engineering in 2030 were fairly positive. The median evaluation for all interviewees was 5. However, a few respondents were very critical towards even these kinds of applications.

Stances on the use of genetic engineering in cattle feed production were split pretty evenly between for and against, but with a slight majority of supporters. Once again, the party

groups were in many cases split internally almost evenly between proponents and opponents.

On average, the MPs accepted the use of genetic engineering in the production of bioenergy was fairly positive, which the median value 6 reveals.

The use of genetic engineering seems to be very essential, if one likes to make economically competitive biofuels using the Finnish biomass (e.g. Finnish wood material). The competition between biofuels made in tropical and subtropical regions will be stiff. One can anticipate severe competition in particular with biofuels produced from algae, sugarcane and the jatropha plant.

The interviewees were asked whether the use of these three promising bio-materials from the tropics is a positive development and how actively their use should be promoted or opposed. The scale used was the same as before.

Table 10.6. Three production techniques for biofuels in tropical and subtropical countries: desirability and need to exert influence.

	Evaluations			
	Average	Median	Range	Variance as deviations from the three most-supported adjacent categories
Development of algae for production of biofuels	0.4	2	7 – (-7)	35%
Cultivation of sugarcane for bio-ethanol production	4.3	5	10 – (-5)	17%
Cultivation of jatropha for biodiesel and possibly animal feeding	5.5	6	8 – (-2)	4%

In calculating the variance the responses have been grouped in the categories 10–8, 7-5, 4-2, 1- (-1), -2 - (-4), -5- (-7) and -8 – (-10). The percentage shown reveals the share of respondents who deviated from the three most-supported adjacent categories.

In the United States, the DOE (U.S. Department of Energy) has made an assessment based on which biofuels made from algae could substitute all oil-based fuels in the USA. However, great promises notwithstanding, there are still a lot of problems associated with growing algae to produce biodiesel. Some of the problems have to do with the technology of growing algae. The risks associated with the uncontrolled spread of algae in saline warm see water are much more serious.

The interviewees accorded approximately equal weight to the vast possibilities and the risks of algae, arriving at a stance that on average slightly supported their use. However, assessments of the possibility of avoiding triggering risks varied greatly. This is revealed by the large variance of responses. However, no one adopted a particularly strong stance for or against algae.

Sugarcane based ethanol production can benefit immensely from gene transfers. Sugarcane is a polyploid plant and it is extremely difficult to develop it with the traditional cross-breeding methods. Other plants belonging to this category include the banana, coffee and garden strawberries. In the pilot projects, using genetically modified varieties of sugarcane it has been possible to produce over 50% more ethanol compared with conventional varieties.

The attitude that the interviewees adopted towards sugarcane as a source of biofuels was generally fairly positive. This is reflected by the evaluation median 5. The groups' median evaluations were within the range 5-7, with the exception of the negative stance adopted by the Green interviewees. They and a few others opposed sugarcane as a future fuel precisely because of genetic engineering. Other reasons for opposing fuel sugarcane were its competition for land use with other varieties, especially those used for food. Competition with Finnish biofuels was also mentioned.

Jatropha is a bush that grows to a height of five metres and has an excellent tolerance towards arid conditions and, for example, saline or alkaline soil. Many experts have regarded jatropha as one of the most promising plants for producing biofuel for use in diesel vehicles, because it makes possible the use of extensive areas of land that are currently producing little. However, studies show that yields from jatropha depend decisively on the sufficient availability of water, although the requirement is fairly moderate compared with many other plants. It has also been accused of competing with small-scale cultivation, especially in arid areas of India. All the interviewees except one had a positive attitude towards increasing jatropha cultivation. The dissident doubted whether biofuels could be produced economically from jatropha.

10.5 Year 2030+ vision and strategic policy lines for the Finns' activities in the biosector outside our country's borders

The following crystallisation into a vision seems to correspond quite well to the interviewed MPs' average view of how the five key objectives should be weighted when the Finns engage in the biosector outside the borders of our country:

> Climate change is the biggest shared challenge to development that humankind will have to face in the period up to 2030. In that period humankind will have to find a common sustainable solution to global warming. The challenge must be responded to in a way that does not lead to a substantial weakening of employment or livelihood in Finland nor to a famine catastrophe in any other country. Protection of species diversity and improving the conditions of people living in developing countries are also important objectives.

The strategy lines adopted by the median respondent in the panel of representatives as progress is made towards the 2030 core vision can be interpreted as being the following:

1. In tropical and subtropical regions, small-scale cultivation based essentially on many mutually complementary plant species and human labour must be specially

favoured. That way, progress will be made towards ensuring food security for the poor in developing countries and the formation of slums in large cities will be prevented. The goal must be promoted by safeguarding the diversity of local plant species. In this, use must be made of rapidly increasing knowledge in bio- and gene technology, including genetic modification. In this way, local varieties will be made better able to cope with diseases, drought, salinity and paucity of nutrients.

2. Genetically modified varieties that are resistant to glyphosate and produce Bt toxin, as well as large-scale plantations based on them in Brazil and other tropical and subtropical regions must be viewed with reservation. Production can be increased using existing genetically modified varieties, but there are major ecological and social risks associated with monoculturisation of cultivation.
3. A critical attitude must be adopted to large-scale eucalyptus plantations based on machine harvesting and abundant use of glyphosate. These plantations use a lot of water in areas where it is scarce and weaken the soil. However, responsibly implemented plantations can be accepted also on the grounds that manufacturing pulp from eucalyptus increases the demand for Finnish products and services. With global sustainable development in mind and from Finland's national perspective, it is problematic that eucalyptus is a substitute for pulpwood from northern forests. Especially considering the need to mitigate climate change, increasing the cultivation of tropical pine is more desirable than increased cultivation of eucalyptus.
4. A growing demand for meat in the world is a big problem because freshwater resources and nutrients are becoming scarcer. By far the bulk of the rapidly increasing amount of soybeans being produced is used for animal fodder. The availability of phosphorus in particular may be a big problem in 2030. The large methane emissions caused by livestock are likewise a problem. If livestock is raised in circumstances where it does not endanger local water resources and is not based on abundant use of supplementary nutrients, it is acceptable.
5. One way of practising agriculture in accordance with sustainable development that suits Finland well is organic farming. However, skill in organic farming must be developed with respect to both cultivation methods and plant breeding, utilising knowledge of plant genomes better than has been done up to now.
6. In the development of biofuels, cellulose and lignin from wood are in principle a very promising source. It may, however, turn out that manufacturing biofuel from wood is still not competitive in 2030. Algae, sugarcane and the jatropha plant which can be developed with the aid of gene-related competence may prove to be better alternatives. However, there are huge environmental risks associated with genetically modifying algae.

11 The UN's Millennium Ecosystem Assessment project's updated scenarios as a futures map[2]

11.1 The original scenarios in the UN's Millennium Ecosystem Assessment project

The Millennium Ecosystem Assessment project (www.millenniumassessment.org) was launched on the initiative of the UN Secretary General in 2001. More than a thousand researchers from all over the world took part in the project, in which the starting points were 34 assessments of development in various parts of the world. The assessment process was made in 2001-2005. Its aims were to evaluate changes taking place in the global ecosystem having impacts on people's well-being, as well as to create a scientific foundation for the conservation and sustainable use of ecosystems (Carpenter et. al. 2005).

As a result of the assessment, four alternative scenarios for the development of the world biosector were formulated. Producing thousands of pages of text, the project can be regarded as one of the most thorough scenario processes ever made. Often, such extensive projects produce quite a banal result, because they try to combine very different views and value bases in a balanced way. In my view, however, the Millennium Ecosystem Assessment scenarios have avoided this trap of massive foresight processes pretty well. Six years after they were completed, the scenarios still open up interesting alternative visions of the future.

It is evident, however, that the scenarios need to be re-interpreted in the light of recent developments. Those who drafted the scenarios either failed to recognise the seriousness of climate change or considered that the global community was not ready for action. This attitude made a lot of sense because President Bush's administration denied the anthropogenic origin of global warming in the early years of the 2000s. The alarming information about melting polar ice caps and the 2007 report by the Intergovernmental Panel on Climate Change (IPCC) changed the general attitudes concerning climate change. Before the global food crisis in 2007, nor was the world food supply interpreted as being a particularly serious problem. In 2008 the global economic crisis began. These new developments require the re-writing of the scenarios.

Having been formulated within the UN framework, the scenarios were also "polite" in all directions. They do not name any country or instance as a main cause of problems. Major controversial issues that create tensions are likewise avoided. Although gene technology is seen in some connections as a promising way to promote the productivity of bioproduction, in many connections this possibility is modestly concealed in general talk about growth in bioproduction productivity. When I update the Millennium Ecosystem Assessment scenarios, I have no use for "polite" talk of that kind.

The methodology used in the Millennium Ecosystem Assessment project deserves to be thoroughly examined. In a plausible way, it combines qualitative methods of scenario writing and quantitative methods of modelling. The methodological solutions made in the scenario process are, however, outlined here with only a few brief references and quotes from the report text. The way that the quantitative and qualitative elements were combined with each other was described as follows in the report (Carpenter et al. 2005 p.149):

2 This chapter is written by Osmo Kuusi

> Two essential activities within the overall scenario development framework were the formulation of alternative scenario storylines and their quantification. These two elements were designed to be mutually reinforcing. The development of scenario storylines facilitates internal consistency of different assumptions and takes into account a broad range of elements and feedback effects that are either difficult to quantify or for which no modelling capability exists, or both. Based on initial storylines, the quantification process helps to provide insights into those processes where sufficient knowledge exists to allow modelling, and to take into account the interactions among the various drivers and services.

The scenarios in the Millennium Ecosystem Assessment project were made with a perspective up to 2050, in which sense they are comparable to previously discussed scenarios outlined by the Finnish Government (Government report on the future 2009). The content cores of the Millennium scenarios took shape by means of an extensive questionnaire survey of the potential users of the research. However, the principal material of basic ideas in the scenarios came from the interviewed key panel. It included 59 leaders of NGOs, scientists, company directors and public sector representatives. Of them, 33% were from the United States, 25% from Europe, 15% from Africa, 12% from South America and 10% from Asia (Carpenter et al. 2005 pp. 123-124). As later noted, the US influence is evident in the evaluations not only in the attitude to climate change, but also in an emphasis on the principles of the so-called Washington Consensus. The report described the significance of the interviews from the perspective of the basic ideas in the scenarios as follows (Carpenter et al. 2005 p.126):

> We identified four clusters of beliefs that embrace most of the fears, hopes, and expectations for the future that were encountered in the interviews and the statements of user needs.
>
> Many leaders felt that the future would bring increased emphasis on national security, leading to greater protection of borders with associated consequences for economic development and changes in direct drivers of ecosystem services. Other respondents felt that the future could, or should, bring greater emphasis on fair, globally accepted economic and environmental policies, as well as greater attention by governments to public goods. Some interviewees pointed to the prospect of technology for managing ecosystem services with greater efficiency. Still others found hope in local adaptive capacity for flexible, innovative management of socio-ecological systems. The future may well involve a mix of these perspectives.

The four policy emphases described above were combined in the scenarios with two drivers of the future: the anticipatory or reactive managing of environmental problems and the extent to which problems are solved through global cooperation. Combining two drivers the following basic solutions for scenario pathways were arrived at (viz. Carpenter et al. 2005 p.227).

Table 11.1. Two key drivers and the basic ideas of the scenarios

	Anticipatory managing of environmental problems	Reactive managing of environmental problems
Solving problems through global cooperation	Focused on environmental technology (TechnoGarden TG) Economic value of good environment is realised. Trust in environmental technologies. Environmental values are priced and standardised locally and globally.	Global Orchestration GO Foci of international cooperation are economic growth and human capital. There is a belief that environmental problems will be solved as they appear, just as long as inputs are made into technological development, education, health care and well-functioning infrastructure.
Solving problems locally	Adapting Mosaic AM Attempts to master global problems, including environmental ones, do not properly succeed. Problems are solved both through local interaction, empowering the local populations and competence and information networks of organizations.	Order from Strength OS Environmental problems are not taken care of, since attention in rich countries is concentrated on questions of national security and safeguarding national interests. Poor countries struggle with basic needs of their population.

Table 11.2. Key features that characterise the four scenarios (Carpenter et al. 2005 p.227)

Name of scenario	Main ways of promoting sustainable development	Operational principles in the economy	Main socio-political focuses	Leading social organisations
Global Orchestration GO	Social sustainability, economic growth, public goods	Fair trade through elimination of customs duties. Global public goods	Promoting health and education globally	Multinational companies, global NGOs
Order from Strength OS	Protected areas and buildings, parks, national conservation solutions	Regional trade blocs, mercantilism	Security	Multinational companies
Adapting Mosaic AM	Regional participatory self-government, ownership with cooperatives	Free trade not expanding substantially. Local regulation of trade, non-commercial activities	Local communities globally linked. Equality locally	Cooperatives, global organisations
TechnoGarden TG	Green technology, eco-efficiency, saleable emission rights	Reduction of customs duties, fairly free mobility of goods, capital and people. Global market for ecological ownerships.	Technical competence esteemed, competitiveness, openness	International expert organisations, global NGOs

The scenario stories are qualified also in the sense that each story has both its good and its bad sides. These are set out in the following table (Carpenter et al. 2005 pp. 230, 239, 245 and 257):

Table 11.3. Advantages and risks of the four scenarios

Name of scenario	Advantages of scenario	Risks associated with scenario
Global Orchestration GO	Prosperity and equality thanks to more efficient world markets Prosperity increases interest in and the opportunity to promote a good environment Global coordination of activities	The world's environmental problems can increase faster than they are solved Increased problems in the biosector affect especially the poor Reactive measures more expensive than anticipatory ones
Order from Strength OS	Increased security in closing-up wealthy countries and countries controlled by them. Not many diseases spreading across borders Preservation of local ecosystems Livelihoods protected from outside competition	Inequality, undernourishment and lack of liberties in poor countries Insecurity created by inequality Deterioration of the environment when poor countries over-use resources and increase emissions Slowing of economic growth when poor countries become poorer and the wealthy ones do not find markets for their products
Adapting Mosaic AM	Effective adaptation through local measures Development of local ecosystems in ways that benefit all local communities Strong national and international networks that are built "from below"	The benefits of global solutions are absent Attention is not paid to inequality Less economic growth, because less international trade Economic growth suffers, because more resources are devoted to bureaucracy
TechnoGarden TG	Benefits for the environment and the economy are effectively combined. Communities act in ways that respect nature and bring them benefits from it	Failures in application of technologies can lead to major adverse effects (such as the uncontrolled spread of GM algae) Destruction of original nature as "parkification" advances. Destruction of original nature leads to excessively simple interpretations of how ecosystems function

In general, the Millennium scenario framework or its futures map of the global biosector still seems to function fairly well. However, scenarios include some developments that, in the light of more recent developments, cannot be regarded as justified. The questionable elements become visible by examining key drivers of the scenarios (Carpenter et al. 2005, pp. 297-330).

11.2 Key drivers of the original Millennium scenarios

Competence and technological development

The amount of human capital and the pace of technological development are key drivers in the scenarios. The development of skills and technology is assumed to be fastest in the Global Orchestration scenario, from which there also follows in this scenario faster growth of incomes and productivity than in the other scenarios up to 2025 (Carpenter et al. 2005 p. 311). The productivity level in the TechnoGarden scenario is close to the productivity level of the Global Orchestration scenario, especially after 2050. In the Adapting Mosaic and Order from Strength scenarios, productivity lags permanently behind that of the Global Orchestration and the TechnoGarden scenarios.

An anticipation made in the scenarios is that multinational companies will possess technologies that can effectively raise the standard of living over the next decades. Openness of the economy is judged to promote technical development, as inputs into education will, naturally, also do. Focus on local solutions will not, however, compensate for the lack of open trade. That can be concluded from the fact that in the Adapting Mosaic scenario productivity growth is interpreted as slow. Over the long term, however, in the scenarios inputs into green technology would lead, according to the thinking in the background to the scenarios, to rapid economic growth. One factor that has an important role here is the pricing of natural resources. In the TechnoGarden scenario, among other things, putting a price on water is considered to promote its efficient use.

