An Overview of the IPBES Global Assessment on Biodiversity and Ecosystem Services: Highlighted Findings and Contributions

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I would like to thank the House Committee on Science, Space and Technology for the opportunity to provide a testimony based on the *global assessment report on biodiversity and ecosystem services* of the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES). I would like to note that all chapters and the SPM are now available on the IPBES web site. This testimony complements that provided by Dr Kate Brauman.

A. A brief overview of the global assessment process:

The global assessment is the first intergovernmental assessment to critically assesses the state of knowledge on past, present and possible future trends of nature and its contributions to people (which embody biodiversity and ecosystem functions and services[1]), the drivers of such changes, their projections and scenarios into the future, and possible pathways and options to meet internationally-agreed goals. Five overarching questions define the scope of the assessment[2]. The geographic coverage includes land, inland waters, coastal zones and oceans, analyzed as appropriate at the level of biomes, ecosystems, species, varieties and breeds. Eighteen categories of nature's contributions and ecosystem services are analyzed. The timeframe examined in the assessment includes going back as far as 50 years, so that current status and trends up to 2020 can be seen in context. Scenarios and plausible future projections are examined with a focus on various periods between 2020 and 2050, for which possible pathways to and options for sustainability across sectors are analyzed. Furthermore, the global assessment provides a framework for analyzing interdependencies between the internationally agreed 2030 Sustainable Development Goals, the 2050 Vision for Biodiversity, the Paris Agreement on Climate Change, and several Environmental Conventions. The assessment was timed to be a major input to the Convention on Biological Diversity's fifth edition of the Global Biodiversity Outlook and its second edition of the Local Biodiversity Outlook, informing the process leading up to the new post-2020 biodiversity framework.

Following this overarching structure, the global assessment was undertaken during a period of three years, based on the voluntary work of 3 co-chairs, 142 nominated experts coordinating and lead authors (CLAs and LAs)[3], review editors, fellows and 310 contributing authors (CAs), a dedicated technical supporting unit, 6 supporting scientists, 1 resource person and a management committee. The final report is the result of multiple levels of co-production involving multidisciplinary collaboration, consideration of different knowledge systems, multiple rounds of open reviews (15,000 comments were received during two rounds of expert and government review), revisions and responses, meetings and consultations with representatives of governments and of Indigenous peoples and local communities, as well as an online call for contributions. The majority of the sections of the report is based on systematic literature review (with a final selection of around 15,000 references), complemented by expert knowledge reviews, and a wide array of data, indicators, reports, and geospatial datasets, compiled, as available and appropriate, from local to global levels[4]. The global assessment is also the first global level assessment to implement a concerted effort to

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[1] The Global Assessment Scoping Report (section III of its decision IPBES-4/1, 2016):

[2] What is the status of and trends in nature, nature's contributions to people and indirect and direct drivers of change? How do nature and its contributions to people influence the implementation of the Sustainable Development Goals? What is the evidence base that can be used for assessing progress towards the achievement of the Aichi Biodiversity Targets? What are the plausible futures for nature, nature's contributions to people and their impacts on quality of life between now and 2050? What pathways and policy intervention scenarios relating to nature, nature's contributions to people and their impacts on quality of life can lead to sustainable futures? What are the opportunities and challenges, as well as options available to decision makers, at all levels relating to nature, its contributions to people and their impacts on quality of life?

[3] Nominated authors from 51 countries.

[4] It's important to note that, as other assessments, the global assessment has not undertaken new primary research, but analyzed, synthetized and critically evaluated available data, information, and evidence previously published or otherwise made available in the public domain in a traceable way.

include a diversity of worldviews and knowledge systems including systematic analyses of evidence on Indigenous and local knowledge and issues.

B. Summary of Key Findings:

The global assessment showed that societal impacts on land, freshwater, and oceans have accelerated significantly during the past 50 years, a rate unprecedented in human history, aggregating to global level changes in the biosphere and atmosphere, which are increasingly interacting and having compounding and cascading effects on biodiversity, ecosystems, and society, at all levels. On the aggregate, 75% of the land surface is significantly altered, 66% of the ocean area is experiencing increasing cumulative impacts, and over 85% of wetlands (area) have been converted. Both the contributions to and the consequences of these changes are distributed unevenly and unequally across regions and society. No matter where people live, the report shows that nature plays a critical role in providing food and feed, water, energy, medicines and genetic resources and a wide array of materials fundamental for people's physical well-being and for maintaining culture. A significant array of contributions, particularly the (largely invisible to society) regulating contributions provided by ecosystems (e.g., regulating climate, pollution, water quality, pollination, floods and storm surges) and non-material contributions e.g., (learning and inspiration, physical and psychological) are currently declining and/or projected to decline, with unequal consequences for different sectors of society.

