Sten Nilsson • Fredrik Ingemarson

Global Foresight 2050

Six global scenarios and implications for the forest sector

Global Foresight 2050 – Six global scenarios and implications for the forest sector
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Foreword

This report outlines emerging developments in society and their possible impact on the forest sector. It provides a context for scientists and decision-makers alike on the role of foresighting for taking proactive steps to meet the challenges that an uncertain future brings. The report is intended to assist the forest sector, in particular *the Swedish University of Agricultural Sciences (SLU)* and *the International Union of Forest Research Organizations (IUFRO)* and its member organisations, in opening their mind-sets and adapting strategies in accordance to development of forest and society towards 2050.

The work has been initiated and supported by the Think Tank for International Forestry Issues, SIFI. The authors as well Ass. Prof. Jonas Rönnberg are members of the SIFI advisory board. The steering group from SLU consisted of Ass. Prof. Karin Öhman, Dr. Rosario García and Ass. Prof. Jonas Rönnberg.

We are convinced that this text will lay the foundations for a real intellectual exercise for individuals and organizations challenged by complex futures. Prof. Nilsson's and Dr. Ingemarson's experiences from policy analysis of natural resource management from all over the world permeate the report and help the reader find a systematic and pattern-based understanding of future scenario analysis. We sincerely hope that this comprehensive compilation of possible future scenarios will be truly useful for the forest sector and sectors connected to it.

Jonas Rönnberg
Vice Dean, SLU

Alexander Buck
Executive Director, IUFRO

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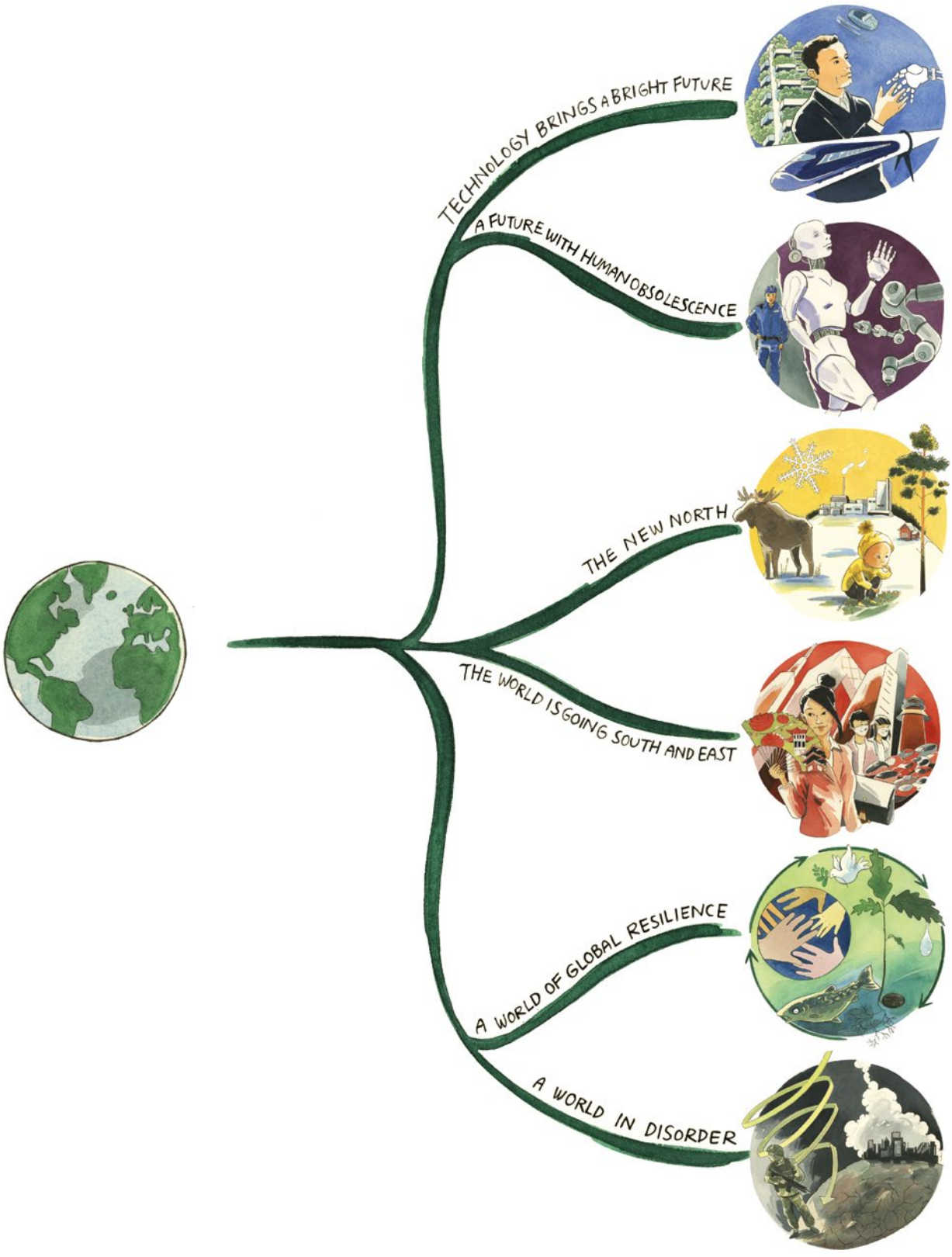
Six global scenarios



Summary

The aim of this report is to inspire organisations to improve their preparedness for uncertain and complex alternative developments and futures. The authors have been commissioned by *the Swedish University of Agricultural Sciences (SLU)* to produce global scenarios for 2050, each one with its implications for the global forest sector. These scenarios are to support strategic operations at SLU and the work of *the International Union of Forest Research Organizations' (IUFRO) Task Force Foresight for Forest Sector Planning*. These scenarios are also intended to be valuable to any other actors involved in the global forest sector and sectors connected to it.

THE SCENARIO PROCESS

The purpose of the scenario process is to train decision-makers and organisations in detecting changing futures and handling unfolding new futures in a suitable manner. Scenarios are part of foresight studies. They are not predictions, rather provocative and plausible stories about how different paths of development might evolve. Six global foresight scenarios are presented based on economic, technological, political, societal and environmental developments by 2050. These scenarios should be interpreted in pairs with the following primary features characterising each pair: technological development and employment (Scenarios 1 and 2), competitive market development (Scenarios 3 and 4) and global policy development (Scenarios 5 and 6). Each scenario is also analysed considering its implications for the global forest sector. The final section of the report outlines the implementation of the scenarios through a possible foresight exercise.

THE SIX GLOBAL FORESIGHT SCENARIOS

1. Technology Brings a Bright Future
2. A Future with Human Obsolescence
3. The New North
4. The World is Going South and East
5. A World of Global Resilience
6. A World in Disorder

SIX GLOBAL SCENARIOS FOR 2050

A summary of the six global scenarios for 2050 and their key trends are presented below.

TECHNOLOGY BRINGS A BRIGHT FUTURE / SCENARIO 1

The numerous massive threats experienced by the world in the 2020s united the world's leaders and major corporations and caused them to invest heavily in advanced technological development. After this turning point, humanity entered a long period of radical transformation in which technology enjoyed the potential to significantly raise basic standards of living into a world of clean water, nutritious food, affordable housing, personalised education, top-tier medical care and non-polluting energy. The transformation affected how we live, work, survive and thrive. Now human, machine and nature are strongly interconnected. The exponential growth of technology has been critical for creating a world of abundance, providing goods and services for everybody. Technological solutions, including social engineering, are sought to meet all major challenges. The transport sector has been revolutionised, climate mitigation will be successful and the majority of *the UN Sustainable Development Goals (SDGs), Agenda 2030,* will be met, but the natural resources are over-consumed.

A FUTURE WITH HUMAN OBSOLESCENCE / SCENARIO 2

By 2050, advancing technology has created structural unemployment in all professional categories. Oft-praised technological developments have improved living standards for some people around the world, but an increasingly large element of the population is suffering from declining standards. The substantially increased gap regarding economy and values in society is not only between rich and poor, but also between urban and rural. The costs for social and health care are a tremendous burden on the economy. Social unrest is extensive and is a high-risk factor for societal development. Consequently, national and international efforts concentrate on security issues. If the overall global goal is to enjoy an equal and equitable world, it is clear that technological development has not managed to contribute to this goal. The result is greater pressure on natural resources, low or stagnated global economic growth, weak governance and climate goals and SDGs are not met.

THE NEW NORTH / SCENARIO 3

The current state of the world and a broad set of physical, ecological and societal forces have set *the New North* in motion. Climate change is forcing a massive ecological reorganisation worldwide with huge losses and extinctions of species. Livelihoods and health are threatened in all regions of the world. The world is urbanised, the US and southern hemisphere are cracking apart due to globalisation and uncertain politics. The situation is different in the North. Natural resource limits and armed conflicts in the southern hemisphere have led to a boomerang effect favouring the North. Compared to other regions of the planet, negative climate change effects are less severe in the North and the region has the preconditions to meet the SDGs. The northern hemisphere occupies a leading position in innovation, governance, preparedness for change and is rich in natural resources in the form of energy carriers, minerals, water, land and forests.

THE WORLD IS GOING SOUTH AND EAST / SCENARIO 4

The dominating trend is characterised by a shift away from Western dominance towards a greater heterogeneity in the world. Increased globalisat-

South-to-South trade, multiple centres of power and networks of mega cities characterise global development. The values and innovation systems of the Asian region will dominate the development of the world. By 2050, the Asian region leads world development both economically and geopolitically. Asia's total GDP is over 50% of global GDP, almost as dominant global economic position as it had before the industrial revolution hundreds of years ago. Africa is showing substantial growth potential due to demographics and structural improvements. Still, these regions face severe challenges, including inequality, extreme urbanisation, corruption, weak institutional capacity, poor governance, declining economic growth, insufficient energy efficiency, environmental degradation, overexploited natural resources, water stress and climate change. Climate and SDG commitments are not met in this scenario.

A WORLD OF GLOBAL RESILIENCE / SCENARIO 5

Technological developments have substantially contributed to the de-materialisation of the global economy. A transition has taken place from neo-classical economic valuations to valuations including environment, inclusiveness, justice, equality and ethics. Priority has shifted away from efficiency maximisation to focus on vulnerability, mitigation and resilience in all domains of society. The world evolves fuelled by a strong global policy dialogue based on cross-society governance dialogues and consensus concerning the sustainable development of natural resources. The world is driven by global agreements on bioeconomic regimes, resulting in sustainable social and economic conditions. This concept resulted in major investments by governments and corporations in infrastructures to make material management more efficient. Climate and SDG commitments are met. The West maintains its leading position, quality of life across the world has reached a historically high level and the number of poor people globally is at a very low level.

A WORLD IN DISORDER / SCENARIO 6

The world has turned authoritarian by 2050. The world experienced a historic turn inwards to homogeneity enforcement and trumpeting of exclusive national virtues. The conventional world collapses, separatist movement and geopolitical conflicts char-

acterise development. Global dialogues are dominated by individualism and protectionism resulting in declining global trade. Negative developments have surfaced very rapidly in many domains of global society and quality of life has deteriorated substantially. The extent of obsolete industrial capacities has caused severe de-industrialisation caused by globalisation and uncertain political futures, as well as rapid technological transformation. Global agreements are not fulfilled, followed by ruined markets, armed conflicts and over-exploitation of natural resources. The guiding hand of governments and the restraining pressures of morality are gone. All efforts concentrate on military and security issues and the SGDs are far from met. International and national crime levels have become the highest in history.

IMPACT ON THE GLOBAL FOREST SECTOR IN 2050

A summary of the implications for the global forest sector for each scenario is presented below, after the introduction of the conventional wisdom. This first section, is a base line, presenting the conventional wisdom for the global forest sector by 2050. In the report, this is a separate chapter with the aim of establishing a foundation for better understanding of forest impacts in the six global scenarios.

CONVENTIONAL WISDOM FOR THE GLOBAL FOREST SECTOR IN 2050

The Conventional Wisdom for the Global Forest Sector in 2050 is a baseline scenario with the aim of assessing how the future may develop based on today's situation. During the 2000s there was a major increase in pressure on natural resources and forests were no exception. This pressure affected most parts of what we consider the natural world: animals, plants, genes, land and water to mention but a few. By 2050, global industrial wood demand has grown, and Asia is the driving force. The conventional forest industry has contracted in developed economies. Climate change has taken its toll, but lifestyles have become potent multipliers of human pressure on natural resources, constituting a much greater threat than the total population alone. Globally, forest is still losing diversity and forest-based species. The global forest sector has not yet found a common tool for how to handle sustainable biodiversity. The quality and quantity of water supply has declined substantially in areas which have lost forests or had their forest areas transformed.

TECHNOLOGY BRINGS A BRIGHT FUTURE / SCENARIO 1

Technological development has been very rapid in many different technological fields. This development has resulted in the introduction of many new products and materials that were unknown in the 2010s. Many of these products, often bio-based, have better environmental characteristics and higher value to the customer than conventional wood, paper and paperboard products. Thus, these new products are produced outside the conventional forest sector and in units gaining from strongly reduced economies of scale. Developments have resulted in less demand for conventional industrial wood and the major part of this supply is taken care of by the fast-growing southern plantations. Priority for forest governance in large parts of the world has largely shifted from growth and yield of timber to other ecosystem services, such as nature recreation and tourism issues. New research institutions have been created based on broad system links as well as full-scale trials of human-nature-technology systems.

A FUTURE WITH HUMAN OBSOLESCENCE / SCENARIO 2

By 2050 global society is divided, leading to peculiar consumption patterns. One very rich segment with strong links to the technological sectors and another larger, poor component of society not able to do so are unemployed and fighting for survival. Technology advances lead to the production and consumption of new products with better characteristics than conventional paper, paperboard and sawn wood products. However, the poorer group cannot afford these products and have to live with conventional and less value-added forest products. A substantial part of forest resources is utilised for energy production. The industrial structure utilising woody biomass is divided into two branches with one being old and not up to date together with a basic bioenergy industry and one smaller, hypermodern branch with high value-added production. The overall weak economy and the fact that the poorer segment of the society needs access to the forest resources for survival in order to avoid political unrest, results in very weak governance of forest resources.

THE NEW NORTH / SCENARIO 3

The world has experienced a boom in population growth dominated by the emerging economies in Africa, India and Southeast Asia. Population growth has also pulled up the global economy substantially. These growth regions are also the centres for globalisation in 2050 but also for negative climate and environmental effects. This development drives a substantial demand for both conventional and new forest products. Natural resource limits and armed conflicts in the southern hemisphere lead to a boomerang effect favouring the North. This has turned out to be a win-win situation for the conventional forest industry of the North with rich experience and solid infrastructure for in-depth, innovative work. The structure of the forest industry in the North is currently a mixture of giant, scale-dependent industries and small, non-scale dependent industries. Still, it is a struggle for the North to find skilled workers for industry and not least for the management of forest resources. This is due to rapid urbanisation and the declining economy of rural areas.

THE WORLD IS GOING SOUTH AND EAST / SCENARIO 4

The tremendous economic growth in Asia is causing rapid growth in consumption of conventional forest products. Asia and India are the leading world regions in the development of new bio-based products. China is now assessed to have a deficit of wood products together with the rest of Asia and India in the magnitude of 500-600 million m^3 round-wood equivalents. In spite of the fact that Africa is a large continent with lot of forested areas, the region is also assessed to be a region with a forest products deficit in the magnitude of 100 million m3 round-wood equivalents. China, the rest of Southeast Asia, India and Africa are experiencing huge problems with their forests losing ecosystem functions day by day, which undermines the sustainable development of the societies in these regions and cause risks and conflicts. Regions with long experience of sustainable management of their forests have great opportunities to sell knowledge services to these fast-growing regions.

A WORLD OF GLOBAL RESILIENCE / SCENARIO 5

The world in 2050 is characterised by a consensus on the sustainable development of natural resources, building on solidarity and bio-economy approaches instead of neo-classical economics based on increased consumption. This has resulted in less material consumption and forest products are not excluded from this. Industry has been forced to move into the production of bio-chemicals and other brand-new bio-products. This transformation has been too slow so far, resulting in a constrained market for small-sized wood which results in passive forest owners, poorly-maintained forests and supply problems for sawn logs. In the Southern hemisphere, the pressure on forest resources has eased, with less deforestation and forest degeneration as a result, thanks to technological advances, the introduction of global agreements and strong sustainability agendas. Due to the fact that societies make high quality of life a priority, nature recreation and tourism, including forest tourism, is booming with an increasing share of forest sector economy. Scientists have become much more active in the public debate concerning forest resources.

A WORLD IN DISORDER / SCENARIO 6

This is a tragic world with nationalism, protectionism and international conflicts. The forest sector suffers tremendously, like all other sectors. The global economy is in a tailspin; China has collapsed and global trade is minimal. Primary demand for forest products is driven by domestic consumption. The industry is hardly earning any money and is not able to make new investments so maintenance is a problem. There is not much technological innovation or development with bearing on the forest sector. The ecosystem functions of the existing forests decline dramatically as governments withdraw from international agreements made in the field. These depressed conditions result in limited harvest levels and neglected forest management. The overuse of forest resources and neglected forest management leads to never before experienced emissions of greenhouse gases from forest ecosystems.

FORESIGHT EXERCISES

The real value of the report presenting the six global scenarios for 2050 surfaces when the scenarios are implemented in a foresight exercise. The aim of the implementation process is for an organisation to be prepared to transform in accordance with the requirements set by the surrounding, rapidly-changing world. The key to the successful implementation of foresight exercises is the understanding of how an organisation is affected by both known and unknown conditions.

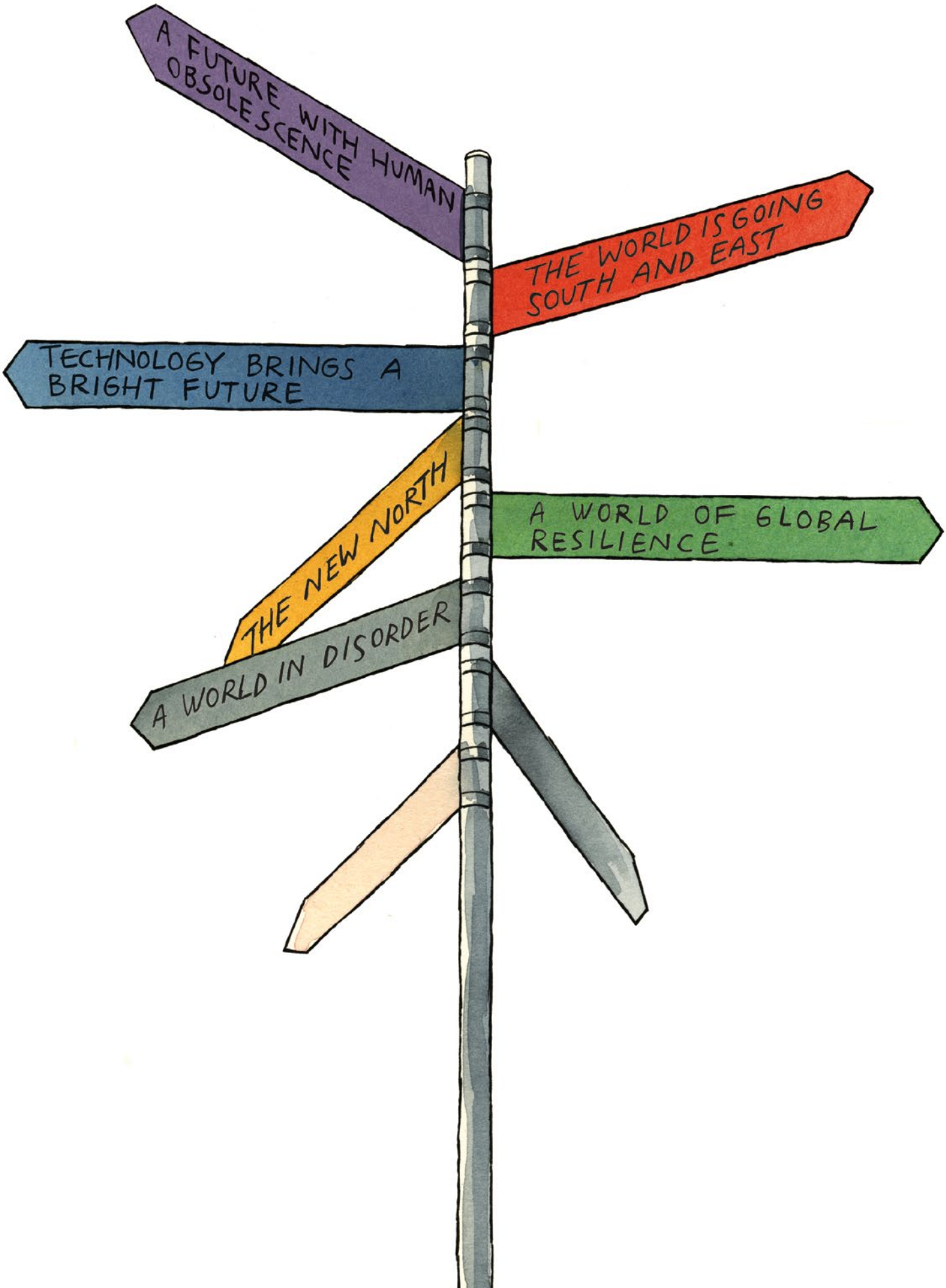
WORKSHOPS BUILDING ON STRONG DIALOGUES

The task is to engage the staff of an organisation in forming the organisation's future and to draw from the knowledge built up in the organisation itself in dealing with these scenarios. One well-established method in project management is to engage staff in workshops building on strong dialogues. An outline of a full day's workshop is presented in the final section of the report.

CHALLENGES AND OPPORTUNITIES

Once it has gained general acceptance, the foresight process and its output is used by the organisation to broaden thinking, clarify choices, articulate visions, suggest new strategies and craft a proposed agenda for change. The foresight process results in deep organisational learning and, ultimately, in the ability to change in response to both challenges and opportunities. A successful exercise following the guidelines in this report requires changing mind-sets and substantial resources allocated to carry out the required processes. It is suggested that this type of scenario exercise be carried out at regular intervals, depending on objective, but at least every four years.

Different paths of development



1 Introduction

The aim of the report is to inspire organisations to promote preparedness for alternative developments and futures. Six global foresight scenarios for 2050 are presented based on economic, technological, political, societal and environmental developments. Each scenario is also analysed considering its implications for the global forest sector. The last section of the report outlines the implementation of the scenarios through a possible foresight exercise.