The above-outlined interpretation of the character of technological development corresponds quite well to the way of thinking that is called “Washington Consensus” (viz. Tiihonen et al. 2004 p.66). In 1989 John Williamson, who was working as an economist at the Institute for International Economics think tank, crystallised the policy collectively represented by the Washington-based International Monetary Fund (IMF), World Bank and US Treasury Department into the following theses: (English-language Wikipedia “Washington Consensus”, 12.12.2009):

- Fiscal policy discipline
- Redirection of public spending from subsidies toward broad-based provision of key pro-growth, pro-poor services like primary education, primary health care and infrastructure investment.
- Broadening the tax base and adopting moderate marginal tax rates
- Interest rates that are market determined and positive (but moderate) in real terms
- Competitive exchange rates
- Liberalisation of imports, with particular emphasis on elimination of quantitative restrictions (licensing, etc.); any trade protection to be provided by low and relatively uniform tariffs

- Liberalisation of foreign direct investment
- Privatisation of state enterprises
- Abolition of regulations that impede market entry or restrict competition, except for those justified on safety, environmental and consumer protection grounds, and prudent oversight of financial institutions
- Legal security for property rights.

Of the scenarios examined, the one that is based most clearly on the Washington Consensus thinking model is "Global Orchestration". In the other scenarios, the principles are more or less violated. In the scenarios Order from Strength and Adapting Mosaic this occurs due to a lack of cooperation between the countries of the world. In the TechnoGarden scenario the Washington Consensus's operating principles are violated because of efforts to mitigate climate change and protect ecosystems. The TechnoGarden has, however, a special strength from the point of view of the Washington Consensus because of clearly defined property rights: the owners of natural resources or ecosystem services are clearly defined. However, in the TechnoGarden, "the price of violations" of the Washington Consensus is the fairly slow growth in productivity in the first few decades.

The development in recent years does not support the view that all of the Washington Consensus's operating principles are beneficial from the point of view of economic growth. This conclusion can be made even more clearly from the perspective of equality in society. A clear fresh ground for disputing the Washington Consensus operating principles has been China's rapid economic growth. Contrary to the Washington Consensus, China has actively restricted imports both through regulations and by keeping the exchange rate of its currency low. Its state-owned enterprises have had a clear growth-supporting impact and they have been used also to promote other national objectives. However, one of the key sub-factors in the Washington Consensus has been decisive: promoting foreign direct investment has played a central role in China's technological modernisation and growth.

Many African, Latin American and Asian countries that have privatised their economies and not restricted imports have been in difficulties. On the basis of these countries' experiences, it is very difficult to combine the removing of trade barriers, as well as favouring large companies and monoculture agriculture with levelling out income and wealth differences and mitigating unemployment. Chronic unemployment in the slums of the big cities is an increasingly acute problem.

On the futures map created by the scenarios in the Millennium Ecosystem Assessment project, one route is portrayed as being especially promising: free trade in agricultural products.

However, the world has not been tempted by the free trade in agricultural products suggested in the scenarios. Contrary to the logic of the Global Orchestration scenario, progress has not been made in liberalising world trade in bio-products, although there has been an atmosphere quite favourable to cooperation in the world. Hardly any progress has been made in liberalising agricultural trade in the WTO's Doha round of negotiations. On the other hand, the EU and the United States have been trying to achieve liberalisation by means of bilateral agreements with individual countries or blocs. China has also liberalised its agricultural trade with its Asian neighbours, and especially India. However, there

has been no willingness to tackle the fundamental challenge of the large subsidies that wealthy countries pay to their farmers. At the beginning of 2009 the EU's average tariff on agricultural produce was 17.9%, or over four times higher than on other products. The tariff on meat averaged 29.7%, on milk products 33.2%, on sugar and sugar products 35.7% and on cereal products 49.4% (Zahrnt 2009).

M. S. Swaminathan recently made an interesting statement on the free trade of agricultural products from the point of view of developing countries and especially India when he commented on the drought catastrophe in India in the summer of 2009 (Swaminathan 2009). Swaminathan is the "Grand Old Man" of the Green Revolution and recently the promoter of what he calls the Evergreen Revolution. According to Swaminathan:

> Enormous support is given to farmers in the United States or Europe, otherwise farming will not be viable there. All over the world support is both needed and given, otherwise farming becomes highly risky, which is why it requires proper insurance, proper credit, and assured remunerative marketing. In India, which has 25% of the world's farmers, only 7% of farmers are insured. So when the crops fail, they have no way to repay the loan. That is why farmer suicides take place.

The 2008 financial crisis made regulation of the world's financial markets and consumption demand in a Keynesian spirit a central operating principle, which also clashes with many of the principles underlying the Washington Consensus. In conjunction with the financial crisis, criticism has been directed in particular at the princely bonuses paid in the financial sector, and from which states benefit only a little in the form of tax revenues. The low-tax policy that belonged to the Washington Consensus has become the target of harsh criticism.

Besides what has been happening on the level of states, the "Washington Consensus's" Global Project has prompted constant resistance on the grassroots level. It acquired inter alia the form of the "Just say No" movement. In opposing the Global Project, the movement turned against simply everything that is modern. (Corbridge 1998, Kyllönen 2009)

> Just say "No" is a political strategy that takes its cue from Gramsci and Gandhi, as well as from Illich and Wendell Berry. The downtrodden 'social majorities' of the South are invited to stand firm against the disciplinary regimes of the Global Project. Instead of buying into the myth of development, they are asked to resist 'the plague of economic thinking', 'the certainty of economic rationality', and the insidious AIDS-like spread of consumerism and cultural genocide. Just saying 'No' means stepping outside the project. Having stepped outside the diseased circles of Modernity, Science, Reason, Technology, Westernisation, Consumption, the Nation-State, Globalisation and Development, the peoples of social majority can then make and rule their own lives at the grassroots. The key to a good life would seem to reside in simplicity, frugality, meeting basic needs from local soils, and shitting together in the commons. (Corbridge 1998, 140.)

In a milder form than the "Just say No" movement, many popular movements and developing country researchers have linked technological development and especially the development of gene technology with large corporations and their monoculture plantations.

A way of thinking along those lines is represented by the production model that Markus Kröger presents in sub-chapter 11.6 and which is called eco-economy in this report. Of the Millennium Ecosystem Assessment scenarios, this way of thinking has been linked to especially the Adapting Mosaic one.

Assumptions concerning the growth in production and consumption as well as the impacts of growth on the environment and demographic development in the world

According to Carpenter et al. (2005), a simple linkage cannot be established between economic growth and sustainable use of the environment. That is the case, although the so-called inverted-U hypothesis is valid to some degree. According to this, the use of natural resources is slight in the early phase of economic growth, the rate at which they are used increases very rapidly in the early phase of economic growth and again turns downwards when the incomes are high. Owing to the questionable nature of the U-shape, it is useful to study the relationship between the economic growth, the volume of production and the use of natural resources in the scenarios.

In the Millennium Ecosystem Assessment scenarios the average income of the global population will grow 2 – 4-fold in the period 2000-2050. The volume of production is anticipated to increase 3 – 6-fold over the same period. The fastest economic growth, an annual average of about 2.8% in 2010-2050, was associated with the Global Orchestration scenario. The slowest rate of growth, an annual average of about 1.1%, was assumed in the Order from Strength scenario.

The world population in 2050 varies in the Millennium Ecosystem Assessment scenarios from just under 10 billion (Order from Strength) to about 8 billion (Global Orchestration). The more prosperous the population, the less the growth of the population. The main argument for the population stabilising at a level of under 10 billion in the scenarios was the fact that annual population growth in the world fell from 2.1% in the late 1960s to 1.35% in 2000. In Asia and Latin America, fertility per mother nearly halved between 1970-75 (5.06 and 5.03) and 1995-2000 (2.72 and 2.72). Fertility in the high-income countries remained on average clearly below the replacement rate of 2.0 in the period 1995-2000.

However, Africa's birth rate has remained high. In the earlier period it was 6.71 and in the later 5.22. Population growth in Africa has been limited by a life expectancy that is clearly lower than in other continents due to, among other factors, the AIDS epidemic. It is assumed in the scenarios that most population growth will be concentrated in poor urban centres in sub-Saharan Africa, South America and the Middle East. The world population is anticipated to age and the rate of ageing is anticipated to be rapid not only in the developed countries, but also in many developing ones.

Food production in the scenarios

One of the central themes in the Millennium Ecosystem Assessment scenarios is the development of food production and the food supply in the world. The global food crisis in 2007 had not yet been experienced when the scenarios were made, which probably helps to explain the fact that in all of the scenarios food production per capita is anticipated to be higher in 2050 than in 2005.

In the Global Orchestration scenario growing incomes everywhere in the world are anticipated to strongly increase demand for food especially because in this scenario diets everywhere in the world would change to include more meat. The food that plants produce is used increasingly in the scenario as animal fodder. Thanks to research and investments in infrastructure, land is used for cultivation much more efficiently. The scenario anticipates the increase of the cropland area only in sub-Saharan Africa. On the other hand, the amount of artificially irrigated cropland increases in the scenario by about 10% in the period 2005-2050. Land is used to an increasing extent to raise livestock and produce biofuels. A key feature in the scenario is that trade in agricultural products has strongly grown. In volume terms, it is assumed that this trade will grow by 240% in the 2005-2050 period. Trade in meat products is anticipated to grow by as much as 675%, which is explained by the low starting level. The source of exports will be especially South America.

In the Global Orchestration scenario livestock products and rice are cheaper in 2050 than in 2005. By contrast, the price of maize used as animal fodder is assumed in the scenario to be higher in 2050. In this scenario the number of undernourished children declines rapidly and already in 2020 is 25% below the 2005 level. The decline by 2050 is assumed to be 60%. Thus, there would be 65 million undernourished children in 2050. This is the biggest reduction of any scenario.

The population to be fed in the Order from Strength scenario in 2050 is the biggest. Also in this scenario, however, per capita food production is anticipated to be higher in 2050 than in 2005, but is only 83% of the level anticipated in the Global Orchestration scenario. Production growth is anticipated to be based on the area of cropland increasing by about 20%, because investments in crop improvements are small and trade in food products is hampered by barriers. The area under cultivation is increased everywhere in the tropical and subtropical regions. The increase in the cropland area in these regions is around 40%.

In the Order from Strength scenario those who have to suffer most from more expensive food are the poorest people in the poorest countries. As a result of high local prices and marketing of surplus production, however, world trade will increase in volume terms by 185% in the period 2005-2050 despite trade barriers. The number of undernourished children will increase by about 20% in the period up to 2020, after which it is assumed that the situation will improve somewhat. Growth in 2050 will be 10% of the 2005 level. The number of undernourished children in 2050 is anticipated to be 184 million. Citizens of developed countries and the well-off in poor countries will not suffer from a shortage of food, but will instead add variety to their diet.

In the Adapting Mosaic scenario, the productivity and the incomes are also assumed to grow slowly but the fact that development is managed well locally is reflected in quite slow population growth. It is assumed that local production of food will demand that new land be taken under cultivation, as in the Order from Strength scenario. A lot of land will be commandeered for crops, especially in sub-Saharan Africa, but artificial irrigation to boost crop yields in the region will not increase significantly. Due to slow productivity growth, there will be a constant shortage of food, which will increase its price and make it more difficult to ensure food security for the poorest people.

In the Adapting Mosaic scenario, the food trade will grow in volume terms by 185% in the period 2005-2050. In spite of trade barriers, the food security is anticipated to require this growth in food trade. The price per tonne of the key cultivated plants will increase in real terms by about 50% in the period 2005-2050. The number of undernourished children is interpreted as increasing by around 15% up to 2020, after which it is assumed that the situation will improve somewhat. The reduction in 2050 will be about 15% from the 2005 level. It is assumed that there will be 145 million undernourished children in 2050.

In the TechnoGarden scenario economic growth will advance more slowly than in the Global Orchestration one, but thanks to the trade between developing and developed countries, the growth will happen evenly in the various continents. Compared with the situation in the Order from Strength scenario, slower population growth will also help matters. In this scenario, improvements in technology and slowly increasing meat consumption lighten the pressure to take new land under cultivation. Slowly increasing meat consumption reduces the volume of global trade in agricultural products and especially its value. It is assumed that the volume of global trade will nevertheless grow by 180% between 2005 and 2050.

In the TechnoGarden scenario even less new land is taken under cultivation than in the Global Orchestration one. Also in this scenario, however, additional land is put under crops in sub-Saharan Africa. The number of undernourished children remains in this scenario on the 2005 level until 2020, which is based on slower productivity growth than in the Global Orchestration scenario in the early years of the period under examination. In the following decades the number of undernourished children declines by about 35% from the 2005 level and is 105 million in 2050.

Fish has had a growing role in world food production thanks to increases in catches and fish farming. The healthiness of fish food is likely to boost its share of the diet of at least wealthy peoples. However, the fish production sector is in crisis, because catch volumes exceed the reproduction rate in the oceans and large lakes. Improvements in the efficiency of fish farming and increasing of its volume will be decisive from the perspective of future fish production. The big problem is, however, the sustainable production of fodder for the fish that are farmed. In the Millennium Ecosystem Assessment scenarios, fish consumption per capita is anticipated to remain on average on its present level. This means that the growth in the catch will correspond approximately to human population growth up to 2020.

Consumption of fish is anticipated to follow the general line in food consumption between the scenarios, ranging from Global Orchestration's 17.3 kg per capita to Order from Strength's 14.8 kg. Since it is especially important from the perspective of fish production to agree on catch quotas that safeguard renewal of stocks, the differences could be anticipated to become fairly great between scenarios based on cooperation and non-cooperation. However, this conclusion is not followed in the Millennium Ecosystem Assessment calculations (viz. Carpenter et. al. 2005 p. 341).

How has the development in recent years corresponded to the scenarios published in 2005? As already noted in the foregoing, liberalisation of world agricultural trade has made slow progress, although the development in the world has been in quite a spirit of cooperation, especially during the recent US presidency of Barak Obama.

Meat consumption has been increasing rapidly in recent years, especially in China; in other words, in this respect the development has been along the lines of the Global Orchestration scenario. Food consumption has also diversified and become increasingly concentrated in the form of industrially prepared food as urban populations rapidly increase. Also in the prospering developing countries China and India, packed food sold in supermarkets has become increasingly common.

In Finland, Kirveennummi et al. (2008) have presented four alternative scenarios for food consumption: Cornucopia, Eco-actions, Scarcity and Need, and Technolife. These scenarios share many features with the Millennium scenarios. Eco-actions correspond quite directly to the Adapting Mosaic scenario and Technolife to the TechnoGarden scenario. The Global Orchestration scenario had no evident counterpart in the Mirhami project.

Forests and biofuels

In the scenarios, new land for agriculture is obtained mainly by clearing forests. In four scenarios, the area of forest either remains unchanged or slightly increases in the developed countries and declines slightly or rapidly in the developing countries.

Most forest is destroyed in the Order from Strength scenario. In it, the annual rate of destruction of forests will increase from about 0.4% in the period 1970-2000 to 0.6% after 2005 (Carpenter et al. 2005 p.323). In this scenario, the amount of forests in the developing countries will decline by about 25% between 2005 and 2050. The decline in the forest areas in developing countries is smallest in the Adapting Mosaic scenario, where it is about 5%. The reduction in the other two scenarios is about 10%. Forests in the developed countries will increase fastest in area, by about 5%, in the TechnoGarden and Global Orchestration scenarios. The increase in the other two scenarios will be close to zero.

