Chapter 4.
Visions, scenarios and future pathways towards 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)

This chapter compares semi-quantitative narratives of what would happen if we continue as we have 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.

People across the world have a range of views or "visions" of what kind of world they would like to see for themselves, their children and grandchildren in the future. The Rio+20 Conference of 2012 (UNCSD) agreed on key elements of a common vision for sustainable development. The OWG on SDGs further explores international consensus. Further, there are different preferences for alternative future pathways towards achievement of the vision. Scenarios are plausible and internally consistent pictures of the future. They are useful tools - often making use of quantitative models - to systematically explore the feasibility of visions and proposed future pathways towards their achievement. They provide information on the means of implementation that are needed and can be useful in monitoring progress.

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 improvements in eco-efficiency remain unknown. In contrast, perspectives differ greatly on the suggested policy solutions arising from different world views, grounded in different values.[160]

The majority of - but not all - scientists are concerned about the trend outlook for the next two generations. The United Nations crowdsourcing 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 about their vision for 2050: *"What do you think the world will be like in 2050?"* The 15 most popular ideas submitted capture almost exclusively environmental and development concerns, which are prominent on the United Nations agenda, such as accelerating climate change, global collapse of ocean fisheries, economic growth, inequity, poverty and hunger (Table 20). 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 towards more holistic and sustainable values well under way".

Table 20. Top-15 crowdsourced answers to the question: "What do you think the world will be like in 2050?"

Idea	Score
Global collapse of ocean fisheries before 2050	90
Accelerating climate change	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 will be under water stress	83
Urbanization will reach 70% (+2.8 billion people in urban areas, -0.6 billion in rural areas)	83
The number of people going hungry will be reduced by 500 million people, still leaving 250 million with insufficient food	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 21st 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 phosphorus and nitrogen cycles well beyond safe thresholds	75
GHG emissions will increase by 70%, from 48 to 83 $GtCO_2$-equivalent. Most of the increase will be in BRICS	75

Source: UN DESA crowdsourcing platform.

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 towards 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 OECD[161] and the Netherlands Environmental Assessment Agency (PBL)[162] 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 six billion people in both the "North" and "South" that will be at the expense of another three billion people living in abject poverty, suffering the negative consequences of others' overconsumption, which by its sheer scale will have overtaken most of the planetary boundaries,[163] 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.[164] Table 21 provides an overview of what this scenario might mean by 2050, and this is described in more detail in section 4.1.1.

Table 21. Brief characterization of the consequences of continuing like in the past (a "dynamics-as-usual" scenario 2010-2050)

Sustainability	Development
Nature in 2050 Crisis responses to irreversible environmental events Accelerated increase in GHG emissions and global warming Unabated, continued loss of biodiversity Massive human interference with phosphorus and nitrogen cycles well beyond safe thresholds	**People in 2050** 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
Life support in 2050 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	**Economy in 2050** 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
Community in 2050 Continued resurgence of intra- and inter-country conflict at least for the medium term, fuelling multiple protracted crises	**Society in 2050** Continuing past trends would suggest widening governance, continuing globalization (with possible regional ups and downs), changing values, and a greatly enhanced role of women

Source: Authors' elaboration.

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 United Nations 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 Africa, the Middle East and South Asia. Urbanization will reach 70 per cent, implying an increase of 2.8 billion people in urban areas, compared to a decrease of 0.6 billion in rural areas. This will be in addition to the roughly 4 billion people already living in urban areas, requiring the building of 400 megacities in and around existing cities.[165]

The world in 2050 will be one of persistent poverty and hunger amid riches. Great progress is expected for another two 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 will leave roughly as many people extremely poor - almost three billion people living on less than 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 towards universal access to electricity and modern cooking fuels will continue, but its pace will differ greatly among countries. Global universal access will not be 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 will 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.[166]

Public investments in education, health, water and sanitation will tend to increase in today's developing countries, and especially emerging economies, but might be gradually reduced in today's developed countries. Social safety nets in developing countries will evolve slowly towards increased coverage, but will remain limited to the formal economy, whereas the coverage will be gradually reduced in today's developed countries. There won't be any special efforts to reduce income disparities among countries or within countries.

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

In line with current trends, economic growth will remain the top policy priority in most countries, but an increasing number of social and environmental issues will be taken seriously and will be addressed within the growth-focused 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 Brazil, Russia, India, China and South Africa (BRICS) alone accounting for 40 per cent of the world economy in 2050. Income convergence across countries will continue rapidly, reaching ranges between emerging and developed countries similar to ranges among developed countries today. Average GDP per capita is expected to triple to US$33,000 in 2050, a level similar to OECD countries today whose GDP per capita is expected to double to US$69,000. GDP per capita in BRICS will quintuple to US$37,000 in 2050. However, some of the most vulnerable and poorest economies will 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 dynamics-as-usual scenario. Incremental technology progress will proceed in line with historical patterns, including in terms of eco-efficiency. This will be achieved with ever-

increasing public commitments and investments, as gaps become increasingly evident. As a result, "green" sectors will be supported by Governments and develop faster than other sectors, but will not receive support commensurate with the social and environmental challenges. Energy efficiency, water efficiency, and crop yields will 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 will increase by 80 per cent, with a fairly stable mix of fossil fuels (85 per cent), modern renewable sources (10 per cent), and nuclear energy (5 per cent). 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. More biofuels also will mean that less water is available for food production.