1.1 FORESIGHT AND SCENARIO STUDIES

Foresight studies play an important role in identifying future challenges, opportunities and threats for different sectors of society and associated organisations. Foresight studies is the discipline of postulating possible and probable futures. It seeks to understand what is likely to continue along existing lines and what could plausibly change dramatically. The discipline seeks to find a systematic and pattern-based understanding of the past and present and to illustrate possible future events and trends. The purpose of the scenario process is to train decision-makers and organisations in detecting changing futures and handling unfolding new futures in a suitable manner. Scenarios are part of foresight studies. They are not predictions, rather provocative and plausible stories about how different paths of development might evolve, such as future demographics, social values, markets, energy demands and natural resources. Because scenarios are hypotheses, not predictions, they are created and used in sets of multiple stories. Scenarios are designed to broaden thinking about opportunities and threats that the future might hold and are used to complement other efforts to create strategic plans, visions and agendas for change. The aim of the scenario approach is to improve ability to make decisions today and in the future through a deeper understanding of the world in which the relevant organisation operates.

Scenario approaches are a tool to open up the view of the staff of an organisation as concerns complex and rapidly-changing developments. It is suggested that insights from the scenarios should be carefully evaluated when preparing new strategic agendas and when making both short and long-term strategic decisions. Unlike many strategy development efforts that are designed around the creation of a strategic plan, scenario thinking is an ongoing, collaborative process in dialogue form. It results in deep organisational learning and, ultimately, in the ability to change in response to both challenges and opportunities. By broadening employees' view of the future, the scenario approach can support the understanding of a decision taken by management regarding organisational change.

THE SCENARIO APPROACH is not based on a single, well-defined methodology, but is a collective term for the development of a set of scenarios used to understand different possible futures. The scenario approach could be divided into *Predictive, Normative and Exploratory scenarios*. *Predictive scenarios* are based on today's situation and predict how the future may evolve based on assumptions about what drives development. *Normative scenarios* or backcasts are performed the other way around and assume a desirable future state and then try to analyse how to best move from the current situation to the desirable future. *Exploratory scenarios* are based on our best knowledge of the certain uncertainties that affect future development. The purpose of exploratory scenarios is to understand the span between a num-

ber of different, but at the same time possible, future developments in order to increase preparedness for alternative developments.

1.2 THE MISSION

The authors have been commissioned by *the Swedish University of Agricultural Sciences (SLU)* to produce global scenarios for 2050 with implications for the global forest sector. These scenarios are to support strategic operations at SLU and at the work of *the International Union of Forest Research Organizations' (IUFRO) Task Force Foresight for Forest Sector Planning*. The aim of the report is also to provide a platform for SLU and IUFRO to learn, adapt and act on strategic priorities.

These scenarios are expected to be valuable to other actors involved in the global forest and connected sectors. They may also help SLU and IUFRO take more active part in the discussion on the development of the global forest sector. This is in line with the SLU strategy of strengthening its international profile.

In this report, six global scenarios for 2050 are employed capturing a range of future possibilities for global development. The global scenarios developed could stand alone and be used for thought provocation to broaden thinking about possible paths of development, but the true value of the scenarios comes when they are implemented in an organisation's strategic work through foresight exercises, as illustrated in the final section of the report. A prerequisite for successful implementation of these scenarios is strong acceptance and involvement by the upper management of the organisation carrying out the foresight exercise.

COMMON APPLICATIONS OF THE SCENARIO APPROACH

1. Collaborative learning
2. Alignment and visioning
3. Setting strategic direction
4. Catalysing bold action

1.3 THE SCENARIO PROCESS

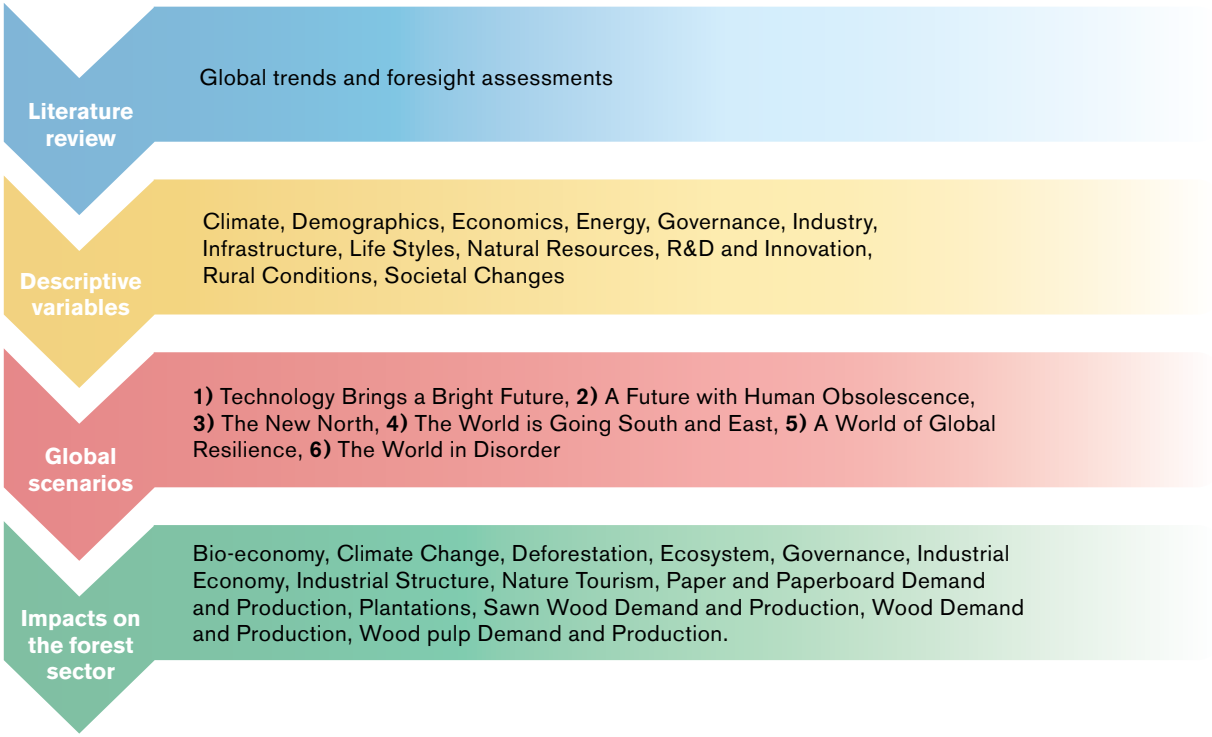
The process for developing these global scenarios and their implications for the forest sector was divided into the following steps: 1) Literature review, 2) Identification of descriptive variables, 3) Global scenarios and finally 4) Impact on the forest sector, as presented in *the Figure* below.

The initial step of the work of this report was to review an extensive list of literature (see the reference list at the end of the report). These references consisting of global trends and foresight assessments constitute the basis of the approach and the scenario descriptions in the report.

Certain trends can be assessed with a relatively high level of precision. Demographics, infrastructure, education and Research and Development (R&D) trends are fairly predictable in a ten-year perspective. Our period of analysis covering 30 years generates a lower level of precision so *exploratory scenarios* is an appropriate methodology to identify future challenges and to increase preparedness for alternative developments. Climate change and increased weather volatility are predictable, but do contain substantial uncertainties. Trade trends, as well as global dependence on energy and commodities, are relatively stable but can shift quickly due to political decisions. National institutions and norms, including democracy and fundamental freedoms and corruption, are slow-moving entities and in most cases major international, national or regional shocks are required to change these trends.

On the other hand, international relations, national political agendas and domestic policy developments and priorities can be swiftly altered and are thus more unpredictable. When countries with larger economies, with significant military capabilities, nationalistic features and political uncertainties end up in conflict, even slow moving

FIGURE. *The process for developing the global scenarios and their implications for the forest sector.*



global trends can be shifted dramatically and rapidly. In other cases, cataclysmic events, such as pandemics, antibiotic resistance, deep economic recessions or unexpected climate change impacts are required at extreme proportions to break down, for example, demographic trends.

THE SECOND STEP of the scenario process was to identify the variables or uncertainties that affect possible future developments. The variables, presented in the section *Descriptive Variables for the Scenarios,* were generated from the literature review and the authors' interpretations. The variables selected are the following: *Climate, Demographics, Economics, Energy, Governance, Industry, Infrastructure, Life Styles, Natural Resources, R&D and Innovation, Rural Conditions, Societal Changes.* The definitions of these variables are presented in *the Appendix*. The intercorrelation between all these variables is often strong, consequently it may not be evident or useful to present the level of impact for certain singular variables in each scenario development. Still, the authors have compiled the Table below, presenting a simplified description of the positive or negative global impacts the various variables exert on the scenarios developed.

THE THIRD STEP, using the variables as a point of departure, was to create prescriptive and exploratory scenarios to understand possible future global developments. The aim of the exploratory scenario approach is to increase preparedness for alternative developments. The six global scenarios for 2050 presented are interpretations made by the authors based on a common understanding of possible developments and on the literature review. The six global scenarios are presented in *Chapter 2*. A detailed presentation of the descriptive variables in relation to each scenario is presented in *the Appendix*. These scenarios should be interpreted in pairs with the following primary features characterising each pair: technological development and employment

TABLE. *The descriptive variables with various positive or negative global impact on the scenarios (strong +++/−−−, medium ++/−−, or low +/− impact).*

	TECHNOLOGY FUTURE	HUMAN OBSOLESCENCE	THE NEW NORTH	SOUTH AND EAST	GLOBAL RESILIENCE	WORLD IN DISORDER
CLIMATE	+++	+	−−	−−	+++	−−−
DEMOGRAPHICS	++	−−	−	+	++	−−−
ECONOMICS	+++	−−	+	++	+++	−−−
ENERGY	+++	+	+	+	+++	−−−
GOVERNANCE	+++	−−	+	+	+++	−−−
INDUSTRY	+++	−	+	++	++	−−
INFRASTRUCTURE	+++	−	+	+	+++	−−
LIFESTYLES	++	−−	+	++	+++	−−−
NATURAL RESOURCES	+	−−	−	−−	+++	−−−
R&D AND INNOVATION	+++	−	++	++	+++	−−
RURAL CONDITIONS	+	−−	−	−−−	+++	−−−
SOCIETAL CHANGES	++	−−	−	+	+++	−−−

(Scenarios 1 and 2), competitive market development (Scenarios 3 and 4) and global policy development (Scenarios 5 and 6).

THE TABLE shows the descriptive variables with various positive or negative global impact on the scenarios (strong +++/---, medium ++/--, or low +/- impact). It should be pointed out that the result of a scenario process is a constantly moving target. *The Table* is an interpretation of the analysis and may change from day to day, interpreter to interpreter and from organization to organization.

THE FORTH STEP of the scenario process was to illustrate the possible implications of these global scenarios for the global forest sector. First, a base line was compiled presenting the conventional wisdom for the global forest sector in 2050. This could correspond to a predictive scenario for the forest sector, based on today's situation, aimed at assessing how the future may develop based on assumptions on the development of different drivers. This section of the report illustrates the authors' interpretations regarding generally-accepted views of developments by experts in the forest sector field and in accordance with the literature review.

THE GLOBAL SCENARIOS developed present other possible future development patterns that notably lead to different implications for the forest sector in comparison to conventional wisdom. These scenario impacts on the global forest sector by 2050, as interpreted by the authors understanding of available information on world development, are presented in *Chapter 3*. The literature used is presented in the reference list at the end of the report.

THE IMPLICATIONS FOR the global forest sector in the scenarios for 2050 rest upon the following factors: *Bio-economy, Climate Change, Deforestation, Ecosystem Services (including forest for the production of food and medical plants), Governance, Industrial Economy, Industrial Structure, Nature Tourism (including urban forestry and life style), Paper and Paperboard Demand and Production, Plantations, Sawn Wood Demand and Production, Wood Demand and Production, Wood pulp Demand and Production*. These factors exert varying impact in the different scenarios.

THE SIX GLOBAL FORESIGHT SCENARIOS

1. **Technology Brings a Bright Future**
2. **A Future with Human Obsolescence**
3. **The New North**
4. **The World is Going South and East**
5. **A World of Global Resilience**
6. **A World in Disorder**

The scenarios should be interpreted in pairs with the following features characterising each pair: technological development and employment (Scenarios 1 and 2), competitive market development (Scenarios 3 and 4) and global policy development (Scenarios 5 and 6).

2 Global scenario description for 2050

Six global scenarios for 2050 are developed and presented in this chapter. These scenarios should be interpreted in pairs with the following factors characterising each pair: technological advancements (Scenarios 1 and 2), competitive market positions (Scenarios 3 and 4) and global policy and governance development (Scenarios 5 and 6).

2.1 TECHNOLOGY BRINGS A BRIGHT FUTURE / SCENARIO 1

The numerous massive threats experienced by the world in the 2020s united the world's leaders and major corporations and caused them to invest heavily in advanced technological development. After this turning point, humanity entered a long period of radical transformation in which technology enjoyed the potential to significantly raise basic standards of living into a world of clean water, nutritious food, affordable housing, personalised education, top-tier medical care and non-polluting energy. The transformation affected how we live, work, survive and thrive. Now human, machine and nature are strongly interconnected. The exponential growth of technology has been critical for creating a world of abundance, providing goods and services for everybody. echnological solutions, including social engineering, are sought to meet all major challenges. The transport sector has been revolutionised, climate mitigation will be successful and the majority of *the UN Sustainable Development Goals (SDGs), Agenda 2030,* will be met, but the natural resources are over-consumed.

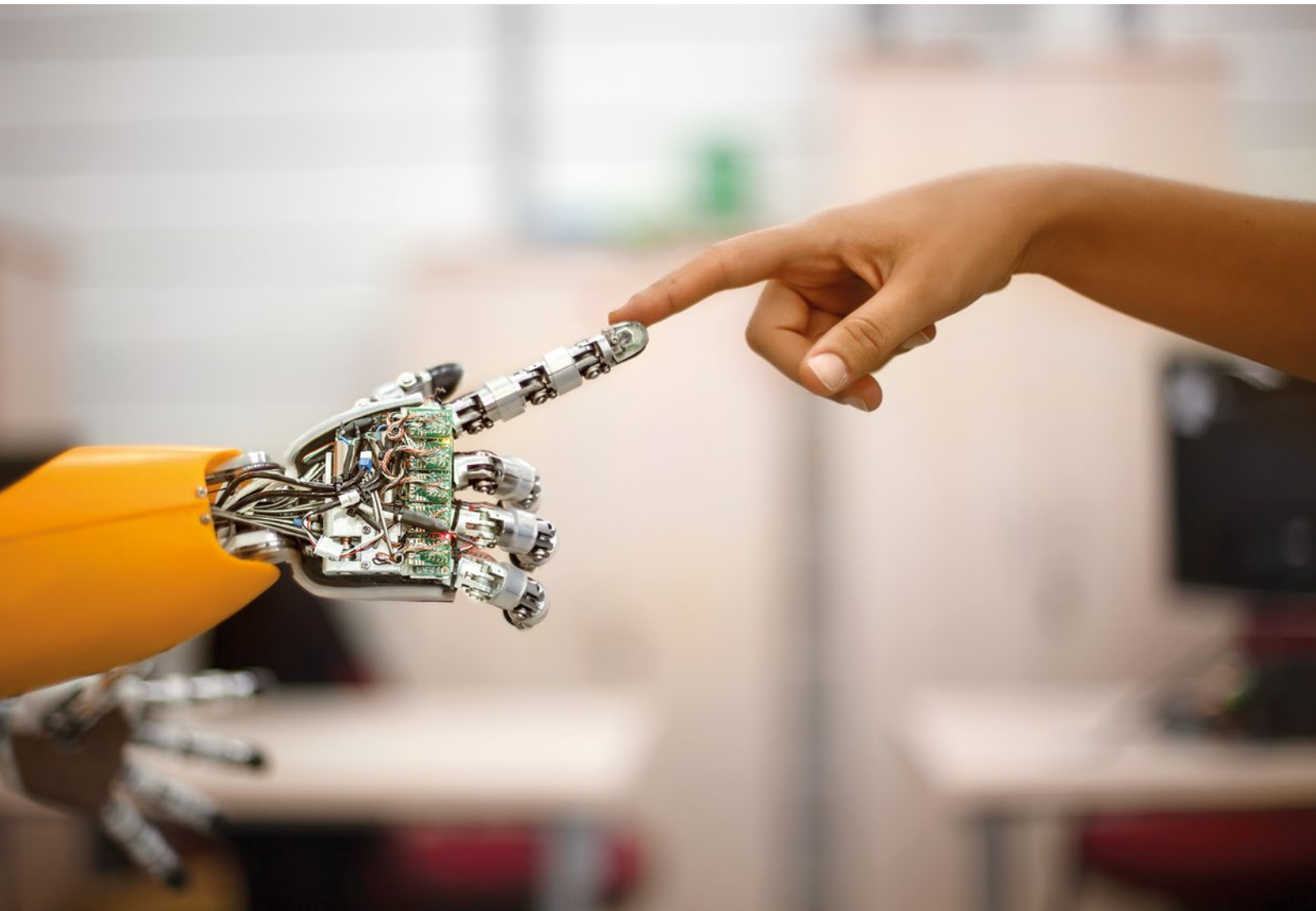
ABUNDANCE OF OPPORTUNITIES

This is a world of information and communication abundance. Advances in new transformational technologies and computational systems – networks and sensors, artificial intelligence, human-machine interfaces, biomedical engineering, robotics, biotechnology, bioinformatics, 3D and 4D printing, nanotechnology – all give most of humanity access to a dramatic increase in living standards. The world is now full of abundance, not for a life in luxury but for a life of nearly unlimited opportunities. The previous educational system was built on a one-size-fits-all framework; the current educational system is decentralised, personalised and extremely interactive.

The combination of cloud computing, artificial intelligence and LOC technology greatly benefits society. A lab-on-a-chip (LOC) is a device integrating one or several laboratory functions on a single integrated circuit. The combination and interconnection of the rapidly- developing technologies creates this abundance of opportunities for everyone to considerably improve their living conditions and to contribute to a sustainable planet. The population of 9.7 billion people are heading into a world of clean water, nutritious food, affordable housing, personalised education, top-tier medical care and non-polluting energy. Around 2010 there was an intense debate about technological singularity. Some defined it as general technological progress causing accelerated change. Others tied it to the invention of artificial superintelligence causing dramatic changes to human civilisation. Now both definitions are a reality with major changes to society. Technological solutions, including social engineering, are sought for all major challenges. Technological innovations have permeated every geographical market, every economic sector and every business on the planet. Now human, machine and nature are strongly interconnected.

BIOTECHNOLOGY AND DIGITAL MANUFACTURING

The exponential growth of biotechnology has been critical for creating a world of abundance. Biomi-



metics has given rise to new technologies inspired by solutions on macro and nanoscales. Green plants and meat are made in laboratories by using the chemistry of assimilation. By modifying the DNA of a novel form of algae it is possible to create a new kind of synthetic life, to produce high-performing human vaccines within hours, to increase agricultural yields 50-fold compared to the early 2000s and to achieve highly efficient, low-cost fuels. What is termed biologics have helped tremendously in discovering the cure for cancer and Alzheimer's Disease and in making 100-year-long human life spans the rule rather than the exception.

IN 2050, nanotechnology and nanomaterials are very common features of society and are employed in manifold applications in every sector of society. This technology makes production of materials within materials possible, embedding and weaving materials of soft and hard materials into complex structures. Nanobots can take any material apart, atom by atom, and these atoms are used to construct whatever you wish to construct. Nanocomposites are substantially stronger than conventional materials and can be constructed at a fraction of the cost. Nanotechnology enhances human performance and brings us closer to sustainable development in the use of materials, natural resources, energy and food.

Digital manufacturing, or 3D and 4D printing, has revolutionised societies. It is used by every kind of industry from industrial designers to transportation and the construction industry. Biotechnology firms use the technology to produce organs and digital manufacturing is used to produce prosthetic limbs. Cloud computing and the development of nanotechnology has made 3D and 4D printing particularly powerful. 3D or 4D printing has reduced manufacturing costs dramatically due to lack of economies of scale. Technology has transformed marketing completely due to rapid prototyping. Every individual has access to a 3D or 4D printer, making it possible to produce any physical item from digital blueprints.

The medical domain has been transformed dramatically. Breakthroughs in biotechnology have already been discussed above. These occurred in combination with the development of *the Lab-on-a-Chip (LOC)*. A blood sample is fed into an LOC, the data is uploaded to the cloud and analysed for deeper diagnostics in specialised centres. It is accurate, low-cost, easy-to-use and diagnostically useful. This results in less pressure and demand on nurses and doctors. Once the global economy ran on oil, now it runs on data.

ARTIFICIAL INTELLIGENCE

By 2050, networks, sensors and drones, also called *the Internet of things*, can capture an enormous amount of data the planet itself generates from natural and social systems and physical objects. Companies are now able to match product demand with raw material needs, streamlining supply chains and minimising waste. Efficiency and productivity have increased exponentially. Energy efficiency in industry has become world changing. The connected sensors on families of drones linked to the Internet makes it possible to sense and report data and pictures of what is happening in nature in real time. Drones can also function as robots and carry out emergency services or maintenance in places that were previously too distant or too difficult to reach.

"Once the global economy ran on oil, now it runs on data."

ROBOTS HAVE BEEN the vehicle of social transformation and have increased the global economy by several orders of magnitude. Chip development has been enormous: they now communicate using light and not electrons. Thanks to these new chips, supercomputer performance has increased a thousand-fold since the 2010s. Robots have taken over most production in factories with dramatically increased productivity as a result. There are also personal robots that help by carrying out many daily chores in the home. Robots in the form of nurses take care of the elderly and robot physicians make healthcare efficient, affordable and easily accessible. Artificial intelligence has taken over much of

the diagnostic function in healthcare and in education at all levels. Artificial intelligence experienced a breakthrough in automobiles in the early 2020s with self-driving cars. This intelligence has further developed so some 50 million car accidents a year have been avoided, thereby saving about 1.2 million lives.

EMISSION-FREE ENERGY CONSUMPTION AND REVOLUTIONISED TRANSPORT SECTOR

Thanks to the *Internet of things*, we can now control our environment very efficiently including how we distribute, use and recycle resources. Our houses are net producers of energy, are recyclable and can think for themselves. There are now tremendous opportunities for radically new, efficient and emission-free energy consumption, resulting in no energy shortage. Also, it is now possible to easily convert carbon dioxide into ethanol by reacting carbon dioxide with water using a simple catalyst. Point-source emissions are effectively controlled in most countries but cumulative emissions from diffuse sources persist. Solar power is now the world's major energy source. The cumulative effects of integrated technologies have made it possible to substantially reduce Green House Gas (GHG) emissions over the last 20 years. However, there is a lag effect in climate impact so the world is still suffering from the effects of climate change.

