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Scenario

4. Future pathways toward sustainable development

“Life can only be understood backwards; but it must be lived forwards.” (Søren Kierkegaard)

“Two different worlds are owned by man: one that created us, the other which in every age we make as best as we can.” (Zobolotsky (1958), from Na zakate, p. 299.)

This chapter compares semi-quantitative narratives of what would happen, if we continued as we did in the past, with alternative pathways towards global sustainable development. The “stories” are internally coherent and deemed feasible by experts, as they are derived from large-scale global modelling of sustainable development scenarios for Rio+20 in 2012.

4.1. If we continue like in the past: a “dynamics-as-usual scenario” 2010-2050

No one knows which path the world will take in the next 40 years. But there should remain no doubt that there has been an impressively strong consensus among experts since the 1970s about the major sustainability issues and the broad direction of trends, even though the precise magnitude and dynamics of the future sustainability challenge and eco-efficiency remain unknown. In contrast, perspectives differ greatly on the suggested policy solutions arising from different world views, grounded in different values.¹

The majority - but not all - scientists are concerned about the trend outlook for the next two generations.

The UN crowd-sourcing platform registered 202 contributions from scientists around the world who voted on each other’s ideas and collectively contributed a total of 95 ideas in response to the question “*What do you think the world will be like in 2050?*” The fifteen most popular ideas submitted capture almost exclusively environmental and development concerns which are prominent on the UN agenda, such as accelerating climate change, global collapse of ocean fisheries, economic growth, inequity, poverty and hunger (Table 1). In contrast, among the least popular ideas submitted were suggestions of peak material consumption, peak farmland, declining per capita energy use, large-scale efforts to reduce the human ecological footprint, and a “paradigm shift paradigm shift toward more holistic and sustainable values well under way”.

Table 1. Top-15 crowd-sourced ideas on “What do you think the world will be like in 2050?”

Idea	Score
Global collapse of ocean fisheries before 2050.	90
Accelerating climate damage	89
There will be increasing inequity, tension, and social strife.	86
Global society will create a better life for most but not all, primarily through continued economic growth.	86
Persistent poverty and hunger amid riches	86
Humanity will avoid “collapse induced by nature” and has rather embarked on a path of “managed decline”.	83
Two thirds of world population under water stress	83
Urbanization reaches 70% (+2.8 billion people in urban areas, - 0.6 billion in rural areas).	83
The number of people going hungry is reduced by 500 million people, still leaving 250 million with insufficient food intake.	83
Continued lack of understanding of the complex non-linear dynamics of ecosystems.	80
Food production peaks around 2040 at a level 60% above today’s current levels, in terms of tonnes of food per year.	75
Gross world product keeps growing until the second half of the 21 st century, but at an ever decreasing rate.	75
Temperatures and sea-levels will continue rising as will the share of renewable energy use.	75
Massive human interference with P and N cycles well beyond safe thresholds	75
GHG emissions will increase by 70%, from 48 to 83 GtCO ₂ -equiv. Most of the GHG emissions increase will be in BRICS.	75

The following is a sketch of what the world could look like in 2050, if we continued the historical path of incremental improvements in reaction to perceived crises, instead of a shift toward a long-term perspective anticipating the troubles ahead. If not explicitly stated otherwise, the following description of the *dynamics-as-usual* (DAU) world in 2050 follows the trend scenarios prepared by OECD² and PBL³ for Rio+20 in 2012.

The dynamics-as-usual world in 2050 is a “growth first”-scenario. It is one of excessive material consumption by 6 billion people in both “North” and “South” which will be at the expense of another 3 billion people living in abject poverty, suffering much of the negative consequences of the others’ “overconsumption” which by its sheer scale will have transgressed the majority of “planetary boundaries”⁴, eventually leading to global collapse. Such potential collapse is not included in any of the mainstream trend scenarios. Hence, the following is an optimistic view of the consequences of continuing as in the past. The dynamics-as-usual scenario describes a future world that results from a continuation of incremental progress, in line with

historical patterns and trends. It is the closest to a future “projection”.⁵ Table 2 provides an overview of what this

scenario might mean by 2050 which is described in more detail below.