Water demand will increase by 55 per cent, mainly due to manufacturing (+400 per cent), electricity (+140 per cent) and domestic use (+130 per cent). In the face of competing demands, there will be little scope for increasing irrigation which will raise serious concerns about global food security.

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.

There will only be isolated national examples of systematic, direct efforts to change consumption patterns by mid-century. Instead, policymakers will rely primarily on price signals to impact consumer behaviour, but prices will remain too low to achieve eco-efficiency changes commensurate with the challenges.

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

In 2050, a whopping 3.9 billion people (>40 per cent of world population) will live in river basins under severe water stress, and 6.9 billion people will experience some water stress. Groundwater will continue to be exploited faster than it can be replenished (>280 km^3 per year) and will also becoming increasingly polluted. Surface water and groundwater quality will be stabilized and restored in most OECD countries, whereas it will deteriorate 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 will continue past trends, including for pollution from toxic chemicals. Transfer of chemical and electronic waste to developing countries will be 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, SO_2 emissions increase by 90 per cent and mono-nitrogen oxide (NOx) emissions by 50 per cent. This will be despite continued declines in SO_2, NOx and black carbon emissions in developed countries. Yet there will be fewer premature deaths from indoor air pollution after 2020.

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

Agricultural land area will increase until 2030, putting pressure on other uses of land, and might decline thereafter, in line with declining population growth and agricultural yield improvements. Deforestation rates will most likely continue to decline, especially after 2030, but most primary forests might be destroyed by 2050.

Protected land and marine areas will continue to increase. Global management of fisheries will not be achieved.

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 it with 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, will be breached. Irreversible environmental events and social strife will be of increasing concern. Governments will focus on crisis response rather than structural change. [167]

Limited effort will be made on climate (continuing the increase in voluntary emissions reductions), reflecting the lack so far of a global binding multilateral agreement post-Kyoto. GHG emissions will increase at an accelerated rate at least until 2030, leading to an increase from 48 to 83 $GtCO_2$-equivalent 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-equivalent), eventually leading to a 3-6˚C warming.

Biodiversity loss will continue unabated. Biodiversity[168] is expected to decline by at least 10 per cent, with the highest losses in Asia, Europe and Southern Africa,[169] and pressure from invasive alien species will increase. Primary forests will steadily decrease until few will be left, even if zero net forest loss will be achieved after 2020.

Human interference with phosphorus and nitrogen cycles will continue well beyond safe thresholds. Eutrophication of surface water and coastal zones will increase almost everywhere until 2030. Thereafter, it might stabilize in developed countries, but will continue to worsen in developing countries. Globally, the number of lakes with harmful algal blooms will increase by at least 20 per cent 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 business-as-usual / dynamics-as-usual scenarios referenced here 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, fuelling multiple, protracted crises.

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

The United Nations crowdsourcing platform registered 287 contributions from scientists around the world who voted on each other's 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 15 most popular ideas submitted capture areas of immediate development and social concern, such as poverty, hunger, vitamin deficiencies, social protection, universal access to basic services and 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 22).

Table 22. Top-15 crowdsourced 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 wastewater 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 ha of degraded lands restored	73
Universal primary and secondary education	71
Universal access to modern, clean and affordable energy services	71
Life expectancy greater than 80 years in all countries	71

Source: UN DESA crowdsourcing platform.

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[170]
- Rio+20 scenarios by PBL, the Netherlands Environmental Assessment Agency [171]
- Alternative pathways towards sustainable development and climate stabilization (ALPS) by the Research Institute of Innovative Technology for the Earth (RITE), Japan [172]
- Shared Development Agenda (SDA) Scenarios for Rio+20 by the Stockholm Environment Institute (SEI), Sweden [173]
- Green growth scenarios for Rio+20 by OECD [174, 175]
- Great transition scenarios (2010 update) by Tellus, United States of America [176]
- Exploratory World Induced Technical Change Hybrid (WITCH) scenarios by Fondazione Eni Enrico Mattei (FEEM), Italy [177]
- Global resource scenarios of the climate–land–energy–water nexus (CLEWs) by the Royal Institute of Technology (Kungliga Tekniska Högskolan [KTH]), Sweden, and UN DESA [178]
- Sustainable Development Global Simulation by National Academy of Sciences of Ukraine; Geophysical Center of Russian Academy of Science; Ukrainian Branch of World Data Center [179]
- In addition, a number of prominent recent reviews of scenarios were considered, where appropriate, including World Wildlife Fund's *Living Planet*,[180] UNEP's GEO-5 scenario review,[181] the World Business Council for Sustainable Development's sustainable vision 2050,[182] and the World Economic Forum's global risk report.[183]

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 a close "family resemblance" with the IPCC Special Report on Emissions Scenarios (SRES) scenario B1.[184]

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 occurs, 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"*.[14] 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 dimensions 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 MDG-related goals relating to basic access to services, education and health, and to reduce aggregate income disparities across countries and regions in the long term. This scenario implies new economic structures, different allocation of capital and investment among public and private sectors, and 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 be further halved by 2030, and eradicated by 2050.[171] In another account of such a world, chronic hunger would be reduced by 50 per cent, 75

per cent and 94 per cent, by 2025, 2050 and 2100, respectively.[176] Poverty as a whole could be virtually eliminated worldwide by 2050.[173]

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 could be halved by 2015, followed by another halving by 2030. Eventually, universal access to improved water sources and basic sanitation would be achieved by 2050. [171]

Universal access to electricity and modern cooking fuels could be achieved by 2030.[170,171] (Others believe it might take until 2050.)[173] This achievement, together with other pollution measures, would significantly decrease the impact of environmental factors on human health, as measured by disability-adjusted life years.[171]

Universal primary education is achievable by 2015.[177] Global population growth would slow, with an expected peak population to be reached in 2050. Global population in that year 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.[185]

This world would continue to become more urban, as 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. This, however, is not expected to alter significantly the global trend towards urbanization and a global network of megacities.