The transport sector has been revolutionised over the last 30-year period with autonomous cars powered by electricity or fuel cells. Vehicles are driven by artificial intelligence and are fuelled by hydrogen or electricity produced by solar energy or wind as the chief energy source. Even trucks run on fuel cells and are autonomous, a large portion of mid-range aircraft use electricity and ships and trains use fuel cells. New efficient railroad corridors have been established in regions such as in Asia and the Middle East. A global super grid of mega transporters has been established with zero emissions and a low general environmental footprint. The different transportation modes are interconnected via cloud computing and traffic organisation and design are highly efficient.

MAJOR CORPORATIONS AND INCREASING INEQUALITIES

There is a constant flow of technological innovation, which creates new industries faster than ever before as well as revolutionising existing operations. The economy has experienced vigorous growth over a fairly long period. Global markets continue to expand, but wealth is very concentrated in major corporations. Major technological corporations dominate the international scene and strongly influence governments. International cooperation is directed towards business goals and the control of the cumulative negative effects of economic growth and patterns of consumption. Material conditions have improved for a large proportion of the global population, but inequity has increased and is at high levels within, and between, countries. For people working in the poorly-paid service sectors, life remains a struggle. Special efforts are made with respect to the conflicts arising from increasing inequalities between countries.

INDIVIDUALISED CONSUMPTION AND NATURAL RESOURCES

Consumerism is the supreme value in society. Individualisation is a phenomenon around the world and has led to individualised consumption and customised lifestyles. This individualistic society is possible due to new technological solutions, good incomes and strong healthcare. These shifts have transformed society and regional trade flows. Some corporations question the short-term consumerism that comes with rapid technological advances and argue, in self-interest, for more long-term horizons. Due to rapid technological advances and extraordinarily high economic growth there is an over-consumption of natural resources. There are concerns about this development. The issue is to balance increased demand for natural resources for economic reasons with increased ecosystem services, recreation and cultural demands. These conflicts have increased strongly since the 2020s.

Natural forests are increasingly disappearing and being replaced by engineered plantation systems (GMOs). Agricultural productivity has increased dramatically in parallel with rapid technological and GMO developments. Agroforestry has become the most efficient form of food production in many parts of the world. There are communities with smaller populations which have completely disappeared since they have not been able to link up with the rapid technological development.

2.2 A FUTURE WITH HUMAN OBSOLESCENCE / SCENARIO 2

By 2050, advancing technology has created structural unemployment in all professional categories. Oft-praised technological developments have improved living standards for some people around the world, but an increasingly large element of the population is suffering from declining standards.

The substantially increased gap regarding economy and values in society is not only between rich and poor, but also between urban and rural. The costs for social and health care are a tremendous burden on the economy. Social unrest is extensive and is a high-risk factor for societal development. Consequently, national and international efforts concentrate on security issues. If the overall global goal is to enjoy an equal and equitable world, it is clear that technological development has not managed to contribute to this goal. The result is greater pressure on natural resources, low or stagnated global economic growth, weak governance and climate goals and SDGs are not met.

A DIVIDE BETWEEN OLD AND NEW INDUSTRIES

The rapid development of technological progress seen in recent decades in different fields has created a different reality today. Accelerating automation technologies have invaded many of industries that have traditionally been labour intensive. This process has caused the creative destruction of old industries and generated new ones that employ very few people. The overall economy has become less labour intensive and reached its tipping point a couple of decades ago. Beyond this tipping point, the economy has not been able to absorb jobs lost due to massive technological progress. Businesses have mainly invested in new technologies, so societies have experienced huge job losses resulting in a substantial decrease in global consumer spending and lost tax income for nations. Weak consumer spending has, in turn, pushed investments toward cost cutting and labour-saving technologies. This has resulted in even more unemployment and a downward spiral.

Technological advances substantially reduced emissions due to improved material use, better logistics, new bio-based products and emission-free energy carriers which has resulted in no energy shortage. New industries and the wealthier part of the populations have been able to implement emission-reducing technologies. This is not the case for old industries and the poorer parts of the population, which have experienced the opposite development. The economic inequality gap has increased dramatically between the rich and poor,

and old and new industries. There are huge numbers of unemployed people who are part of this divide. The poorer segments have not been able to make the necessary investments.

SOCIAL AND HEALTHCARE ARE A TREMENDOUS BURDEN

Advancing technologies have changed basic economic rules and how the overall economy works. During the economic crisis, which began in 2008, it was observed that information technology, by the creation and distribution of derivatives, contributed substantially to the severity of the crisis. The impact of technology combined with a stagnating and declining global economy coincidences with the aging of the population. In most of the western world and in China there is a rapidly-aging population and the dramatically-dwindling younger generations must support a greater number of elderly people than in the past. In combination with increased unemployment, the costs for social and health care are a tremendous burden on the economy.

NET JOB LOSSES AMONG BETTER EDUCATED

Earlier, the general view was that technological advances would only take over the most unskilled labour. However, the reality is that this is not really the case. New technologies have replaced many well-paid jobs requiring high levels of training or education. To a great extent, the entire category of office workers and professionals (lawyers, doctors, financial advisors and teachers) has been under severe pressure due to replacement by new technologies. Recent assessments of net job losses in the developed world point to job losses in the region of 50% compared to the 2010s. A similar trend is underway in emerging economies.

Systematic unemployment due to technological advances has afflicted the economy and brings bad news for retirement programs. It has also impacted China's economy. Consumer spending around the word has been depressed for years. This means less trade with China and India, the world's workshops, resulting in difficulties in sustaining growth and sustainability and in keeping large parts of society employed. There are constant instabilities in global financial markets and weak, stagnating growth in the global economy. Economic conditions have created ugly, irrational political battles which are more heated, partisan and fact-resistant than ever before. It is necessary to re-engineer the free market economy into something new and relevant to the new conditions. There are now reputable economists suggesting that what we regarded as modern capitalism has outlived its usefulness in this new technological world.

CONCENTRATION IN CITIES AND DECLINE OF NATURAL RESOURCES

The common understanding some 30 years ago was that the new technologies and especially digitalisation would dissolve geography and create job opportunities and better living conditions outside the cities and in the countryside. The reality is the opposite; there has been increased concentration in the cities due to digitalisation. The relative rate of poverty has increased within nations; the climate change problem has improved but the climate goals and *the UN Sustainable Development Goals (SDGs)* will not be met. Consequently, in addition to the stress of economic equalities, societies also suffer from severe climate change impact in form of severely increased temperatures, droughts, water scarcity, flooding etc. Climate effects impact agricultural production in many parts of the world. The poorer segments of the population are trying to produce more food by expanding agriculture areas resulting in greater pressure on natural resources. The wealthy segments of the population are solving this dilemma by increased imports of food products. Thus, there are two powers at play: one is trying to produce more food locally and have less imported food products and the other is pushing for more trade in agricultural products and increased globalisation.

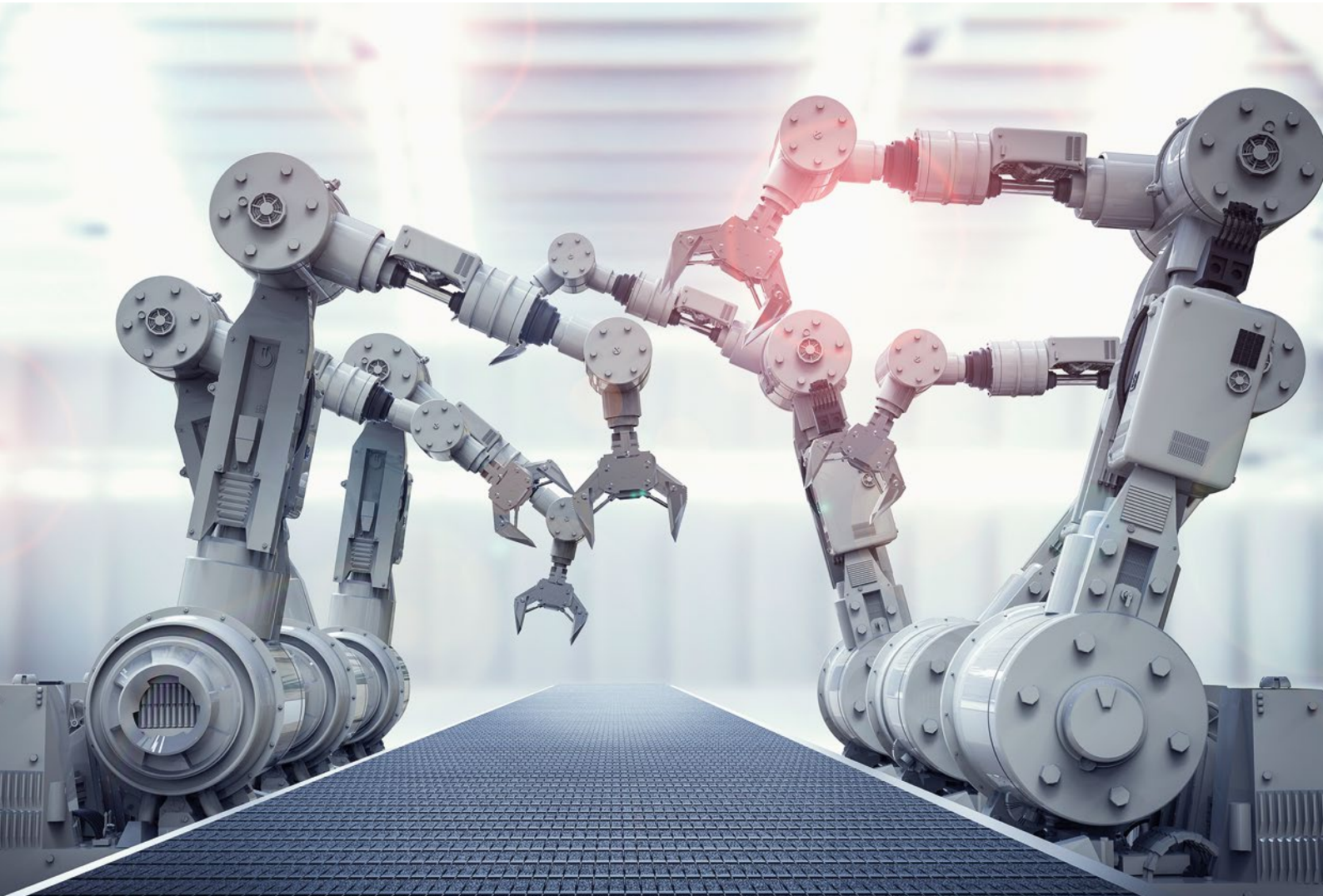
"New technologies have replaced many well-paid jobs requiring high levels of training or education."

INCREASED GAPS IN SOCIETY

Due to economic inequalities, there is a deep divide in society. The high technology component of society is very dependent on increased globalisation with respect to innovations, capital, people and trade. The poorer segments of society regard globalisation as the cause of their often-desperate situation. Consumerism is the supreme value for the wealthy section of society for whom material conditions and living standards have improved quite dramatically. Survival is the key priority for the poorer groups of people and, for this expanding segment, living standards have declined substantially. These segments consume less and have developed a negative attitude towards society. As a result, one segment is protecting their havens of highly technological living standards with their increased consumption of resources in general and especially resources for maintaining technological development and on the other hand another segment is fighting for survival and to access cheap resources. In this situation, there are difficulties in protecting environmental values and natural resources in general and a decline is underway.

A divided society causes major challenges to governance; it is almost impossible to govern countries under these conditions. The rate of cybercrime is currently the highest society has experienced, costing many trillions of dollars per year and threatening established institutions and democracy. There are many conflicts between the rich and the poor worlds followed by increased emigration flows. Health conditions have also declined among the increasing and less favoured groups in society.

This divided society has led to strong differences in values, which in turn has driven conflicts. These developments require new, innovative governance structures, permitting participatory processes. This divided society requires new structures for policies and institutions, but there are limited financial resources for their implementation so as a result, national and international efforts are concentrated on security.



2.3 THE NEW NORTH / SCENARIO 3

The current state of the world and a broad set of physical, ecological and societal forces have set *the New North* in motion. Climate change is forcing a massive ecological reorganisation worldwide with huge losses and extinctions of species. Livelihoods and health are threatened in all regions of the world. The world is urbanised, the US and southern hemisphere are cracking apart due to globalisation and uncertain politics. The situation is different in the North. Natural resource limits and armed conflicts in the southern hemisphere have led to a boomerang effect favouring the North. Compared to other regions of the planet, negative climate change effects are less severe in the North and the region has the preconditions to meet the SDGs. The northern hemisphere occupies a leading position in innovation, governance, preparedness for change and is rich in natural resources in the form of energy carriers, minerals, water, land and forests.

POPULATION GROWTH

Global population has increased by nearly 2.5 billion since 2015. The greatest population growth has occurred in Africa, India, Southeast Asia and the United States. India is now the most populated country in the world and even Nigeria has a larger population than the United States. The fact that the largest population growth is concentrated in the poorest countries in the world causes challenges. It is difficult to eradicate poverty and inequality, to combat hunger and malnutrition and to expand educational enrolment and efficient health systems. On the other hand, these countries have a young population creating an opportunity to capture a demographic dividend. The ageing population has grown rapidly and, in Europe, 35% of the population is now over 60 years of age. In Latin America and Asia, the corresponding number is 25% and 10% in Africa. At global level, the elderly population has nearly tripled since 2015. Japan, Russia and Germany have lost about 15% of their population since 2015. The dependency ratio has quadrupled since 2015 in many countries and people are not retiring at 65 instead they have to work much longer for survival.

THE WORLD IS URBANISED and some 85-90% of the population in the United States and Latin America now live in urban areas. The corresponding number for Europe is over 80%. In Africa and Asia, 55% and 65% respectively are urbanised by 2050. The rural population has decreased by about a billion worldwide. Population growth has also been a driving force for economic growth. Earnings have increased

tenfold since 2015 at global level, however there is a huge divide between poor rural people and rich urban people. India and China now have the largest economies in the world. Geopolitical and economic power has shifted from west to east. China gained hugely from globalisation during the 2000-2015 period. Asia is now the centre of gravity with respect to globalisation. Other regions have gone from globalisation to regionalisation by shifting policies. Asia's share of global GDP has roughly doubled since 2010.

NATIONALISM HAS BECOME A MARKETABLE COMMODITY

Despite this very positive development, in the mid-2010s many people in the developed economies regarded themselves as losers in the globalisation process and demanded a retreat from the globalisation agenda and movement towards an agenda of strongly increased nationalism. The movements that came to the fore championed a historic turn inward: breaking out from EU membership, enforcement of homogeneity and favoured the trumpeting of exclusively national virtues. The driving forces behind this turn were the political leaders in the UK, Russia, Hungary, the French National Front Party, the USA, India, Japan and Egypt to name just a few. As a group, they heralded a change in world politics still working itself out 35 years later. Nationalism has become a marketable commodity. Free trade and providing people with a better life were not popular values for these groups as free trade demands change: transition demands new business models, new services, new technological solutions etc. Despite this retreat, the world is becoming more open and industry is more independent than in the past, and many of the forces underpinning globalisation remain so strong that innovations and societal improvements do not stop just because some regions close themselves in.

A WORLDWIDE ECOLOGICAL REORGANISATION

Every year there is a new record in the average global temperature increase. Climate change is forcing a massive ecological reorganisation worldwide with huge losses and extinctions of species. The effects of climate change unfold erratically over time and are a combination of the climate and the vulnerability and exposure of humans and natural systems. Frequent extreme weather and climate events in the form of heat waves, high water levels and flooding and heavy precipitation have all been observed all over the world. Food production (agriculture, crops) has decreased substantially in Latin America, Africa, Asia and Australia as well as in southern Europe. Fish stocks are under threat in Latin America, Southeast Asia, Australia and the Arctic. Livelihoods and health (by exacerbating existing health problems) are threatened in all regions of the world.

Wildfires are frequent in many regions. Water scarcity due to climate change in combination with strongly increased demand due to rapid population growth is a huge problem, especially in the southern hemisphere, the USA, southern Europe, Central Asia and China. Modern societies have differentiated the use of fresh water: drinking and cooking, washing and bathing, for the animals, watering crops etc. Due to technological innovation, water is seldom used for lavatories. In urban areas, climate change has increased risks for people, assets, economies and ecosystems. In rural areas, water availability, food supply and security, infrastructure and incomes are under severe stress due to climate change. This has also substantially increased the displacement of people.

NATURAL RESOURCES AND ARMED CONFLICTS IN THE SOUTHERN HEMISPHERE

There has been an increase in political and armed conflicts in the southern hemisphere by some 50% due to starvation, water deficits, refugee flows and population clashes all linked to climate change. Natural resource demands and environmental conflicts have increased dramatically due to rapid population growth, an expanded global economy, protectionism and climate change. Pressure on agricultural production is tremendous under conditions of huge production deficits. There is currently a water shortage of some 50% around the world.

Demand has increased by 65% since 2010 and some 40% of the global population live in water-stressed areas. Energy demand has increased by some 80% since 2010. Natural forests have continued to shrink and are now 15% smaller than in 2010 with a loss of 10% of global biodiversity. The earth is now experiencing severe depletion of key metals such as silver, gold, indium, tin, lead, zinc and copper. Stresses on resources are also due to the rare metals necessary for production of the new technologies such as gallium, germanium, tellurium, thorium, molybdenum, cobalt, niobium and tantalum.

"The impact of climate change can be said to be less harmful in the North and the region has the preconditions to meet the SDGs."

THE NEW NORTH IN MOTION

The current state of the world and a broad set of physical, ecological and societal forces have set t*he New North* in motion. *The NORC countries,* which consist of northern USA, Canada, Norway, Denmark, Sweden, Finland and northern Russia are scarcely populated and have a lot of land available per inhabitant (the lowest population density on earth). However, between 2010 and 2050 the population of the NORC countries has increased by 15% to about 95 million. In several countries immigrants have offset the ageing population problem.
The New North has experienced substantial climate change, but mainly in the form of milder and wetter weather with a longer growing season as result. The North was already water-rich and has become even richer with climate change. Compared to other regions of the planet, habitat loss is less severe in *the New North*. Primary production of plant biomass has increased substantially. Also, agricultural produc-

tion has greatly increased. Relative to other regions, the impact of climate change can be said to be less harmful in the North and the region has the preconditions to meet the SDGs.

RESOURCE REVOLUTION IN THE NORTH

Due to the lower number of inhabitants per km^2 and technological advancements, stress on natural resources is at a much lower level compared to other regions of the world. The North is rich in natural resources in the form of energy carriers, minerals, land and forests. Most of the countries in *the New North* have developed extensive and efficient infrastructure and enjoy stable governments, the rule of law, towns, ports and foresighted companies. The countries in *the New North* lie at the top of efficient globalisation countries and liberties indexes compared to the rest of the world. They are also business-friendly, trade liberal and score at the top among the world's happiest places to live. The region has many universities, in cooperation with industry, driving technological advances and their applications.

The New North has the potential to become a winner in the global resource race. There are countless resource-related business opportunities in unexpected forms. The resource revolution has already given birth to a host of innovative products, solutions and services. The technology-driven change and the scale of the resource revolution has required institutions and companies to step up their ability to digitise and harness data analytics. Digitalisation and data opportunities have deep cross-cutting impacts on institutions, companies and economic development. Though it should be noted that the small European countries have, up to this point, not been able to maintain their leading roles in the international policy arena.

2.4 THE WORLD IS GOING SOUTH AND EAST / SCENARIO 4

The dominating trend is characterised by a shift away from Western dominance towards a greater heterogeneity in the world. Increased globalisation, South-to-South trade, multiple centres of power and networks of mega cities characterise global development.

The values and innovation systems of the Asian region will dominate the development of the world. By 2050, the Asian region leads world development both economically and geopolitically. Asia's total GDP is over 50% of global GDP, almost as dominant global economic position as it had before the industrial revolution hundreds of years ago. Africa is showing substantial growth potential due to demographics and structural improvements. Still, these regions face severe challenges, including inequality, extreme urbanisation, corruption, weak institutional capacity, poor governance, declining economic growth, insufficient energy efficiency, environmental degradation, overexploited natural resources, water stress and climate change. Climate and SDG commitments are not met.

MULTIPLE CENTRES OF POWER AND THE ASIAN CENTURY

With increased protectionism in the USA and Europe there has been a development towards multiple centres of power across the world, meaning that many competing centres of power have emerged globally. This is the result of the shift away from Western dominance and towards a larger heterogeneity and complexity in the world. Networks of megacities and other cities strongly influence the economic and geopolitical development. The values of the Asian societies are affecting the rest of the world. Latin America has steady, but slower, economic growth and does not exert the same influence on global development.

By 2050, not only China and India enjoy leading positions in the world, the entire Asian region occupies superior positions. Every day people speak about the Asian Century. Asia has 55% of global GDP, the region has almost as dominant a global economic position as it had 300 years ago before the industrial revolution. China's GDP is over USD 62 trillion in purchasing power parity (PPP) terms and is the world's largest economy. GDP growth rate has now stabilised at around 3% annually and, in so doing, has normalised with the developed world. In this scenario India has a GDP (in PPP terms) of some USD 42 trillion and has overtaken the European Union and the USA as the second biggest economy in the world. India's GDP growth rate is around 6.5% due to its rapidly-growing, young population and greater opportunities for catch-up

growth than in China. This achievement has not been easy and has required great efforts in changing to different growth patterns and resolving a broad array of politically-differing issues over a long period of time. Several challenges remain, including issues of inequality, corruption, weak institutional capacities, poor governance, Middle Income Traps meaning bursts of economic growth followed by a stagnant state of low or declining economic growth, environmental degradation and climate change.

SOUTH-TO-SOUTH TRADE AND INNOVATION

The engines of the Asian Century have been China, India, Indonesia, Japan, South Korea, Thailand and Malaysia. They account for some 90% of Asia's current total GDP. Asian success has been driven by new, strong national strategies dealing with the topics listed above, as well as the development of strong regional and global agendas. Asia is now the dominant driving force for globalisation and free trade in the world, and thereby is also dominant in global geo-politics. Interregional trade has increased dramatically as has South-to-South trade.