Table 2. Brief characterization of the consequences of continuing like in the past (a “dynamics-as-usual scenario” 2010-2050).

<i>Sustainability</i>	<i>Development</i>
<u>Nature in 2050</u> Crisis responses to irreversible environmental events. Accelerated increase in GHG emissions and global warming. Unabated, continued loss of biodiversity. Massive human interference with P and N cycles well beyond safe thresholds.	<u>People in 2050</u> A more crowded, urban world. Persistent poverty and hunger amid riches. One billion people without access to basic services. Billions excluded from otherwise improved global health. Universal primary and secondary education for all. Social safety nets increase coverage in developing world, but are reduced in the developed world.
<u>Life support in 2050</u> Only isolated examples of systemic changes in consumption patterns. Two thirds of world population under water stress. Global deterioration of urban air pollution, but fewer deaths from indoor air pollution. Protected land and marine areas increase. Fewer forests, more land for agriculture until 2030, then reversed trends. Unabated increase in hazardous chemicals exposure. Global collapse of ocean fisheries.	<u>Economy in 2050</u> Economic growth remains the top policy priority in most countries. A global middle class in a US\$300 trillion world economy amid abject poverty. Improvements in technology and eco-efficiency at historical rates. An energy-hungry, fossil-fuelled world. A thirsty world. A world repeatedly rippled by price shocks and supply disruptions.
<u>Community in 2050</u> Continued resurgence of intra- and inter-country conflict at least for the medium-term, fueling multiple, protracted crises.	<u>Society in 2050</u> Continuing past trends would suggest widening governance, continuing globalization (with possible regional ups and downs), changing values, and a greatly enhanced role of women.

4.1.1. People in 2050 in a dynamics-as-usual scenario

The world in 2050 will be a more crowded, urban world. Population will follow the UN median projection. World population will be 9.2 billion in 2050, which is 2.2 billion higher than today, with most of the increase in South Asia, the Middle East and Africa. Urbanization will reach 70%, implying an increase of 2.8 billion people in urban areas, compared to a decrease of 0.6 billion in rural areas. According to other trend estimates, about 4 billion people will be added to in urban areas, requiring the building of 400 mega-cities in and around existing cities.⁶

The world in 2050 will be one of persistent poverty and hunger amid riches. Great progress is expected for another 2 billion people being lifted from poverty and hunger. As in recent decades, such progress will be fast enough to compensate for the growing world population, but leave roughly as many people extremely poor - almost 3 billion people living on <US\$2 per day - as there are today. The number of people going hungry will likely be reduced by 500 million people, still leaving 250 million with insufficient food intake.

By mid-century, more than 240 million people, mostly in rural areas, will remain without access to improved water sources, and 1.4 billion people without access to basic sanitation. Child mortality from diarrhoea, caused by unsafe water supply and poor sanitation, will decrease, but Sub-Saharan Africa will lag behind.

Progress toward universal access to electricity and modern cooking fuels continues, but its pace differs greatly among countries. Global universal access is not achieved before the end of the 21st century. By 2050, there will be some 1.8 billion people without access to modern energy services for cooking and heating, down from 2.75 billion in 2010.

By 2050, billions will continue to be excluded from otherwise improved global health. For example, global premature mortality from malaria is expected to be halved to 0.4 million from 2010 to 2050.

Universal primary and secondary education for all will have been achieved by 2050. Great progress is expected on making not only primary, but also secondary education universal, with women most likely accounting for most of the higher-level degrees worldwide in 2050.⁷

Public investments in education, health, water and sanitation tend to increase in today's developing countries, and especially emerging economies, but are gradually reduced in today's developed countries. Social safety nets in developing countries evolve slowly towards increased coverage, but remain limited to the formal economy, whereas the coverage is gradually reduced in today's developed countries. There are no special efforts to reduce income disparities between countries or within countries.

4.1.2. Economy in 2050 in a dynamics-as-usual scenario

In line with current trends, economic growth remains the top policy priority in most countries, but an increasing number of social and environmental issues are increasingly taken seriously and are being addressed within the growth-focussed paradigm. This will also be reflected in an increasingly complex and wide ranging system of regional and global institutions.