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 for all countries. The primary goal here is to achieve a shared development agenda scenario where poor countries reach at least today's middle income by 2050. As a result of pursuing sustainable development objectives, global income convergence is expected, including through the catch-up development of African countries by mid-century.[177] As a result, GDP per capita might be more than US$10,000 (in 2005 PPP terms) in all regions by 2050, including the world's poorest regions.[173] This implies almost a doubling of GDP per capita by 2050 in these regions, compared with the baseline scenario.

By the end of the 21st century, the range of differences in GDP per capita among countries worldwide would be similar to the prevailing range of differences among OECD countries today. Also, conscious efforts to limit intra-country income differences could significantly lower conflict potential.

Along with much higher incomes in all regions, the world would manage to optimize energy efficiencies and conservation, so that it could do with primary energy use of less than 70 GJ per capita by 2050.[177]

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 would be a co-benefit of environmental policies.[170]

Absolute water use would increase from 3,560 km^3 in 2000 to 4,140 km^3 in 2050. This is at least 25 per cent lower than in the trend scenario due to accelerated increases in water efficiency and conservation.[174]

Possibly, in this scenario the 500 million richest people, regardless in which developed or developing country they live, would take a leading role in adopting more sustainable consumption patterns and contribute resources to eradicate poverty. The high willingness to pay for higher technology performance and quality of life by "the rich" would lead to accelerated technology change towards cleaner technology 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 measures taken in the sustainable development world, there might be an additional 2 billion to 3.7 billion people living under severe water stress in 2050 compared to the year 2000.[174] More optimistic scenarios outline pathways towards a future in which the number of people living under severe water stress could be limited to fewer than 2 billion until 2050.[176] 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.[171] But overall flooding risks, as well as surface and 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 $\mu g/m^3$ by 2030,[171] and to reduce NOx, SO_2 and black carbon emissions by 25 per cent compared to the baseline by 2050.[176] Less air pollution could reduce the number of premature deaths globally by 50 per cent by 2030. [170]

Similarly, in this world deforestation and land degradation will be slowed and later even reversed.[176]

In this world, increased efforts will be made to minimize chemical 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 used in the production of the green technologies needed to address global environmental threats.

Overfishing will be slowed and fish stocks later restored towards mid-century.[176]

4.2.4. Nature in 2050 in a sustainable development scenario

Coordinated efforts are made to curb GHG 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 per cent (or 60 per cent) from 2050 to 2100.[170,171,174,176] This could be achieved by stabilizing atmospheric GHG concentrations below 450 ppmv CO_2-equivalent from 2010 to 2100.[171] A lower target of 350 ppmv appears possible as well by 2100,[176] but only with unprecedented measures and global collaboration.

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

fragmentation reduced by 2020. Ultimately, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas would be conserved by 2020, in line with the CBD Aichi protected area targets.[171, 174]

Great efforts will be made to limit the continued rise of human interference with the global phosphorus and nitrogen cycles, however, only with limited success, through removal in wastewater treatment and reduction in use, without harming the ability of the agricultural system to meet the hunger target. [171,174]

4.2.5. Community and society in 2050 in a sustainable development scenario

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 cannot offer any further details in this area.

Table 23 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.

Table 23. Goals and targets in sustainable development scenarios for Rio+20

Vision		Theme	Types of goals, targets, and outcomes	IIASA-GEA	PBL	SEI	OECD	RITE-ALPS	FEEM	GSG
To develop	People	Poverty	Eradicate hunger by 2050		X					X
			Eliminate poverty by 2050			X				
		Access	Universal access to improved water source and basic sanitation by 2050		X		X			
			Universal access to electricity and modern cooking fuels by 2030 (or 2050)	X	X	(X)				
		Health and education	Decreased impact of environmental factors on disability-adjusted life years		X					
			Universal primary education by 2015						X	
	Economy	Income	GDP per capita > US$10,000 (PPP) in all regions by 2050			X				
			Income convergence; catch-up of Africa by 2050						X	
		Resources	Primary energy use less than 70 GJ per capita by 2050						X	
			Primary energy use per capita is only 13% higher in 2050 than in 2010, and 48% higher in 2100					X		
			Use of renewables increase by 3.1 times from 2010 to 2050					X		
			Water demand increases from 3,560 km^3 in 2000 to only 4,140 km^3 in 2050				X			
		Security	Limit energy trade, increase diversity and resilience of energy supply by 2050	X						
			Population weighted average of energy security index increases only by 2.3					X		
To sustain	Life support	Resources	Limit the increase in the number of people under severe water stress to an additional +2 billion (or +1.4 billion) from 2000, reaching 3.7 billion (or 3.1 billion) in 2050				X	(X)		
			People under severe water stress <2 billion until 2050 (or 2.9 billion in 2100)					(X)		X
			Reduce number of people living in water scarce areas vs trend scenario		X					
			Reduce the area for energy crop production to almost zero by 2020. From 2010 to 2050, limit increase in cropland area for food production to +15%, and reduce the irrigated area for food production by 5%					X		
			Cumulative fossil fuel use limited to <520 Gtoe from 2010 to 2050					X		
			Slow and later reverse deforestation and land degradation							X
			Slow overfishing and later restore fish stocks							X
		Air pollution	Keep PM2.5 concentration below 35 µg/ m^3 by 2030		X					
			Reduce NOx, SO_2 and black carbon emission by 25% vs baseline by 2050				X			
			Reduce SO_2 by 42% and black carbon by 21% by 2050 vs 2010					X		
			Reduce premature deaths due to air pollution by 50% by 2030	X						
	Nature	Climate change	Limit global average temperature change to 2°C [or 2.8°C] above pre-industrial levels with a likelihood of >50% (or 60%) by 2100	X	X	(X)	X	(X)		X
			Atmospheric GHG concentration stabilization below 450 ppm [or 350 ppmv] (or 550 ppmv) CO_2-equivalent by 2100		X				(X)	[X]
			Limit ocean acidification to keep aragonite stable, with pH=8.0 in 2150					X		
		Biodiversity	By 2020: Prevent extinction of known threatened species and improve situation of those in steepest decline; halve the rate of biodiversity loss; halve the rate of loss of natural habitats and reduce degradation and fragmentation by 2020; conserve at least 17% of terrestrial and inland water. By 2050: stabilize biodiversity at the 2020/2030 level		X					
			CBD Aichi protected area targets of 17% of terrestrial and inland water areas and 10% of coastal and marine areas by 2020				X			
		Phosphorus and nitrogen cycles	Phosphorus removal in wastewater treatment increases from 0.7 Mt in 2000 to 1.7 Mt in 2030, to 3.3 Mt in 2050				X			
			Reduce nitrogen and phosphorus use where possible, but without harming the ability of the agricultural system to meet the hunger target		X					