Important features have been the rapid development of technological advances, innovations and entrepreneurship. The leading countries in Asia have invested huge amounts in technological development with the objective of moving away from catch-up in innovation to becoming a breakthrough region in science, technology and innovation in all fields of society. It should be mentioned that Asia, by 2050, is the world leader in technological development in medical and health services. These advancements are crucial for the promotion of broader social wellbeing. There has also been a financial transformation. In that Asia generates over 50% of global GDP, strong financial centres have developed in the Asian region taking financial power from the conventional players in Europe, Japan and North America. This has required dramatic changes to high quality education which promotes creativity. In order to stay in front, this has become a never-ending story.

THE QUALITY OF URBAN AREAS

A true challenge has been, and remains, the tremendous urbanisation process taking place in the region (65% of the population lives in urban areas by 2050). Economic output is strongly correlated to the population of urban areas. There have been huge housing problems followed by efforts to achieve a satisfactory level of efficiency and quality in urban areas, infrastructure and eco-friendly conditions. A crucial challenge is keeping the development of rural areas in line. However even in 2050, politicians have not realised that the urban areas cannot survive without strong rural areas to provide food, water, clean air, better environmental and weather conditions, biodiversity, recreation etc. If rural areas collapse as a result of the urbanisation process, economic progress will also break down.

ENERGY EFFICIENCY AND OVEREXPLOITED NATURAL RESOURCES

It is conceivable that the major challenges for the region have been, and still are, greatly increased energy efficiency, a strong reduction in natural resource use, a greatly-improved environment in general and climate change. Thanks to rapid regional technological advances, energy efficiency has improved substantially, but much more needs to be done and the climate and SDG commitments are not met. All larger cities have banned combustion engines: vehicles are now electricity or fuel cells. Public transport has been further developed, but a lot remains to be improved and made more efficient.

"The values of the Asian societies are affecting the rest of the world."

Around 2010, natural resources were severely overexploited. This is still the situation in 2050 with continued deforestation, and expansion of agricultural land instead of higher efficiency in agricultural production. Water stress levels are high in practically the whole region, but the most observed water deficits are in China and India with severe impacts on irrigation and food production. This stress is mainly driven by population and economic growth

that overshadows climate change impacts. China and India have done much to try to improve the efficiency of water use both in industry and households, but there are still severe problems. Fish have been, and remain, a key source of food for all coastal Asian states and with growing populations and economies resulted in severe overfishing. Asia has seen the rapid development of aquaculture, which has improved the situation substantially, but fish farms have, to a large extent, been managed unsustainably putting pressure on other ecosystems.

SEVERE ENVIRONMENTAL PROBLEMS AND THREATS TO HUMAN SECURITY

Asia has been riddled with severe environmental problems. The list is long including air pollution, haze, smog, water and soil pollution, destruction of agricultural land by increased urbanisation, soil erosion and degradation, hazardous waste, chemical pollution, industrial and municipal waste, degradation of marine environments, an increased number of endangered species, increased loss of habitats and biodiversity, increased biological pollution (e.g. dead animals), flooding and landslides, noise pollution etc. All of these have been, and are, a threat to human security in 2050. With the help of new technologies, Asia has reduced some environmental problems (some quite dramatically) but the total picture is far from satisfactory. Asia is also heavily impacted by climate change in the form of rising temperatures, droughts, flooding and severe disruptions. Asia likely has more at stake in this respect than any other world region. The region has made major efforts to mitigate and adapt to climate change, but much more must be done to ensure human security. This means, among other aspects, identifying innovative solutions to mass transportation and also dramatically changing lifestyles to achieve less consumption in general.

INFLUENCES OF AFRICAN DEVELOPMENT

Asia is not alone in seeing rapid development since the 2000s. Africa has had the same experience, although the continent still has many problems. Africa's population has doubled since 2010 to 2.4 billion people. This is the result of strongly improved medical and healthcare services. Africa has a very young population and therefore a huge workforce, driving economic growth. African development has been very similar to the economic development of India but with a time lag. The situation is also similar to Asia regarding a rapid urbanisation (although not at the same level), which fuels economic activities. This urbanisation has placed extraordinary demands on urban planning and a lot remains to be accomplished.

There has been a relative decrease of USA and European influence on African development. At the same time, a tremendous rise in the influence of China, India and some other Asian countries has been observed and this development will continue, including positive trends in the form of investments, increased trade, growth economy and technology spill-overs. The negative feature of this development is primary resource exploitation in Africa. Africa has turned to Asia for economic development and to Europe for promotion of good governance. Still, European countries have not been able to maintain leading roles in the African policy arena. Substantial structural improvements in the management and composition of the African economies have taken place. Internal trade between African countries and South-to-South trade have boomed. There are also stronger influences from non-state actors in society, such as civil society and financial institutions and, unfortunately, from criminal networks (cybercrime). Europe has been squeezed out of much of the development taking place in Africa with one exception: interaction with North Africa. North African countries see the Mediterranean region as their natural market place. The Mediterrane-

an Solar Plan has also tied the two continents closer together. North African countries have also looked to Europe for governance and their political future, which has linked them closer.

IMPROVED BUSINESS ENVIRONMENT

More than 75% of the continent's GDP depends on manufacturing and services by 2050. The picture is similar in all countries. Africa has 40% of the world's gold reserves and 80 to 90% of chromium and platinum group metals and there are still massive future discoveries foreseeable in the metal sector. Improved efficiency in business and changed policies towards less direct governmental involvement in businesses have also contributed to this development. The GDP (in PPP terms) in Africa is, by 2050, about USD 42 trillion making it larger than the US and EU economies in the early 2010s. The annual average GDP growth rate for the continent is around 6%. Infrastructure investments have been responsible for a major part of the economic growth. Africa's share of global trade and foreign direct investments has doubled since 2010. However, by 2050 there are still vast differences between individual countries in Africa. The leading economic regions are Southern Africa and Northern Africa. South Africa, Egypt, Nigeria and Algeria have shown better economic performance than other emerging economies in other world regions. These countries, together with Tunisia, have the most diversified economies. Ghana, Kenya and Senegal have experienced very rapid growth. The economies of Uganda and Tanzania have diversified substantially. Ethiopia, DRC, Sierra Leone and Mali have also seen substantial growth rates but with a higher degree of volatility.

TRANSFORMATION OF AGRICULTURE AND INCREASED TEMPERATURES IN AFRICA

In the 2010s, about 60% of the world's uncultivated arable land (about 600 million ha) was located in Africa, however their agriculture yields were also the lowest in the world. At that time the agriculture sector employed 70% of the labour force and provided 50% of exports. African agricultural soils are largely nutrient poor. The massive transformation of the agriculture sector has been possible due to technology transfers and active involvement by China and some other Asian and Middle East countries. By 2050, Africa shows the largest food production in the world, in spite of disruptions, outstripping the production of Europe and the USA. Broad-scaled agroforestry implementations have been crucial for this development. Outstanding food production regions are eastern, central and western regions of Africa. This transformation of agriculture and food production has been crucial for the positive development of the continent.

Today Africa is suffering substantially from climate change in the form of increased temperatures in an already hot climate, inconsistent rainfalls and extensive flooding and droughts in combination with poor soil fertility. All of this impacts agriculture, food production and human security. Rising temperatures exert the most negative effect on agricultural production. Crops are at their temperature tolerance limit. Major inputs are underway using temperature tolerant GMOs. Northern and southern Africa suffer from severe water stress due to declining precipitation. There is weak infrastructure for water supply, which further exacerbates the water problem. Dramatically increased population together with increased economic growth and the impact of climate change have also increased water stress in regions of Africa that did not used to suffer from water shortages.

"Internal trade between African countries and South-to-South trade have boomed."

SUSTAINABLE INVESTMENTS AND RESILIENCE TO CONFLICTS IN AFRICA

Demand for energy in Africa has increased by about 80% since 2010 when Africa had some 10% of the world's oil reserves and southern Africa had huge coal reserves. Given the climate change situation in Africa, this resource cannot be used for energy purposes. Africa has invested in a huge number of windmill parks, enormous solar plants and in geothermal

energy. These investments must continue in order to secure future energy demand. Africa experienced, and still does, severe environmental problems which are similar to those discussed for Asia. Added to this list are oil pollution from earlier oil exploitation and desertification. African governments have worked hard together with international organisations to regain control of its environmental problems, but many problems remain to be solved and climate and SDG commitments are not met.

The socio-political change that has taken place in Africa, is based on improved human development, improved governance, improved democratisation, reduced corruption, improved rule of law and more efficient public policies. The major challenge for Africa has been, and still is in 2050, human resource development and employment of the younger generations. This involves improved education, improved health (there has been a dramatic decrease in communicable diseases), improved human security, reduced corruption and reduced rate of persistent poverty with linked malnutrition. The steady integration of the African regions and enhanced and diversified global integration, as well as multilateral security, have all substantially increased resilience to conflicts in Africa. Most African countries promote increased globalisation.

2.5 A WORLD OF GLOBAL RESILIENCE / SCENARIO 5

Technological developments have substantially contributed to the de-materialisation of the global economy. A transition has taken place from neo-classical economic valuations to valuations including environment, inclusiveness, justice, equality and ethics.

Priority has shifted away from efficiency maximisation to focus on vulnerability, mitigation and resilience in all domains of society. The world evolves fuelled by a strong global policy dialogue based on cross-society governance dialogues and consensus concerning the sustainable development of natural resources. The world is driven by global agreements on bioeconomic regimes, resulting in sustainable social and economic conditions. This concept resulted in major investments by governments and corporations in infrastructures to make material management more efficient. Climate and SDG commitments are met. The West maintains its leading position, quality of life across the world has reached a historically high level and the number of poor people globally is at a very low level.

REDISTRIBUTION OF FINANCIAL AND HUMAN ASSETS

Recent studies demonstrate that countries with good governance structures, a high rate of urbanisation and strong economic growth have reduced their environmental footprints. Comparable countries with weak governance have increased their environmental footprint substantially. The period between 1980 and 2015 demonstrated that the neo-liberal conception of capitalism, together with its globalisation, increased inequalities to unsustainable levels with a fraction of the world's population controlling most of the world's wealth. It left large segments of the population in advanced economies without any increase in real income and with decreased security. Simultaneously, millions of people were lifted out of poverty in emerging economies. This development was followed by flawed populist policies. In the 2020s, governments realised that there was an urgent need to address structural weaknesses in governance and in the economic systems at that time. This resulted in a redistribution of both financial and human assets, which meant de-concentration of capital. Technological developments contributed substantially to the de-materialisation of the global economy. The priority has been a shift away from efficiency maximisation to focus on vulnerability, mitigation and resilience in all domains of society.

It was learned the hard way in the 2010s that protectionist policies reduced overall demand and economic growth. The world got together and concluded that this is not the way forward and that it is best to work together with free trade in line with David Ricardo's findings several decades ago. Some strong leaders around the world saw how the world would disintegrate as a result of these nationalist and protectionist movements. They realised that the world had been fragmenting at a time when the world sorely needed international cooperation and integration. These leaders managed to mobilise the world to turn politics back to a global agenda around 2025, building on solidarity across religions, ethnicity and class.

TRANSITION FROM NEO-CLASSICAL ECONOMICS

In line with projections made in the early 2010s, the global economy regressed over time and the global average growth rate by 2050 is 2.8%. In the second half of the 2010s it was 3.8%. This regression has occurred in all regions of the world and is nothing new. It had already begun in around 2000 in advanced economies. The theory is that the old economy had settled into a state of secular stagnation with insufficient demand, slow growth, low inflation and low interest rates. The most troublesome issue has been that the conventional menu of financial policies did not lead to sustainable economies. Thus, the governments have lacked instruments for change. In the late 2020s there was a political breakthrough in new economic thinking: this new economic theory considered that the consumption of materials must be substantially reduced in order to maintain natural capital. This meant a new perspective on how to value nature. There was a transition from neo-classical economic valuations to valuations including environment, inclusiveness, justice, equality and ethics. This drove development strongly towards the bio-economy concept with substantially reduced material consumption and innovation in all domains of society. The degree of technological innovation and dissemination is high and focused on sustainable solutions. Technological developments have substantially contributed to the de-materialisation of the global economy.

The financial world has changed dramatically. It was concluded that the spiralling government and private debts in the 2020s hindered the sustainable development of societies and economic growth. The banking system has been forced by governments to restructure from financial speculators to supporters of the development of society. Many of the financial products the banks sold in 2010s are illegal today due to the fact they were judged not to be in the interest of consumers and the broader society. At the same time, there were many experts predicting that China, the world's economic engine, would collapse however this did not happen. Extensive policy changes have taken place and the economic slowdown in China is not an economic meltdown – it is policy driven.

"There was a transition from neo-classical economic valuations to valuations including environment, inclusiveness, justice, equality and ethics."

BIO-ECONOMIC PRINCIPLES CHARACTERISED BY REDUCED MATERIAL USE

In the early 2030s, governments decided to pull together to fundamentally redesign the mechanism of checks and balances, giving highest priority to the long-term sustainability of the global system. This meant a transformation from material economic growth to a non-material economy and learning from nature. Thus, the priority has been to shift away from efficiency maximisation and focus on vulnerability, mitigation and resilience in all domains of society. The material and energy throughput of the global economy has, after this, steadily decreased. The ambition in the advanced economies is to reduce material consumption per year and person by some 40% in comparison to the level in 2015. It was the transformation to the bio-economy in the 2030s, on which there was full agreement, that made

it possible to transform the global economy. The concept was based on studies and an understanding of what type of new products would be useful for customers and society, stimulation of innovation and product development and national frameworks on sustainability based on bio-economic principles with reduced material use and waste of finite and natural resources.

Technological advances and changed consumption patterns have contributed strongly to reduced GHG emissions due to decreased use of materials and energy, but also due to new, smart solutions. Climate and SDG commitments are met. However, the impact of climate change is still increasing due to time lags in the climatic system. There is also a decreasing exploitation pressure on natural resources compared to before due to changed consumption and new technologies. The world realised 20-30 years ago that changing old competences for brand new ones was the only way to develop, sustain and to keep social unrest from the door.

This concept resulted in major investments by governments and corporations in infrastructures to make material management more efficient. Industry developed new operations to increase resource efficiency, which were successful. Innovation and product development generated brand new bio-products that were sustainable and enjoyed longer life-times than existing products, and which found brand new markets. These new products are also blessed with higher added value than the older products. They are less scale dependent which has resulted in a restructuring of industry towards a smaller-scale and more investments closer to raw materials in rural areas.

INTERNATIONAL COOPERATION WITH INCLUSIVE INSTITUTIONS

In the 2010s, dialogue between governments, industry and environmentalists was hardly efficient. The world has learned its lesson and, with the introduction of new governance and the bio-economy, dia-

logue between the different parties has become constructive and everyone is looking for joint solutions. The change in the global economic system opened new channels for international cooperation. Developments towards a type of global federation can be seen to be underway and multicultural global society appears to be slowly but surely unfolding.

Institutions play an important role in the stability of societies and are critical to long-term sustainable development. Many of the emerging economic regions of the world had extractive institutions for a very long time which did not generate much sustainability or economic growth. In the 2020s, many regions of the world managed to transform institutions to become inclusive and thereby provide the right incentives for innovation, entrepreneurship and sustainability. People thought that the slowdown of the economy would cause social unrest and uprising in e.g. China, it turned out that education, health, human security, corruption and legal justice matter just as much as economic growth. In fact, the somewhat slower economy has brought several benefits to China in the form of less pollution, fewer land-grabbing incidents, less inequality, less corruption, less energy consumption, lower socioeconomic tension and an improved international reputation.

CROSS-SOCIETY GOVERNANCE DIALOGUES

A breakthrough for the transition from a rather ruthless world in 2020s to a world in harmony in 2050 was largely driven by the insight that in order to solve the difficult issues, all elements of society - politicians, institutions and the public - must understand the problems and must be involved in the solutions. This demanded a form of governance rather different to centralised decision making in silos. Instead, a cross-society governance dialogue was introduced. Regional governance, coupled with increased power to local authorities, fostered greater self-sufficiency in society. One important feature has also been the strengthening of property rights world-wide.

Social enterprises at regional level have helped individuals, families and communities to invest in and adapt to new technologies, and have improved development opportunities, economic and living conditions resulting in growing regions. Thus, national governmental power has, in certain domains, been transferred to the regions.

The world has developed towards a network of regions with urban centres as hubs. The regions are more virtually than physically connected. The overall result has been increased integration between urban and rural areas with a perception of greater equality. This was made possible by the building of new knowledge and business clusters. The ambition has been to provide people with access to what they need in order to become more productive and creative. The regions that have been most successful in this integration have also been the most successful from a development point of view. It can be said that the world, by 2050, has reached a new *Welfare Economy* which is reflective of natural, human, and social capital in addition to conventional business and asset economics. Consumerism has lost its glamour and is gradually replaced by a growing interest in social interaction. Solidarity has become a shared value. People have changed consumption patterns and are using up what they have instead of buying new. With stable economic development, changes of values and reduction of poverty, the quality of life across the world has reached a historically high level.

"In order to solve the difficult issues, all elements of society – politicians, institutions and the public – must understand the problems and must be involved in the solutions."

2.6 A WORLD IN DISORDER / SCENARIO 6

The world has turned authoritarian by 2050. The world experienced a historic turn inwards to homogeneity enforcement and trumpeting of exclusive national virtues. The conventional world collapses, separatist movement and geopolitical conflicts characterise development. Global dialogues are dominated by individualism and protectionism resulting in declining global trade. Negative developments have surfaced very rapidly in many domains of global society and quality of life has deteriorated substantially. The extent of obsolete industrial capacities has caused severe de-industrialisation caused by globalisation and uncertain political futures, as well as rapid technological transformation. Global agreements are not fulfilled, followed by ruined markets, armed conflicts and over-exploitation of natural resources. The guiding hand of governments and the restraining pressures of morality are gone. All efforts concentrate on military and security issues and the SGDs are far from met. International and national crime levels have become the highest in history.

NEW POWER MOVEMENTS

Many developments observed since the 2010s such as populism, protectionism and nationalism/patriotism, feeling disadvantaged and wronged, perceived inequalities, hatred of foreigners, dissatisfaction with politicians and institutions, weak political leaders, polarisation, being frightened by anything new and egoism, have led to rules of law that are adjusted to these new power movements. Media control, information wars using fake data etc. are the same forces that let evil powers take control before *WWII*. At that time, people argued that they should remain calm and wait and that the roles of the offices of power would make people reasonable *(bad things can not happen)*. All of this was incorrect and negative developments occurred very rapidly. The world experienced a similar pattern after the 2010s. Global political uncertainty following this turn in global politics contributed substantially to lower economic growth. The de-industrialisation of obsolete industries caused by globalisation and increased international competition, as well as rapid technological transformation, all played an important role in the negative development experienced. The change of competences to fill the jobs of the future had failed. Regions with obsolete industries ended up as backwaters and blamed the elite and the political powers for the negative development.

EXCLUSIVE NATIONAL VIRTUES

Before 2015 everybody believed in greater integration, more globalisation, more free trade and expanding global markets. In 2015, countries were so busy committing themselves to diversity, multi-culturalism, liberty, solidarity and equality that they did not notice the tidal wave of backlash against globalisation. The world experienced a historic turn inwards to homogeneity enforcement and trumpeting of exclusive national virtues. This development was led by a group of politicians sceptical to any kind of transnational cooperation, focused on imaginary golden ages of the past demanding a change in world politics which, 35 years later, is still trying to find its working form. Nationalism as a movement remapped today's world. The first cracks in the globalised system appeared in the Middle East with *the Arab Spring* and the flood of refugees became a tipping point for the European Union. This led to economic and political pressures in the EU resulting in a wall of Euroscepticism. Eurosceptic parties were established in every country within the EU. The Union survived for a number of years but from 2030 the remains were only a shell without any real power.

SEPARATIST MOVEMENTS

Historians have, for a long period of time, claimed that Russia is too large to manage. The unrest in the Middle East and the dissolution of the European Union exerted a strong impact on Russia. Separatist movements started up all over the country and the *Second Great Perestroika* in 2035 resulted in a division of Russia into *European Russia, the Republic of Siberia, the Republic of the Far East* and *the Republic of Caucasus*. The United States is still functioning as a federation but is more a collection of regional fragments fighting over shrinking resources than a united federation. US domestic politics are so polarised that Congress cannot unify on how to kick-start the economy. Separatist movements have destroyed the development of India and Pakistan. Countries like Indonesia, Malaysia and Myanmar have, by 2050, fractured along ethnic lines. In Africa, the Democratic Republic of Congo, Central African Republic, Nigeria and Chad have fallen apart.

China followed a similar trajectory. The earlier economic growth model of boosting investment and at the same time suppressing consumption resulted in a fast build-up of economic growth and large trade surpluses. The huge differences between the rich coastal and poor inland provinces created tensions. This built up high levels of income inequality which contributed to social unrest in China. These imbalances reversed and the economy collapsed. Money was moved out of China which triggered financial upheaval. A declining economy and consumption demand in China, coupled with debt deflation, caused the collapse. It is probable that, as China became more prosperous, it also became more unstable with more and more demonstrations. The government tried to adopt many policy reforms but few were actually implemented. The Chinese collapse has sent the world economy into a tailspin.

"Nobody had anticipated the huge impact of nationalism on climate change."

WITHDRAWAL FROM CLIMATE COMMITMENTS

It is conceivable that, under the best conditions, countries and federations would have been able to push the environmental agenda and trade agreements to an edge. But with nationalist and protective agendas, countries have withdrawn from their previous climate commitments to reducing emissions substantially and the SGDs are not met. Thus, the world has experienced temperature increases, water shortages, droughts, pandemics, destroyed coastlines, conflicts and food shortages never before witnessed or anticipated. Climate change effects became a tipping point for the nationalist movements of the world. Nobody had anticipated the huge impact of nationalism on climate change. By 2050, the world climate is on the path to a 3 degrees temperature increase by the end of the century. Currently, globally about 2 million people annually die due to

the direct impact of climate change, mainly due to declines in production and the quality of food. Nationalism has proved to be this century's most potent ideology and created multiple confusions of many worlds in a desperate planet. The guiding hand of governments and the restraining pressures of morality are gone. This is how the cookie has crumbled.

DECLINING GLOBAL ECONOMY AND NATURAL RESOURCES

By 2050, there has been a long period of slow global economic growth, as Larry Summers projected in the 2010s, which caused a number of sovereign defaults. All of this combined with paralysing protectionism meant that global trade declined dramatically. Institutions are crucial for sustainable development and economic growth. Public distrust of government management of institutions greatly increased. Emerging economies have not been able to remedy the severe deficiencies of their institutions. Actually, they have become worse. Even the advanced economies have experienced a substantial decline in institutional efficiencies. Causes can be identified in the nationalist and protectionist movements.