In all scenarios, pressure to destroy forests is greatest in Central Africa. In the Order from Strength scenario, two-thirds of the forests that existed in Central Africa in 1996 will have disappeared by 2050. In the Global Orchestration scenario, the proportion arrived at is 50%. The reduction in the Adapting Mosaic scenario is only about 20% and in the TechnoGarden scenario it is even less than this. In the Order from Strength scenario, forest destruction is fairly rapid also elsewhere in the developing countries. The reduction in Asia is estimated at 40% and in Latin America at 25%.

In the TechnoGarden scenario land is freed from livestock-raising to be used for other purposes. However, the main use anticipated is biofuel production rather than growing forests. In the Global Orchestration scenario, however, production of biofuels increases faster than in any other scenario, i.e. about six-fold compared with 2005. The explanation is increasing prices for fossil fuels. The scenario with the second highest level of biofuels production is TechnoGarden. The main production region anticipated in the scenario is Asia, which would account for as much as 70% of the world total in 2050. The anticipation seems really strange with respect to South America, which would account for a less than 10% share of total biofuel production in 2050. The anticipation may be based on traditional sources of biofuels like maize and oil palm. Maize was specially mentioned in the text. The problems of oil palm became very obvious during the 2007 food crisis. The share of South America is hardly justified if key future biofuels will be algae and sugarcane.

Use of fertilisers

Fertilisers are a key basis for productivity growth in bioproduction and at the same time a future limiting factor. The use of nitrogen fertiliser increased around eight-fold between 1960 and 2004. Alongside synthetically produced nitrogen, leguminous plants are another important source of this nutrient. Carpenter et al. (2005) present an estimate that humans have doubled the amount of nitrogen in land ecosystems. An estimate that the leguminous plants' share of this increase is 25% is presented. The problem has been that plants have no longer utilised the additional nitrogen. Often, half of the added nitrogen has not benefited plants, but has been washed away by water to eutrophicate rivers and lakes.

When the world population grows, the need for nitrogen fertilisers – and fertilisers of all kinds – will likewise increase. Of the various Millennium Ecosystem Assessment scenarios, the one with which the biggest increase in the use of nitrogen fertilisers is associated is Global Orchestration. The openness of economies to international interaction will lead to fertiliser use in regions where they are not now used, i.e. also in the poorest countries. Also in the Order from Strength scenario, the use of fertilisers will increase a fair amount, but mainly through more abundant use in the wealthier countries. In the TechnoGarden scenario, the technology that makes the use of fertilisers more efficient is in the key position, and their use is less than in the other scenarios. The Adapting Mosaic scenario has the second lowest use of fertilisers. In it, proactive use of environment leads to a reduction in fertiliser use, but the low level of trade between regions means that fertilisation is uneconomical.

The use of phosphorus fertilisers roughly trebled in the period 1960-1990 (Carpenter et al. 2005). Over 99% of phosphate is extracted from rock that contains it. In addition to plants, phosphorus is also used as a supplementary nutrient for livestock. After 1990, the use of phosphorus fertilisers temporarily declined when it was observed that excessive use led to fertilisers being leached into rivers and lakes. Use markedly declined in the developed countries when an awareness of the detrimental environmental impacts of phosphorus were realised. In 1975 only about 30% of the phosphorus spread on cropland in the developed countries was removed with products. When the use of phosphorus declined by a third in these countries by 1998, the share removed with products also increased to a half. Part of the explanation for the reduction in use was a sharp fall in the use of fertilisers in the area of the former Soviet Union.

The use of nitrogen fertilisers nearly quadrupled in the developing countries between 1975 and 1998. Production was so efficient that about half of the phosphorus was removed with products. In Africa, among other places, the use of phosphorus fertilisers was still at a low level in the early years of the 21st century and the amount of phosphorus in the soil constantly declined as a result of cultivation becoming more intensive. In acidic regions of the tropics, phosphate deficiency is a constant problem. Also in China, the level of phosphorus in the soil was still declining on average in the early years of the 21st century. On the other hand, rice cultivation in China, India, Indonesia, Thailand and the Philippines brought large amounts of extra phosphorus into the soil according to research quoted by Carpenter et al. (2005).

With regard to phosphorus perhaps even more than to nitrogen, the challenge is to strike a balance in the future between necessary and excessive use. The development of the use of phosphorus fertilisers is assessed in the various scenarios as being similar in its principal features to the use of nitrogen fertilisers.

The use of potassium fertilisers approximately doubled between 1970 and 1990. Since then, growth in consumption has either ceased or gone slightly into reverse in most of the developed countries. In Eastern Europe, which had gone over to a market economy, the use of these fertilisers collapsed in the 1990s. In the developing countries, the amount used increased more than ten-fold between 1970 and 2000. Potassium production occurred overwhelmingly in developed countries in the early years of the 21st century. 87% of total production was accounted for by nine companies in Canada, Russia, Belarus, Germany, the United States and Israel. As a result of changing cultivation techniques, the amount of potassium in the soil had declined rapidly by the beginning of the 21st century in many developing countries such as China and India, despite the application of potassium fertilisers being increased.

Potassium fertiliser does not have the same kind of pollution effect as nitrogen and phosphorus; in other words, excessive use of it in the future will not cause the same kind of problem as the abundant use of nitrogen and phosphorus does. The development of the use of potassium fertilisers was assessed in the various scenarios as being similar in its principal features to the use of nitrogen fertilisers.

11.3 How were the Millennium Assessment scenarios updated?

How should the scenarios in the Millennium Ecosystem Assessment project be developed in such a way that they could provide a futures map with features (the vision and the strategy) outlined in 11.1, taking into account the developments that we have seen during the last six years? The following points of departure seem reasonable for all scenarios:

- The importance of the so-called BRICS countries, i.e. Brazil, Russia, India, China and South Africa, is growing in the world economy and politics. China in particular is assuming a place alongside the United States, the EU and Japan.
- The results of the Copenhagen and Cancun climate conferences are starting points for future paths branching out in different directions when it comes to mitigating climate change.
- Climate change is developing according to the laws identified by the Intergovernmental Panel on Climate Change (IPCC) in 2007; in other words, there is a clear interdependence between global warming and anthropogenic emissions of greenhouse gases. The adverse effects manifest themselves not only as gradually increasing problems, but also as catastrophes that will change public opinion in the world. The attitude changing catastrophes would be e.g. cyclones, deluges, rising sea levels or tsunamis as glaciers melt, and long periods of drought. Opinions could also be quickly changed by dramatic releases of methane from the Siberian permafrost.
- Technological development is advancing rapidly and changing the prerequisites for worldwide development through both new applications of information and communication technologies and bio- and nanotechnology innovations. For the global biosector, major advances in the new biotechnology are especially important. Zinc

finger nucleases might change the role of GMOs in a fundamental way. They might be a step forward comparable to the PCR (polymerase chain reaction) in the 1980s.

- The population is increasing in the developing countries. People from rural areas will move to the slums of large megapolies. In the slums, people will find it increasingly difficult to find honest work that guarantees a minimal standard of living. At the same time as the population is young in the least developed countries, the demographic structure in the developed countries is increasingly ageing and ageing. Developed countries will face problems with old people services, first of all with health care. Prosperous developing countries and especially China will later encounter similar problems based on its one-child policy.

Is the "Washington Consensus" still a reasonable strategy? The Washington Consensus seems to overestimate the importance of trade liberalisation, privatisation of production and determination of ownership rights as the sources of innovations and productivity growth. The Global Orchestration scenario following operational principles in the Washington Consensus hardly results in better productivity than the TechnoGarden scenario. From the productivity point of view, incentives for environment-friendly technologies – especially the trade of carbon emission rights – seem to be a better choice than the lack of those kinds of incentives. Besides the challenges of climate change, the development of global productivity and the stability in development are threatened by the monopolistic power of multinational corporations and large income and wealth differences.

11.4 The world's centres of power and development of relations between them

It seems almost certain that China will be one of the world's centres of power in the next few decades. Relations between China and the other centres of power in the world will determine global development.

A fresh starting point for pondering China's future role is provided by Risto Hyvärinen's and Jaana Pukkila's book Katse itään – kuinka Aasian nousu muuttaa maailman ("Gaze eastwards – how the rise of Asia is changing the world") (Hyvärinen and Pukkila 2009). Hyvärinen has had a long diplomatic career in Asia, including stints at the Finnish embassies in Beijing and New Delhi. Pukkila, in turn, has spent a couple of decades working in commerce and finance in Asia. In the beginning of their book, they quote a study by the investment bank Goldman Sachs in 2003. According to it, of the then "big industrial countries" – the United States, Japan, Germany, the UK, France and Italy – only the United States and Japan will be among the world's six biggest economies in 2050. China will then be, according to the report, the world's biggest economy, with the United States second and India third, followed by Japan, Russia and Brazil. The bank later added South Africa to the vanguard group. Thus, economic power in 2050 would be wielded by, in addition to the United States and Japan, the BRICS countries (Brazil – Russia – India – China – South Africa). That would mean the EU having been relegated to the margin of the global economy.

Hyvärinen and Pukkila (2009) quote many developments from the recent past in support of their anticipation of the rise of the BRICS countries and especially China and East Asia. The central countries in East Asia are China, Japan and South Korea. China's investment rate has exceeded 40% since 2000, or twice the average global rate and nearly three times Finland's. China's and East Asia's status as the world's "goods production factory" is re-

vealed by the fact that fourteen of the world's twenty largest container ports are in Asia. Some 60% of East Asia's trade is conducted within the region. In 2007 some 45% of India's foreign trade was with East Asia. Trade between the BRICS countries, as well as Asian, African and South American countries grew to half of global trade in 2007. The share ten years earlier had been only 38%.

A striking feature in Hyvärinen's and Pukkila's book is that climate change questions are almost totally ignored. Only a few subordinate clauses are devoted to it in the whole book. The challenges facing the world food supply are likewise touched on only briefly by stating that the price of food has been declining for a long time. Only a scarcity of water is seen as threatening a blissful future. Hyvärinen and Pukkila note hopefully: "China's and India's influence on the world food supply may be less than, for example, production of biofuels. For the moment, China is still a net exporter of food and also India, which has suffered from downright famine in the past, has achieved self-sufficiency" (Hyvärinen and Pukkila 2009 p. 35).

How can one interpret the fact that Hyvärinen and Pukkila almost completely ignore the challenges of climate change and the world food supply that have been so forcefully underscored in the EU and the Eduskunta, the parliament of Finland? One possibility is that these challenges have remained personally alien to the authors. For example, they have failed to note that India is no longer self-sufficient in food production. Or how the situation of the poorest will develop if the better-off in India become meat-eaters.

Another possible interpretation is, however, more probable and at the same time a lot more alarming. Hyvärinen and Pukkila represent the general view of the leading echelons of the population in the Asian countries that they know. Could it even be that in Asia European concern about climate change is interpreted as an aspect of a lack of dynamism on the part of the ageing EU population that their wealth has made lazy? Perhaps the well-off in Asia have no genuine commitment to mitigating climate change in any other form than as an additional reason to make energy production more efficient. China's commitments at the Copenhagen and Cancun climate conferences can also be interpreted that way. The Russian President Medvedev (2009) and Prime Minister Putin (2009) have likewise expressed a position of this kind in their published speeches. Nor is it difficult to imagine that from the perspective of a nouveau riche Chinese or Indian worrying about the world food supply is futile sentimentality.

A second main dichotomy in the original Millennium Assessment scenarios contrasted a world acting in cooperation with one incapable of cooperation. Alongside countering terrorism, a different attitude to climate change can be one factor that hampers cooperation. However, disagreements on these questions will hardly suffice any longer to maintain permanent hostility between blocs of the kind envisaged in the Order from Strength scenario. What might the factors be that would get the world to divide into mutually hostile blocs?

The strongest candidate for the cause of permanent tensions and trade wars appears to be a struggle for the world's scarce resources and also for competence-based production. When different views relating to democracy, human rights and environmental protection, as well as religious and other cultural differences between East and West are combined with this, the ingredients for a permanent conflict could be present.

World politics have for a long time been guided by a struggle for dwindling oil resources. The Middle East's oil reserves are still very important, although inputs into technology to reduce the use of oil are lessening their importance. The United States and the EU are still very dependent on Middle Eastern oil and Asia's need to gain access to oil resources in the Middle East and North Africa is constantly growing. According to Hyvärinen and Pukkila (2009), Japan and South Korea buy four-fifths of their oil from the Gulf states and China more than half. India and several South-East Asian countries are likewise increasingly dependent on the Middle East's large oil reserves.

In pursuit of its efforts to secure supplies of energy, food and raw materials, China has made major investments not only in the Middle East, but also in Africa, West Asia and "the United States' back yard", South America (Diagram 11.1). China's non-bond investments in the United States and Europe lag clearly behind its investments in Sub-Saharan Africa, where its acquisitions include extensive areas of land to ensure its own food supply. According to Hyvärinen and Pukkila (2009), over 800 Chinese state-owned companies were operating in Africa already by the beginning of 2008. It has been estimated that Chinese contractors are nowadays securing as much as a half of all public building projects in Southern Africa. Early 2009 also saw the announcement of an agreement that was hailed as a landmark and within the framework of which Brazil will begin selling oil to China in return for a large loan.

China's policy has been to act with a low profile and play down its own significance. However, it is gradually becoming impossible to overlook China's growing influence and its operating principles, which are questionable from a European and American point of view. If unemployment figures in Europe and the United States begin significantly growing, these countries may be prompted to defend the high-competence sectors that are the foundation of their employment. In this stage, the view taken of decisions by companies like Stora-Enso to transfer their high-competence production to countries to which investments are attracted on grounds that are questionable by European standards and mainly to the benefit of elite groups in the target countries has no longer been frivolous. Why do Europeans in those circumstances passively accept the Asian point of view presented by Hyvärinen and Pukkila (2009, p. 44) that Europe is a region in regression?

The question of the social responsibility that states bear for their populations would appear to be a decisive factor from the perspective of global orchestration. A more "welfare state like" responsibility for populations in the United States, China, India Brazil and Russia, could gradually turn into a kind of global social policy. This thinking model can be found in the original Global Orchestration scenario. A positive social turn at least in the early stage does not presuppose democratisation, although its probability might increase in the long term.

From the perspective of the Global Orchestration scenario, the active attitude adopted by the new United States administration towards reforming its health care system to make it cover the entire population was a promising opening. The big difficulties of the Obama government with the US Congress do not, however, give much hope for the welfare state like global development.

Diagram 11.1. China's investments in production in various parts of the world

Whatever the case, in the updated Global Orchestration scenario, the social responsibility that spreads to the whole world has been taken as the core idea of the scenario. In order to be realistic, it presupposes a clear turn towards emphasising social responsibility in the internal development of China. Certain weak signs of a development trend of this kind have indeed been visible with respect to health care in China.

If a global social responsibility turn does not happen, an exacerbation of conflicts between groups of states appears fairly probable, over the long term at least. It is also questionable whether it is at all possible to deal effectively with climate change without such a turn.

11.5 Climate change and mitigation of it after the Copenhagen and Cancun conferences

Considering the great expectations focussed on it, the Copenhagen climate conference was a disappointment. To quote an editorial in the daily Helsingin Sanomat on 20.12.2009,

it ended in a belly landing for expectations. However, the results of the conference were no surprise when attitudes to climate change outside the EU are taken into consideration. The great expectations focused on President Obama were unreasonable given that attitudes to the necessity of mitigating climate change are still very critical in the United States. In the run up to the conference, climate change sceptics were conspicuously in the public view and concealment of information by the head of the Intergovernmental Panel on Climate Change IPCC undermined the credibility of the panel's conclusions.

There was a certain irony of fate in the fact that just as the Copenhagen conference was ending Washington, Beijing and Europe were gripped by the most severe frost and blizzards for decades, though the average temperature in the whole world in 2009 was the highest ever measured. The 2010-2011 winter was also exceptionally cold in Europe and especially in Finland. This seems to be one reason besides other reasons for the heavy defeat of the Finnish Green party in the parliamentary elections in April 2011.