Sources: IIASA-GEA (Riahi et al., 2012)[170]; PBL (van Vuuren et al., 2012)[171]; SEI (Nilsson et al., 2012)[173]; OECD (2012)[174]; RITE-ALPS (Akimoto et al., 2012)[172]; FEEM (2011)[177]; GSG (Raskin et al., 2010)[176].

4.3. The most likely world in 2050? A prediction for the world in 2052

Jorgen Randers, one of the authors of the *Limits to Growth* report in 1972, presented a new report to the Club of Rome in 2012. In the book, entitled 2052, he reflects on his 40 years of "*worrying about the future*", based on which he prepared a "*forecast*" for 2052. Indeed, it is a forecast and not a scenario, as he believes that humanity will continue not to take the necessary actions to get on a desirable sustainable development path that could prevent overshoot. It is against this background that he predicts a future world in "*managed decline*".[186]

While the study considers a wide range of constraints, such as finite reserves of fossil fuels, finite availability of arable land, finite amounts of wild fish, and finite space for biodiversity reserves, it foresees the emerging climate crisis as the most pressing global constraint over the next 40 years. GHG emissions are already two times higher than what is absorbed by oceans and forests. The study notes that the world is already in "*overshoot*", heading towards the climate crisis. Rising atmospheric GHG concentrations and rising temperatures will worsen humanity's living conditions increasingly. Actions are not expected to be sufficient to limit global warming to below plus 2°C. However, there are signs that humanity will avoid "*collapse induced by nature*" and has rather embarked on a path of "*managed decline*".

The study predicts most variables to follow historical trends until around 2030, after which a number of "*variables start to stagnate and decline*". Temperatures and sea levels will continue rising, as will the share of renewable energy use.

While global CO_2 emissions might peak around 2030, they will fall back to 2010 levels by 2050, due to economic decline and continued incremental progress in emissions mitigation. While global CO_2 emissions will fall linearly from 2050 to zero in 2100, global temperature will continue increasing through the second half of the 21st century.

Global population might peak by 2040 and slowly decline thereafter. Global primary energy use is forecast to peak in the year 2042, staying almost flat between 2030 and 2050. Per capita energy use will decline gradually after 2035, due to energy efficiency investments.

Global consumption (i.e. the annual expenditure, private and public, on goods and services) will peak around 2050. Gross world product keeps growing until the second half of the 21st century, but at an ever decreasing rate. GDP per person continues increasing, as does annual production of goods and services. Investment shares in GDP will start rising, in view of needed investments to tackle depletion, pollution, climate change, and biodiversity loss. Production of consumer goods and services per person will peak around 2050 and decline thereafter.

Food production will peak around 2040 at a level 60% above today's current levels, in terms of tonnes of food per year. Climate change will start to reduce the amount of land suitable for agriculture and slow the rise in land yields, overwhelming the fertilizing effect of more CO_2 in the atmosphere. Per capita food availability will stagnate at 30% above today's level, which means that many people will still go hungry.

The ecological cost of growth will be seen in the continuing decline in the amount of unused biological capacity. By 2050, half of all land that had been unused by humans in 2010 will have been grabbed for human use, e.g. for buildings, infrastructure, forestry and agriculture.

The study's author characterized the future depicted in his forecast as one of collective failure being the most likely future outcome: "*I would not say the future I've just described is anyone's goal. It is not where I, nor the contributors to the book, or likely you as a reader, would want to go... we won't go there as a result of consciously bad intent. Rather, we will go there in a forty-year-long marathon during which global society will try to create a better life for everyone - mainly through continued economic growth. The effort will succeed in some places, but not everywhere. Billions will be better off in 2052 than in 2012, and some will reach Western lifestyles. The poorest two billion will be stuck near where they are today... There will be increasing inequity, tension, and social strife... the world of 2052 will not be an optimal starting point for the ensuing forty years.*" (Randers, 2012, p.229).[186]

4.4. Note on global scenarios at the science-policy interface

4.4.1. Scope and ambition

The sustainable development scenarios for Rio+20 illustrate what would be needed to achieve a better future for everyone. They were designed to inspire decision-making. Hence, they are important for a functioning science–policy interface.