The world has moved from being a *small world on a big planet* to a *big world on a small planet*. With this transition, prevailing economic principles have driven the world to more and more consumption of natural resources. There is tremendous pressure on natural capital and there is limited capital left. People have realised that natural capital regulates the stability of the earth and consequently the global economy, but have not been able to introduce new economic theories and tools that are inclusive of all the important natural resources. By 2050, the world is in a vicious circle with a declining global economy and failing natural resources.

AUTHORITARIAN GOVERNANCE

Nationalism across the world in the 2010s soon hit the wall and became absurd to most people. At that time the world was like one big single factory, and then suddenly management started building walls inside the factory. This was not a sensible idea, but it was not possible to curb the political shift taking place in this direction. With this new political direction, governance changed to become much more authoritarian and the world is still suffering as a re-

sult. At the same time, *New Public Management* was implemented with often politically-appointed heads and leaders of the countries' administrative institutions. These leaders had the *right* political views with respect to the overall political shift but they had limited knowledge about the responsibilities and objectives of their institutions. In addition, these leaders invested in information and communication, administrative systems, IT development, management training, regulatory functions etc., to help them to manage the institutions. But hardly any investments were made in the core competences necessary to fulfil their responsibilities. This has brought long-lived impacts with many institutions imploding, unable to fulfil their responsibilities and with limp governance as a result.

INTERNATIONAL CONFLICTS AND DECREASED QUALITY OF LIFE

Thus, the world has experienced instability in economic growth and societies for a long period and rare growth spurts have only been sporadic. Due to economic difficulties, innovation and technological developments have stagnated. All efforts made have concentrated on military and security issues due to the fact that global terrorism thrives in the political environments generated with their unprecedented uncertainties about the future. Earlier efforts to harness climate change impacts have been closed down. Countries have closed their doors to immigration. Agriculture has expanded or even intensified somewhat in all countries in order to reach the highest possible level of food self-sufficiency.

Consumerism remains the personal goal for most people, but individual self-interest and paranoid mistrust dominate. It can be said that this is a fight for survival, to control resources and the social order has increasingly disappeared. The fight for control of natural resources has caused a number of international conflicts. There are large numbers of environmental refugees wandering around looking for better survival chances. International and national crime levels have become the highest in history. The general quality of life has declined substantially.


MELLANMJÖLK

3 Impacts on the global forest sector in 2050

This section examines the implications of the global scenarios on the forest sector. In the first section, a base line was compiled, presenting *the Conventional wisdom* for the global forest sector by 2050. This could correspond to a predictive scenario for the forest sector, using the current situation to predict how the future could be developed based on general assumptions about what drives development. Then, the implications for the six global scenarios are presented, touching upon the following factors: *Bio-economy, Climate Change, Deforestation, Ecosystem, Governance, Industrial Economy, Industrial Structure, Nature Tourism, Paper and Paperboard Demand and Production, Plantations, Sawn Wood Demand and Production, Wood Demand and Production, Wood pulp Demand and Production.*

3.1 CONVENTIONAL WISDOM FOR THE GLOBAL FOREST SECTOR IN 2050

The Conventional Wisdom for the Global Forest Sector in 2050 is a baseline scenario with the aim of assessing how the future may develop based on today's situation. During the 2000s there was a major increase in pressure on natural resources and forests were no exception. This pressure affected most parts of what we consider the natural world: animals, plants, genes, land and water to mention but a few. By 2050, global industrial wood demand has grown, and Asia is the driving force. The conventional forest industry has contracted in developed economies. Climate change has taken its toll, but lifestyles have become potent multipliers of human pressure on natural resources, constituting a much greater threat than the total population alone. Globally, forest is still losing diversity and forest-based species. The global forest sector has not yet found a common tool for how to handle sustainable biodiversity. The quality and quantity of water supply has declined substantially in areas which have lost forests or had their forest areas transformed.

CLIMATE CHANGE has taken its toll on natural systems and forests. Different biomes have both contracted and expanded in North America, Europe, Asia, Africa and New Zealand due to climate change and socio-economic driven land-use change. These changes have resulted in shrinking primary forest coverage and increasing secondary forests and non-forest land. Disruptions of both plants and animals due to climate change have increased in the form of changed phenology, primary productivity, species range, invasions, extinctions and water use efficiency. The regions most affected are the tropics and sub-arctic regions. The disruptions take the form of wind-falls by storms, wild fires, insect outbreaks and flooding which impact the forests and have increased in all global regions.

A northward expansion and a shift in species composition toward more temperate plant types can be detected in the boreal forests. Its productivity has increased due to climate change, however there have also been boreal forests experiencing productivity declines due to warming-induced droughts. The total carbon stock has increased and the region has also experienced larger areas of wild fires. The increased thawing and degradation of permafrost forested areas has had a critical impact, resulting in green deserts and increased emissions of methane and carbon. The vulnerability of the boreal biome is the cascading series of interacting processes affected by climate change.

In temperate forests, there has been an increase in growth rates and carbon stocks, but there have been recent indications that temperate forests are beginning to show signs of climate stress and reduced growth rates. Temperate forests show a northward shift. Most of the temperate tree species are showing a similar pattern and a shift to growing at higher altitudes.

In the tropics, the fast-growing species are showing increased growth rate and signs of expansion. There is now clear evidence that certain ecological thresholds of drought, severe weather conditions and fire (indirectly driven by climate change) are surpassed leading to abrupt tree mortality. Many species in the humid tropical forests are sensitive to these thresholds. The ecological thresholds also constitute a risk for replacement and degradation in the dry tropical forests.

ECOSYSTEM SERVICES

Ecosystem services for forests are still poorly valued and priced in 2050 with forest resources still used wastefully and disregarded in land conversion decisions. For example, agribusiness expansion has occurred by using more and more land rather than through increased productivity. Expanding agribusiness is responsible for 60-70% of all tropical deforestation and the rest is caused by increased infrastructure, mining etc. Some 300 million ha of

tropical forest was cleared between 2015 and 2050, an area of land of the size of India or about 15% of the tropical forest area in 2050. This clearing causes additional emissions of about 170 Gt of CO^2, which corresponds to about 17% of the remaining carbon that can be emitted if the rise in Earth's temperature is to be held below 2 degrees Celsius. On the other hand, other ecosystem services such as utilisation of medicinal plants and nature tourism, including wild game management and recreation, now show a turnover which is two-thirds of the turnover of the conventional forest industry. Increased competition over land and between different interests, as indicated above, has led to changed governance of the forest resources to more inclusive and dialogue-based governance models. It should be noted that the European countries with smaller populations face a true challenge to maintain their roles in the international policy arena with respect to natural resources.

"The conventional forest industry has not possessed the capability to carry out the necessary structural change."

INDUSTRIAL DEMAND AND SUPPLY

Global industrial wood demand has grown, and Asia is the driving force. China has a deficit of 350 million m^3 round-wood equivalents in 2050. The global industrial round wood demand plateaued in about 2030 at around 2.0 - 2.2 billion m^3 per year and has stayed at that level until 2050. The global demand for other biomass for fuelwood, bioenergy and biomaterials, has boomed with a demand of about 4.5 billion m^3 in 2030 and 6 - 7 billion m^3 in 2050.

Some 150 million hectares of southern commercial fast-growing plantations could supply most of this industrial wood and about double that area is required to cover the additional global demand for biomass for bioenergy and biomaterials. The southern commercial plantations are estimated to have increased to 300 million ha by 2050. It has become more difficult and more expensive to increase the areas of commercial plantations due to increased competition as concerns land for food, energy and environmental services and social demands. The value of commercial forest plantation land in 2050 is still half or less than the best prices for agricultural alternatives. The yield in southern fast-growing commercial plantations has continued to increase and is assessed as 50-60% higher, as a global average, in 2050 compared to 2015.

INDUSTRIAL CONSUMPTION

Industrial wood supply from the northern regions and in tropical natural forests has declined due to lost competitiveness, increased environmental and social constraints respectively. Global wood pulp production has increased by some 35 million tons between 2015 and 2050. The real increase in production has taken place in Latin America, Asia and Oceania. All other regions have experienced decreased or flat production development. Increases are predominantly in the form of hardwood pulp from fast-growing plantations. Pulpwood production follows, of course, the consumption pattern for pulp. Recovered paper use in pulp production has seen global levels dramatically increase and recycled paper is now a scarce resource. The increase is also valid for trade in recovered paper. Pulp production in developed economies is now directed towards special pulps. Developed economies cannot compete with the southern hemisphere with respect to conventional bulk pulp products.

Global paper and paperboard consumption has grown by nearly 200 million tons and is around 550 million tons in 2050. Growth in consumption is taking place in emerging economies, especially in China and India. In advanced economies there is a substantial decrease in consumption. In Europe, the production decrease was around 30% between 2015 and 2050. The most dramatic change has taken place in graphics paper due to competition from growth products that are packaging and tissue grades.

The consumption of coniferous sawn wood increased substantially to some 100 million m^3 in Asia between 2015 and 2050 and has also shown strong growth in Latin America. In other regions of the world, consumption rate has been fairly flat during this period. This has led to substantially

increased areas of coniferous plantations in the southern hemisphere.

The conventional forest industry is not a high economic yield industry. It has to compete on cost-efficiency and quality deliveries. Globalisation is a deep and powerful force for the development and structural change of the conventional forest industry. Northern sawn wood production now focuses on quality and aesthetic values in wood products. The latter requires new forest management regimes in order to grow specific qualities.

BIO-ECONOMY

Since 2010 there has been discussion on the development of the bio-economy and how this will transform the conventional forest industry into a much more value added oriented industry with brand new products. Real developments up to 2050 lead us to conclude that this has not been the case. The conventional forest industry is heavily dependent on economies of scale and the introduction of new bio-products is based on many products with speciality functions, but in small volumes. Consequently, smaller companies and starts-ups have more often occupied the market niches provided by the highly profitable, new, bio-products. The conventional forest industry has not possessed the capability to carry out the necessary structural change. The conventional forest industry has expanded in the emerging economies of the southern hemisphere with pulp and sawn wood in Latin America, and paper and sawn wood in Southeast Asia. The conventional forest industry has contracted in developed economies.

In the following, the impacts of the individual scenarios on the forest sector are presented.

3.2 TECHNOLOGY BRINGS A BRIGHT FUTURE / SCENARIO 1

Technological development has been very rapid in many different technological fields. This development has resulted in the introduction of many new products and materials that were unknown in the 2010s. Many of these products, often bio-based, have better environmental characteristics and higher value to the customer than conventional wood, paper and paperboard products. Thus, these new products are produced outside the conventional forest sector and in units gaining from strongly reduced economies of scale. Developments have resulted in less demand for conventional industrial wood and the major part of this supply is taken care of by the fast-growing southern plantations. Priority for forest governance in large parts of the world has largely shifted from growth and yield of timber to other ecosystem services, such as nature recreation and tourism issues. New research institutions have been created based on broad system links as well as full-scale trials of human-nature-technology systems.

GLOBAL CONSUMPTION OF CONVENTIONAL PRODUCTS HAS DECLINED

Technological developments have resulted in the global consumption of conventional paper and paperboard products levelling at 100 million tons less than that stated in *the Conventional Wisdom* and presented in the earlier section. This is imposing pressure on the wood pulp industry and global capacities have shrunk corresponding to the decline in paper consumption. In the 2010s there were expectations that everything produced from fossil raw materials could be produced from woody fibres, bringing a strongly improved economy for the forest sector. But time has proven that reality has been more difficult. The transition of the large scale dependent forest industry to the production of these new green products represents a true challenge. In addition, this transformation requires major R&D and innovation efforts in the form of networks of quite different competencies. The forest sector has not been successful in opening up new opportunities and business models based on these new technological innovations.

NEW RESEARCH INSTITUTIONS

Conventional forest research has not been able to attract industry and crowd sourcing capital in the amounts needed. New research institutions have been created based on broad system links as well as full-scale trials of human-nature-technology systems. New technologies create many new working opportunities, but the forest sector has not been able to harness this positive trend, one issue being lack of customised basic training for professionals based on

individualised and interactive methods. Other industrial sectors have taken the lead and utilised technological advances made in materials development and the conventional forest industry has ended up in a backwater. Bioenergy is not an option of great interest due to the development of other energy alternatives. There are a number of successful transitions in the forest industry, including advanced bio-refineries, but far from the extent expected in the 2010s.

FOREST INDUSTRY

With respect to sawn wood products, conventional sawn wood consumption has also declined. Materials development of composites driven by technological development has been very rapid. The conventional sawn wood industry has not been on its toes as concerns this transformation from conventional sawn wood to composites consisting of combinations of wood, chemicals, electronics, concrete, steel and glass as developments have occurred in industries other than the sawn wood industry. The demand for conventional construction sawn wood has consequently declined. Thus, these new products are produced outside the conventional forest sector and in units gaining from strongly reduced economies of scale, as well as in mobile production units able to utilise raw materials that are closer to source. They also demand smaller supply volumes than conventional forest industry which in turn means substantially less transportation of non-processed raw materials. This has imposed tremendous economic pressure on the conventional forest industry, which has contracted and shows almost no economic performance to speak of. The conventional forest industry can be said to be a giant with feet of clay.

FAST-GROWING PLANTATIONS TAKE OVER

Developments have resulted in less demand for conventional industrial wood, which is around 1.6-1.8 billion m^3/year. The major part of this supply is taken care of by the fast-growing southern plantations. Natural forests are disappearing, replaced by engineered plantation systems (GMOs). Technological development has also generated emission-free energy technologies, which has resulted in hardly any demand for wood fibres for bio-energy purposes. New industries are utilising biomass more efficiently with a yield of 70-80%, compared to 40-50% in conventional industries. All of this results in hardly any profitability in conventional forestry, which in turn leads to weak payment levels for the raw material and passive forest owners, not utilising their forests. This results in increased greenhouse gas emissions from decaying and unmanaged forests as compared to *the Conventional Wisdom*. The rapid technological development of alternative energy carriers has resulted in an increasingly emission-free society and a diminished role for forests in global greenhouse gas balance and climate mitigation.

"Other industrial sectors have taken the lead and utilised technological advances made in materials development."

CONFLICTS AND NEW MARKETS FOR ECOSYSTEM SERVICES

In spite of lower consumption of industrial wood due to the rapid increase of population and high economic growth, pressure on the forest resources has increased strongly, especially in the emerging economies through other economic activities due to land-use changes caused by expanding population, agriculture and new infrastructures for housing, transportation and industrial development. Conflicts over the forest resources have increased.

These advanced technologies also helped to capture an enormous amount of data and to picture what happens in nature instantly, creating opportunities for advanced environmental planning and monitoring. This constitutes a strong foundation for monitoring the environment and policy setting. Technological development has also made it possible to measure, through big data, the real role of forests with respect to ecosystem functions and services, and we realise that the interaction of the different system components of the ecosystems are much more complicated than had been assumed earlier.

However, in order to secure ecosystem functions and services, the forests have to be managed – but managed in accordance with objectives other than merely growth and yield of timber. However, there are hardly any markets for these services and in order to get the management actually carried out, governments have to establish market values for the other services and more research about ecosystem functions and services is needed.

NATURE TOURISM ISSUES HAVE AN INCREASED ROLE IN FOREST GOVERNANCE

The major technological corporations dominate the international scene and also strongly influence governments. Rapid technological changes demand governance structures able to handle rapid change. Governance is forced to use new technologies and approaches in policy making and monitoring of policy impact. Overlapping cross-sectoral policy making is compulsory.

Due to technological advances, emissions to the atmosphere are less compared to *the Conventional Wisdom* and it seems likely that the 1.5 degree target will be reached. There are still impacts on forest resources from climate change due to lag effects in the climate system, but impacts are less compared to expectations, in accordance to *the Conventional Wisdom*.

People are making good money and are living in a very technocratic and urbanised world. Consequently they need, and can afford, to spend more time in natural environments. As a result, nature tourism in forest environments has increased multi-fold. Priority for forest governance in large parts of the world has largely shifted from growth and yield of timber to other ecosystem services, such as nature recreation and tourism issues.

3.3 A FUTURE WITH HUMAN OBSOLESCENCE / SCENARIO 2

By 2050 global society is divided, leading to peculiar consumption patterns. One very rich segment with strong links to the technological sectors and another larger, poor component of society not able to do so are unemployed and fighting for survival. Technology advances lead to the production and consumption of new products with better characteristics than conventional paper, paperboard and sawn wood products. However, the poorer group cannot afford these products and have to live with conventional and less value-added forest products. A substantial part of forest resources is utilised for energy production. The industrial structure utilising woody biomass is divided into two branches with one being old and not up to date together with a basic bioenergy industry and one smaller, hypermodern branch with high value-added production. The overall weak economy and the fact that the poorer segment of the society needs access to the forest resources for survival in order to avoid political unrest, results in very weak governance of forest resources.

POORER SEGMENT OF THE SOCIETY KEEPS UP THE VOLUME

It can be said that the poorer segment of society keeps the volume of consumption of conventional forest products up to some extent. The consumption of conventional paper and paperboard products is around 50 million tons less per year compared to *Conventional Wisdom*. The consumption of low-value-added sawn wood has increased by 25 million m^3 per year, which is much lower compared to *Conventional Wisdom* assessments. However, the depressed global economy and the weak paying capacity of a large part of society means the economic conditions in the conventional forest sector are very depressed. The industry cannot afford to invest in new technologies so it is difficult to maintain high educational and R&D levels in forestry. The demand for industrial and crowd funding for R&D and innovation has increased. Altogether, this means that the structure and knowledge base of the conventional forest industry by 2050 are old and partially obsolete. New industries using biomass show a modest turnover, and are driven by sectors outside the conventional forest sector.

DIVIDED INDUSTRIAL STRUCTURE

Depressed global economic conditions force many people and companies to use older technologies and sources nearby for energy provision so a substantial part of forest resources is utilised for energy produc-

tion. This means bio-energy from forests is booming. The assessment is that 2.5 billion m^3 per year of woody biomass is used for energy purposes, but the demand for industrial fibre is depressed. Biomass for energy pays less as compared to industrial wood. This development has resulted in low prices for wood fibres and very low economic gains from forestry. The forest owners who are able to provide tailor-made deliveries to the new industries are the only ones earning a substantial amount of money. Thus, the industrial structure utilising woody biomass is divided into two branches with one being old and not up to date together with a basic bioenergy industry and one smaller, hypermodern branch with high value-added production.

"The industry cannot afford to invest in new technologies so it is difficult to maintain high educational and R&D levels in forestry."

INCREASED EMISSIONS

The poorer part of the global population is, to a greater degree, obliged to live off the land meaning more self-sufficiency in food and so a substantial increase in clearing of land and forests. Increased deforestation and increased mortality in the production forests due to neglected management has resulted in increased emissions from forestry in comparison to *the Conventional Wisdom* assessment. The overall impact of less consumption and over-use of natural resources will make it difficult to reach the 2 degree climate target. The estimated climate change processes for the different forest regions according to *Conventional Wisdom* now appear more rapid and severe. Climate effects also occur much more abruptly.

Technological development has made it possible to make ecosystem functions and services more understandable and brought the chance to better assess the impacts of different forest management regimes, as well as the long-term negative impact of climate change. Due to the overall harsh economic conditions, very few of these new technologies are implemented within forestry.

WEAK GOVERNANCE

The rich segment of the population wants to enjoy increased opportunities for nature recreation and tourism and want to reserve forest areas for these purposes. Nature tourism by this group has increased substantially. The poorer segment wants to have free access to forest resources for utilisation of food, energy and conventional forest products in order to survive. This leads to conflicts on the use of the forests. Governments are well aware of the need for sustainable management of forest resources for industrial, social and ecological reasons. However, they are in a difficult position with an overall weak economy and the fact they must let the poorer segment of the society access the forest resources for survival in order to avoid political unrest. All of this results in very weak governance of forest resources.

3.4 THE NEW NORTH / SCENARIO 3

The world has experienced a boom in population growth dominated by the emerging economies in Africa, India and Southeast Asia. Population growth has also pulled up the global economy substantially. These growth regions are also the centres for globalisation in 2050 but also for negative climate and environmental effects. This development drives a substantial demand for both conventional and new forest products. Natural resource limits and armed conflicts in the southern hemisphere lead to a boomerang effect favouring the North. This has turned out to be a win-win situation for the conventional forest industry of the North with rich experience and solid infrastructure for in-depth, innovative work. The structure of the forest industry in the North is currently a mixture of giant, scale-dependent industries and small, non-scale dependent industries. Still, it is a struggle for the North to find skilled workers for industry and not least for the management of forest resources. This is due to rapid urbanisation and the declining economy of rural areas.

OVEREXPLOITATION AND THE GAP BETWEEN DEMAND AND SUPPLY

The explosion of consumption of, in principle, all kinds of products in these growth regions results in a tremendous overuse of natural resources and dramatically increased emissions in relation to *Conventional Wisdom*. Overuse results in deforestation, degeneration of forest resources and failed fast-growing plantations in emerging economies in the southern hemisphere. Consequently, the conventional forest industry in these regions has lost its competitive edge and experiences difficulties in supplying both domestic markets and export markets.

It appears there is a global demand for conventional forest products in line with *the Conventional Wisdom* assessment. Also, global demand for new products is booming. However, the conventional domestic forest industry in these rapidly-growing regions has contracted due to a decline in natural forests as well as in fast-growing plantations. Natural forests have continued to shrink and are now 15% smaller than in 2010 with a loss of 10% of global biodiversity. Also, climate change has resulted in declining forests by increased droughts, flooding, wildfires and other disruptions. Thus, there is a wide gap between demand and supply. This has turned out to be a win-win situation for the conventional forest industry of the North. Climate change impacts are less drastic in the North, except for the sub-arctic regions. Risk of windfalls, insect or

disease outbreaks and wildfires have increased and forest management has been modified accordingly. In fact, total growth of forests has expanded and consequently harvest levels can be increased. The conventional forest industry can sell as much as it can produce at good prices to all the regions of world due to the global imbalance between demand and supply.