The direct drivers of change in nature with the largest global impact have been (starting with those with most impact): changes in land and sea use; direct exploitation of organisms; climate change; pollution; and invasion of alien species. Those five direct drivers result from an array of underlying causes – the indirect drivers of change – which are in turn underpinned by societal values and behaviours that include production and consumption patterns, human population dynamics and trends, trade, technological innovations and local through global governance.

The assessment shows that societal responses, including successes, are also evident from local to global levels, and that more sustainable pathways forward are possible. While progress has been made on many fronts, the great majority of indicators of ecosystems and biodiversity, and their benefits to society continue to show decline, marked by clear regional differences. These trends are projected to continue or worsen in many future scenarios. Current trends will undermine most of the internationally agreed 2020 Aichi Biodiversity Targets and 2050 Vision for Biodiversity, the 2030 Sustainable Development Goals, the Paris Agreement on Climate Change, and several Environmental Conventions. On the other hand, more positive outcomes emerge from scenarios that account for transformative change and cross-sectoral approaches aligning production, consumption, and conservation of food, feed, fiber, energy, and water, as well as nature-friendly solutions to urban issues and to climate adaptation and mitigation.

Societal goals can be achieved in sustainable pathways through the rapid and improved deployment of existing policy instruments and new initiatives that more effectively enlist individual and collective action for transformative change. By its very nature, transformative change can expect opposition from those with interests vested in the status quo. If obstacles are overcome, commitment to mutually supportive international goals and targets, supporting actions by indigenous peoples and local communities at the local level, new frameworks for private sector investment and innovation, inclusive and adaptive governance approaches and arrangements, multi-sectoral planning and strategic policy mixes can help to transform the public and private sectors to achieve sustainability at the local, national and global levels.

The assessment clearly demonstrates that the loss of biodiversity is not only an environmental issue, but an economic, development, social, security, moral and ethical issue. Biodiversity has significant economic value, which should be recognized in national accounting systems; is central to development, through food, water and energy security; is a security issue in so-far-as loss of natural resources, especially in poor developing countries can lead to conflict; is an ethical issue because loss of biodiversity hurts the poorest of people who depend on it, further exacerbating an already inequitable world; and is a moral issue because we should not destroy it.

C. Some highlighted findings and their implications:

Since 1970, trends in agricultural production, fish harvest, bioenergy production and harvest of materials have increased substantially, along with the doubling of the world's population, a 4-fold increase in the global economy, and 10-fold increase in trade. Today, humans extract more from the Earth and produce more waste than ever before but do so unequally. Furthermore, the accelerated increase in demand for natural resources has been associated with the spatial decoupling of production from consumption, which has contributed to shifting the economic and environmental gains and losses of production and consumption to different regions, contributing to new economic opportunities, but also unequal impacts on biodiversity, ecosystems, and people. While environmental conditions have improved in some parts of the world, particularly among more developed countries, it has declined in other regions where exploitation of natural resources, commodity expansion, and industrial production have intensified. However, countries at different levels of development have experienced different levels of deterioration of nature for any given gain in economic growth.

C1. The continuing expansion of human activities is significantly altering the fabric of life of the planet:

-Global indicators of ecosystem extent and condition have shown a decrease by an average of 47 per cent of their estimated natural baselines, with many continuing to decline by at least 4 per cent per decade; terrestrial hotspots of endemic species are undergoing faster changes. Only around 25% of land is sufficiently unimpacted that ecological and evolutionary processes still operate with minimal human intervention, and global forest area is now approximately 68 per cent of the estimated pre-industrial level. While decline of forest has slowed down globally, it is still marked in the tropics. Particularly sensitive ecosystems include old-growth forests, insular ecosystems, and wetlands.

-The largest driver of biodiversity loss in terrestrial systems in the last several decades has been land use change and use, primarily the conversion of native habitats into the agricultural systems that have been needed to feed the world (Figure 1 shows the 5 direct drivers of the loss of biodiversity). The challenge is to transform our agricultural practices, many of which are unsustainable today, into ones that produce the food we need while protecting and conserving biodiversity, and in particular protecting the quantity and quality of our water resources. This means not expanding into pristine natural habitats, but using sustainable agroecological practices, less chemicals, and protecting our soils and pollinators. Too often fertilizers, pesticides and other chemicals run-off into our rivers, polluting them and many coastal regions around the world – a key issue for the quantity and quality of our water resources.