By 2050, a global middle class will emerge amid abject poverty. Gross world product quadruples to US\$300 trillion, with BRICS alone accounting for 40% of the world economy in 2050. Income convergence across countries continues rapidly, reaching ranges between emerging and developed countries similar ranges between developed countries today. Average GDP per capita is expected to triple to US\$33,000 in 2050, a level similar to OECD countries today where GDP per capita is expected to double to US\$69,000. GDP per capita in BRICS would quintuple to US\$37,000 in 2050. However, some of the most vulnerable and poorest economies remain marginalized and in abject poverty.

The trade, intellectual property rights, and investment and financial systems, including official development flows follow the assumptions in the business-as-usual scenario. Incremental technology progress proceeds in line with historical patterns, including in terms of eco-efficiency. This is achieved with ever increasing public commitments and investments, as gaps become increasingly evident. As a result, "green" sectors are supported by governments and develop faster than other sectors, but do not receive support commensurate with the social and environmental efforts. Energy efficiency, water efficiency, and crop yields continue to improve as per past trends.

Renewable energy diffuses slowly into the global primary energy mix, with large differences among countries. Until at least the mid-21st century, fossil fuels remain the dominant energy source. Governments fully implement the present biofuels mandates for 2020-2025, but thereafter there is

potentially a significant backlash, in view of ensuing land conflicts and rising food prices.

Global primary energy use increases by 80%, with a fairly stable mix of fossil fuels (85%), modern renewable sources (10%), and nuclear energy (5%). Rapid energy efficiency and intensity improvements will continue to be outstripped by energy demand. Absolute demand for biofuels will increase by at least one third by 2035, requiring additional land, including from clearing forests and pastureland conversions, which will put additional pressure on food prices leaving millions of urban dwellers hungry.

Water demand increases by 55%, mainly due to manufacturing (+400%), electricity (+140%) and domestic use (+130%). In the face of competing demands, there will be little scope for increasing irrigation.

The world in 2050 will be one that continues to be repeatedly rippled by price shocks and supply disruptions. National energy security is expected to decrease for most countries, especially the large, Asian economies. Pressure on exploration and opening of lower quality, unconventional fossil fuel sources will contribute to repeated major energy crises that will adversely affect the poor and food security.

4.1.3. Life support in 2050 in a dynamics-as-usual scenario

There will only be isolated national examples of systematic, direct efforts to change consumption patterns by mid-century. Instead, policy makers rely primarily on price signals to impact consumer behaviour, but prices remain too low to achieve eco-efficiency changes commensurate with the challenges, in view of the successful lobbying efforts of special interest groups and strategic gaming behaviour of market actors.

In 2050, a whopping 3.9 billion people (>40% of world population) will live in river basins under severe water stress, and 6.9 billion people will experience some water stress. Groundwater continues to be exploited faster than it can be replenished (>280 km³ per year) and is also becoming increasingly polluted. Surface water and groundwater quality is stabilized and restored in most OECD countries, whereas it deteriorates in developing countries. The number of people at risk from floods might increase by 400 million to 1.6 billion, with the value of assets at risk almost quadrupling to US\$45 trillion.

Pollution loads by industry continue past trends, including for pollution from toxic chemicals. Transfer of chemical and

electronic waste to developing countries is progressively restricted to reflect stricter regulations or enforcement in some regions.

Urban air quality will continue to deteriorate globally, with concentrations in many cities far exceeding acceptable health standards. Premature deaths from exposure to particulate matter might double to 3.6 million per year, SO₂ emissions increase by 90% and NO_x emissions by 50%. This is despite continued declines in SO₂, NO_x and black carbon emissions in developed countries. Yet, there will be fewer premature deaths from indoor air pollution after 2020.

Protected land and marine areas continue to increase. No global management of fisheries is reached.

Agricultural land area is expected to increase until 2030, intensifying competition for land, and might decline thereafter, in line with declining population growth and agricultural yield improvements. Deforestation rates most likely continue to decline, especially after 2030, but most primary forests might be destroyed by 2050.