The main outlines of the updated Millennium Ecosystem Assessment scenarios presented in this report already took shape before the Copenhagen and Cancun conferences. It has not been necessary to make any essential changes to the main lines on the basis of the conferences' results. The United States' caution in commitments was in accordance with the outlined scenarios as well as the Green Climate Fund launched in Cancun. The Copenhagen commitment to cut emissions by 14–17% from the 2005 level by 2020 is approximately the same as in the original Global Orchestration scenario, i.e. very modest. Where China is concerned, one could even speak of a mild positive surprise compared with the scenarios sketched out before Copenhagen. China undertook to reduce the carbon-intensity of its GDP by 40-45% from the 2005 level by 2020.

In the updated Millennium Ecosystem Assessment scenarios, China is regarded as having a key role in mitigating climate change. The grounds on which this is assumed are first of all the country's rapidly strengthening role in the global economy. China has become a world centre of industrial manufacturing. With the land acquisitions and other investments that it is making in various parts of the world, China is challenging the United States, Europe and Japan as determiners of the direction of the global economy. Second, China, unlike Europe, the United States, Japan and the former socialist countries in Europe, does not have the burden of historically high emissions. Thus, it can by reducing its emissions show the way for other countries in a comparable situation. In addition, it would seem that the Chinese leadership, unlike the political leaderships in, for example, India and Brazil, has real prerequisites for changing the country's course towards lower emissions fairly rapidly in practice. It is no coincidence that a major catastrophe in the Hong Kong region acquires a central role in the updated scenarios.

A very interesting question from the perspective of the future is how different countries will form alliances in climate questions and also more generally. The power axis at the Copenhagen climate conference comprised the United States, China, India, South Africa and Brazil. These countries drafted the conference declaration in their internal negotiations. Would this axis - which does not include the present powerful actors the EU, Japan and Russia - determine the future course of world politics? Will the Copenhagen axis (with Russia?), on the one hand, and the powerful countries that were excluded from it, on the

other, form alliances between themselves not only in climate change questions, but also in questions relating to economic growth? Blocs of this kind seem quite natural, especially in the Global Orchestration scenario with its emphasis on large-scale cultivation or agribusiness.

The most tangible results at the Copenhagen and Cancun climate conferences were achieved in funding to be provided to developing countries for climate change mitigation. The urgent question is how to evaluate and valuate carbon storages and sinks of forests and ecosystems. In the long run, it does not make much sense to give different values to avoided CO_2 tonnes based on reduced emissions from burning fossil fuel and the sinks of forests. The lower value of the forest sink does make no sense if the evaluation method of the carbon storage of a forest is trustful and emissions from the use of the forest are trustfully followed.

It makes much sense to define a global value for an avoided/emitted CO_2tonne greenhouse gas equivalent which systematically takes into account the source related uncertainty. In a country like Finland, it is possible to reduce the uncertainties related to the carbon storages of its forests on the level comparable with the emissions from electric power stations. Evidently, the uncertainties are considerable concerning the carbon storages of the rain forests e.g. in Brazil. Also there, however, special rain forest areas might be carefully evaluated and followed.

The updated TechnoGarden scenario is based on the global trade of greenhouse emission rights. The value of an emission right is based on the bonus system that takes into account the risks of wrong evaluation and cheating. Any actor in any country that has the legitimate ownership of emission rights or carbon sinks can register itself in the emission right trade in the scenario. The registration requires, however, a history of responsible behaviour. In the first stage, the new seller of emission rights does not receive the full price. As in the bonus system for cars, the full value emission right requires, besides trustworthy measurements, a long period without cheating in the emission trade.

Professor Nicholas Stern has proposed for developed countries a general tax of 20-25$ per CO_2 tonne greenhouse gas equivalent. In the updated TechnoGarden scenario, this type of tax will finance greenhouse gas mitigation of the registered emission right sellers in the developing countries.

The original Millennium Ecosystem Assessment scenarios were based on the calculations made by the IPCC in 2002, which were somewhat more optimistic with regard to warming than the calculations it made in 2007. According to the IPCC 2007 anticipation, a reduction of about 45% in emissions would suffice to keep the temperature rise below 2ºC. The difference between the 2002 and 2007 evaluations is taken into account linking higher global warming figures to greenhouse gas emission figures for 2050 of the original Millennium Ecosystem Assessment scenarios.

Table 11.4 Emissions in 2050 in different scenarios compared with 1990, as well as average temperature rise compared with the pre-industrial era in 2050 (Carpenter et al 2005 pp. 8 and 276) and the corrected estimate based on the 2007 IPCC report.

	Emissions in 2050 as percentages of 1990 level in the scenarios	Temperature rise in original scenarios	Corrected temperature rise
Global Orchestration	65%	1.75 ºC	2.4 ºC
Order from Strength	50%	1.3 ºC	1.9 ºC
Adapting Mosaic	45%	1.4 ºC	2.0 ºC
TechnoGarden	20%	1 ºC	1.4 ºC

In the original scenario stories, advancing climate change produced catastrophes, the most dramatic o f which brought about rapid changes in attitude. The most dramatic catastrophe described in the original scenario stories is a cyclone that hits the Hong Kong area (Carpenter et al. 2005 p.249). Because China's attitudes are so central, this catastrophe has been chosen in the updated scenario stories to illustrate all catastrophes that change environmental attitudes globally from reactive to anticipatory.

The timing of the Hong Kong catastrophe differs in the updated scenarios. As in the original scenario story, it happens in 2017 in the Adapting Mosaic scenario. This scenario underscores the independence of regions. Although attitudes will change based on the Hong Kong catastrophe, effective global actions take time in this scenario because of the lack of global governance.

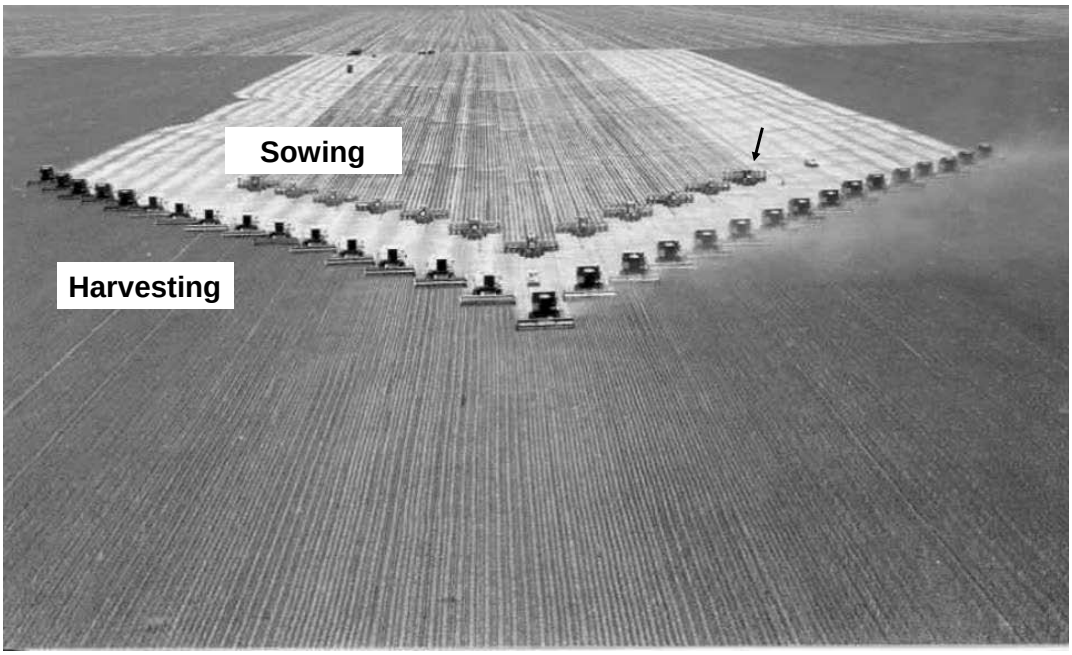
In the Global Orchestration scenario the catastrophe afflicts Hong Kong in 2033. What makes the later date of this shocking catastrophe reasonable in this scenario is the delayed action despite cooperation in the world. If the climate change advances without major catastrophes the political choices of the original Global Orchestration scenario are believable, otherwise the temperature rise of 2.4ºC in 1990-2050 is unbelievable. Another possibility for a credible story is to skip the assumption that IPCC 2007 rightly anticipated the global warming or its impacts. Also on this basis, 2033 is a plausible date for the catastrophe.

In the scenario Order from Strength the catastrophe hits Hong Kong in 2039. The reason for setting it at this date is that one of the sides in the "new Cold war", i.e. the EU-United States-Japan axis, has taken mitigating climate change fairly seriously in the countries it controls. The other reason is the slowing of economic growth which reduces emissions of greenhouse gases. Thus, there are grounds to anticipate that it will take until 2040 or so for global warming to reach the stage where a really significant catastrophe can happen.

11.6 The three main models for arranging the world's bioproduction

An important dimension of the original, and especially of the updated, Millennium Assessment scenarios concerns the future role of agribusiness. Typical features of the present agribusiness, e.g. in Brazil, include large scale and mechanization, high labour productivity, the leading position of large multinational corporations, monoculture cultivation based on herbicides and the use of genetic modification of the kind that we know today (e.g. the

glyphosate resistance of soybeans). The following picture from the state of Mato Grosso in Brazil illustrates this model of bioproduction.



Scale, mechanization

Two crops in the same year without irrigation

Harvesting (soybeans) and sowing (corn) in the same day

(Source: Celia Fortes Ferreira, presentation in Eduskunta 8.10.2009).

The updated Millennium scenarios provide two alternative models for agribusiness: Eco-economy and Evergreen Revolution. Both of them prefer the labour intensive small-scale production.

In the model called Eco-economy, not all cultivation is organic, but its features are regarded as a kind of ideal. In the model, small-scale farming gives employment to the populations of developing countries. Neither genetic modification nor extensive application of fertilisers are used. Consumers used to perceive this way of production as safe and compliant with high ethical standards. In the following compilation by Markus Kröger, the features that are associated with this mode of production are characterised.

A human capital-intensive agricultural model

Markus Kröger

T*he world population is anticipated to grow by billions in the next few decades. At the same time as the growing population should be fed, the aim should, however, also be to reduce the enormous burden that agriculture is already placing on nature and offer employment. It is obvious that the present agricultural system, which is based on large monocultural fields, heavy application of fertilisers and toxins, can not simply be expanded. Bigger crops and more jobs will have to be achieved in alternative ways.*

Increased use of chemical fertilisers, i.e. the Green Revolution, has boosted crop yields explosively since the 1960s. Indeed, the present petrochemical agricultural system is a very efficient producer of calories. Never before has a similar amount of energy been produced so cheaply and on such a massive scale as with today's petrochemical agricultural regime. However, this growth in crop yields has had hidden costs. With the advance of the Green Revolution, the diversity of cultivated varieties and the nutritional value of food have both weakened. Fast-food culture is a result of decisions through which production of calories was set as the main emphasis in agriculture.

Africa ran into enormous problems in the 1980s when the Green Revolution had first trebled the population but also led to unsustainable increases in crop yields, collapses in crop yields as a result of the erosion caused by intensive cultivation, famine and dependence on imported food. Indeed, increasing crop yields must be compared with the extensive costs that the agricultural system causes. An indirect cost that has not yet been taken sufficiently into account is a narrowing of species and dietary diversity, obesity and eutrophication.

Nor can increasing crop yields be understood without its social costs. The spread of large-scale industrial monoculture plantations has happened – at least in the global South – at the expense of local populations, nature, consumers, the agricultural workforce, small farmers and rural communities. Poor oversight of compliance with laws and deficient environmental legislation have made it possible to externalise the costs to society. It is obvious that the global agricultural system must be changed significantly. In this review I briefly compare the petrochemical agribusiness model as well as the natural small-scale farming model, concentrating attention on marginalisation, maximisation of human capacity, employment and the boundary conditions of modified geneticity.

Around the world, small farmers who have lost their land have founded movements of the landless to oppose the uncontrolled spread of industrial plantations. As a solution to the problems of the Green Revolution, they offer small-scale natural farming. On a broad scale and carried out with the support of state agricultural subsidies, natural cultivation could replace the petrochemical agricultural system, argue organic growers in the North and the poor small farmers in the South who wouldn't even be able to afford oil-dependent petrochemical cultivation.

Climate change requires meat consumption and petrochemical cultivation to be reduced, because both are central causes of emissions.

In Brazil alone, over 700 million litres of chemical crop protection agents were consumed in 2008. Most of these were derived from oil. The use of crop protection agents has increased substantially ever since cultivation of Monsanto's genetically modified Roundup-Ready (RR) soybeans, which require the use of glyphosate pesticide, began in the country. The first legislative revision carried out after genetically modified cultivation had been allowed dramatically raised the upper limit for the use of glyphosate.

It is obvious that the situation can not continue like this: genetic modification should reduce rather than increase the use of crop protection agents, and in addition genetically modified plants should be under the direct control of the local population and owned and developed by them. Without democratisation and less use of crop protection agents, genetic modification does not offer solutions for reforming the Green Revolution model; on the contrary, it exacerbates the problems with the model. Extortion with patented seeds, controlling markets and technology can become an important political weapon, and lead to the emergence of a worldwide bio-hegemony. This would have devastating effects from the perspective of creating a human capital-intensive agricultural model: in practice, agribusiness's bio-hegemony would make it impossible for a mixed or small-scale farming model to be developed or to exist.

The new century's agricultural system should employ more people, produce a diverse range of food for a large population and take the biodiversity of nature into account. Cultivation on the terms of nature increases crops in a sustainable way, increasing organic material, but requires more labour. However, there are already unemployed in the global South and population growth does not promise an improvement in the matter. Neither the Green Revolution nor genetic modification in its present form holds out hope of employment for a large number of farmers, because both of them are capital-intensive investments. Thus of the three alternatives the most suitable solution seems to be that of supporting an agricultural system that operates on the terms of nature and is farmer-oriented, not spreading the Green Revolution or legalising GM cultivation in its present form.

The development model in the new century will be founded on human capital-intensiveness, maximisation of human capacity, as the leading development researchers Amartya Sen and Peter Evans have theorised. Where are we now and what should be changed? The present situation is described in Mike Davis's book Planet of Slums, in which the reasons for over a billion people nowadays living in slums are sought. Especially in the past 10 years, the number of slums has increased explosively worldwide, and the situation does not look bright with the present agricultural model, i.e. agribusiness, gaining ground. Some 82% of the population in Brazil are already living in cities and the percentage is anticipated to increase to 88 in the next few years.

In Brazil, which produces 25% of the world's food and has the world's biggest unused food-production potential, agricultural productivity has increased explosively with the growth of agribusiness, but employment has either not increased at all or has declined (I Encontro de Estudos Rurais, Universade Federal Fluminense, July 2007). With the spread of agribusiness, farm sizes have grown, land ownership has become centralised and the flight from the land has increased. Agribusiness has led to major conflicts, driving people violently out of rural areas. In the soybean-dominated province of Mato Grosso, for example, 6.2% of the

entire rural population, i.e. 32,275 people, were evicted from the land in 2002 (Comissão Pastoral da Terra. 2003. "Conflitos no Campo Brasil.").

In the whole of Brazil, agribusiness created only 500,000 jobs in 2004 (IBGE 2004). At the same time, there were 20 million people in Brazil who did not have shoes and 30 million without teeth. Only 8% got to university, 60% in north-eastern Brazil couldn't read and in the whole country 50 million went hungry every day. Subsidy programmes, such as Bolsa Familia, subsequently launched by the government have been responsible for inexpensively and effectively eradicating extreme poverty, considerably reducing child mortality, for example. These programmes were essential and help explain why over 80% of Brazilians nowadays support

President Luiz Inacio Lula da Silva. However, these emergency solutions are not enough to solve the structural problems associated with the present agricultural model; instead, at their worst they will create a dependence between the poor in the slums and the mechanised large farms, one in which people are kept alive and unemployed. This can not be a sustainable solution, because people must themselves be able to participate in production and live independently of constant state support.