The scenarios illustrate futures that most people would consider more desirable than trend scenarios. They describe a world that is more sustainable in important environmental and social dimensions and that promises a decent quality of life for everyone. Table 23 lists all the explicit sustainable development goals and targets used in the prominent sustainable development scenarios prepared for Rio+20. While these scenarios differ in various aspects, they are nevertheless fairly similar in spirit and content.

Yet the level of ambition of the sustainable development objectives used by scenarios is limited both in terms of their scope and their target levels. The resulting "sustainable development worlds" appear far from paradise visions for 2050. In fact, they are not free from contradictions, and confront decision-makers with a number of unresolved trade-offs. They highlight the enormity of the global sustainable development challenge, and indicate that - no matter what - at some point in the future we will be forced to make more drastic behavioural changes. It is the strength of these mainstream scenarios to highlight this important fact, based firmly on assumptions about the future that are considered plausible and reasonable today. Essentially, they show what could be achieved if we would overcome - at a global level - the major socioeconomic political and technological constraints.

The sustainable development goals and targets compiled in Table 23 are similar to major international development and sustainability goals that are either agreed or are under consideration. They are also grounded in (subsets of) existing mainstream scientific sets. However, for a number of reasons they leave out elements of wider sustainable development perspectives that typically include community or societal aspects, such as peace or social capital.

4.4.2. Trade-offs and synergies

All the sustainable development scenarios for Rio+20 include

unresolved trade-offs and untapped synergies. Many sustainable development scenarios are *unsustainable* in at least one or more respects. Further, none of the mainstream scenarios for Rio+20 explores a path towards sustainable development in 2050 that achieves the full set of sustainable development goals suggested by science. [187]

One key problem is the existence of important trade-offs across time, sectors and issues. For example, proposed solutions suggested by energy policymakers may be inconsistent or even contradictory with trade policy, macroeconomic goals, or ecological objectives. Even sustainable development goals agreed at the global level may turn out to be inconsistent when defined by sectoral or issue-focused experts and policymakers.[188]

The scenario studies for Rio+20 illustrate synergies and opportunities that could be reaped with integrated policy strategies geared to the simultaneous achievement of multiple sustainable development goals. Synergies are especially large for simultaneously addressing climate change mitigation, energy security and air pollution. However, in some countries CO_2 emission reduction measures can also lead to reduced energy security. Synergies are also large between ensuring food security and restoring agricultural ecosystems; between climate policy and R&D; and between education, R&D, environmental improvements and economic growth.

The scenario studies for Rio+20 also illustrate trade-offs between objectives that need to resolved. For example, all the mainstream sustainable development scenarios for Rio+20 see increases in biofuel production and deployment of modern renewables, and consequently lead to significantly increased water and land use, contributing to increased water stress for the majority of the world population, as well as unsustainable anthropogenic interference with phosphorous and nitrogen flows. These trade-offs are unresolved. Yet these scenarios were designed to be sustainable development scenarios. They satisfy the sustainable development goals chosen by modellers, yet would fail to achieve a wider range of scientifically accepted goals.

Among the sustainable development scenarios for Rio+20 considered here, the PBL scenarios go the furthest in trying to resolve trade-offs among the broadest range of sustainable development goals.[171] However, even in that case, some trade-offs remain unresolved. For example, in these scenarios climate mitigation and water-use efficiency will significantly reduce the demand for water, but the total number of people living in severely water-stressed river basins will only marginally decrease. Similarly, in all their Rio+20 scenarios, global nitrogen fertilizer use continues to increase by at least another 50 per cent until 2050. The same applies to phosphorus fertilizer use. *"Nitrogen and phosphorus fertilizer use will inevitably have to increase to sustain the increasing food production. The increase is particularly strong in developing countries."*[171] It should be noted that the planetary boundaries for nitrogen[189] and phosphorus[190] were already being exceeded in 2010. And there would still be more than 400,000 children dying from hunger, unsafe water and indoor air pollution from traditional energy use in the PBL's GlobT scenario by 2050.[171]

Most sectoral scenario studies (e.g. those on food, water, forests or development), as well as national integrated studies, are carried out in isolation from integrated, cross-sectoral global scenario studies.[191] Hence, while these national and sectoral studies show ways of overcoming some of the local and sectoral trade-offs, they all but disregard feedbacks and constraints across sectors or world regions. At the same time, it should be noted that the global integrated studies also underestimate binding constraints to overcoming trade-offs, since they aggregate over local constraints, basically assuming availability of resources over large geographic areas. In other words, it is highly likely that sustainable development scenarios in general tend to underestimate the challenge of what would need to be done to move humanity onto a truly sustainable development path. The lesson is a need for greater caution and humility regarding what can be done.

In summary, all sustainable development scenarios for Rio+20 illustrate important trade-offs and synergies, the magnitude of which varies greatly depending on assumptions. No sustainable development strategy was proposed and quantified in any of these scenarios that does not show unresolved trade-offs leading to unsustainability in several areas. There is a need for scenarios that follow a plausible, robust sustainable development strategy to achieve a truly comprehensive list of sustainable development goals.