World chemicals industry sales are expected to grow by about 3% per year to 2050, leading to an unabated increase in the global burden of disease attributable to exposure to hazardous chemicals.

Continued overfishing beyond maximum sustainable yield, together with ocean warming and acidification, eutrophication, habitat degradation, and destruction of coral reefs, might lead to a global collapse of ocean fisheries based on “wild catch”, with efforts to replace by aquaculture-based fisheries.

4.1.4. Nature in 2050 in a dynamics-as-usual scenario

Many of the planetary boundaries, including in terms of climate change, are expected to be breached. Irreversible environmental events and social strife are of increasing concern. Governments focus on crisis response rather than structural change.⁸

Limited effort is made on climate (continuing the increase in voluntary emissions reductions), reflecting lack of a binding multilateral agreement post Kyoto. GHG emissions are expected to increase at an accelerated rate at least until 2030, leading to an increase 48 to 83 GtCO_{2-equiv} from 2010 to 2050. Most of the GHG emissions increase will be due to large emerging economies. This is despite expected decreases in LULUCF emissions from 2040 onwards.

Atmospheric GHG concentrations might reach about 685 ppmv (CO_{2-equ.}), eventually leading to a 3-6°C warming.

Biodiversity loss is expected to continue unabated. Biodiversity⁹ is expected to decline by at least 10%, with the highest losses in Asia, Europe, and Southern Africa¹⁰, and pressure from invasive alien species will increase. Primary forests will steadily decrease until few will be left, even if zero net forest loss were to be achieved after 2020.

Human interference with P and N cycles will continue well beyond safe thresholds. Eutrophication of surface water and coastal zones is expected to increase almost everywhere until 2030. Thereafter, it might stabilize in developed countries, but continue to worsen in developing countries. Globally, the number of lakes with harmful algal blooms will increase by at least 20% until 2050. Phosphorus discharges will increase more rapidly than those of nitrogen and silicon (exacerbated by the rapid growth in the number of dams).

4.1.5. Society and community in 2050 in a dynamics-as-usual scenario

Mainstream BAU/DAU scenarios say nothing about future trends in neither community nor society. This is in contrast to some sustainable development assessments of the past. However, continuing past trends would suggest widening governance, continuing globalization (with possible regional ups and downs), changing values, and a greatly enhanced role of women. Continuing past trends suggest a continued resurgence of intra- and inter-country conflict at least for the medium-term, fueling multiple, protracted crises.

4.2. A better world we can achieve: a sustainable development scenario

The UN crowd-sourcing platform registered 287 contributions from scientists around the world who voted on each others ideas and contributed a total of 61 ideas in response to the question “*What kind of world would you like to see for yourself, your children and grandchildren in 2050?*”. The fifteen most popular ideas submitted capture areas of immediate development and social concerns, such as poverty, hunger, vitamin deficiencies, social protection, universal access to basic services universal education, as well as human rights and access to justice, redress and remedy for all. In contrast, among the least popular ideas submitted were suggestions to reduce water stress, reduce air pollution and various climate change targets.

Table 3. Top-15 crowd-sourced ideas on “What kind of world would you like to see for yourself, your children and grandchildren in 2050?”

Idea	Score
Access to justice, redress and remedy for all	92
Vitamin deficiencies eliminated	90
No hunger	90
Social protection floor everywhere	89
Greatly reduced child mortality	88
Contraception available to all who want it	85
World peace and human security	85
Universal access to improved water source and basic sanitation	85
No poverty worldwide	83
Universal access to waste water treatment and solid waste management services	79
Access to decent work, socially fair and environmentally correct	78
Political, economic and social human rights for all	75
150 million hectares of degraded lands restored	73
Universal primary and secondary education	71
Universal access to modern, clean and affordable energy services	71
Life expectancy greater 80 years in all countries	71

Consistent paths to a “better world” are described in a number of sustainable development scenarios for Rio+20. The following description of a sustainable development future in 2050 is based on results from the following sustainable development scenarios:

- Global Energy Assessment Scenarios by the International Institute for Applied Systems Analysis (IIASA), Austria,¹¹
- Rio+20 scenarios by PBL Netherlands Environmental Assessment Agency¹²,
- Alternative pathways toward sustainable development and climate stabilization (ALPS) by RITE, Japan,¹³
- Shared Development Scenarios (SDA) for Rio+20 by the Stockholm Environment Institute (SEI), Sweden¹⁴
- Green growth scenarios for Rio+20 by OECD,¹⁵
- Great transition scenarios (2010 update) by Tellus, USA,¹⁶
- Exploratory WITCH scenarios by Fondazione Eni Enrico Mattei (FEEM), Italy,¹⁷
- Global resource scenarios of the climate-land-energy and water (CLEWs) Nexus by the Royal Institute of Technology (KTH), Sweden, and the United Nations-Department for Economic and Social Affairs (DESA)¹⁸

- Sustainable Development Global Simulation by National Academy of Sciences of Ukraine; Geophysical Center of Russian Academy of Science; Ukrainian Branch of World Data Center.¹⁹
- In addition, a number of prominent recent reviews of scenarios were considered, where appropriate, including World Wildlife Fund’s Living Planet²⁰, UNEP’s GEO-5 scenario review²¹, the World Business Council for Sustainable Development’s sustainable vision 2050²², and the World Economic Forum’s global risk report.²³

While they do not refer to one single scenario, these mainstream scenarios are fairly similar in spirit and content, not least because they all bear close “family resemblance” with the IPCC SRES scenario B1.²⁴

The sustainable development scenario describes a future world in which policy follows an integrated approach to economic, social and environmental goals, and major institutional change, with the overall goal of development that *“meets the needs of the present without compromising the ability of future generations to meet their own needs”*. It describes a world that is clearly much more in line with the world that we all want. It is more sustainable in environmental and social dimensions and promises a decent quality of life for all people.

The sustainable development scenario reflects an integrated focus on the three pillars of sustainable development, as well as an explicit integration of (dynamic) planetary limits to ecosystems capacity. Conscious efforts are made by the international community to achieve and sustain MDGs-related goals relating to basic access to services, education, and health, and to reduce aggregate income disparities across regions in the long term. This scenario implies new economic structures, different allocation of capital and investment among public and private sectors, cooperative management of the commons at the global and national levels. In the latter half of the 21st century, sustainable development would be achieved in the sense that all regions are developed, poverty is eradicated, and the demand on natural sources and sinks does not exceed their regeneration capacity. Yet, this world in 2050 will be far from a paradise vision.

4.2.1. People in 2050 in a sustainable development scenario

In the sustainable development world, the proportion of people who suffer from hunger would be halved by 2015. It would further halved by 2030, and eradicated by 2050.¹² In

another account of such world, chronic hunger would be reduced by 50%, 75% and 94%, by 2025, 2050, and 2100, respectively.¹⁶ Poverty as a whole could be virtually eliminated worldwide by 2050.¹⁴

Great progress would be made in terms of improving access to water and sanitation. In particular, the proportion of the population without sustainable access to safe drinking water and basic sanitation by could be halved by 2015, followed by another halving 2030. Eventually, universal access to improved water source and basic sanitation would be achieved by 2050.¹²

Universal access to electricity and modern cooking fuels could be achieved by 2030.^{11,12} Others believe it might take until 2050.¹⁴ This achievement, together with other pollution measures, would significantly decrease the impact of environmental factors on human health, as measured by DALY.¹²

Universal primary education is achievable by 2015.¹⁷ Global population growth would slow, with an expected peak population to be reached in 2050. Global population could be reduced by about one billion, simply by making contraception available to all who want it and by increasing opportunities for girls and women to have education and jobs.²⁵

This world would continue to become more urban like in the dynamics-as-usual world. Yet, special efforts will be made to ensure the provision of reliable and high quality public services not only in smaller urban centres but also in remote areas, which, however, is not expected to significantly alter the global trend toward urbanization and a global network of mega-cities.