Brazil has about 350 million hectares of arable land. Owing to unequal ownership, however, only 50 million hectares, i.e. 14%, was in use in 2004, and 75% of this was used by agribusiness. This was the best land and was being used to cultivate export crops like soybeans, cotton, oranges, coffee, sugarcane and eucalyptus. Although the best land is nowadays being used to grow crops for export, Brazil still has 120 million hectares of non-producing land on 53,761 large estates. In other words, an area the size of Europe lies idle.

Brazilian land law divides farms into size categories: small farms are on average maximally 200 hectares, medium-sized ones between 200 and 2,000 hectares and large ones over 2,000 hectares. According to figures compiled by the state statistical centre IBGE, small farms employ 14 million people, medium-sized ones 1.8 million and large agribusiness estates only 500,000 (IBGE 2004). The half million who work in agribusiness are almost entirely wage-earning workers, because few of the owners of large estates work on them themselves and there are not many of them anyway. Small farmers (14 million) live on their holdings with their families, but at the same time employ nearly double the number of agricultural workers that agribusiness does; in other words, they provide about a million people with work in addition to themselves. Thus small-scale farming provides most employment even though it accounts for the smallest part of the land area.

In addition, small-scale farming is more productive when looked at from the perspective of supporting industry, ripple effects on the economy. 63% of all tractors are used on farms of less than 200 hectares, only 36% on holdings of over 1,000 hectares. Demand for tractors has not increased in 20 years; annual sales by the industry average 50,000. Thus imagining that agribusiness would be the best way to support industrialisation and create jobs in the service sector and manufacturing is a myth; in reality, supporting small-scale farming is a lot more profitable for the national economy. In addition, small-scale farming fosters a bigger market, spreading purchasing power and GDP in a more balanced way.

According to IBGE, Brazil's large estates accounted for only 13.6% of the country's agricultural output, the medium-sized ones for 29.6 % and small farms for 56.6%. Small-scale holdings accounted for 60% of meat and milk production. In terms of yield per hectare, small-scale production is overwhelmingly more productive than agribusiness. Claims that large-scale production or GM is needed to be able to produce output represent a myth.

In fact, 75% of all of the world's food is produced by small farmers. It would be possible for them to produce even more if only they got support. The majority of them do not receive significant state subsidies at present. In 2003-04, for example, Brazil's small farmers received only 3 billion reals in credits, whereas medium-sized farms and large estates received 24 billion from the Bank of Brazil (Blanco do Brasil) (Stédile 2004).

The human capital-intensive agricultural model can no longer mean following classical land reform. Land distribution is not enough. The new rural production model can not mean a return to family farms only. The aim in rural investments and economic policy in the new century should be to employ as many as possible and in several different sectors, not just in fields and forests. Thus the traditional land-distributing rural reform is not enough; rather, rural reform must support also small industry and services production in the countryside. That would enable meaningful jobs to be provided, especially for young people in rural areas. It is not realistic to assume that young people would want to remain in the countryside and lead a farmer's life; instead, the economy must offer them other opportunities as well. The lure of the city is founded precisely on the fact that there one can work elsewhere than in basic production, and that at least alternatives and opportunities are to be found.

To increase industry and services in the countryside, education and training for the rural population must be taken into consideration and supported as much as possible. New third-level institutions must be established in rural areas so that people do not need to move to cities. For example, the Brazilian movement of the landless has done that, using a grant of €1 million from the EU and its own labour to build a university for the landless in São Paulo. Over 5,000 students from all over Latin America study there, specialising as teachers, lawyers, geographers, agrologists and coordinators to meet the needs of land reform and small-scale farming on the terms of nature. Even a small amount of money can help enormously in solving big problems if it is focused correctly.

The main rule in the new model is to support investments and projects that maximise growth of human capacity. It is best for people themselves to be involved from the beginning, themselves organising and creating new development, as was the case when the landless built their own university, thereby learning to duplicate the task if necessary and teach it to others. Investments of this kind to maximise human capacity can make possible a snowball effect in which those helped do not become dependent, but instead take development into their own hands. That way, with an investment of, say, a million euro, the capital can be made to yield an enormous social profit.

It is important that rural people themselves control activities and production. Thus, for example, seed ownership and reforming and guaranteeing agricultural production among farmers is important. Most GM cultivation does not currently meet this precondition, but instead creates a dependence on experts and companies that possess GM-related expertise. This increases uncertainty and reduces maximisation of human capacity, because in

the greater part of the world the poor have no opportunity to create or understand, let alone own gene technology. Patented technology must be bought again every year. Patenting life and nature can not be recommended.

A better solution would be to develop and test local varieties using methods that are human capital-intensive rather than capital-intensive and which succeed in even the poorest conditions. The methods must be of a kind that anyone at all, also illiterate small farmers in the poorest countries, can take part in developing. If knowledge accumulates and specialises, there is the danger that the status and marginalisation of the poor will be further exacerbated by the fact that they have constantly less say in the direction of development or chance to be an integral part of the change processes by means of which the aim is try and improve specifically their status. Indeed, because of the danger of bio-hegemony, it is advisable to support grassroots-level solutions, democratic and human capital-intensive small-scale farming. The state must ensure through legislation and oversight of compliance with it that both at home and abroad costs externalisation and privatisation of know-how are kept in check. The rule of law, respect for human rights and actually a democratic investment process are essential in the creation of a human capital-intensive model.

The Indian bio scientist M.S. Swaminathan has introduced the concept of the Evergreen Revolution. Swaminathan has been called the "Father of the Green Revolution in India" that took place in the 1960s and 1970s. According to this Gandhian, who enjoys high national and international esteem, many features of the Green Revolution have been in contradiction with sustainable development and must be avoided in the new revolution. Swaminathan and Kröger above hold a common opinion about this issue, as well as about the empowering of small farmers. Swaminathan, however, believes much more in the opportunities of the new biotechnology, including genetic modification. In Dr. Swami Nathan's words (2009):

> Building a successful ever-green revolution requires four components: technology, services, favourable public policies, and farmer enthusiasm.

A central element in the Evergreen Revolution is mediation of cultivation skills through training and advisory organisations and challenging the large multinational corporations in new biotechnology. In Dr. Swami Nathan's case that is not empty talk; he can point to real achievements with this kind of operational method in both the 1960s and the 21st century. In the 1960s he started in India a network of 2000 model farms to show local farmers the advantageousness of new plant varieties. In the 21st century he has been working actively to bring Internet connections to Indian villages. In collaboration with a rural development academy, he has launched an ambitious project in which a woman and a man in every Indian village would be trained to promote sustainable agriculture. The toughest challenge is more efficient use of water (www.prlog.org).

Table 11.5. Eco-economy and Evergreen Revolution

Eco-economy	**Evergreen Revolution**
The central point of departure is that of giving a large number of the population meaningful employment in small-scale farming on holdings of less than 100 hectares or in production cooperatives.	The central point of departure is that of giving a large number of the population meaningful employment in small-scale farming on holdings of less than 100 hectares or in production cooperatives.
Genetic modification is not allowed and strict safety systems are used to prevent "genetic contamination" from GMO agribusiness.	The latest knowledge in the field of bio- and gene technology is used as effectively as possible to develop local plant varieties. Plants are developed using genetic modification to primarily serve local consumers' needs and only secondarily for export.
Utilisation of the diversity of local plants and animals.	
Protecting biodiversity and preventing the spread of alien species and their hereditary material.	Effective advisory services help ensure that the soil is kept suitable for cultivation, nutrient cycles are managed, irrigation uses water resources efficiently and suitable varieties have been chosen for cultivation.
Local and traditional production methods, as well as new cultivation methods that either involve the use of no, or very little, crop protection chemicals and fertilisers. Advisory services promote skilled use of irrigation and the selection of plant varieties.	Training and advice networks reaching to the village level in developing countries and led by publicly funded research and development centres are formed. Networking with the food production in developed countries is also made more effective.
Special monitoring is done to ensure that products do not contain residues that threaten their purity.	

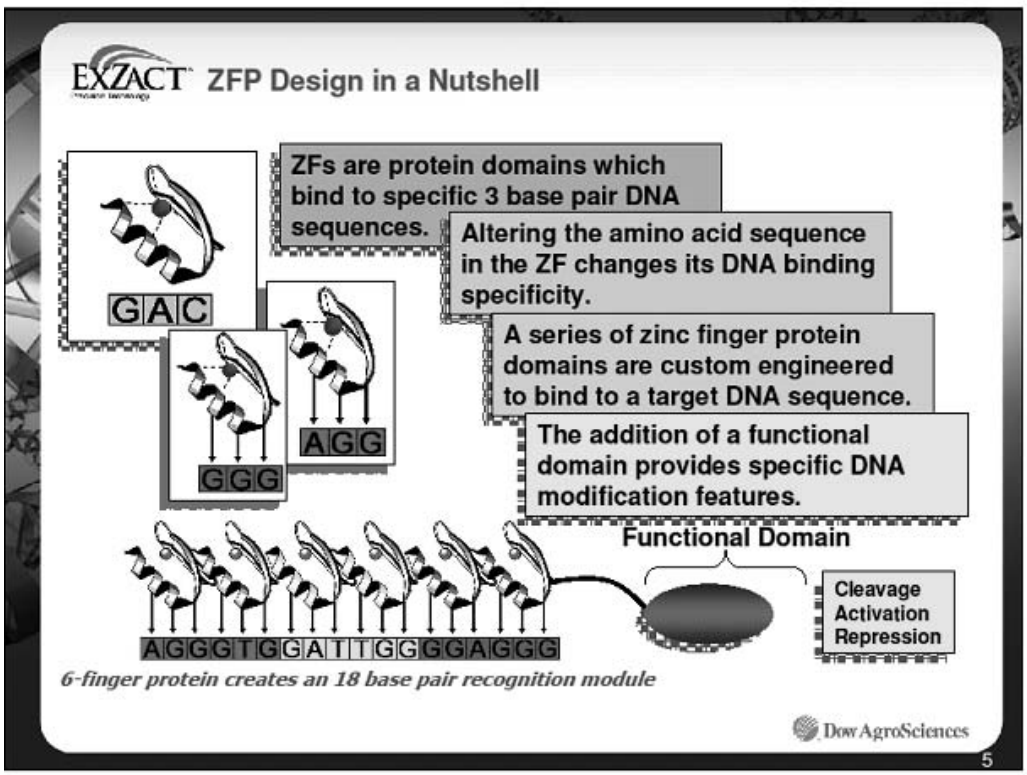
The use of genetic modification, artificial fertilisers and crop protection chemicals is interpreted as a key distinguishing feature between the Eco-economy and the Evergreen Revolution. Below, the point of departure chosen for the sake of simplicity is that present-day cultivation in developing countries or in tropical and subtropical regions can be interpreted as being either agribusiness or Eco-economy equatable with organic farming in the way outlined by Markus Kröger in the foregoing and that the Evergreen Revolution production model represents in the situation at the beginning of 2010 only one per cent of land use. Thus interpreted, the main distinguishing feature between the Evergreen Revolution operational model and the Eco-economy is above all the acceptance and use of genetic modification. Another difference concerns biodiversity. For the Eco-economy the present plants are more important than for the Evergreen revolution, which develops new varieties using genetic modification.

EU Council Regulation (EC) No. 834/2007 prohibits the use of genetically modified organisms in any form in organic production. The prohibition applies to fodder, foodstuffs, auxiliary substances used in manufacturing, crop protection chemicals, fertilisers, soil-improvement agents, seeds, plant propagation materials, microorganisms and animals. From the perspective of the Evergreen Revolution, by contrast, it is essential that the hegemony that large multinational corporations like Monsanto enjoy in genetic modification be broken.

The focuses chosen for genetic modification will be, rather than resistance to crop protection chemicals, in particular plants of many kinds with a better ability to tolerate drought, salinity and low levels of nutrients. In practice, a prerequisite for breaking the power of the large corporations would be above all less complex procedures for approving genetically modified varieties and perhaps also intervention in patent protection.

The global Evergreen Revolution is possible only if the acceptance rules for GM plants are changed. There are more and less risky applications of genetic modification. One possibility would be to permit a lightened acceptance process in cases where the GM plant could in principle be achieved using cross-breeding methods.

The newest methods in biotechnology make it possible to place a specific DNA sequence in an exactly defined place in a selected chromosome of a plant. The method of the zinc-finger nucleases or proteins (ZFP) might constitute a revolution in biotechnology comparable to the PCR (Polymerase Chain Reaction) of the 1990s. Its main features are described in the following picture.



If experiments can reveal the places in a plant's genome to which DNA is transferred in cross-breeding, these areas could be defined as areas in which plant genus specific DNA changes are permitted. With the aid of gene tests, it is possible using present-day technology to examine fairly well where in a genome genetic material has ended up. Most probably, also the use of the antibiotic kanamycin to ensure the transfer of a gene will become unnecessary already in the near future. Using ZFP it will no longer be necessary to transfer the marker gene of the antibiotic resistance.

Alongside precise targeting of DNA transfers, another way in which approval procedures could be made less ponderous is by changing the patenting regulation. If a genetic modification is made available without compensation for general use, the procedure for approving it could be simplified. It could perhaps also be possible to give preference to publicly funded research establishments in approval procedures.

A further criterion could be the purpose for which a modification is intended, although this does already affect approval. Corresponding to views expressed by the steering group of the Forests-Food-Water project in their interviews, genetic modification could be approved with the least restrictions for use in biofuels production, with more for use as raw materials to make fodder and with stricter controls when used in human food.

How could the development in the various updated scenarios be interpreted with the cultivation solutions described in the foregoing? Let us assume – following the figures presented by Kröger above - that nowadays about 50% of bioproduction in tropical and subtropical regions is based on agribusiness-type cultivation and just under 50% is equatable with the eco-cultivation model. Interpreting the matter thus, Evergreen-type cultivation is deemed to be still very rare. In the table, 1% of cultivation is considered to fall into this category. Very different kinds of interpretations of the present situation could also be arrived at, because a large part of cultivation has features belonging to more than one of the simplified cultivation models. Because, however, the purpose of the examination is to describe the change to be associated with the scenarios rather than the existing situation, the initial distribution is not of particularly great significance from the perspective of the examination.

Considering the very rapid development of biotechnology, there are very sound reasons to start from the assumption that organic farming-type cultivation will have become a marginal solution by 2050 at the latest. Only if some other area has remained outside the scope of technical development will organic-type cultivation be extensively practised there in 2050. That kind of possibility is strongest in the Order from Strength scenario, on the basis of which the share of organic-type cultivation in it will have reached 20% in 2050, with the other scenarios getting 10-15% shares.

It is probable that even in 2020 organic-type cultivation will remain an alternative to be taken very seriously. There is good reason for the interpretation that its share will grow in the Adapting Mosaic scenario. It is reasonable to assume that suspicions towards genetic modification will still be so great at this stage that the Evergreen alternative will achieve at best a 15% share of the cultivated area.

It can be anticipated that the fundamental change will take place between 2020 and 2030. It is fairly natural to assume that in 2030 organic-type and Evergreen-type cultivation will enjoy equal standing as alternatives. It is also natural to assume that the Evergreen alternative will be the strongest in the TechnoGarden scenario, which represents expert power. In the Global Orchestration scenario it is natural to assume that agribusiness will be dominant in 2020, but the Evergreen alternative will be a real challenge to it in 2030. It can be anticipated that Eco-economy it will lose ground slightly, but in the Adapting Mosaic scenario it will retain the status of agribusiness's main competitor.