4.4.3. Scenario agreement on overall policy conclusions and on specific solutions

Among the scenarios reviewed here, there is a high level of agreement on overall scenario conclusions, but little agreement on specific policy suggestions.

Despite a variety of modelling approaches and sustainable development goals, the sustainable development scenarios for Rio+20 agree to a high extent in terms of their overall conclusions:

- There are numerous, feasible pathways to sustainable development
- There is no agreement on "must have" lists, but scenarios show the benefits of: reining in overall material and energy use, increased end-use efficiency and reduced poverty
- Making progress in one dimension can lead to both synergies and trade-offs
- Complex trade-offs related to the global commons need to be tackled globally
- There is no single solution or policy for sustainable development. Bottom-up measures and policies need to be tailored to each issue, country and sector
- Politicians' sustainable development goals have become increasingly ambitious, while their attainment has become increasingly difficult
- Education, R&D and population goals are essential and have very large synergies with the development and environmental dimensions
- A broad pursuit of sustainable development is far superior in performance over pursuing single-issue objectives in isolation[192] (e.g. promote economic growth first and introduce cap-and-trade later).

Great differences remain in terms of specific policy recommendations that are drawn ex-post from the scenario results, reflecting the range of analysts' worldviews and organizations' interests. This is despite the fact that these scenario development teams showed large overlaps in terms of participation of prominent modellers and models. [193]

In view of the focus on technology solutions in most scenarios, it is important to note that prevailing solutions proposed by key decision-makers have fallen far short of the technically feasible factor of 4 (to 5) increase in global eco-efficiency as shown in the scenarios - an increase which would allow doubling of global wealth while halving resource and energy use.

4.4.4. Progress in global scenario modelling since the 1970s

Today's global models are generally much more user-friendly, can tap into better data, and be run on higher-performing computers than in the past. In particular, models have become geographically more disaggregated and draw on extensive technology and environmental data, including in spatial form. However, these additional details have come at a price in terms of models focusing increasingly on a single or just a few issues and objectives. Similarly, scenario time horizons have become shorter.

The primary concerns that global models address have moved from fundamental questions to specific, single issues. Most recently, global econometric models have re-emerged to quantify economic policies in the sustainable development context, especially for energy and climate change.

By some accounts, the single most important progress in global modelling has been in modelling of technology change. However, this focus has had the impact of conveying the message that technology is the single most important or even the only lever of change for achieving sustainable development. Some models have also explicitly included political variables.

Very large-scale collaborations have emerged with tens or even hundreds of collaborators in some global modelling projects. At the same time, the limited consensus among modellers is apparent. There is limited agreement on sustainable development scenarios development and especially on the nature and level of scientific-technical, political, social, economic and financial "limits".

The predictive performance of baseline scenarios has remained low. They have tended to be more pessimistic than actual trends that unfolded in reality. It should be noted that most baseline scenarios have not been designed as future projections, yet users have typically interpreted them as such. And the performance of those global scenarios that were explicitly designed as "predictions" or "most likely cases" have typically been low.

In the past 20 years, a donor-driven global scenario model "industry" has arisen with many players and disjoint communities. Extra-budgetary donors have had a strong influence on the topics addressed and the overall policy messages.

Expenditures have focused on model applications and adaptations for government and business clients. A decreasing share has been invested in basic research, model methodologies and the development of completely new models.

In short, progress has been made in key areas, but weaknesses and limitations have become apparent in some areas as well.

4.4.5. Lessons learned

There is no agreement on the role of science in policymaking. Hence, not everyone thinks scenario analysis is a useful activity. Yet scenario models reflect specific worldviews that have greatly shaped the views of decision-makers. Hence, policy recommendations made by analysts need to make special efforts to make underlying assumptions clear to decision-makers.

Scenarios have been powerful tools at the science–policy interface. But more often than not, model results are "cherry-picked" by decision-makers. Scenario analysts need to anticipate such cherry-picking and offer their recommendations with this in mind.

It is easier to agree on goals/targets than on policies, actions or indicators. There is no consensus on limits, but almost everyone agrees that technology is important.

To date, no scenario exists that would consider the full range of sustainable development goals suggested by science or by politics. And the broader the set, the more unresolved trade-offs and synergies remain. This is a serious challenge and will require significant resources to resolve.

For the past 40 years, global models have been looking for applications, rather than vice versa. The results are fragmented modeller communities focusing on applications. More resources are needed for model development tailored to broad, new problems.

There are obvious problems with an increasingly complex hierarchy of assessments, which is perceived as burdensome by some parts of government. In order to make scenario modelling relevant and sustainable at the same time, this problem must be acknowledged and many lower-level (project) assessments might be replaced by fewer higher-level, strategic assessments.

Results require a long lead time. This is especially true in the case of policy impacts of scenario work. Hence, scenario analysts need to be patient and focus on the long term.

4.5. Investment and technology needs and market potentials

Each of the sustainable development scenarios for Rio+20 that has been the basis of the description of a feasible sustainable development world in 2050 provides information on financing and technology needs to achieve the chosen goals. However, since the scope of these scenarios and the model assumptions vary significantly, their results also range widely. In view of the trade-offs and synergies discussed above, it is not possible simply to add up the various costs of achieving each one of the goals.