CONVENTIONAL FOREST INDUSTRY HAS BEEN ABLE TO INVEST

This also means that the conventional forest industry has been able to invest in new activities. The North has long, rich experience and solid infrastructure for in-depth, innovative work. The conventional forest industry has learned that development of new forest-based products has not only to be green but also must have better prices, functions, qualities, design, life-time etc. than conventional products in order to make it to market. The conventional forest industry in the North has learned the hard way how to achieve this position. There has been a dramatic change in industry, government, academia, finances and other sectors and they have realised that they have to work together. Industry has also learned that they must invest more in innovative work and start with small-scale production of new products, often in the form of start-ups. Consequently, the structure of the forest industry in the North is currently a mixture of giant, scale-dependent industries and small, non-scale dependent industries. This has been possible through the considerable profits made from exporting conventional forest products.

Industry in the North has also learned, to its great surprise, that there are huge opportunities for new business in services related to forest resources. Recreation and nature tourism from countries with strong urbanisation trends and dwindling natural resources has increased dramatically. As has the health industry linked to forests.

The issue of ecosystem services is hotter than ever in the North. Increased demand for forest resources

for all uses has made the balance of sustainability a very delicate issue, and a satisfactory solution is not yet in place. This is the primary struggle in the governance of forest resources globally, and in the North, due to the rapid rate of developments.

"Industry has also learned that they must invest more in innovative work."

LACK OF SKILLED WORKERS

Based on well-developed preparedness for change, *the New North* countries are leading the transition together with Asia. Many universities in the North are driving technological advances and their applications. Still, it is a struggle for the North to find skilled workers for industry and not least for the management of forest resources. This is due to rapid urbanisation and the declining economy of rural areas. This forms a major headache as it constrains opportunities for development and sustainability. The regions on earth struggling with deteriorating natural resources are looking hard at all the options to mitigate or adapt to these conditions. This is a business opportunity for the North, selling services and knowledge on how to take on these problems. The North has a great deal of experience in tackling complex systemic issues. The success of governance is partly due to the ability of the governments of the North to understand the crucial importance of creating strong environments for informative dialogue platforms, adapted to handle swift change, with multidimensional interests across sectors. It should be noted that the European countries with smaller populations are experiencing problems in maintaining their roles in the international policy arena with respect to natural resources.

3.5 THE WORLD IS GOING SOUTH AND EAST / SCENARIO 4

The tremendous economic growth in Asia is causing rapid growth in consumption of conventional forest products. Asia and India are the leading world regions in the development of new bio-based products. China is now assessed to have a deficit of wood products together with the rest of Asia and India in the magnitude of 500-600 million m^3 round-wood equivalents. In spite of the fact that Africa is a large continent with lot of forested areas, the region is also assessed to be a region with a forest products deficit in the magnitude of 100 million m^3 round-wood equivalents. China, the rest of Southeast Asia, India and Africa are experiencing huge problems with their forests losing ecosystem functions day by day, which undermines the sustainable development of the societies in these regions and cause risks and conflicts. Regions with long experience of sustainable management of their forests have great opportunities to sell knowledge services to these fast-growing regions.

DECREASED CAPACITY FOR ECOSYSTEM SERVICES

Natural resources are severely overused in Asia and Africa in 2050. Deforestation is driven by the expansion of agricultural land due to lack of efficiency in existing agriculture. The transformation of the agriculture sector has been possible due to technology transfers and active financial involvement by China and some countries in the Middle East. Forest resources are overused not only for commercial harvesting but also from pure population pressure and economic growth, and in certain aspects in interaction with climate change. The pressure from population and economic growth is the most serious as it results not only in disappearing forest areas and volumes, but also dramatically decreased capacity for ecosystem services which brings severe drawbacks to these societies. Consequently, both regions have to set aside much more protected forest areas and to restore more degenerated forests. Both regions have to deliver sustainable energy balances, and bio-energy forms an important component of this. More and more energy plantations are established which are becoming more important than forest industry plantations. Certain sub-regions of Africa have the world's best growing conditions for fast-growing plantations.

CHINA AND INDIA LEADING DEVELOPMENT

With respect to the industrial structure for the production of conventional forest paper and paperboard products China has the world's most mod-

ern fleet. Previously, China had a profusion of small, obsolete mills but they have been closed down over time. India has a conventional forest industry with high technical age. However, Indians are good at squeezing productivity out of the machinery. In Africa in 2050, there is a modern industry worthy of mention only in South Africa with respect to pulp and paper, although several countries have a strong potential and investment climate compared to three decades ago, in accordance to the description in chapter two. The sawmilling industry is in somewhat better shape all over the continent. The Asian countries, especially China but also others, are trying to improve their domestic wood supply situation by investing in harvesting and wood production in Africa and importing the wood to China. However, China and India are not inclined to invest in an expensive forest industry in Africa, possibly with the exception of saw milling capacity.

AN OPPORTUNITY FOR EXPORT COUNTRIES

With the current wood supply situation, raw wood material is expensive for industry in the regions with declining forest resources and the profitability in the industry is meagre. This is an opportunity for traditional exporting countries, like those in the North, to increase their market shares and compensate for substantially declining markets in other world regions, such as Europe and North America.

It should be stressed, in their position as global economic leaders, China and India set the rules for the trade and they are low price traders. Thus, even if exporters can place big volumes of conventional forest products, profits in 2050 are not the highest and make life hard for exporting industries from other regions. Forest countries have to get involved in both forest production and industrial production in Africa in order to avoid that the continent becoming *Little China* and *Little India*. Their involvement must encompass the complete sustainable supply chain of conventional forest products.

KNOWLEDGE SERVICES TO LEADING REGIONS

With respect to the new bio-based products, China has invested enormous amounts in innovations and is in the front line. It is very difficult for other regions to break this position. India has also invested substantial amounts in bio-innovations e.g. textiles. As it looks now, Asia and India are the leading world regions in the development of new bio-based products.

"China and India set the rules for the trade and they are low price traders."

China, the rest of Southeast Asia, India and Africa are experiencing huge problems with their forests losing ecosystem functions day by day, which undermines the sustainable development of the societies in these regions and cause risks and conflicts. Regions with long experience of sustainable management of their forests have great opportunities to sell knowledge services to these fast-growing regions. They are capable of substantial payment for these services. The urbanisation process has placed extraordinary demands on urban planning and the role of trees in this development needs further research and analysis.

3.6 A WORLD OF GLOBAL RESILIENCE / SCENARIO 5

The world in 2050 is characterised by a consensus on the sustainable development of natural resources, building on solidarity and bio-economy approaches instead of neo-classical economics based on increased consumption. This has resulted in less material consumption and forest products are not excluded from this. Industry has been forced to move into the production of bio-chemicals and other brand-new bio-products. This transformation has been too slow so far, resulting in a constrained market for small-sized wood which results in passive forest owners, poorly-maintained forests and supply problems for sawn logs. In the Southern hemisphere, the pressure on forest resources has eased, with less deforestation and forest degeneration as a result, thanks to technological advances, the introduction of global agreements and strong sustainability agendas. Due to the fact that societies make high quality of life a priority, nature recreation and tourism, including forest tourism, is booming with an increasing share of forest sector economy. Scientists have become much more active in the public debate concerning forest resources.

PAPER AND PAPERBOARD PRODUCTION IS LOCATED IN THE SOUTHERN HEMISPHERE

The conventional forest industry has adjusted to the new realities and reduced capacity all over the world, except in areas with fast-growing plantations. Today, global paper and paperboard consumption is at the same level as in 2020s. Sawn wood consumption is somewhat higher than in 2020. This is a result of increased use of wood in construction, but also due to increased material-efficient construction technologies and new bio-composite products. The most important change in the forest industrial structure by 2050 is that nearly all conventional paper and paperboard production is located to the Southern hemisphere. Softwood sawn wood production is still concentrated in the Northern hemisphere thanks to huge investments in re-structuring the saw-milling industry into mills for production of new building systems, including wood composite materials combined with other materials as well as quality products for interior use.

REDUCED DEMAND FOR SMALL-SIZED WOOD

This situation is a dilemma for the Northern industry and forest owners as there is limited demand for small-sized wood, specifically thinning and treetop wood. The demand for these products used to

be one of the key factors behind the success of the Nordic forestry model with active small-scale family forest owners. The industry has been forced to move into the production of bio-chemicals and other brand-new bio-products. This transformation has been to slow so far, resulting in a constrained market for small-sized wood resulting in passive forest owners, poorly maintained forests and supply problems for sawn logs.

In the Southern hemisphere, the pressure on forest resources has eased, with less deforestation and forest degeneration as a result, thanks to technological advances, the introduction of global agreements and strong sustainability agendas. This has, in turn, substantially reduced greenhouse gas emissions from forestry. The global goal of limiting temperature change to 1.5 degrees appears to be within reach.

"The industry has been forced to move into the production of bio-chemicals and other brand-new bio-products."

SCIENTISTS IN THE PUBLIC DEBATE

The improved situation for global forest resources has also improved ecosystem functions, although there is still a long way to go. Technological advances have helped to a better understanding of the complex interactions of the different ecosystem services. The dialogue between governments, industry, science and civil society has improved substantially with respect to management of global forest resources. Scientists have become much more active in the public debate concerning forest resources. *The Informed Scientists* and IUFRO have become the most important global NGOs in this respect.

The consumption of materials has been substantially reduced in order to maintain natural capital and a sustainable world, giving a new perspective on how to value nature and forests. Due to the fact that societies make high quality of life a priority, nature recreation and tourism, including forest tourism, is booming with an increasing share of forest sector economy. The concepts of bio-economics, learning from nature and higher life quality have resulted in forest policy frameworks trying to consider all the values of the different forest biomes globally in a systemic manner. This is the leading principle and the new governance guideline, at national level and in efforts by international regimes. The conventional forest industry has realised that they must adjust to the perception of the international customers with respect to sustainable development of forest resources as this is decisive to the industry's future survival and economic performance.

3.7 A WORLD IN DISORDER / SCENARIO 6

This is a tragic world with nationalism, protectionism and international conflicts. The forest sector suffers tremendously, like all other sectors. The global economy is in a tailspin; China has collapsed and global trade is minimal.

Primary demand for forest products is driven by domestic consumption. The industry is hardly earning any money and is not able to make new investments so maintenance is a problem. There is not much technological innovation or development with bearing on the forest sector. The ecosystem functions of the existing forests decline dramatically as governments withdraw from international agreements made in the field. These depressed conditions result in hardly any sustainable harvest due to neglected sustainable forest management. The overuse of forest resources and neglected forest management leads to never before experienced emissions of greenhouse gases from forest ecosystems.

DEPENDENT ON DOMESTIC MARKETS

Some global trade still exists with respect to forest products which is driven by military and security demands. Thus, primary demand for forest products is driven by domestic consumption and shows a pattern similar to the situation during *WWII*. Consequently there is not much conventional forest industrial capacity in full operation and the industry that is operating is predominantly dependent on its domestic markets. The industry is hardly earning any money and is not able to make new investments so maintenance is a problem. There is no technological innovation nor development with bearing on the forest sector.

CONFLICTS AND FOREST DECLINE

These depressed conditions result in limited conventional industrial and sustainable harvest levels due to neglected forest management. On the other hand, forest resources are overused and devastated for other reasons. Forests are depleted for increased food, marijuana and fuel production. Other examples of negative developments are mining spreading without any controls, habitats destroyed and wild animals become overheated and die due to increased temperatures. Consumerism of natural resources occurs uninhibitedly.

The overuse of forest resources and neglected forest management leads to never before experienced emissions of greenhouse gases from forest ecosystems. The global goal of a temperature increase of 2 degrees becomes unattainable. Due to declining economies and collapsing institutions, governments are withdrawing from previous climate agreements. The ecosystem functions of the existing forests decline dramatically as international agreements

made in this field are withdrawn by governments. Nobody has any interest in worrying about forest ecosystem functions.

In the mid 2010s, the formal forest sector employed some 13 million people and the informal sector about 41 million. Forest products in different forms gave shelter to about 1.3 billion people, which was more than 15% of the world population. Wood energy was often the only source of energy for the rural population in less developed countries. Some 750 million people lived in or near forests. They did not only use forests for energy, but the forests also played an important role for food security and water supply, and by that for general security. This has now changed almost entirely due to the harsh conditions and overuse of forests, but also due to the fact that this overuse is controlled by corrupt and organized criminal individuals. Thus, people do not even have access to forests anymore. This development has led to a strong increase in starvation as well as decreased health conditions. The cultural and spiritual values, recreational values and aesthetic values have to a large extent been ruined under the current conditions.

4 Implementation of scenarios

The real value of the report showing the six global scenarios for 2050 surfaces when the scenarios are implemented in a foresight exercise. The purpose of the scenario process is to train decision makers to detect changing futures and relevantly handle unfolding new futures. A prerequisite for successful implementation and foresight exercise is a strong level of acceptance and involvement in the process by the management of the relevant organisation.

THERE ARE MANY organisations, in government and public service, business and civil society using the scenario approach to broaden views within organisations and prepare organisations for rapidly-changing environments that include conditions not currently considered. The results of successful implementation of the scenario approach may lead to drastically-changed strategies followed by possible transformation of the organisation in broad terms. With rapidly-changing, complex environments at global, regional and national levels, every organisation needs to take these changes into account in their planning in order to prosper in the future.

The aim of the implementation process is for an organisation to transform in accordance with the requirements set by the outside, and rapidly-changing, world. One prerequisite for a useful transformation process is that the participants open their minds to an unknown and uncertain world and are willing to prepare themselves and their organisation for rapid changes. If this is not the case, the organisation risks developing irrelevant strategies and irrelevant production of future services and products.

4.1 THE UNKNOWN UNKNOWNS

The key to successful implementation of foresight exercises is the understanding of how an organisation is affected by both known and unknown conditions. This understanding must characterise the process when it comes to meeting changing and unknown conditions. The terms *known unknowns* and *unknown unknowns* are often used in project management. *Known unknowns* result from phenomena which are recognised, but poorly understood. *Known unknowns* (expected or foreseeable conditions) can be anticipated, but not quantified or their probability assessed, based on earlier experiences.

"The *unknown known*, which we intentionally refuse to acknowledge that we know. This is probably the most vulnerable category for an organisation."

Unknown unknowns are phenomena which can be imagined but we do not know forms, magnitudes, timelines etc. due to no prior experience or theoretical basis for expecting the phenomena. *Unknown unknowns* (unexpected or unforeseeable conditions) pose a potentially greater risk for an organisation simply because they cannot be assessed based on ex-

perience or investigation. *Known knowns* is the third category, stating the things we really know. Beyond these three categories there is a fourth, the *unknown known*, which we intentionally refuse to acknowledge that we know. This is probably the most vulnerable category for an organisation.

4.2 FORESIGHT EXERCISES

The task is to engage the staff of an organisation in forming the organisation's future and to draw from the knowledge built up in the organisation itself to deal with the scenarios. A well-established method in project management is to involve staff in workshops based on strong dialogues. One prerequisite for successful processes is that participants enter the workshop with a strong commitment and without preconceived opinions about the outcome of the workshop. It is also crucial that professional facilitators implement the workshop. The first workshop could be carried out with the upper management of the organisation, before working with the rest of the organisation.

AN OUTLINE of a full day's workshop may look as follows. The scenarios are presented and used by different working groups of the organisation. The group members are asked to identify new insights they learned from the scenarios. The results of the group exercise are presented and discussed in *plenum*. Then, group members are asked to identify the implications of these new insights e.g. threats and strategic opportunities for their organisation and their tasks and responsibilities.

In the next step, groups should formulate relevant strategies and organisational consequences based on the identifications made above. In a final step a discussion should be carried out *in plenum* assigning priorities to identified strategies and organisational changes. It is crucial for scenario implementation success that organisers and facilitators rapidly document the results of the workshop(s) in a holistic and consistent manner. Suggested areas for further analysis are summarised. Thus, the accepted foresight process and its output is used by the organisation to broaden thinking, clarify choices, articulate visions, suggest new strategies and craft a suggested agenda for change. The foresight process results in deep organisational learning and, ultimately, in the ability to change in response to both challenges and opportunities. Experiences show that the implementation of foresight analyses is a challenge for every organization. A successful exercise following the guidelines in this report requires changing mind-sets and substantial resources allocated to carry out the required processes. It is proposed that this type of scenario exercise be carried through at regular intervals, depending on objective, but at least every four years.

"The accepted foresight process and its output is used by the organisation to broaden thinking, clarify choices, articulate visions, suggest new strategies and craft a suggested agenda for change."

THE OUTLINE OF A FORESIGHT EXERCISE

1. A summary of the scenarios is presented.
2. Identification of new insights using a group learning experience.
3. Implications of the new insights are identified.
4. Strategies and organisational consequences are formulated.
5. Prioritised strategies and organisation changes are presented.
6. A facilitator documents the results in a holistic and consistent manner.
7. Suggested areas for further analysis are summarised.
8. Foresight exercises are carried out at regular intervals.

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Appendix: Descriptive variables in relation to global scenarios

The descriptive variables for the six global scenarios developed for 2050 are presented in this Appendix. The first section defines the variables, followed by a detailed presentation of the descriptive variables in relation to each scenario. The variables are as follows: *Climate, Demographics, Economics, Energy, Governance, Industry, Infrastructure, Life Styles, Natural Resources, R&D and Innovation, Conditions and Societal Changes.*

Definitions of descriptive variables for Scenarios

The definition of the descriptive variables affecting the future developments for the six global scenarios developed for 2050 are presented below.

CLIMATE: The climate will respond and its impact will differ (e.g. temperature and precipitation) depending on different climate policies and the varying degree of mitigation in the different scenarios. Different climate policies will generate different environmental and socio-economic effects. The climate variable is closely linked to the energy routes chosen as well as to global economic activities and associated consumption.

DEMOGRAPHICS: The demographics variable concerns the number and the distribution of people, population growth, skills and education, migration and emigration flows, distribution of economic prosperity and age structures.

ECONOMICS: The dynamics of the economic variable concerns the relationship between economic growth (consumption and production, GDP and other measures), degree of globalisation and internationalisation, international trade, international financial systems and investment climates, business models, environmental and societal goals and the interrelationships between the different economic sectors.

ENERGY: The preconditions for future energy systems (e.g. fossil fuels, nuclear and renewable energy) and energy mixes will vary in the different scenarios. The climate variable is closely linked to the success of technological innovations in the field of energy and digitalisation as well as to global economic activities. Different scenarios will cause different environmental and socio-economic effects.

GOVERNANCE: The different scenarios will generate different governance models. This variable concerns the degree of new governance mechanisms adapted to new conditions, environments and business models. Governance includes policy making and institutions, formal and informal, and the implementations of informal regulation and legislation. Governance and institutions are strongly linked to societal change. The relationships between governance at global, national and regional levels are important to consider.

INDUSTRY: The industry variable concerns consumption and production, economics, globalisation and structural changes. Different product demands generate different scales of industrial economy. The industry variable is closely linked to economics, demographics, innovation and societal change.

INFRASTRUCTURE: The infrastructure variable concerns the interrelated systems of the physical components intended to provide commodities and services essential to enable, sustain or enhance societal living conditions. The focus is on quality, volumes, accessibility, costs for infrastructure and environmental impacts. It is crucial to consider the integration of different infrastructures and future modes of transportation. The infrastructure variable is closely linked to innovation and industry.

LIFE STYLES: The lifestyles variable concerns changed consumption patterns, changes in values and behaviours. There are strong links between lifestyles, economics, governance, demographics, health and not least societal changes.

NATURAL RESOURCES: The natural resources variable concerns the extent, level of protection and exploitation of natural resources, degrees of resilience, land use (e.g. forestry, agriculture, mining, nature tourism), consumption and production. The integrated view on natural resources (cross sectoral) as well as the relationship between protection and utilisation is of great importance. The natural resources variable is closely linked to the climate variable and the socio-economic dimensions.

R&D AND INNOVATION: Research, development and innovation are based on the general educational level as well as the quality and extent of research and development. One focus is on the creation of strong innovation environments, e.g. a financial mechanism for market innovation, and the creation of emerging research institutions based on the recognition of increasingly complex human-nature-technological interactions and new forms of sciences.

RURAL CONDITIONS: The rural variable concerns rural development paths and urbanisation. The rural variable is closely linked to natural resources, the demographics variable, economics, governance and societal changes.

SOCIETAL CHANGES: Societal changes concerns individualisation, values, gender, social equality, health, income and living standards. The societal changes variable is crucial with respect to governance, including formal and informal institutions.

Descriptive variables in relation global scenarios for 2050

This section contains a detailed presentation of the descriptive variables in relation to each global scenario for 2050. The variables were generated from the literature review and the authors' interpretations.

TECHNOLOGY BRINGS A BRIGHT FUTURE / SCENARIO 1

Technological advancements drive economic development, create employment and promote health and sustainable development. Climate mitigation has been successful and the 2030 agenda of sustainable development goals as well as the objective of slowing the increase in global temperature to under 1.5 degrees Celsius have been fulfilled.

CLIMATE: Emissions are decreasing rapidly, the 1.5-degree target will be met. It will be possible to solve the environmental and social impacts caused by climate change. Point-source emissions are effectively controlled in most countries but cumulative emissions from diffuse sources persist. Solar power is now the world's major energy source. The cumulative effects of integrated technologies have made it possible to substantially reduce GHG emissions over the last 20 years. However, there is a lag effect in climate impact so the world is still suffering from the effects of climate change.

DEMOGRAPHICS: Work opportunities are created locally in areas with historical weak labour markets, but this has required the implementation of decentralised, personalised and extremely interactive education. This has, in turn, resulted in more even distribution of economic prosperity, of goods and services as well as to reduced emigration and migration. The medical domain has transformed dramatically. The breakthroughs in biotechnology have already been discussed above. These occurred in combination with the development of the Lab-on-a-Chip (LOC). A blood sample is fed into an LOC, the data is uploaded to the cloud and analysed for deeper diagnostics in special centres. These diagnostics are accurate, low-cost, easy-to-use and preventive. This results in less pressure and demand on hospitals, nurses and doctors. Artificial intelligence has taken over much of the diagnostic function in healthcare and new technologies for human medicine will change the age structure, there will be an increased share of elderly people.

ECONOMICS: Global markets expand continuously but the wealth is highly concentrated in major corporations. Earlier, the global economy ran on oil, now it runs on data. Robots have become the ve-

hicle to transform society and increase the global economy by several orders of magnitude. 3D or 4D printing has reduced manufacturing costs dramatically due to lack of economies of scale. Technology has transformed marketing completely due to rapid prototyping. The shift towards individualised consumption and customised lifestyles have transformed society and regional trade flows. Strong GDP growth is driven by technological developments creating more employment opportunities, higher income per capita and greater consumption as well as increased trade. New business models have been developed to respond to and open up new opportunities based on technological innovation. Industry and crowd sourcing are financing an increasingly large part of the research, and more risk capital has been created. The high intensity of technological innovation means that preconditions for the planning horizon are considerably shorter. More advanced technologies in medicine and care lead to positive change in the ability to achieve social goals and aspirations. This has required customised basic training and advanced R&D in the technology area linked to natural resources and society.