Table 11.6 Millennium Ecosystem Assessment scenarios updated with respect to the main cultivation-mode solutions. The relative shares of the three basic bioproduction solutions in bioproduction in the world's tropical and subtropical regions by scenario, estimate for 2011 and anticipations for 2020, 2030 and 2050

	Alternative 1	Alternative 2	Alternative 3
Basic bioproduction solution in tropical and subtropical regions in 2009	Agribusiness practised on large areas of land and monoculture cultivation 50%	Eco-economy. Employment-generating cultivation based on local tradition and only slight use of artificial fertilisers 49%	Evergreen Revolution. Tailored use of bio- and gene technology, as well as of genetic modification in employment-generating cultivation 1%
Basic bioproduction solution in 2020	*Agribusiness*	*Eco-economy*	*Evergreen Revolution*
Global Orchestration	65	25	10
Order from Strength	60	39	1
Adapting Mosaic	40	55	5
TechnoGarden	45	40	15
Basic bioproduction solution in 2030	*Agribusiness*	*Eco-economy*	*Evergreen Revolution*
Global Orchestration	60	15	25
Order from Strength	60	25	15
Adapting Mosaic	35	45	20
TechnoGarden	35	30	35
Basic bioproduction solution in 2050	*Agribusiness*	*Eco-economy*	*Evergreen Revolution*
Global Orchestration	40	10	50
Order from Strength	50	20	30
Adapting Mosaic	30	15	55
TechnoGarden	30	10	60

11.7 The first scenario story: Global Orchestration

The updated scenario stories are told below "reminiscing backwards" from 2050. This was also the approach in the original scenarios. The events that, taking the recent development into consideration, are still very possible and topical have been extracted from the original, approximately 5,000-word description of each scenario (Carpenter et al. 2005 pp. 230-264). However, a lot of new material has been added to the stories and their plots have been revised on the basis of recent development. Three of the scenarios are more or less positive in character and the Order from Strength, negative. In the first three scenarios China is among the "good guys". In the last story it has been assigned the role of "villain".

Global Orchestration

Now in 2050 the world's centre of gravity is clearly located on the Pacific Rim. The shift away from the Atlantic became obvious after the economic crisis that began in 2008. Before the economic crisis, production in East Asia and especially in China primarily served western consumers. After it, the needs of the continent's own population were elevated to paramount status. To succeed in the world economy, the Europeans and Americans have had to take consumers in the BRICS countries (Brazil-Russia-India-China-South Africa) and especially Chinese consumers striving for "a little prosperity" as the starting point in their production. "A little prosperity" is a concept adopted by the Chinese Prime Minister in the early years of the 21st century. It characterised the living standard to which China aspired for all of its citizens.

China and the United States have become the world's leading nations. They work in good cooperation in Africa, West Asia and South America. The superpowers do not by any means specially emphasise their strong position. On the contrary, indeed, they consider themselves to be the guarantor states of a global consensus policy. The EU is still recognised as belonging, alongside the BRICS countries, Japan and the United States, to the world's leading powers. Admittedly, its influence outside Europe is considerably less than in the early years of the 21st century. The EU is respected as a kind of world values leader. Nearly all states in the world acknowledge that it has acted as a pioneer both in a socially responsible market economy and in mitigating climate change.

Now all recognise the devastating consequences of downplaying climate change. At the Copenhagen climate summit, as well as in several UN summits after it, the United States, China, India, Brazil and South Africa forged an alliance against the EU's climate change policy, which they considered too radical. According to the "moderate climate policy axis", each country should itself determine what level of climate change policy it could afford. Over the next 20 years, President Obama's closing speech at the Copenhagen climate conference was repeated many times. In his view, it is unreasonable to expect activity in climate policy from a country in which a significant part of the population lacks even electricity. It was not until a catastrophe in China in 2033 that talk of this kind was finally silenced.

A slogan that took shape at the UN and was often repeated was *Prosperity and health through joint efforts. People and also nature succeed by developing technology*. The "moderate climate policy axis" thus crystallised its policy. The central objectives of the policy were a raising of the standard of living everywhere in the world, as well as basic services associated with health and security. Climate change was to be mitigated without jeopardising the first two objectives mentioned.

The United States and China began almost simultaneously to underscore health and basic services for the population in their policies. As late as the early years of the 21st century, China did not find it a particularly big problem that income and wealth differences between its citizens were growing rapidly. The country's political leadership was often accused of pursuing the interests of elite groups only. In 2010s, however, enormous income differences, as well as inequality associated with health care and education began seriously threatening China's internal order, economic growth and the Communist Party's position of leadership.

The Chinese government changed the direction of its social policy after the global economic crisis that began in 2008. At the same time, US President Obama placed social equality at the centre of his policy. A step was the reform of the US health care system carried through in 2010. Although Obama's policy met serious difficulties at the beginning of the 2010s, e.g. the young people uprisings in North Africa kept social reforms on the global agenda. Successes in managing the 2008 economic crisis and mitigating swine flu and SARS epidemics likewise encouraged cooperation.

Alongside the new orientation in social policy, rapidly advancing technological development contributed to the United States – China axis's position of global leadership. Both countries have been in the vanguard of technological development. The countries that isolated themselves from the general technological development have realised that they have lagged fatefully behind in their production and missed the benefits of global interaction. In order to benefit from the new technology, education has been needed as well. Many developing countries have followed the example of Singapore and South Korea, which have been making inputs into education since as long ago as the 1990s. On that basis they prospered rapidly.

It was decided that the drawbacks of isolation also affected agriculture, as well as food and energy production. World agricultural trade was significantly opened up so that products from developing countries, too, were given a genuine opportunity to compete on an equal footing in the markets of the developed countries. At the same time, unfair subsidies for the promotion of exports of agricultural products from the developed countries to developing ones were prevented.

The opening up of world agricultural trade to fair competition, rapid technological development and faith in its superior possibilities led initially to large-scale cultivation being uncritically favoured. Agricultural production was made more efficient almost everywhere in tropical and subtropical regions by means of new, largely GM plant varieties, artificial irrigation, crop protection chemicals and fertilisers. Production did increase substantially and famines were avoided thanks to social programmes. At the same time, however, forests were still being cleared for use as farmland on a scale that was very problematic from the perspective of mitigating climate change and protecting biodiversity as late as the end of the 2010s.

Especially in the early years of the 2010s, agribusiness and monoculture cultivation were advancing strongly. An increasingly smaller part of cropland was left outside the scope of mechanised large-scale production. The significance of small-scale farming remained slight from the perspective of the GNP. It was associated mainly with cultivation for the farmers' own use and farming on poor-quality soil.

Gradually, however, the problems of increased agribusiness started to become acute. A problem that became a burning one already in the mid-2010s was the hegemony of big multinational corporations in agricultural production, which was based in particular on a few genetically modified better-yielding varieties. Free agricultural trade led to a rapid spread of alien varieties, which impoverished local ones and drove them to extinction. A poor level of environmental protection together with a substantial increase in irrigation, as well as a considerable increase in the use of fertilisers and crop protection chemicals led to

a deterioration of groundwater quality and the emergence of diseases and weed populations resistant to crop protection chemicals.

It was gradually realised that agribusiness with few varieties was squandering resources and had not been able to take into consideration and sufficiently utilise local conditions and varieties that functioned better locally. Fortunately, already in the 2010s, a comprehensive range of varieties were stored in international gene banks, something that made an important change in the mid-2020s possible. The vision of an "Evergreen Revolution" presented in the early years of the 21st century by the Indian scientist M.S. Swaminathan became important. In accordance with his ideas, rapidly developed new biotechnology and especially genetic modification began to be applied also in small-scale and employment-generating garden-type cultivation. New varieties were developed to use nutrients and water efficiently, as well as to stand frost, drought and salinity.

Social problems that had become acute also contributed to bringing about the change. In particular, the flight of rural populations to the slums in major population centres in the developing countries accelerated. Social problems in the megaconcentrations of population jeopardised the development of the entire globe due to radicalisation and crime caused by unemployment on an enormous scale. Growing unemployment began manifesting itself in the form of increasing health problems. Trained people working in the biosector in developing countries, who did not find work in their home countries, directed their activities especially against the multinational companies that dominated the biosector. Together, the countries of Asia, Europe, South America and Africa accomplished reforms in patenting and intellectual property rights to which the United States reluctantly agreed. These reforms made it possible to launch local pharmaceutical, gene technology and nanotechnology companies and orient them to serve local markets. The changes gradually staunched the brain drain from developing to developed countries and reversed the direction of its flow.

Thus, from a 2050 perspective a lot of positive things have happened in the world in the past 40 years. The number of people in a desperate situation in the world has substantially declined. A rise in the standard of living and improved social security have decisively contributed to the global population having stabilised at about 8.5 billion.

As mentioned in the beginning, now in 2050 the special focus of concern is climate change, which is threatening to slip completely out of humankind's control. A hefty bill for the wishful thinking of the "moderate climate policy axis" is now being presented to humankind. A shocking notice of this was received in 2033, when a cyclone destroyed 25% of the industrial facilities in the Hong Kong economic region, which is home to 25 million people. China finally changed from exerting a braking effect on efforts to mitigate climate change to being a promoter of effective measures in the world.

There has certainly been enough talk about mitigating climate change and related tinkering since 2010. However, the EU and Japan are the only ones among the world's powerful actors that have been prepared to make significant economic sacrifices to achieve this. In the majority of countries in the world, the only ways in which climate change was mitigated up to about 2035 were those meant to increase economic growth and companies' competitiveness beside the conservation of forests financed by the Green Climate Fund founded at the Cancun meeting in 2010. The United States made especially strong inputs

into producing biofuels from algae. A lot of new nuclear power capacity has been added, especially in Russia and some EU countries, even though the tsunami catastrophe at Japanese nuclear power stations halted many nuclear power projects. Japan has focused its resources on, among other things, electric cars and new battery technology, although the scarcity of electric power created serious problems after the 2011 catastrophe.

It is now clear that the awakening to the recognition of the climate problem came too late. Now in 2050 the global temperature is about 2.4º C higher than it was in the pre-industrial era. Greenhouse gas emissions are still about 65% of the 1990 level. Despite the fact that the world has stepped up its efforts in the past 15 years, achievement of the well-justified target of a 50% reduction set in Copenhagen in 2009 is still quite far off.

The EU has really earned its present status as the world's value leader. Under pressure from NGOs which have been working to mitigate climate change and communities of researchers, the Union has persisted doggedly as a pioneer in efforts to mitigate climate change. Alongside the development of its own production, it has more than fulfilled the funding commitments it made to the developing countries at the Copenhagen and Cancun UN climate change summits. Mainly thanks to the EU, destruction of the rain forests was finally ended. Since 2020, the area of rain forests has started slightly increasing again. In the period 2010-2020 approximately 50% of the loans and grants with which the EU has provided the developing countries have been approved to reduce emissions.

Now in 2050 the EU is an important supplier of technologies for mitigating climate change. It could have enjoyed even more success with its responsible orientation if a fearful attitude to the possibilities of new technologies and especially gene technology had not been adopted on the continent.

11.8 TechnoGarden

After the climate change summits in Copenhagen and Cancun, only a rare few believed it possible that rapid progress would be made in mitigating climate change. In 2013, however, China made a proposal that was surprising. It promised to reduce its greenhouse gas emissions by 15% from the 2005 level by 2025 if the United States committed itself to a 30% reduction over the same period. With respect to the EU, China considered its promise to reduce emissions by 30% from the 1990 level by 2025 to be sufficient. Also, other countries should be persuaded, inter alia by using trade sanctions, to implement comparable cuts, taking their present standard of living into account. The proposal was radically better than what had been put forward at the Copenhagen conference, because China no longer linked its emission target to the carbon intensity of the GDP.

Examined more precisely, China's proposal was not surprising. In the intervening three years China had obviously become convinced that climate change posed a real threat to it. Or at least that its position of leadership in the world demanded an active climate policy. One decisive factor may have been the genuine concern that the Chinese felt about methane emissions from melting permafrost (see the compilation below). Pressure for activity had also grown within China. In particular, it was important to calm the population of southern China. After cyclones, protracted periods of drought and other exceptional weather phenomena, it had really begun to fear the future effects of climate change.

Is melting of the Siberian permafrost causing a chain reaction that will rapidly warm the climate?[3]

Methane is 20 times more effective as a greenhouse gas than carbon dioxide. In 2009 the possibility was confirmed that the methane released by melting of the Siberian permafrost could trigger a chain reaction that would cause rapid global warming.

Professor Igor Semilotov's research team has been studying the methane hydrates, i.e. methane bound in ice, in the Siberian permafrost for the past twenty years. The methane is released when the ice melts, in principle when the temperature rises above 0° C. Under pressure, for example at the bottom of the ocean, the hydrates remain frozen at higher temperatures.

As the atmosphere warms, the Siberian coastal shelf is releasing methane into the sea at an accelerating rate. From his base at the University of Alaska, Dr. Semilotov is heading the International Siberian Shelf Study project. It has been observed in this research that in summer 2009 methane emissions were the highest ever measured in the Arctic Ocean. BBC News published an item about these methane emissions on 6.1.2010 (Fitzpatrick 2010). The worst scenario is that what is getting under way is a chain reaction that will heat up the entire globe as billions of tonnes of methane are released into the atmosphere. This has happened at least once in the history of the Earth.

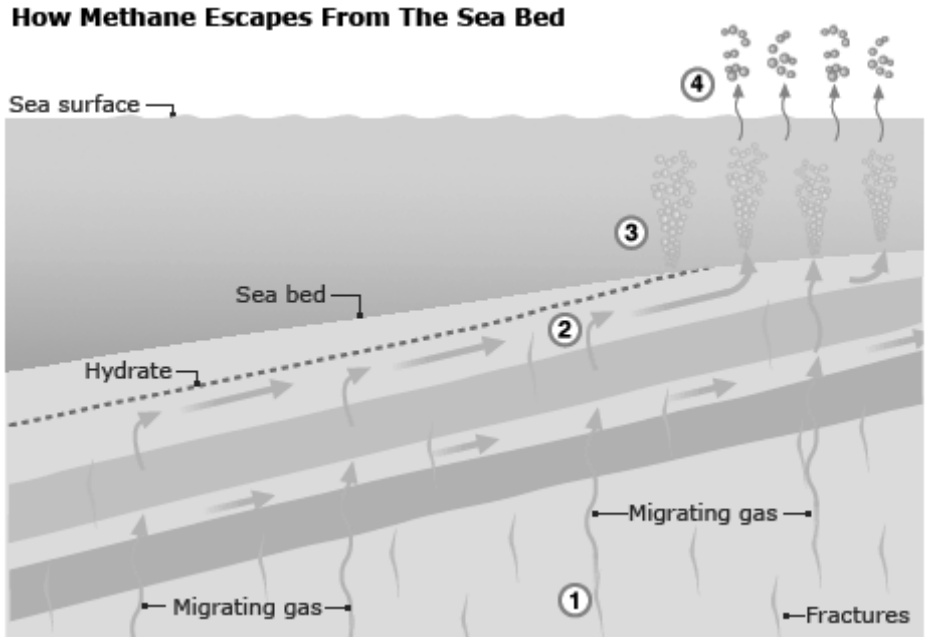
It was earlier believed that the sea absorbs a lot of methane emissions. However, according to a recent estimate by the Semilotov working group, undissolved methane appears to be rising into the atmosphere. One member of the working group, the Swedish professor Orjan Gustafsson, reported that in summer 2009 the methane level in the area was 100 times and in places 1,000 times higher than normal. However, he adds that further research is needed in order to understand the formation of emissions. In any event, a very major risk is involved, because by some estimates 1,600 billion tonnes of methane is bound in permafrost, which means about twice the amount of carbon as is now in the atmosphere.

That the Chinese government joined in the long-term effort to mitigate climate change was not surprising in the light of the country's recent history, either. Few other countries in the world would have been able to implement in practice the one-child policy that was decided on in 1979. A further demonstration of China's capacity for long-term action is its gradual changeover from a socialist economy to an open, but tightly managed market economy.