Therefore, assessing financing and technology needs for sustainable development continues to present considerable conceptual and practical challenges. In order to quantify "needs", normative goals and targets have to be agreed upon. Different goals and targets give rise to different needs. Costs and investment requirements can be defined only with respect to a counterfactual situation or baseline. A clear understanding of the baseline is essential to interpret the needs estimates. Different sustainability goals are associated with different time frames, and this has implications in terms of sequencing of investment and financing needs.

The transition to sustainable development involves concerted action in a range of sectors. There are many interdependencies, synergies and trade-offs across sectors, which affects investment requirements and financing needs. There may be co-benefits or cross-sector impacts. Thus, estimates of investment requirements or "needs" are best derived from integrated models with a clear set of global goals.

For sustainability purposes, the quality of investment (i.e. in what technologies and services investments are made in, for example, for energy infrastructure or agriculture) is as important as the amounts of investment. Yet the extent to which the qualitative dimension is captured by existing models and studies is highly variable.

Within each of the clusters or sectors examined globally, the range of published estimates is wide, reflecting differences in data, scope, methodologies, baselines and other factors - including sheer uncertainty.

The most comprehensive assessments indicate trade-offs and synergies among areas and clusters. However, there is no agreement among models on the implications of those trade-offs and synergies for investment requirements and financing needs.

Taking into account the above-mentioned caveats, analyses of investment requirements and financing needs for sustainable development in the coming decades conclude that financial needs are significant, of the order of the several trillions of US dollars per year.[194]

Quantitative estimates of investment needs for the thematic areas and cross-sectoral issues identified in section III of the Rio+20 outcome document were reviewed by UN DESA in the context of the work of the Intergovernmental Committee of Experts on Sustainable Development Financing.[195, 196]

Investment requirements for the energy transition respecting agreed climate targets are large, of the order of trillions of US dollars per year. Overall, the order of magnitude of the investment requirements for climate-compatible and sustainable development scenarios (which include goals and targets related to climate) are also of the order of several trillion dollars per year.

Investment requirements for MDGs and other related goals (e.g. universal access to electricity) are one order of magnitude lower than those related to climate change mitigation. The opportunity cost of achieving those goals would seem to be low, regardless of what other goals are adopted. The order of magnitude of estimated investment requirements for the management of global commons (biodiversity, oceans, forests) is several tens to hundreds of billion dollars per year.

Figure 15 presents orders of magnitude estimates for investment requirements in various sectors, obtained from the literature. This includes:

- *Energy:* US$30-80 billion per year for universal access to modern energy services; US$250-400 billion per year for energy efficiency; and US$200-700 billion per year for renewable energy depending on assumptions for energy demand and ambitions for emissions mitigation
- *Climate change:* US$300-1,200 billion per year for climate change mitigation and US$50-400 billion per year for climate change adaptation, with estimates depending on the level of ambition
- *Sustainable transport:* US$2.5-$3 trillion per year to 2050
- *Biodiversity:* US$154-436 billion per year for achieving the 20 Aichi Targets.

The identified ranges of estimates of total investment needs in developing countries are as follows:

- *Poverty eradication:* US$20-200 billion per year to achieve the MDGs
- *Food security:* US$50-83 billion (without capital replacement) per year to increase agricultural yields and feed everyone without expansion of agricultural land
- *Water and sanitation:* US$18-80 billion per year depending on ambition (e.g. MDG 7 versus universal coverage) and geographic scope
- *Forests:* US$40-160 billion per year
- *Oceans:* US$30-40 billion per year
- *Infrastructure investment in developing countries:* need to more than double from a current level of US$0.8-0.9 trillion per year
- *Education:* US$9-26 billion per year for achieving 'education for all' in developing countries by 2015
- *LDCs:* Financing gap estimated at US$50-75 billion per year
- *Africa (infrastructure only):* Financing gaps of US$31 billion per year for infrastructure (mainly power), US$25 billion a year for universal access to modern energy services by 2030, and US$18 billion per year for climate change adaptation.