ENERGY: New, cost-effective, highly efficient energy systems have been introduced, as well as breakthroughs in solar and hydrogen, which means no energy shortage. Solar power is now the world's major energy supplier. Energy efficiency in industry has become world changing. Bioenergy is not an option of great interest due to the development of other alternatives. Thanks to *the Internet of things*, it is now possible to, very efficiently, control our environment and how we distribute, use and recycle resources. Our houses are net producers of energy, are recyclable and can think for themselves. There are now tremendous opportunities for radically new, efficient and emission-free energy consumption. Also, it is possible to easily convert carbon dioxide into ethanol by reacting carbon dioxide with water using a simple catalyst. Vehicles are driven by artificial intelligence and are fuelled by hydrogen or electricity produced by using solar energy and wind as chief energy sources.

GOVERNANCE: The major technological corporations dominate the international scene and also strongly influence governments. International cooperation is directed towards business goals and control of the cumulative negative effects of economic growth and patterns of consumption. Special efforts are made with respect to conflicts arising from increasing inequalities between countries. Rapid technological change demands governance structures able to handle rapid, complex changes. Governments are forced to use the new technologies and approaches in policy making and monitoring of results. Overlapping, cross-sectoral policy making is compulsory.

INDUSTRY: A constant flow of technological innovations concerning new products and brands has created new start-up businesses and industries faster than ever before and is revolutionising existing businesses. This creates a substantial increase in employment. On the other hand, conventional industry has been automated, with a corresponding reduction in its labour force. The new industry is substantially less dependent on economies of scale as compared to conventional industry. Digital manufacturing, or 3D and 4D printing, has revolutionised societies. This process is used by every kind of industry from industrial designers to transportation, to the construction industry and more. It is used to produce prosthetic limbs. Biotechnology firms use the technology to produce organs. Companies are now able to match product demand with raw material needs, streamlining supply chains and minimising waste. Together with robots that have taken over most of the production in factories, this has resulted in exponentially increased productivity. Energy efficiency in industry has become a world changing force.

INFRASTRUCTURE: Technological development requires efficient infrastructure and has put pressure on the need for substantially increased investment capital. The transport sector has been revolutionised over the last 30 years with autonomous cars powered by electricity or fuel cells; trucks also run on fuel cells and are autonomous, a large portion of mid-range aircraft use electricity and ships and trains use fuel cells. The Formula One car races have been transformed to Formula E races. New efficient railroad corridors have been established in regions such as in Asia and the Middle East. A global super grid of mega transporters for different transportation systems has been established with zero emissions and a

low general environmental footprint. The different transportation modes are interconnected by cloud computing and traffic organisation and traffic design are extremely efficient. These investments have concentrated on finding system solutions by combining the different components of infrastructures. Parts of these investments have been financed by private and industrial funds. New infrastructure systems had to be developed in order to implement the new transportation systems.

LIFE STYLES: Robots have taken the place of nurses, deal with many daily duties including helping the elderly, and robot physicians make healthcare efficient, affordable and easily accessible. The world is now full of abundance, providing everyone with a life of opportunity. High-tech development generates high-tech lifestyles, but it is not about a life of luxury but of opportunities. In a world of 9.7 billion people we are heading to a world with clean water, nutritious food, affordable housing, personalised education, top-tier medical care and non-polluting energy. The biologics have helped us to discover the cure for cancer and Alzheimer's and to make 100-year-long human life spans the rule rather than the exception. Technological lifestyles have resulted in less impact on the environment due to changes in consumption patterns, including more environmentally friendly innovations. Artificial intelligence had already broken through in automobiles in the early 2020s in the form of self-driving cars. This intelligence has been further developed so some 50 million car accidents annually are now not happening, saving about 1.2 million lives.

NATURAL RESOURCES: The very high rate of economic growth and substantial population growth has meant that the pressure on natural resources has increased considerably, although management is characterised by sustainable natural resource management. Natural forests are disappearing and are being replaced by engineered plantation systems (GMOs). Agricultural productivity has increased dramatically in parallel with rapid technological and GMO development. Agroforestry has become the most efficient form of food production in many parts of the world. There are communities with small populations which have disappeared due to the fact that they were not able to link up with rapid technological development. Networks, sensors and drones, also called internet of things has made it possible to sense and report data and pictures of what is happening in nature in real time. The planet itself generates extensive data from natural systems, social systems and physical objects. Advanced technologies also help to capture an enormous amount of data, creating opportunities for advanced environmental planning and monitoring. This constitutes a strong foundation for monitoring of the environment and policy setting. The pressure on natural resources and conflicts between protection and utilisation have increased since the 2020s. Still, we are heading into a world with clean water, nutritious food and non-polluting energy. The issue is to balance the increased demand for natural resources for economic reasons with increased ecosystem services, recreation and cultural demands.

R&D AND INNOVATION: There is a constant flow of technological innovation, and the world is characterised by information and communication abundance. The exponential growth of biotechnology has been critical to the creation of a world of abundance. It is now possible to create a new kind of synthetic life, to produce high-performance human vaccines within hours, increase agricultural yield 50-fold compared to the early 2000s and use highly efficient, low cost energy types. The advancement of new transformational technologies/computational systems, networks and sensors, artificial intelligence, human-machine interfaces, biomedical engineering, robotics, biotechnology, bioinformatics, 3D and 4D printing, nanotechnology – all enabled the vast majority of humanity to increase their living standards dramatically. Cloud computing and the development of nanotechnology has made 3D and 4D printing particularly powerful. Everyone has access to 3D or 4D printers making it possible to produce any physical item from digital blueprints. Nanotechnology and nanomaterials are very common nowadays in all features of society, and are employed in manifold applications in every sector of society.

NANOBOTS take any material apart, atom by atom, and these atoms are used to construct whatever you wish to construct. Nanocomposites are substantially stronger than conventional materials and can be constructed at a fraction of their cost. Chip development has been enormous: they now communicate

with light and not by electrons. Thanks to these new chips, supercomputer performance has increased a thousand-fold since the 2010s. This development has required advanced technological investments in education and R&D, especially in the links between human-nature-technology. New research institutions have been created based on this system link as well as on full-scale trials of human-nature-technology systems. However, more research is needed as concerns our joint use of natural resources.

RURAL CONDITIONS: Material wealth has improved for a large proportion of the global population but economic inequity has increased and is high within, and between, countries. New technologies have substantially increased gaps in society, not only between rich and poor but also between urban and rural. For people working in the poorly-paid service sectors, life remains a struggle. The dilemma for rural areas is the ability to take part in, and utilise, these technological breakthroughs. This dilemma is underlined by the fact that rural areas are not able to supply or recruit the needs of advanced competences. This in turn leads to declining social services in rural areas and increased migration to urban areas. Innovation is, however, making life easier in some ways e.g. drones functioning as robots carrying out maintenance and services in difficult or distant rural areas.

SOCIETAL CHANGES: Technological progress and artificial superintelligence cause accelerating and dramatic changes in human values and civilisation. Consumerism is the supreme value in society. Individualisation is a dominating phenomenon around the world and has led to individualised consumption and customised lifestyles. This individualistic society is possible due to new technological solutions, good incomes and strong healthcare. Artificial intelligence has taken over much of the diagnostic function in healthcare. Inequalities have increased between groups that are able to benefit from technological developments versus groups that are not. Technological innovations have permeated every geographical market, every economic sector and every business on the planet. Now human, machine and nature are strongly interconnected.

A FUTURE WITH HUMAN OBSOLESCENCE / SCENARIO 2

Robotics and artificial intelligence take over human labour in all professional categories, not only the poorly-paid tasks. The result is low levels of global economic growth, weak governance and climate goals and SDGs are not fulfilled.

CLIMATE: Emissions are decreasing due to new technologies and low economic global growth but not sufficiently, consequently the 1.5 degree target will not be met. Technological advances experienced have substantially reduced emissions by improved material use, better logistics, new bio-based products and emission-free energy carriers. Industries based on new technologies and the wealthier part of the populations have been able to implement emission reducing technologies. This is not the case for old technology industries and the poorer parts of the population. The relative rate of poverty has increased within nations; the climate change problem has improved but is nearly as serious as before. As a result, in addition to the stress of economic equalities, societies also suffer from severe climate change impacts in the form of increased temperatures, droughts, water scarcity, flooding, disruption etc.

DEMOGRAPHICS: The unemployment rate and income inequality have increased substantially, followed by increased emigration flows. New technologies have replaced many jobs requiring advanced education that had previously been highly paid. An entire category of office and knowledge workers (lawyers, doctors, financial advisors and teachers) have been replaced by new technologies to a considerable degree. Recent assessments of net job losses in the developed world point to a magnitude of a loss of about 50% compared to the 2010s. A similar development is underway in emerging economies. The age structure has changed with a higher proportion of elderly people due to new healthcare technologies to improve human health.

ECONOMICS: There are continuous instabilities in the global financial markets and weak, stagnating growth in the global economy. The economy had reached a tipping point a couple of decades ago. Beyond this tipping point, it has not been able to absorb jobs lost to new technologies at all levels of so-

ciety. Rapid technological development resulted in fewer jobs, which in turn resulted in substantially less economic growth, globalisation, trade and less income for states. Governmental renewals and investments declined to a substantially lower level. Less income resulted in less end use, and in less industrial consumption. Businesses have primarily invested in new technologies. Weak consumer spending has pushed investments toward cost cutting and labour-saving technologies. This has in turn resulted in even more unemployment and the economy is spiralling downward. Advancing technologies have changed the basic economic game rules and how the overall economy works. The combination of ageing population and increased unemployment, the costs for social welfare and healthcare together impose a tremendous burden on the overall economy. Less trade with China and India, the world's workshops, result in difficulties in maintaining growth and sustainability and keeping large parts of world in employment.

ENERGY: The depressed global economic conditions force many people and companies to use older technologies and sources close by for energy provision. This means bio-energy from forests booms. Thanks to the *internet of things*, it is possible to very efficiently control the environment, distribute, use and recycle resources. Houses are able to produce net energy, are recyclable and can think for themselves. There are now tremendous opportunities for a radically new type of efficient and emission-free energy consumption, but funding is only available for a fraction of society.

GOVERNANCE: There are many conflicts between the rich and poor worlds. Consequently, national and international efforts concentrate on security issues. Governance challenges are concerned with how to handle this divided society, and it is nearly impossible to govern countries under these conditions. These developments require new and innovative governance structures, permitting participatory processes. This divided society requires new structures for policies and institutions, but there are limited financial resources for their implementation. The rate of cybercrime is currently the most severe the society has ever experienced, costing many trillions of dollars per year and threatens established institutions and democracy.

INDUSTRY: Accelerating automation technologies have invaded many of industries that were traditionally labour intensive. This process has caused the destruction of old industries and has generated new ones that employ very few people. The field is characterised by declining conventional industry and less investment in start-ups and new industries. Rural-based industry has declined due to difficulties in recruiting skilled labour and acquiring capital. Due to reduced consumption, a number of industries are no longer competitive and have closed down with increasing unemployment as a result. The financial inequality gap has increased dramatically between the rich and the poor, and the old and the new technology industries. There are huge numbers of unemployed people constituting this divide; the poorer population segments have not been able to make any investment in the new technologies.

INFRASTRUCTURE: There has been less investment in new infrastructure due to limited financial resources, leading to further decline in industrial capacity and production. New transportation systems have been developed aimed at producing new electricity and hydrogen solutions, but the most serious challenge is to create the capital needed.

LIFE STYLES: A substantial proportion of the population has difficulty in maintaining previous living standards. These segments consume less and have developed a negative attitude towards society and the state. The divided society has increased the unemployment rate and the income gap between different groups has resulted in increased societal conflicts. The high technology part of society is very dependent on increased globalisation with respect to innovation, capital, people and trade. The poorer part of society sees globalisation as a cause for their often-desperate condition. Consumerism is the supreme value for the wealthy part of society for whom material conditions and living standards have increased dramatically. Survival is the key priority for the poorer parts of the population and living standards have declined substantially for this growing group.

NATURAL RESOURCES: The demand for natural resources is decreasing due to more efficient use of raw materials in parts of society and to a declin-

ing global economy, which has reduced the general consumption level. Land use sustainability and resilience issues enjoy only a lesser degree of interest and thereby have a low priority in policy making. Advanced technology with respect to advanced environmental planning and monitoring does exist, but the investment capital required constitutes a bottleneck. Climate effects impact agricultural production in many parts of the world. The poorer parts of the population are trying to produce more food by expanding agriculture, resulting in a greater burden on natural resources. The wealthy segments of the population solve this dilemma by increasing imports of food products. Thus, there are two forces in play, one is trying to produce more food locally and use less imported food products and the other is pushing for more trade in agricultural products and increased globalisation. Conflicts with respect to land use and utilisation of forests have increased. In this situation, there are difficulties in protecting environmental values and natural resources in general and a decline is underway.

R&D AND INNOVATION: The number of investments in R&D and innovation, in fields other than technologies, has declined due to lack of investment capital. It is consequently difficult to maintain high educational and R&D levels in fields other than technology. The government cannot afford to invest, due to reduced income. The demand for industrial and crowd funding for R&D and innovation is tremendous.

RURAL CONDITIONS: The new technologies have substantially increased the gaps in society, not only between rich and poor, but also between urban and rural. There is an increased concentration of job opportunities in the cities due to digitalisation. Already weak regions have declined further as their opportunities have been very limited as concerns becoming part of, and utilising, technological breakthroughs. One of the causes is the difficulties these areas experience in maintaining a high educational level and lack of advanced competences as well as financial resources. This, in turn, has led to declining social services and production in rural areas and increased migration to urban areas. Thus, social unrest is substantial and forms a high-risk factor for societal development.

SOCIETAL CHANGES: Developments have resulted in a divided society with a fast-growing, prosperous technological component on the one hand and the rest of society struggling to survive on the other. The favoured group has sufficient means and the other group has insufficient financial means. The economic conditions have created ugly, irrational political battles, which are more heated, partisan and fact-resistant than ever. Healthcare conditions have also declined among the less-favoured groups of society who are growing in number. This divided society has led to immense differences in values, which in turn has fuelled conflicts.

THE NEW NORTH / SCENARIO 3

The US and the southern hemisphere are cracking due to globalisation and uncertain politics. The northern hemisphere has experienced a boomerang effect due to its leading position in innovation and efficiency in globalisation. The global regions with the strongest competitive position are those with the greatest abundance of natural resources, that are not overcrowded, enjoy the strongest governance and are least affected by climate change. The current state of the world and a broad set of physical, ecological and societal forces have set *the New North* in motion. *The NORC countries* are northern USA, Canada, Norway, Denmark, Sweden, Finland and northern Russia who are scarcely populated and have a lot of land available per inhabitant (the lowest population density on earth). However, between 2010 and 2050 the population increased by 15% to about 95 million people. In several countries immigrants, have offset the ageing population problem.

CLIMATE: Every year there is a new record as concerns average global temperature increase. Climate change is forcing a massive ecological reorganisation worldwide with both huge losses in, and extinction of, species. The effects of climate change unfold erratically over time and are a combination of the climate and the vulnerability and exposure of human and natural systems. There are frequent extreme weather and climate events in the form of heat waves, high water levels and flooding, and heavy precipitation has all been seen over the world. In urban areas, climate change has increased risks for people, assets, economies and ecosystems. There has been an increase in political and armed conflicts in

the southern hemisphere by some 50% due to starvation, water deficit, refugee flows and population clashes all linked to climate change.

THE NEW NORTH has experienced substantial climate change, but this has mainly manifested in the form of milder and wetter weather, with a longer growing season as result. The North was already water-rich and has become even richer with climate change. Compared to other regions of the planet, habitat loss is less severe in *the New North*. Primary production of plant biomass has increased substantially as has agricultural production. Relative to other regions, the impact of climate change can be said to be less harmful in the North.

DEMOGRAPHICS: The global population has increased by nearly 2.5 billion since 2015. The dominating population growth has occurred in Africa, India, Southeast Asia and the United States. India is now the most populated country in the world and even Nigeria has a larger population than the United States. The fact that the largest part of the population growth is concentrated in the poorer countries of the world causes challenges. It is difficult to eradicate poverty and inequality, to combat hunger and malnutrition and to expand educational enrolment and health systems in areas of rapid population growth. On the other hand, these countries do have a young population, creating an opportunity to capture a demographic dividend. Japan, Russia and Germany have lost about 15% of their populations since 2015. The ageing population has grown rapidly and in Europe 35% are now over 60 years of age. In Latin America and Asia, the corresponding number is 25% and 10% in Africa. The global aged population has nearly tripled since 2015. The dependency ratio has quadrupled since 2015 in many countries, and people are not retiring at 65 but have to work much longer for survival. The NORC countries are scarcely populated and have more land available per inhabitant (the lowest population density on earth). However, between 2010 and 2050 their population increased by 15% to about 95 million. In several countries immigrants, have offset the ageing population problem.

ECONOMICS: Population growth has also acted as a driving force for economic growth. Earnings have increased tenfold since 2015 at global level, however there is a huge divide between poor rural and rich urban groups. India and China have now the largest scale economies in the world. Geopolitical and economic power has shifted from West to East. Free trade and providing people with a better life were not popular goals for the groups with nationalistic agendas as free trade demands changes in society. Transition to global and free trade demands new business models, new services, new technological solutions, new policy frameworks etc.

CHINA GAINED hugely from the globalisation 2000-2015. Asia is now the centre of gravity with respect to globalisation. Other regions have gone from globalisation to regionalisation. Asia's share of global GDP has roughly doubled since 2010. *The New North* countries are business-friendly and trade liberal. There are countless opportunities to find resource-related business opportunities in unexpected forms. *The New North* has the potential to become a winner in the global resource race.

ENERGY: Efficient energy systems have characterised development, but are only available to parts of society. Energy demand has increased by some 80% since 2010. *The New North* is rich in sustainable energies (hydro, wind, bio-energies and new technology-driven alternatives) and characterised by reliable delivery with no shortage of energy. Some parts are rich in natural gas.

GOVERNANCE: Most of *the New North* countries have stable institutions, governments and rule of law, markets and clear rules for actors based on a democratic system. This creates a stable foundation for the development of a successful governance system. The success of governance is partly due to the ability of the governments of the North to understand the crucial importance of creating strong environments for informative dialogue platforms. Another contributing factor has been the capability to adapt and to handle swift changes in a systemic manner. Consequently, the governance systems have been reconstructed, resulting in delegation of decisions from national to regional and local levels. These platforms have shown great ability to rapidly analyse, and swiftly follow, changes in the highly technological societies. European countries with smaller popula-

tions have experienced a true challenge to maintaining their roles in the international policy arena with respect to natural resources.

INDUSTRY: Global industry is characterised by declining conventional industries and less investment in new industries due to social challenges following demographic and climate change. The economic inequality gap has increased dramatically between old and new industries. Globally, rural-based industry has declined due to difficulties in recruiting skilled labour, the North being an exception from this fact. The North has a long industrial tradition and well-structured industry and the technical age of their machines is still rather young. Industrial know-how is well developed with respect to how to introduce and scale up new innovation in industry.

INFRASTRUCTURE: The regions able to invest in infrastructure have proven to occupy a strong position by 2050. Most of *the New North* countries have, over a period of many years, developed extensive, efficient infrastructure, enjoy stable governments and rule of law, have well-functioning towns, ports and companies. The different transportation modes constitute an efficient system that has been constantly improved through technological advancement up to 2050. Russia is involved in most of the challenges to the development of the infrastructure of the North.

LIFE STYLES: Due to economic inequalities, there is a deep divide in society. *The New North* countries have top scores for the world's happiest places to live. The positive development of the region is also built on substantially strong economic development on household level, high level living conditions and a rich outdoor life.

NATURAL RESOURCES: Globally, natural resource demands and environmental conflicts have increased dramatically due to rapid population growth, protectionism and climate change. Pressure on agricultural production is tremendous under conditions of huge production deficits. There is currently a water shortage of some 50% around the world due to climate change in combination with strongly-increased demand due to rapid population growth, especially in the southern hemisphere - the USA, southern Europe, central Asia and China. Demand has increased by 65% since 2010 and some 40% of the global population live in water-stressed areas. Natural forests have continued to shrink, and are now 15% smaller than in 2010 and with a loss of 10% of global biodiversity. The world is now experiencing severe depletion of key metals such as silver, gold, indium, tin, lead, zinc and copper. These stresses on resources also hold true for rare metals, necessary for the manufacture of new technological products, such as gallium, germanium, tellurium, thorium, molybdenum, cobalt, niobium and tantalum. Food production (agriculture, crops) has decreased substantially in Latin America, Africa, Asia and Australia as well as in Southern Europe. Fish stocks are under threat in Latin America, Southeast Asia, Australia and the Arctic. The situation is different in the North and pressure on natural resources in Southeast Asia leads to a boomerang effect favouring the North. Due to the lower number of inhabitants per km^2 and technological advancements, stress on natural resources is at a much lower level compared to other regions of the world. *The New North* is rich in natural resources in the form of minerals, water, land and forests.

R&D AND INNOVATION: One of the driving force for the current state in the world is technological advancement. Based on a strong preparedness for change, *the New North* countries are leading the transition together with Asia. There is a critical mass of universities in the North who, in cooperation with industry, drive the development of technological advances and their applications. The resource revolution has already given birth to a host of innovative products, solutions and services in the region. Technology-driven change and the scale of the resource revolution have required institutions and companies to step up their ability to digitalise and harness data. Digitalisation and big data applications have deep cross-cutting impacts on institutions, companies and economic development in *the New North*.

RURAL CONDITIONS: New technologies have substantially increased gaps in society, not only between rich and poor, but also between urban and rural, the North being an exception to this. The world population is now urbanised and there is a huge divide between poor rural and rich urban groups. Some

85-90% of the population in the United States and Latin America now live in urban areas. The corresponding number for Europe is over 80%. In Africa and Asia 55%, respectively 65%, of the population is urbanised. The rural population has decreased by about 1 billion people worldwide. In rural areas, water availability, food supply, security, infrastructure and incomes are under severe stress due to climate change, which has also substantially increased the displacement of people.