In its offer to the USA, China announced that based on thorough deliberation it had become convinced that there was reason to trust the calculations made by the Intergovernmental Panel on Climate Change IPCC in 2007 and that the risks of the permafrost melting in Siberia were really major. When the United States received the Chinese offer, the US administration's first reaction was natural. It initiated negotiations with China about the possibility of advancing at a slower pace in mitigating climate change. The funds to be saved that way could be used to improve the lot of the world's poorest and to mitigate climate change in the developing countries through the Cancun founded Green Climate Fund.

3 Professor-Emeritus Ossi Lindqvist supplied the material for this compilation

Diagram 11.1. How methane is released into the atmosphere from permafrost (Fitzpatrick 2010)



1. Methane hydrate is stable at high pressure and low temperature.

2. Nearer the surface, where water pressure is lower, hydrates break down earlier than at greater depth as temperatures rise.

3. Gas rises from the sea-bed in plumes of bubbles - some of it dissolves before it reaches the surface.

4. The ISSS team says it has detected methane breaking the ocean surface.

China stuck, however, firmly to the plan that it had proposed. Only with a programme of this level would it be possible to keep global warming by 2050 to less than two degrees. As a compromise, China was, however, ready to negotiate about an agreement where the reduction of emissions are partly compensated by greenhouse gas reductions in developing countries. China suggested that the USA would use for the purpose a general tax of 20-25$ per CO2 tonne greenhouse gas equivalent proposed by professor Nicholas Stern in 2010. This tax would both reduce greenhouse gas emissions in the USA and finance the mitigation of climate change in developing countries.

An indication of China's clear change of policy was that at the same time it began negotiations with the EU on trade sanctions against the United States. They would come into force if the United States had failed by 2015 to accept the proposed level of cuts in greenhouse gas emissions. An intense debate on the Chinese proposal began in the United States. A part of US industry, with the support of Republican politicians, launched an extensive press campaign to reject the proposal. In the campaign, the arguments put forward by climate

change critics were repeated and patriotic sentiment against China and the EU was stirred up. Perhaps what proved decisive was the stance adopted by the US information technology industry. Led by Microsoft and Google, it pointed out that it was time for the United States to accept realities and look to the future without getting bogged down in the past. Only the acceptance of China's proposal could secure the US a future as the world technology leader.

After a fierce debate, the US Congress accepted the Chinese proposal. However, it stipulated an important reservation. The objective would have to be achieved through strictly monitored global trade in emissions. This change suited China well, because in that way limitations on emissions did not threaten its own economic growth in the same way. China was also prepared to allow an international group of experts to conduct inspections on its territory.

In the global trade of greenhouse emission rights the value of an emission right is now based on the bonus system that takes into account the risks of wrong evaluation and cheating. Any actor in any country that has the legitimate ownership of emission rights or carbon sinks can register itself to the emission right trade in the scenario. The registration requires, however, a history of responsible behaviour. In the first stage, the new seller of emission rights does not receive the full price. As in the bonus system for cars, the full value emission right also requires trustful measurements over a long period without cheating in the emission trade.

For the practical organisation of trade in emissions, the UN Global Carbon Office was set up in 2015 and, subordinate to it, the Cancun founded Green Climate Fund and a new Green Technology Fund. The aim with the new fund maintained by industrial countries was to curb climate change by means of energy systems causing fewer emissions. Alongside the fund, a strong faith in the possibilities of technology facilitated the introduction of solutions with lower levels of emissions. So that the best technology would be quickly introduced everywhere in the world, it was considered especially important to create effective markets for the diffusion of environmental technologies.

Drafting technical standards and ecological parameters and applying them to various contexts was, and is, something that requires a high level of competence. The drafting of standards and parameters has been accomplished by collaboration between scientific communities, professional bodies, expert companies and NGOs. In practice, unelected technocrats belonging to these organisations have become important legislators in the world. Democratic oversight of the technocrats has been increased through the openness of their decisions and the reasons they present for them. Although nearly all of the information on which the experts base their decisions is now freely available on the Internet, very high demands, which must be certified through formal qualifications, are set for those who draft standards and parameters.

The Global Carbon Office set in train a worldwide process in which the aim was to designate legitimate owners of world ecological resources, such as soil, the seas, fresh water and natural forests. This was necessary for the efficient and justified trade of carbon emission rights.

With respect to seas, lakes and especially rivers that cross national boundaries, recognising and approving the parties that would benefit led to difficult negotiations. First of all, states quarrelled over transboundary freshwater resources. Often, the party that presented itself as the owner was a state, the representatives of which could, however, be regarded as speaking on behalf of only a narrow elite or interest group in the use of resources. For example, people who lived along rivers were in some cases initially not counted among resource owners at all.

As the outcome of long and awkward negotiations, agreement on the parties that benefit from water resources and on the general principles concerning the ownership and use of river flows was finally achieved in 2035. Now all water resources have a notional price, which is paid when water is used to the party collectively recognised as the owner of the water resources. The owners of water sources now pay to those who maintain their good quality. Those who weaken the quality of sources with pollutants have to pay to those who are recognised as the owners of the sources.

Similar principles as in the case of water use are observed also with respect to soil. Many of the values that local ecosystems produce, such as biodiversity and attractive scenery, have been chosen for measurement. Ecological markets have been created on different levels: locally, nationally, regionally and globally.

A responsible liberalisation of agricultural trade was a logical step in the promotion of eco-efficient production. Trade barriers and subsidies intended to increase local production promoted environmental emissions in wealthy countries. They also impeded development and weakened rural communities in developing countries. A broad alliance of neo-liberals, expatriate employees of multinational corporations, developing country activists and environmental activists combined their efforts against artificial barriers. This alliance was able to triumph over those who, invoking the drawbacks of globalisation, opposed opening up agricultural trade. Their victory was founded above all on the eco-efficiency of freer trade.

World trade in agricultural products is now decisively freer, but still regulated. It follows the policy that was adopted in the EU as long ago as the 1990s. Now farmers are not paid only according to the amount produced. By means of such instruments as taxation they are rewarded on the basis of what kind their production has been from the perspective of the operation of ecological systems.

Farmers now offer services like capturing greenhouse gases and many other kinds of eco-services such as providing nesting places for birds, ponds for fishing and protection of heritage landscapes. Already in 2015 about 50% of European agriculture and 10% of United States agriculture obtained its income primarily from sources other than quantitative agricultural production.

By abolishing export subsidies and other barriers to agricultural trade, food imports to wealthy countries were substantially increased. Agribusiness and big retail chains increased cultivation in Eastern Europe, Latin America and Africa. This boosted the efficiency of production in these regions.

The vision of an “Evergreen Revolution” presented in the early years of the 21st century by the Indian scientist M.S. Swaminathan, assumed an important place in the revitalisation of

agriculture in the world and India. In accordance with his ideas, the new technology that had rapidly developed, and especially genetic modification, began to be applied also to small-scale and employment-generating garden-style cultivation.

Increased cultivation of GM plants initially led to severe conflicts with those who cultivated using traditional methods, and especially organic farmers. Organic farmers could not get their produce to sell, because it was suspected of having been contaminated by GM plants. This required more precise deliberation of what kinds of ecological values had to be taken into consideration in cultivation. An important innovation was an easier approval procedure for genetic modification that applied to parts of a plant's genome that had been defined as safe. The new technologies - especially zinc finger nucleases - made it possible to transfer genes just to the planned places in the genome.

However, the production of pharmaceutical molecules in plants was found to be very problematic. When genes from plants that produced medical substances were transferred to other plants, health problems that were difficult to manage came into being. This led to cultivation of this kind continuing only in areas where there were few plant species and that were isolated from the rest of the world. Countries like Iceland and New Zealand have succeeded as cultivators of plants like these.

Genetic modification was made easier first in the production of energy plants and substitution for fossil fuels. GM energy cultivation was practised for twenty years or so without problems. In 2029, however, there came a severe setback. In this case, energy production was not involved, but rather an escape of GM algae from the Living Art exhibition in Tokyo into the city's water mains network. The spread of the algae through the system caused 189 deaths and an $18 billion cleanup bill.

For a long time, in order to protect organic farming, the EU opposed the idea of easier approval procedures for GM plants. Sub-Saharan Africa in particular became a testing ground for new GM technologies. Large sums of money flowed there to finance large-scale and bold cultivation experiments. This led to a revival of agriculture in the region. However, the region also suffered setbacks associated with the daring development of technology. In any event, by 2050 sub-Saharan Africa, which had been transformed into the world's "breadbasket", was difficult to recognise as the conflict-torn mystical region that it had still been in the early years of the millennium.

Now in 2050 it is possible to compare in a balanced way the benefits of GM plants relative to the deaths, illnesses and genetic contamination that they cause. Molecular biologists now generally acknowledge the incredible environmental merits of this technology, although some of them still grieve for the loss of non-GM nature.

New cultivated plants and trees have by no means been the only new forms of eco-technology. Various applications of information, material and nanotechnology have also been very important. The most advanced biotechnology is still being developed in the wealthy countries. However, most applications are made in small companies in the world's poorer countries to meet local needs.

The world in 2050 is cosmopolitan and wealthy, but inequality is still great. The population is 9 billion, half of whom live in Asia. As a result of greener energy production and more

efficient use of energy, world emissions of greenhouse gases reached their peak in 2020. They fell to less than the 1990 level a lot before 2050. Greenhouse emissions in 2050 are only 20% of the 1990 level and the temperature has risen by 1.4º C from this year.

11.9 Adapting Mosaic

When did the development that decisively changed the world in recent decades get under way? Should its roots be sought from a century ago? That was when talk of consumerism, i.e. of the power of consumers, first began. Or would a more natural starting point be about fifty years ago? That was when the first Internet communities of consumers began taking shape. One way or the other, consumers aware of their power of influence have played a key role in steering developments in recent decades.

Education in the world has risen to a completely different level than in 2010. The developing countries, especially, have used the Internet really effectively as a support for education. Even the most remote villages in developing countries acquired at least one computer with an Internet connection not later than in the 2010s. Thousands of online universities that offer their services everywhere in the world have been established. Young people in developing countries efficiently avail themselves of them.

In the 2010s, it was already possible for the leading group of young people in all countries of the world to educate themselves independently and comprehensively through the Internet. Interaction made it possible to share experiences and form shared views all over the world. The “crazy year” of 2011 in Arab countries was only possible based on the new information technology. The preconditions for a global awareness shared by the world’s young people and consumers were created at the beginning of the 2010s.

Of course, the unreliability of the Internet as a source of information has been a problem. The general critical perception of technology in the world is explainable to a significant degree by the fact that so many Internet sites magnify the fear of technology. Those who believe in technology are generally interpreted on discussion sites as irresponsible “emissaries of evil”, or at most specialist idiots with a defective understanding of the world.

Citizens have been encouraged through the Internet to act locally. A slogan that has established itself is glocalisation: *think globally and act locally*. Veterans have also related encouraging examples of how local communities and organisations have substantially changed the course of development in the past. The importance of NGOs was already grasped in many countries in the early years of the millennium. In the Philippines, for example, NGOs were already increasing rapidly around the turn of the millennium. There, the number of non-profit organisations grew from 18,000 in 1989 to 58,000 in 1997 and then to 134,000 in 2008.

The new online communities are not composed only of people with the same political interests; instead, many of them develop into very expert forums in questions relating to such matters as water supply, fishing, occupational safety and health care. Networking gradually leads also to the formation of important international consumer organisations, think-tanks and consultancy firms. These organisations and other communities formed through the Internet are now among the world’s most important decision makers.

These new communities have played an especially important role in mitigating climate change. Already in the 20th century, international organisations like Greenpeace and the Worldwide Fund for Nature were working actively to protect nature. It is largely thanks to them that, among other things, the first certificates of sustainable production from forests were issued. However, it was only when the new Internet communities came along that consumers and their organisations were propelled to the core of climate-responsible action.

The Copenhagen and Cancun climate summits and the weak efforts to mitigate climate change that followed them were a major disappointment to many young people who were very concerned about climate change. As late as the beginning of the 2010s the leaders of China, the United States, India and Russia were still not taking climate change seriously. The reasons were the conspicuous activities of those who denied the anthropogenic nature of climate change, lobbying by business and changeable weather like the cold spell immediately after the Copenhagen and Cancun summits.

What was probably the most important reason for negligence was, however, global competition for influence between the United States and China. These two countries were aware that they were the main rivals for influence in Africa, South America and West Asia. In this configuration of competition, the world's two superpowers found it difficult to keep mitigating climate change to the fore without jeopardising their economic interests. Fortunately, relations between the key influential actors in the world remained polite, though cool.

After the Copenhagen and Cancun climate summits in 2011 it soon became clear that mitigating climate change would be delayed. Not even the alarming reports about permafrost melting in Siberia have prompted concern on the part of the world's key decision makers.

Young people all over the world engaged in an intense debate on the Internet as to how to add momentum to the feeble efforts that were being made to mitigate climate change. It was obvious that merely making declarations would not help the matter. Direct influence had to be exerted on the multinational corporations that bore the key responsibility for the world economy. In addition to the young activists, the EU, too, was irritated at the way in which it was sidelined from the "moderate" group (the United States, China, India, Brazil and South Africa) when the key decisions at UN summits were drafted.

The EU, the environmental organisations and Internet activists found a common form of action in responsible consumption. A procedure resembling forest certification offered a practical operational model. Organisations and communities agreed that the EU, in collaboration with them, would assess the environment-friendliness of every consumer product. By 2015 an evaluation, based on clear criteria, of every consumer product could be found on the Internet. The key to recognition was the product's bar code or RFID code. Another important key to recognition was the place of manufacture. Internet consumer communities and environmental organisations then launched a worldwide campaign to encourage the use of especially good products and discourage the use of those deemed bad.

The products assessed as most environment-friendly in a category received an environment certificate. In 2015 some 25% of world trade was in certified products. By 2030 the

proportion had risen to 50%. Certification schemes also revealed the parties who on the local level pursued their own narrow interests with disregard for common objectives. Identifying them led to upheavals in the local exercise of power. For example, many corporate executives or local authorities who had obtained certificates under false pretences had to resign. The importance of certification was already very great by around 2020. Thus, 2022 saw the establishment of the Global Sustainable Ecosystem Business Organisation to coordinate this activity worldwide.

The Internet campaign made local environment-friendly products well-known and easier to obtain. The importance of local products became great, because progress in liberalising world trade and especially trade in bio-products was not made. Consumers were induced to develop an enthusiasm for both local products from their own area of residence and local special products from all over the world. States were not able to prevent unofficial and small-scale exchanges of goods via the Internet, and in the end did not really want to do so, either.

Multinational corporations likewise responded to consumers' changed purchasing behaviour. They began acting more and more locally instead of according to a global operational model. The most successful were the companies that let their local units act very freely in accordance with local circumstances. Local thinking was accentuated also in the UN's activities. The United Nations Regional Organisation (UNRO) was created in 2018. It was given extensive tasks in the development of regions and increasing cooperation between regions in education and training, environmental protection and human rights.

Without the EU and the online organisations' project, global warming would have progressed substantially faster. Influenced by the online campaign, the technology of mitigating climate change was developed actively, especially in the United States. Again, China was forced by consumer boycotts to speed up its phasing out of coal.

A cyclone in 2017 destroyed 25% of the industrial establishments in the Hong Kong economic region, which is home to 25 million people. Not even this enormous catastrophe led immediately to changes in the state climate policies of the world's economic superpowers. The main reason for the delay was the superpowers' rivalry for global economic influence; this was intense, but disguised by diplomacy,

It was not until 2019 that the US administration managed to get a really meaningful programme to reduce greenhouse gases through Congress. It was even more difficult for China to change over to actively mitigating climate change. It was only protests by thousands of young Chinese people on the Internet and in the streets that prompted the government to put mitigating climate change among its top priority objectives. The policy had to be changed, because criticism began to turn against the Communist Party's power in general.