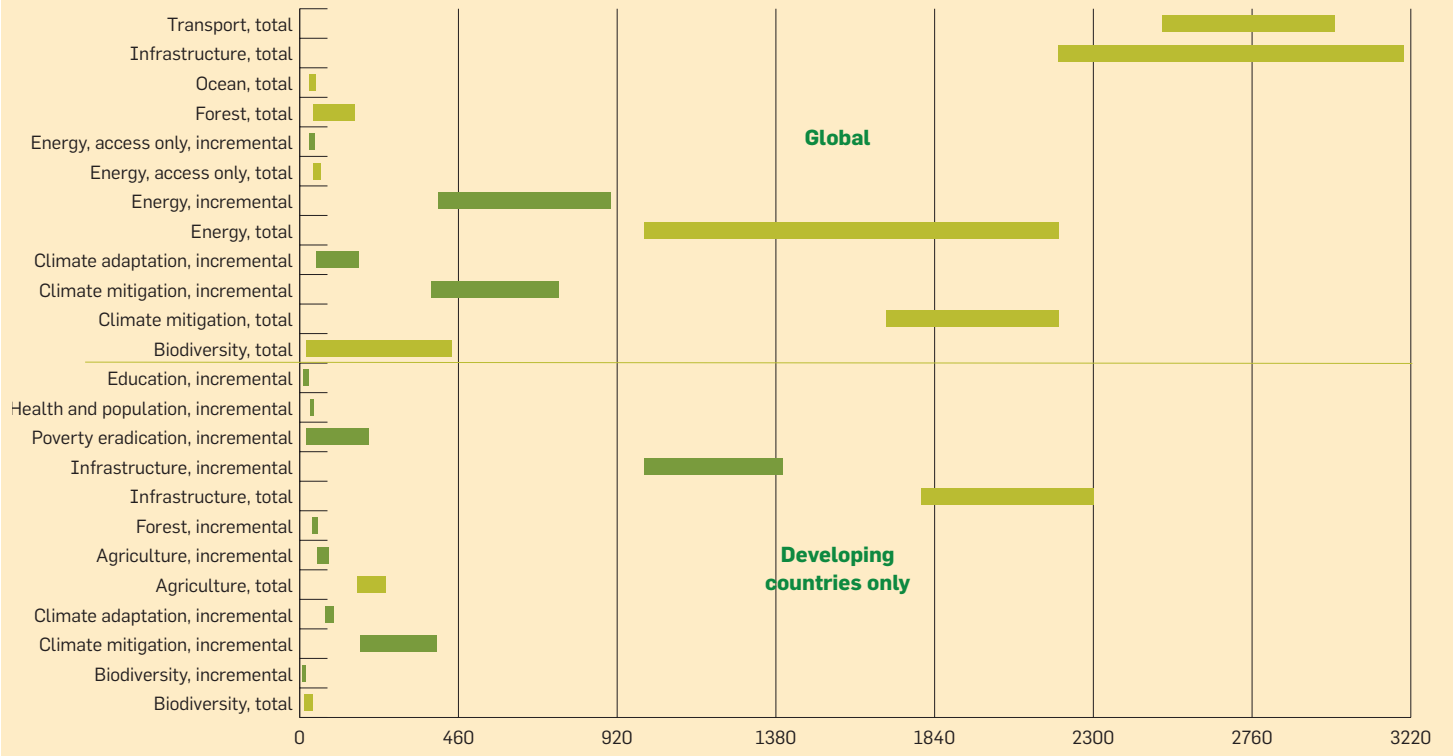
Table 49 in Annex 4 provides a range of selected sources of estimates of total, global investment needs.

It is worth restating that it does not make sense to add up the estimates of investment needs presented in Figure 15, since action in one area would have important and non-trivial synergies and trade-offs in the other areas. Also, the investment needs are total investment needs - both public and private. They are *not* estimates of public investment needs alone.

In a number of sectors or areas, reliable estimates of investment needs for the future do not exist. Focusing on the 27 thematic areas and cross-sectoral issues identified in section III of the Rio+20 outcome document, global estimates could not be identified for the areas of sustainable tourism; sustainable cities and human settlements; promoting full and productive employment, decent work for all and social protection; SIDS; LLDCs; regional efforts; disaster risk reduction; desertification, land degradation and drought; mountains; chemicals and waste; sustainable consumption and production; and mining.

Existing reviews highlight the heterogeneity of financing models across sectors and areas relevant to sustainable development. The main actors and sources of finance are different, and so are the main financial instruments and channels used. For example, in low and lower-middle income countries, households are the primary source of expenditure on health, overwhelmingly from out-of-pocket expenditures. This contrasts with sectors like infrastructure and renewable energy, where the majority of financing flows to large projects financed by corporations and Governments. The importance of international public finance varies considerably across sectors. In terms of financing channels, there are obvious differences among sectors regarding the role of banks and other financial institutions, capital markets, and development banks (from national to regional to international). In sum, the heterogeneity of financial models and circuits both across and within sectors is a constitutive feature of development finance, and this has important implications for policy-making.

Figure 15: Orders of magnitude of investment requirements from various sectors from the literature (US$ billion)



Note: Dark green bars represent incremental needs and green light bars represent total needs. Source: UN DESA (2013)[194]

In order to improve the delivery of financing to support sustainable development objectives, knowledge of how financing works in different sectors, as well as knowledge of obstacles and bottlenecks, will be an important prerequisite. Comprehensive reviews of financing sources, channels and instruments exist for sectors such as infrastructure, energy, climate change mitigation, and many others. Some of these reviews are undertaken by international organizations such as United Nations conventions or by international financing institutions. However, for many other sectors, no such reviews seem to exist.

In the future, it will be important to develop such reviews at the sector level, to complement existing reviews of financing flows at the macroeconomic level. Ideally, the goal should be to produce mappings of financial flows distinguishing among different sources and final uses, with channels and instruments in the middle. At the minimum, sector reviews should aim to address the following questions: What are the sources of financing flows in the sector? How are the flows being used within each sector? What are the channels and instruments used? What are the synergies and complementarities among flows? What are the future challenges?[197]

Future editions of the Global Sustainable Development Report could synthesize such sector assessments, in line with the mandate of the HLPF to review the status of existing commitments.

In terms of what developing countries need in the area of clean and environmentally sound technology facilitation, it was found out that (a) technology needs have not been mapped systematically, and that (b) views vary significantly as to whether the international programmes and mechanisms to assist in terms of capacity-building or otherwise correspond to the existing needs (see Secretary-General's Report A/68/310, 2013).[198]

Data are limited and fragmented for assessing the magnitude and nature of the technology gap that developing countries are facing. This is particularly the case for smaller developing economies and the LDCs. Indeed, "most empirical evidence focuses on emerging economies. There is a need for more comprehensive information about the needs of technology recipients in developing countries."

There is also a need to survey technology requirements at the country level. It is generally accepted that both technology needs and capabilities differ among developing countries. Certain technologies may be better suited for some countries than for others, given resource endowments, existing technological capabilities and other factors.