SOCIETAL CHANGES: Nationalism has become a marketable commodity. Movements that came to the fore championed a historic turn inward: breaking out from EU membership, enforcement of homogeneity and the trumpeting of exclusively national virtues. The driving forces behind this turnabout were the political leaders of the UK, Russia, Hungary, the French National Front Party, the USA, India, Japan and Egypt to name just a few. This group heralded a change in world politics, which is still working itself out 35 years later. In spite of this development, the world is now becoming more open and industry more independent than it was 15 years ago. Many of the forces underpinning globalisation remain so strong that innovation and societal improvements do not stop even if some regions lock themselves in politically. Livelihoods and health (by exacerbating existing health problems) are threatened in all regions of the world. *The New North* countries score top indexes as compared to the rest of the world in efficient globalisation, healthcare, and liberty.

THE WORLD IS GOING SOUTH AND EAST / SCENARIO 4

China and South-East Asia have evolved superior intellectual capacity, institutions and markets, while Europe and the US are in decline. By 2050, the Asian region is leading world development both economically and geopolitically. The values and innovative systems of the region dominate the development of the world. Africa demonstrates substantial growth potential due to demographics and structural improvements. Asia's total GDP is over 50% of global GDP.

CLIMATE: Climate change impact is a true burden to all societies in Asia and Africa, in spite of available knowledge regarding necessary mitigation and adaptation measures. Asia is heavily impacted by climate change in the form of rising temperatures, droughts, flooding and severe disruption. The list is long, including air pollution, haze pollution, smog, water and soil pollution, destruction of agricultural land due to increased urbanisation, soil erosion and degradation, hazardous waste, chemical pollution, industrial and municipal waste, degradation of marine environments, increased number of endangered species, increased loss of habitats and biodiversity, increased biological pollution (e.g. dead animals), flooding and landslides, noise pollution etc. Asia has made major efforts to mitigate and adapt to climate change, but much more has to be done in order to preserve human security and economic growth.

By 2050, Africa is suffering substantially from climate change due to increased temperatures in an already hot climate, inconsistent rainfalls and extensive flooding and droughts in combination with poor soil fertility. All of this is impacting agriculture, food production and human security. Declining precipitation is a major issue in northern and southern Africa. Other regions of Africa previously did not experience water shortages, however the dramatically increased population together with increased economic growth and the impact of climate change have changed this.

DEMOGRAPHICS: India's GDP growth rate is around 6.5% due to its rapidly-growing young population and greater opportunities for catch-up growth than in China. This has required dramatic changes to high quality education which promotes creativity. This transition will never be finished and Asia has to work hard on this in the future. Africa's population has doubled since 2010 to 2.4 billion people. This is the result of strongly improved medical and healthcare services. Africa has a very young population and therefore a huge workforce, which drives economic growth. The major challenge for Africa has been, and still is, human resource development and job creation for young people. This involves improved education, improved health conditions (there has been a dramatic decrease in communicable diseases), improved human security, reduced corruption and a reduced rate of persistent poverty with associated malnutrition.

ECONOMICS: Strong financial centres have developed in the Asian region taking over financial power

from the conventional players in Europe, Japan and North America. The engines of the Asian Century have been China, India, Indonesia, Japan, South Korea, Thailand and Malaysia. These accounted for some 90% of total GDP in Asia in 2017. Interregional trade has increased dramatically, as has South-South trade in general. Asia's total GDP now exceeds 55% of global GDP. China's GDP is over USD 62 trillion in purchasing power parity (PPP) terms and is the world's biggest economy. GDP growth rate has now stabilised at around 3% annually and thus normalised with the developed world. The population growth rate is low, the ageing population is increasing rapidly, and the increase in GDP growth can be explained in terms of a successful economic model with increased labour productivity. India has today a GDP (in PPP terms) of some USD 42 trillion and has overtaken the European Union and USA as the second biggest economy in the world. Africa's share of global trade and foreign direct investments has doubled since 2010. Their economy is growing rapidly, but is still well behind Asia. The leading economic regions are Southern Africa and North Africa. South Africa, Egypt, Nigeria and Algeria have demonstrated better economic performance than other emerging economies in other world regions. Ghana, Kenya and Senegal have experienced very rapid growth. The economies of Uganda and Tanzania have diversified substantially. Ethiopia, DRC, Sierra Leone and Mali have also shown great growth rates but with a high degree of volatility due to political instability. Internal trade between African countries, as well as the South-to-South trade, has been booming. African development has been very similar to economic development in India, but with a time lag. The annual average GDP growth rate for the continent is around 6%. In 2050, more than 75% of Africa's GDP depends on manufacturing and services. Africa has 40% of the world's gold reserves and 80-90% of the chromium and platinum group metals, and there are still massive future discoveries foreseeable within the metals sector.

ENERGY: Thanks to rapid regional technological advances, energy efficiency has improved substantially, but much more needs to be done. It is conceivable that the major challenges in Asia have been, and still are, linked to increased energy efficiency, reduction in natural resource use, improved environment in general, climate change and societal development. All larger cities have banned combustion engines so vehicles now use fuel-cells or are electric. Public transport has been further developed, but a lot remains in order to achieve satisfactory conditions.

Africa's energy demand has increased by about 80% since 2010 when Africa had some 10% of the world's oil reserves and southern Africa had huge coal reserves. Given the climate change situation in Africa, these resources cannot be used for energy purposes. Africa has invested in a huge number of windmill parks, enormous solar plants and geothermal energy. These investments have to continue in order to secure future energy demand and a sound environment.

GOVERNANCE: With increased protectionism in the USA and Europe there has been a development towards multiple centres of power across the world, meaning that a number of competing centres of power have emerged globally. This is the result of the shift away from Western dominance and towards larger heterogeneity as well complexity in the world. The key to successful development in Southeast Asia has been the strong development of governance. Asia is now the dominant driving force for globalisation and free trade in the world, and thereby also dominant in global geo-politics. Substantial structural improvements in the management and composition of African economies have taken place. There is also stronger influence exerted by non-state actors in society, actors such as civil society and financial institutions, but unfortunately also criminal networks (e.g. cybercrime).

AFRICA HAS TURNED TO ASIA for help with economic development and to Europe for promotion of good governance. North African countries have also looked especially to Europe for governance concerning their political future, which has linked the two continents further. Improved efficiency in business and changed policies as concerns less direct governmental involvement in businesses have also contributed to this development. Still, the smaller European countries have not been able to keep their leading roles in regional international policy arenas. The socio-political change which has taken place in Africa is based on improved human development,

improved governance, improved democratisation, reduced corruption, improved rule of law and more efficient public policies.

INDUSTRY: Industrial development is impressive and rapid in Asia, which follows the latest global trends in industrial structure and design. Through leading-edge research they have taken ownership of global industrial development and implementation. Africa is still behind, but has a strong development curve. The industries of the rest of the world are experiencing true difficulties in competing with products from the South East, but the North is successful in exporting natural resources to these regions.

INFRASTRUCTURE: Globally, infrastructure investments have been responsible for a major part of economic growth. There is weak water supply infrastructure in Africa, which imposes further stress on the water problem. Both Asia and Africa have to work hard on more efficient water use and better water infrastructure as well as general infrastructure.

LIFE STYLES: Through geopolitical power, the values of the Asian societies are influencing the rest of the world. However, regional differences in values will, with time, decrease because of globalisation. Asia has made major efforts to mitigate and adapt to climate change, but much more has to be done in order to ensure human security. This means, among other aspects, identifying innovative solutions for mass transportation and also dramatically changing consumption patterns.

NATURAL RESOURCES: Natural resources are severely overexploited in Asia in 2050. Deforestation has been driven by expansion of agricultural land. Water stress is high in nearly the entire region.

This stress is mainly driven by population and economic growth that overshadows climate change impact. Fish have been, and remain, a key source of food for all Asian states and due to growing populations and economies the result is severe overfishing. More sustainable aquacultures must be established and become sustainable. In Africa, the exhaustion of natural resources is mainly driven by resource exploitation. The transformation of the agriculture sector has been possible due to technology transfers and active financial involvement by China and some countries in the Middle East. Now, Africa shows the largest food production in the world outstripping Europe and the USA. Broad-scale agroforestry implementation has been crucial to this development. Outstanding food production regions are eastern, central and western regions of Africa. Africa had, and still has, severe environmental problems which are similar to those discussed for Asia. Added to that list are oil pollution from earlier oil exploitation and desertification. African governments have worked hard together with international organisations to regain control of its environmental problems, but much remains to be done.

R&D AND INNOVATION: Important features of development have included the rapid development of technological advances, innovations and entrepreneurship. Leading countries in Asia have invested huge amounts in technological development with the objective of moving away from catching-up on innovation and instead becoming a breakthrough region in science, technology and innovations in all fields of society. With the help of new technologies, Asia has reduced some environmental problems (a few quite dramatically) but the overall picture is far from satisfactory.

RURAL CONDITIONS: Politicians have not realised that urban areas cannot survive without strong rural areas to provide urban areas with food, water, clean air, better environmental and weather conditions, biodiversity, recreation etc. The new technologies have substantially increased gaps in society in the Asian regions, not only between rich and poor, but also between urban and rural. A special challenge has been the tremendous urbanisation process taking place in the region (85-90% of the population live in urban areas). In order to maintain economic growth in the future, the efficiency and quality of urban areas, their infrastructure and eco-friendly conditions have to be further improved. One crucial challenge is to keep the development of rural areas in line with that of urban areas. The situation is similar in Africa with rapid urbanisation (although not at the same level), which fuels economic activities. Urbanisation has imposed extraordinary demands on sustainable urban development and a lot remains to be accomplished in this area.

SOCIETAL CHANGES: Increased globalisation and eastern values characterise global development. It should be mentioned that Asia is, in 2050, the world leader in technological development for medical and health services. These advancements are crucial for the promotion of broader social well-being. The steady integration of African regions, and enhanced and diversified global integration as well as multilateral security, have substantially increased resilience against conflicts in Africa. Most African countries promote increased globalisation.

A WORLD OF GLOBAL RESILIENCE / SCENARIO 5

The conventional world evolves based on a strong global policy dialogue using the sustainability of natural resources consensus as its foundation. Climate and SDG commitments are met. The world is driven by global agreements based on bio-economic regimes, resulting in sustainable social and economic conditions. The West has maintained its leading position and the number of people in poverty globally is at a very low level.

CLIMATE: technological advances and changed consumption patterns have contributed strongly to reduced GHG emissions due to less use of materials and energy, but also due to new smart solutions. However, the impacts of climate change are still increasing due to time lags in the climatic system.

DEMOGRAPHICS: Millions of people have been lifted out of poverty in emerging economies. Countries operate open doors to immigration. The world realised 20-30 years ago that the transition of old competences to brand new ones was the only way to move towards sustainable development and away from social unrest.

ECONOMICS: In line with projections made in the early 2010s, the global economy regressed over time and average global growth rate is now 2.8%. In the second half of the 2010s it was 3.8%. There has been a transition from neo-classical economic concepts to concepts including inclusiveness, justice, equality and ethics. In the early 2030s, governments decided to pull together in a fundamentally redesign of the mechanism of checks and balances thereby giving highest priority to the long-term sustainability of the global system. This meant a transformation from material economic growth to a non-material economy and learning from nature. Thus, the priority has been to shift away from efficiency maximisation and focus on vulnerability, mitigation and resilience in all domains of society. The material and energy throughput of the global economy has steadily decreased after this. The ambition in the advanced economies is to level out at a material consumption of 8 000 kg per year per person. The transformation to bio-economy concepts in the 2020s, on which there was global agreement, made this global economy transformation possible.

ENERGY: The priority has been placed on shifting away from efficiency maximisation and towards vulnerability, mitigation and resilience. Technological advances and changed consumption patterns have also contributed to the reduced use of raw materials and energy. Thanks to this trend, energy throughput for the global economy has decreased steadily. The slowed-down economy has brought several benefits to China in the form of less pollution and less energy consumption.

GOVERNANCE: Millions of people were lifted out of poverty in emerging economies in the early 2000s by globalisation and trade liberalisation. This positive development was followed by an era of populistic and nationalistic policies putting their own countries first. In the 2020s, governments realised that these policies were flawed and that there was an urgent need to address the structural weaknesses of the market economy existing at that time. This resulted in, among other things, a redistribution of both financial and human assets. In the 2010s, dialogue between governments, industry and ecologists was not very efficient. The world has learned its lesson and, with the introduction of new governance and the bio-economy concept, the dialogue between the different parties has now become constructive and all parties are looking for joint sustainable solutions.

In the 2020s, many regions of the world managed to transform institutions to become inclusive and thereby provide the right incentives for innovation, entrepreneurship and sustainability. The banking system has been forced by governments to restructure from financial speculation outfits to social development supporters. Many of the financial

products the banks sold in 2010s are today illegal as they were judged not to be in the interest of consumers and broader society. Anti-corruption campaigns have been very successful in China. The economic slowdown in China has not become an economic meltdown, it was an intentional, policy-driven process.

INDUSTRY: Industry has developed new operations in order to increase resource efficiency, which has been successful. These new products are less scale dependent than the previous products, which has resulted in a restructuring of industry towards a smaller scale with more investments closer to the raw materials located in rural areas.

INFRASTRUCTURE: Major investments have been made by governments and corporations in infrastructures aimed at making material handling and natural resource management more efficient and at reducing the prices of the products. Consequently, efficient transportation systems have been created to support markets swiftly with products and services.

LIFE STYLES: People have changed consumption patterns and are using up what they have and reusing instead of buying something new. With stable economic development, change in values and reduction of poverty, the quality of life across the world has reached a historically high level.

NATURAL RESOURCES: In the late 2020s there was a political breakthrough in new economic thinking: implementation of this new economics took into account the fact that the consumption of natural raw materials has to be substantially reduced in order to maintain natural capital and a sustainable world. This meant a new perspective on how to value nature. There was a transition from neo-classical economic concepts to concepts including inclusiveness, justice, equality and ethics. This drove development strongly towards the bio-economy concept, with its substantially reduced material consumption and increased innovation in all domains of society.

R&D AND INNOVATION: Innovations and new unique product developments generated brand new bio-based products that were sustainable and enjoyed longer life-times and better qualities than conventional products. These new products also enjoy higher added value than the old products because they have higher value for consumers. The degree of technological innovation and dissemination is high and focussed on sustainable solutions in all sectors of society. Technological developments have substantially contributed to the de-materialisation of the global economy. Technological advances and changed consumption patterns have also contributed to reduced GHG emissions due to decreased use of materials and energy, but also due to new smart technological solutions and digitalisation.

RURAL CONDITIONS: In general, implementation of new technologies substantially increased gaps in the society, but that is not the case now with a world aiming at global resilience. The overall result has instead been increased integration between urban and rural areas with a perception of greater equality.

This has been possible by building new, strong knowledge and business clusters located in both urban and rural areas. Also, new technologies have created smaller-scale industry, which has led to more investments closer to raw materials in rural areas.

SOCIETAL CHANGES: Consumerism has lost its glamour and is gradually replaced by a growing interest in social interaction. Solidarity has become a shared value. This agenda is based on solidarity across religions, ethnicity and classes. The changes in the global economic system opened up new channels for international cooperation. It is observable that developments towards some type of global federation is underway and that a multicultural global society is unfolding slowly but surely. National governmental power has, in certain domains, been transferred to regions. The world has developed towards a network of regions with urban centres as hubs. These regions are more virtually than physically connected.

Economic growth is important for the Chinese people but it turned out that education, health, human security, combatting corruption and legal justice matter just as much as economic growth. The slowed-down economy has brought several benefits to China in the form of less pollution, fewer land-grabbing incidents, less inequality, less

corruption, less energy consumption, lower socio-economic tensions and an improved international reputation.

A WORLD IN DISORDER / SCENARIO 6

The conventional world, as we were used to after the Millennium, has collapsed and geopolitical conflicts characterise development. Global dialogue is dominated by individualism and protectionism and the US has lost its leading position while other national champions have risen. The regions are not able to find new economic mechanisms and systems to solve the unconquerable environmental problems facing the world. The result is that global agreements are not met, followed by ruined markets and exploitation of natural resources.

CLIMATE: Earlier efforts to harness climate change impact have been closed down. With their nationalist, protective agendas, countries have withdrawn from international climate commitments to reduce emissions. Thus, the world has experienced temperature increases, water shortages, droughts pandemics, destroyed coastlines, conflicts and food shortages never before anticipated. The climate change issue became the tipping point for the nationalist movements of the world. Nobody could foresee the huge impact nationalism would have on climate change. The world climate is now on the way to a 3 degrees temperature increase by the end of the century.

DEMOGRAPHICS: Currently, globally about 2 million people die due to the direct impact of climate change and due to declines in production levels and quality of food. Skyrocketing crime, broken education and imploding health systems have been too difficult for governments to handle. The transition to competences for the jobs of the future have failed. Countries have closed their doors to immigration. There is a mass of environmental refugees wandering around the world looking for better survival options. International and national crime levels have become the highest in history.

ECONOMICS: The regions are not able to find new economic mechanisms and systems to solve the unconquerable environmental problems facing the world and to maintain economic growth. Global political uncertainty contributed substantially to a long period of slow global growth causing a number of sovereign defaults. All of this combined with a paralysing protectionism meant that global trade declined dramatically. Funding was moved out of China and triggered financial upheaval in the country. The collapse was driven by three bubbles: real estate, shadow banking, and local government debts accompanied by negative investment rates. The collapse of China and its economy has sent the world's economy into a tailspin. The earlier economic growth model with huge debts, boosting of investment and, at the same time, suppression of consumption resulted in a fast build-up of economic growth and large trade surpluses. This development triggered high income inequalities contributing to social unrest in China. These imbalances drove the economic collapse. The government lacked the competence to handle the dynamics of these processes.

ENERGY: Technological advancement has indicated the design of efficient, sustainable energy systems, but collapse of the conventional world and geopolitical conflicts has led to an energy shortage. Implementation of sustainable and cost-efficient energy systems was never carried out and energy sources such as bio-energy are now sought after which leads to over-use of natural resources.

GOVERNANCE: Distrust from the public with respect to governments' management of policies and institutions has increased substantially. Results can be observed in the nationalist and protectionist movements. The first cracks in the globalised system appeared in the Middle East with the Arab Spring and the flood of refugees became a tipping point for the European Union. This led to economic and political pressures in the EU resulting in a wave of Euroscepticism and Eurosceptic parties became established in every EU country. The EU survived for a number of years but from 2030 it is merely a shell without any real power. The Chinese government was not able to meet the challenges posed by a more open domestic and global society. Leaders invested in information and communication, administrative systems, IT development, management training, regulatory functions etc. to help them control and manage institutions. However hardly any investments were made in the core competences essential

to fulfil institutional responsibilities. This has exerted long-lasting effects with many institutions imploding, unable to fulfil their responsibilities and limp governance has been the result.

INDUSTRY: The closing down of obsolete industries caused by earlier globalisation, protectionism, slowed-down economic growth and trade as well as tremendous global political uncertainties have played crucial roles in the negative industrial development experienced. Regions with obsolete industries have ended up in backwaters and blamed the elite and the political powers for this negative development. Currently, investments in high tech industries is at a threateningly low level.

INFRASTRUCTURE: The collapse of the conventional world has led to declining infrastructure investments and consequently infrastructures that are falling apart.

LIFE STYLES: Consumerism remains the personal goal for most people, but individual self-interest and paranoid mistrust dominate. It can be said that this is a fight for survival, to control resources and that the social order has increasingly faded away. The general quality of life has decreased substantially.

NATURAL RESOURCES: The world has moved from being a small world on a big planet to a big world on a small planet. With this transition, economic principles have driven the world to more and more consumption and unsustainable management of natural resources. There is tremendous pressure on natural capital, and there is limited capital left. People have realised that the natural capital is regulating the stability of the Earth and thereby the global economy, but have not been able to introduce new economic mechanisms and tools to change direction. As a result, the world is in a vicious circle with a declining global economy and declining natural resources. Agriculture has expanded onto new land in every country in order to reach the highest level of food self-sufficiency possible. The fight for control of natural resources has caused a number of international conflicts.

R&D AND INNOVATION: Due to these economic difficulties, innovation and technological developments have stagnated. All development efforts have been directed towards military and security issues due to the fact that global terrorism thrives in the political environments that have been generated and there are unprecedented uncertainties about the future.

RURAL CONDITIONS: Overall economic decline and geopolitical developments have sent rural areas on a downward trajectory with depopulation, closure of industries and weak economies. Regions with obsolete industries ended up as backwaters and blamed the elite and political powers for this negative development. In many regions of the world rural areas are simply dying.

SOCIETAL CHANGES: Nationalism as a movement has remapped today's world and has spread like the globalisation process. Nationalism has proven to be this century's most potent ideology and created multiple confusions of many societies in a desperate planet. The guiding hand of governments and the restraining pressures of morality are gone. Earlier the world supported individualism, freedom and opportunity and now the world has turned authoritarian.

Unrest in the Middle East and the dissolution of European Union power exerted a major impact on Russia. Separatist movements started up all over the country and *the Second Great Perestroika* in 2035 resulted in a division of Russia into *European Russia, the Republic of Siberia, the Republic of the Far East* and *the Republic of Caucasus*. China followed a similar trajectory. It is probable that as China became more prosperous in the early 2000s, it also became more unstable with more and more demonstrations. Government policies widened the gap between the people and the government. The government attempted to adopt many policy reforms but few were actually implemented. The United States is still functioning as a federation but is more like a collection of regional fragments fighting over shrinking resources than a united federation. US domestic politics is so polarised that Congress cannot unify on how to kick-start the economy. Separatist movements have destroyed the development of India and Pakistan. Countries such as Indonesia, Malaysia and Myanmar are now fractured along ethnic lines. In Africa, the Democratic Republic of Congo, Central African Republic, Nigeria, and Chad have fallen apart.

Global Foresight 2050

– Six global scenarios and implications for the forest sector

The aim of this report is to inspire organisations to improve preparedness for uncertain alternative future developments and thereby support strategic planning and governance. Six global foresight scenarios are presented based on economic, technological, political, societal and environmental developments by 2050. The real value of the report surfaces when the scenarios are implemented in a foresight exercise, as presented in the final section.

The key to the successful implementation is the understanding of how an organisation is affected by both known and unknown conditions. The scenarios are to support strategic operations at *the Swedish University of Agricultural Sciences (SLU)* and *the International Union of Forest Research Organizations (IUFRO)* and its member organisations. The report is also intended to be valuable to any other actors involved in the global forest sector and sectors connected to it.

Key words: *foresight exercise, strategies, economic development, societal development, environmental development*

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