4.2.2. The economy in 2050 in a sustainable development scenario

In the sustainable world, economic growth would no-longer be the primary goal, nor one of the most important goals. Yet, as a result of pursuing other SDGs, global income convergence is expected, including through catch-up development of African countries by mid-century.¹⁷ As a result, GDP per capita might be more than US\$10,000 (in PPP terms) in all regions by 2050.¹⁴

By the end of the 21st century, differences in GDP per capita between countries worldwide would be similar to the prevailing such differences between OECD countries today. This leads to much lower differences in incomes across countries, as well as conscious efforts to limit intra-

country income differences, and thus significantly lower conflict potential.

Despite this much higher incomes in all world regions, the world would manage to optimize energy efficiencies and conservation, so that it could do with primary energy use of less than 70GJ per capita by 2050.¹⁷

Absolute water use will increase from 3,560 km³ in 2000 to 4,140 km³ in 2050. This is at least 25% lower than in the trend scenario due to accelerated increases in water efficiency and conservation.¹⁵

The sustainable development world would also benefit from higher energy security, due to limited energy trade, increased diversity and resilience of energy supply by 2050, much of which as a co-benefit of environmental policies.¹¹

Possibly, in this scenario the 500 million richest people, regardless in which developing or developed country they live, would take a leading role in changing their consumption pattern and contribute resources to eradicate poverty. The high willingness to pay for technology performance by these “rich” leads to accelerated technology change toward cleaner clusters that are thereafter gradually adopted by lower income groups.

4.2.3. Life support in 2050 in a sustainable development scenario

Despite all the water measures taken in the sustainable development world, it is expected that there might be an additional 2 billion people living under severe water stress compared to the year 2000, reaching 3.7 billion people living under water stress in 2050.¹⁵ More optimistic scenarios outline pathways toward a future in which the number of people living under severe water stress could be limited to less than 2 billion until 2050.¹⁶ In all these cases, it would mean a significant reduction of the number of people living in water scarce areas compared to the trend scenario.¹² However, overall flooding risks, as well as surface or groundwater quality are expected to continue to worsen, even in this “better world we can achieve”.

Great improvements could be achieved in terms of reducing air pollution. In particular, it should be possible to keep PM2.5 concentrations below 35 µg m³ by 2030¹², and to reduce NO_x, SO₂ and black carbon emissions by 25% compared to the baseline by 2050.¹⁶ Reduced air pollution could reduce the number of premature deaths globally by 50% by 2030.¹¹

Similarly, in this world deforestation and land degradation will be slowed and later even reversed deforestation.¹⁶

In this world, increased efforts will be made to minimize chemicals pollution to the environment and related health hazards. However, even with such efforts, chemicals will most likely continue to pose serious and even increasing threats to human health and the environment in the future. This is in part due to chemicals and materials needed for the production of “green technologies” needed to address the series of global commons issues.

Overfishing will be slowed and fish stocks later restored towards mid-century.¹⁶

4.2.4. Nature in 2050 in a sustainable development scenario

Coordinated efforts are made to curb greenhouse gas emissions in order to achieve scientifically recommended targets (e.g. 350 ppm), through the whole range of possible policies, technologies and regulations. Global average temperature change could be limited to 2°C above pre-industrial levels with a likelihood of at least 50% (or 60%) from 2050 to 2100.^{11,12,15,16} This could be achieved by stabilizing atmospheric GHG concentrations below 450 ppmv CO_{2,eq.} from 2010 to 2100¹², even though lower targets of 350ppmv appear possible as well by 2100¹⁶, all of which would however, require unprecedented measures and global collaboration.

In this “better future we can achieve”, the extinction of known threatened species will be prevented and the situation improved of those in most decline by 2020. In quantitative terms, the world will achieve halving the rate of biodiversity loss by 2020 and stabilizing biodiversity at that level (depending on region) by 2050. The rate of loss of natural habitats would be halved and degradation and

Developments in community and society will be essential to achieve such comprehensive transformation to a sustainable development world. However, as scenario analysts do not offer a clear vision of what changes this would precisely entail, we do not offer any further details in this area either.

Table 4 provides an overview of the goals and targets contained in the sustainable development scenarios for Rio+20, the outcome of which in 2050 has just been described.

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