One of the ways in which glocalisation manifested itself in the biosector was the organic cultivation that emphasised the healthiness of food. First-generation genetic modification aimed at plants' herbicide resistance ran into crisis in 2013. The reason was the spread of populations of weed plants resistant to crop protection chemicals, as well as suspicions that had been propagated, especially via the Internet, about the detrimental effects that crop protection agents had on human health. The position of the dominant force in gene

technology in this sector of application, Monsanto, collapsed also due to new patenting practices for bio-products.

Healthy food was given top priority. The health and safety of products was often resolved in court. Many countries even made healthy food a fundamental right of their citizens. At the end of the 2020s, the market share of organic food increased to 34% in Europe and 21% in the United States. Food also began to be increasingly seen as an important expression of local culture and identity. A clear positive effect of this development was less polluted water resources. Europe and Finland were among the world leaders in organic cultivation in the early years of the 2010s.

Organic farming was efficiently shielded from "genetic contamination". Around 2025, however, the EU countries and their citizens also began to be more favourably disposed towards genetic modification of local species. New varieties were developed to make efficient use of nutrients and water, as well as to resist frost, drought and salinification.

Concrete demonstrations of the possibilities of second-generation genetic modification were realised in India. The vision of an "Evergreen Revolution" that M.S. Swaminathan in particular had presented in the early years of the 21st century assumed an important role from 2025 onwards. In accordance with his ideas, the new biotechnology that had rapidly developed, and especially genetic modification, began to be applied also in small-scale and employment-generating garden-type cultivation.

Although the operational model based on locality has had many advantages, looked at from the perspective of 2050 it has led to many problems as well. One of the most difficult has been associated with exploiting the seas and maritime fishing. Since it was not possible to reach international agreement on utilisation of the sea, fish stocks were not exploited sustainably, particularly in the 2010s and 2020s. Problem regions such as those in sub-Saharan Africa did not receive sufficient support to resolve their problems. Since problems have been managed locally, resources have also been squandered on multiple sets of administrative machinery. Many tasks could have been taken care of with considerably less administration, if matters had been managed centrally.

Now in 2050 greenhouse gas emissions are about 45% of their 1990 level. The global temperature rise now in 2050 has been about 2.1 º C compared with 1990.

11.10 Order from Strength

Globalisation drifted into an open crisis in the early half of the 2010s when relations between, on the one hand, China and the countries allied with it and, on the other, the axis formed by the United States, Europe and Japan became inflamed. On the surface, the explanation for this was China's being accused of supporting terrorism and treating its Western-minded dissidents heavy-handedly at home. China's climate policy, which was regarded as irresponsible, has been put forward in the West as a reason for a "new Cold War", too. In the end, China did not agree to allow an international verification group to examine what the country's real greenhouse gas emissions were, contrary to what was agreed at UN climate summits.

However, the most fundamental reason for the development has been China's active efforts that have jeopardised the Western countries' and Japan's interests in developing countries. Also in the background was a smouldering fear in the countries of the United States-EU-Japan axis of losing high-competence jobs and their living standards being jeopardised. The axis was not ready to give a dishonestly behaving China a leading technical and economic status in the world. China was perceived as competing unfairly for influence, because it did not criticise its partners' societal solutions. Wanting to be freed from the Western countries' nannying caused many states, including those with radical Islamic or totalitarian backgrounds, to ally themselves with China. This provided arguments lending strength to accusations that China was supporting international terrorism and tyrannise.

The situation became especially inflamed after a terror strike against a French nuclear power station had been launched from one of China's allies in 2015. Accusations and counter-accusations led to China's beginning to arrest those of its citizens it considered excessively sympathetic to Americans and especially to Europeans as dissidents who endangered its stability. Every country in the world had to choose sides. The alliance led by the United States, the EU and Japan gave special privileges to countries that agreed to the rules it defined.

Relations between Russia, India, Brazil, South Korea, South Africa and China have fluctuated rapidly between favourably disposed and hostile. Disputes over land and sea areas, as well as their natural resources have created tensions between China and Russia, although they have felt an attraction for each other's "guided democracies". India has regarded China as a good trade partner, but has found its fraternisation with countries that have Islamic backgrounds problematic. Guarding their economic interests, Brazil, South Africa and South Korea have been performing a balancing act between the USA-EU-Japan bloc and the one led by China.

Something that has added further difficulty to the situation is that there have also been tensions within the EU-USA-Japan axis. The EU and the United States have formed partially competing groupings of countries and China has adopted a more positive attitude to the United States and Japan than to the EU. As a close neighbour, Japan has been a natural trade partner for China, although the Chinese political leadership has at times stoked up a sense of common national spirit by recalling events during the Second World War. European moralism in relation to climate change and social issues has really irked the Chinese leadership. Only after the catastrophe in 2039 in the Hong Kong area was China's leadership forced reluctantly to admit that climate change is an urgent issue.

One strengthening alliance has been formed by the EU, the Commonwealth of Independent States (CIS) countries and a few African countries. These African countries have been granted advantages in the European market. Cooperation between the United States and Latin America has become firmer and at the same time Latin America's ties to the rest of the world have weakened.

No one spoke seriously about a general liberalisation of world trade after relations between the main blocs had become inflamed in the wake of the terror attack on a French nuclear power station in 2015. After that incident, the World Trade Organisation (WTO) ceased to operate in practice. It became more difficult for large multinational corporations

to operate internationally and they had increasingly to fragment their operations between independent regional units. It was only after détente between the blocs had got under way in the late 2030s that plans for a free trade system covering the whole world began again.

The countries of the United States-EU-Japan axis have found industrial espionage and thefts of industrial ideas to be a very serious problem. Sanctions against countries that have violated these rights have been harsh. In addition to their strict protection of intangible property rights, the developed countries have used subsidies, tariffs, import quotas and eco-labels to protect their own production. The developing countries likewise try to protect their domestic production using, for example, export quotas. In a spirit of ascendant nationalism, various countries developed an interest in their own special biological heritages. Powerful nationalistic criticism was focused on the Monsanto corporation's dominant position. In India active patriotism concerning development of gene technology enjoyed an upswing on the basis of M.S. Swaminathan's ideas.

Only the wealthy countries have had the resources to provide subsidies and other forms of support for their domestic agricultural production. Although the residents of developing countries thus obtained cheaper food, prospects for profitable local production of foodstuffs dwindled at the same time. Sometimes this benefited the environment in that it was spared because of reduced production. Production in the developing countries is concentrated on commodities that are not produced in the developed countries: tropical woods, minerals, fish, wild animals, and so on. This use of natural resources has often been devastating for ecosystems.

Favouring domestic production and strict protectionistic shielding of industrial rights have clearly supported the economic hegemony that the United States-EU-Japan axis enjoys in the world. China with its bloc has been able to reduce these countries' technological lead slightly. Compared with the economic growth that could have been achieved without conflicts between blocs, both sides have suffered. However, the Chinese-led bloc has suffered markedly more.

Those who have really suffered have been the developing countries. Agricultural technology has been so expensive that farmers in poor countries have not been able to afford the technology that is best from the perspective of sustainable use of the soil. In addition to a reduced volume of production, plant diseases have afflicted fields that are cultivated using old methods. On the other hand, a desire to reach the wealthy countries' standard of living has been great in the poor countries. To achieve sufficient production, new fields have been cleared and areas important for biodiversity have been destroyed. Especially in densely populated regions, so many natural environments were destroyed before 2040 that floods, drought and erosion led to undernourishment and diseases.

The wealthy countries have perceived the hordes of immigrants trying to cross their borders as a threat to their security and way of life. The "crazy year" of 2011 in Arab countries resulted in a large inflow of refugees to Europe and made attitudes towards immigrants very hostile. Very strict measures to prevent immigration became widespread in the 2010s, especially after a terror 2015 attack on a French nuclear power station. Before 2040, only persons with education, wealth and a safe background were allowed to enter the United States, the EU or Japan, even as tourists. Development aid from the countries of the United

States-EU-Japan axis was harnessed primarily to support security-related objectives. Of course, climate-related objectives were also underscored when aid was being granted, but happily it was still a really important criterion for receiving grants in EU projects. Many developing countries, however, refused to accept aid on such terms. Instead, they resorted to the aid that came with fewer strings attached from the Chinese-led alliance.

In the impoverished developing countries, the education of women has especially been neglected, which has led to a more rapid increase in population. The number of people in the world is now approaching 10 billion. This, together with the reduction in aid from the wealthy countries, has led to population clearing new cropland. Two-thirds of the forests that existed in Central Africa in 1995 have been destroyed by 2050. The proportion of forests destroyed in Asia is 40% and in South America 25 %.

With attention concentrated on security questions, environmental issues have been addressed only in countries that acknowledge the importance of climate change. It has been very difficult to agree on the key global challenges. A configuration of confrontation between the EU-United States-Japan coalition and the coalition led by China has always been run into. Thus, besides mitigating climate change, the regulation of sea fishing and countering disease epidemics are also matters in which progress has been poor. However, slow global economic growth has slowed down global warming.

The EU has stuck to its 2010s emissions targets and mitigating climate change has continued by means of various types of conferences e.g. UN summits. Gradually, as environmental technology has become more economical, the other countries in the EU-United States-Japan coalition have also reduced their greenhouse gas emissions, although the United States has done so markedly more slowly than the others. After a pause as the result of the 2011 nuclear catastrophe in Japan, many EU countries have resorted to nuclear power. They realised that it is the best way both to achieve their agreed emission targets and to preserve their international competitiveness as carbon leakages to other countries threatened. A further factor that has slowed climate change is the EU's practice of linking its development aid fairly tightly to its climate-related objectives. However, since the EU had to compete with China for influence, especially in Africa, it has had to compromise to some extent there on its strict principles with regard to mitigating climate change.

Although the countries of the EU-United States-Japan coalition committed themselves to rather strict emission limits in the period after 2020 as well, a comprehensive and tight agreement to slow down climate change was not achieved on the global level until 2042. That agreement was finally reached then is explained by the shocking events of 2039, when a cyclone destroyed 25% of the industrial facilities in the Hong Kong economic region with its 25 million inhabitants.

China has still not admitted the significance of its own passivity in the genesis of the catastrophe. Nevertheless, China and the coalition headed by it agreed in 2040 to a strict programme to arrest climate change. In the atmosphere of strong mistrust between the blocs, however, it was almost impossible to agree on how compliance with the arrangement would be controlled. Negotiating a credible system of verification delayed the achievement of agreement until 2042.

Around 2020 the significance of the UN shrank to almost nothing in a world divided between blocs. Only since 2040 has its importance begun growing again at the same time as the world has begun awakening to an awareness of the inescapability of mitigating climate change.

Thanks mainly to slow economic growth, the efforts of responsible countries and new technologies, the greenhouse effect has not been able to exert its full force. Now in 2050 greenhouse gas emissions are about 50% of their 2000 level. The rise in the global temperature between 1990 and 2050 has been 1.9º C.

11.11 Action possibilities in Finland and the updated UN Millennium Ecosystem Assessment scenarios

The updated UN Millennium Ecosystem Assessment scenarios are a global futures map, a map that can be used as a starting point not only when deliberating Finland's choices in a global operating environment, but also when pondering the solutions that are to be made inside Finland. The scenarios can be used especially to ponder occupations and employment opportunities ("green jobs"). Green jobs are those jobs that within the framework of the scenarios will promote the visionary targets of the globally responsible bio- and climate policy. An interpretation of the visionary targets was formulated on the basis of interviews with the Members of the Finnish Parliament in chapter 10. The examination might be especially focused on those of the Finns' occupations and job tasks that will make sense in the world of around 2040, where mitigating climate change has been actively grasped in all of the updated Millennium scenarios.

Below, the scenarios are compared only briefly with the four scenarios outlined in the Finnish Government's report on the future (Government future report 2009). The domestic scenarios for mitigating climate change can be interpreted as action strategies that make sense in different ways in the circumstances of the four global scenarios. The following table presents a simplified general evaluation of how the Government's four scenarios (see sub-chapter 10.1) are suitable as operational models for the four updated Millennium Ecosystem Assessment scenarios. The most suitable solution is marked with the number 1 and the least suitable with a 4.

Table 11.7. Links between the updated Millennium Ecosystem Assessment scenarios and the Government's climate change scenarios

	A. Efficiency revolution	B. Sustainable everyday kilometre	C. Better on own resources	D. Technology decides
Global Orchestration	2	3	4	1
Order from Strength	1	2	4	3
Adapting Mosaic	3	2	1	4
TechnoGarden	1	3	4	2

In the Global Orchestration scenario the world concentrated for a long time on raising the standard of living and improving social security in the developing countries before it woke up to an awareness of climate change. The way that makes most sense in these circumstances is to mitigate climate change by building nuclear power capacity, because it does not jeopardise international competitiveness. Energy conservation using new technology, i.e. the efficiency revolution operational model, does not jeopardise competitiveness, either. However, developing new energy technology can be more difficult than building nuclear power capacity when the rest of the world hardly compromises at all on its energy consumption because of climate change. One side of the sustainable everyday kilometre, i.e. substituting Internet links for travelling can be an excellent way of acting in the scenario. If, however, the cost of travelling remains moderate, motivation to travel less can be difficult to achieve. From the perspective of a scenario founded on broad international interaction, striving for self-sufficiency, i.e. the Better on own resources scenario is an odd solution.

The aim in the TechnoGarden scenario is to act, using the means that technology provides and as rapidly as possible, to prevent climate change. In a global environment that strongly emphasises eco-technologies, the efficiency revolution operational model is the most natural. In energy consumption, the prevailing techno-optimism is in favour of nuclear power besides renewable energy sources. That is in accordance with the "Technology decides" scenario. Travelling can also be replaced quite quickly by Internet connections, i.e. with the Sustainable everyday kilometre operational model. Gradually, it is also possible to change the community structure into one that consumes less energy. Because the world solves problems through orchestration, there is hardly any need to reduce (eco)efficiency through Better on own resources.

A change in consumers' attitudes and way of life to depend on local resources and mitigate climate change locally is central to the Adapting Mosaic scenario. What is also very natural in this scenario that rests strongly on using the Internet is less travelling. Interaction can happen much more based on the Internet. A further feature of the scenario is a strong suspicion of technology, focused especially on genetic modification and nuclear power. In other words, the green technologies of Efficiency revolution and especially the nuclear power of Technology decisions are not in line with the Adapting Mosaic scenario.

Safety issues and especially minimisation of the risks associated with terrorism are accentuated in the Order from Strength scenario. In principle, nuclear power is an efficient form of energy that guarantees certainty of energy supply, but the threat of terror strikes against nuclear power stations that is associated with the scenario makes it less promising. Because trade functions relatively well within the United States-EU-Japan bloc, there is no particularly great need to develop one's own relatively inefficient solutions when others can be obtained from abroad. Since, in addition, determined efforts are being made within the US-EU-Japan bloc to mitigate climate change, the mode of action that emerges as the best is the Efficiency revolution. The Sustainable everyday kilometre ideas of substituting for travelling by using Internet connections and having an energy-efficient community structure also suit this scenario fairly well. In a scenario where economic growth is also otherwise slow, there will hardly be a particularly positive attitude to local energy production, at least if it raises the price of energy.

It can be stated in summary that from the perspective of the updated Millennium Ecosystem Assessment scenarios the Efficiency Revolution operational model would appear to be the best way of preparing for various futures. The Sustainable everyday kilometre scenario also offers an operational model that suits all of the scenarios quite well, especially by substituting Internet connections for physical travel. The "Technology decides" scenario, based as it is on nuclear power, is quite a good solution in the Global Orchestration and TechnoGarden scenarios, but is clearly in conflict with the world of values of the Adapting Mosaic scenario. In the Order from Strength scenario, protecting nuclear power stations from terror attacks lessens the desirability of this solution. Looked at from the perspective of the three Millennium scenarios, the "Better on own resources" scenario seems to be the alternative that works worst. If, however, the Adapting Mosaic future with its accentuation of localness comes to pass, this operational model will be well justified.

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