-While climate change has not been the dominant driver of the loss of biodiversity to date in most parts of the world, it is projected to become as important or more important than the other drivers in the coming decades. Since 1980, greenhouse gas emissions have doubled, raising average global temperatures by at least 0.7 degrees Celsius, changing precipitation patterns and increasing extreme weather events. Climate change is already adversely affecting genetic variability, species richness and populations, and ecosystems and it imposes a growing risk. Shifts in species distribution, changes in phenology, altered population dynamics and changes in the composition of species assemblage, or the structure and function of ecosystems, are evident and accelerating in marine, terrestrial and freshwater systems. Almost half (47 per cent) of threatened terrestrial mammals, excluding bats, and one quarter (23 per cent) of threatened birds may have already been negatively affected by climate change in at least part of their distribution (birds in North America and Europe suggest effects of climate change in their population trends since the 1980s). Ecosystems such as tundra and taiga and regions such as Greenland, previously little affected by people directly, are increasingly experiencing impacts of climate change. Large reductions and local extinctions of populations are widespread. This indicates that many species are unable to cope locally with the rapid pace of climate change, through either evolutionary or behavioral processes, and that their continued existence will also depend on the extent to which they are able to disperse, to track suitable climatic conditions, and to preserve their capacity to evolve. Climate change shifts the boundaries of terrestrial biomes, in particular in boreal, subpolar and polar regions and semi-arid environments, and a warmer, drier climate will reduce productivity in many places. In contrast, rising atmospheric carbon dioxide concentrations can be beneficial for net primary productivity and enhance woody vegetation cover, especially in semi-arid regions. In turn loss of biodiversity can adversely affect climate, e.g., deforestation increases the atmospheric abundance of carbon dioxide, a key greenhouse gas.

-Therefore, it is essential that the issues of biodiversity loss and climate change are addressed together. This can be accomplished by transforming the way energy is produced and used. Fossil fuel energy can be replaced with cost-effective renewable energy sources, e.g., wind and solar power. There is also a need to improve the efficiency with which energy is used in transportation, buildings and industry. There are many nature-based approaches, e.g., large-scale reforestation and ecosystem restoration, that can be used to adapt to, or mitigate human-induced climate change. However, it is important to recognize that some of the suggested approaches to limit human-induced climate change, such as large-scale afforestation and bioenergy, will adversely affect biodiversity and food and water security, especially if native vegetation is replaced by monoculture bioenergy crops.

-Estimates that synthesizes trends in vertebrate populations, such as the Living Planet Index, show that such trends have declined rapidly since 1970, falling by 40% for terrestrial species, 84% for freshwater species and 35% for marine species.

-Currently, land degradation has reduced productivity in 23 per cent of the global terrestrial area, and between $235 billion and $577 billion (US dollars in 2015) in annual global crop output is at risk as a result of pollinator loss. The loss of coastal habitats and coral reefs reduces coastal protection, which increases the risk from floods and hurricanes to and property for the 100 million–300 million people living within coastal 100-year flood zones.

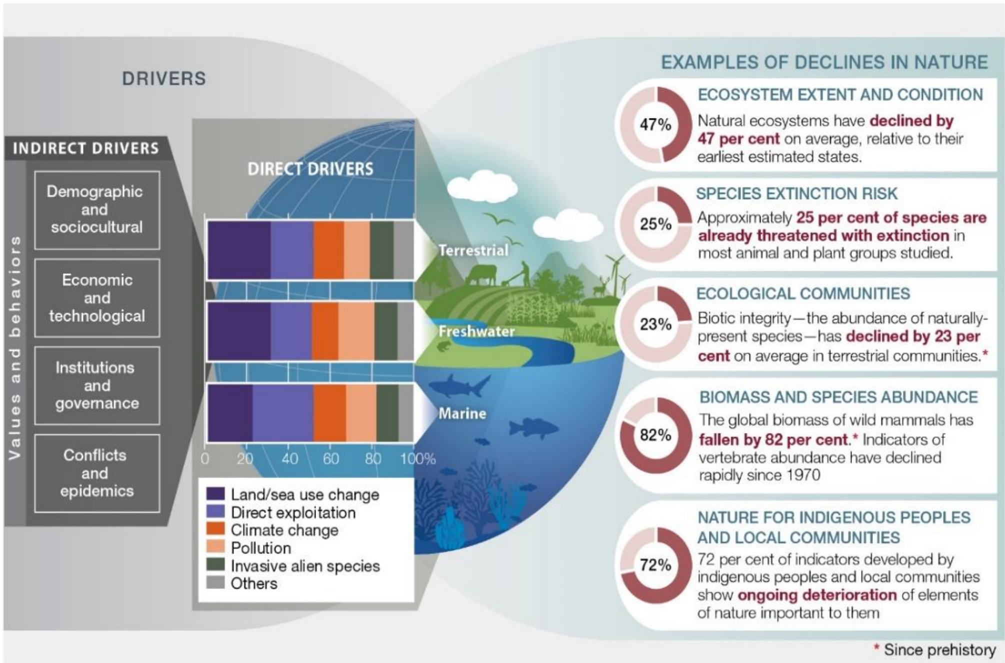

Figure 1: Drivers of the Loss of Biodiversity

-Inland waters and freshwater ecosystems show among the highest rates of decline. Only 13% of the wetland present in 1700 remained by 2000; recent losses have been even more rapid (0.8% per year from 1970 to 2008). Some regions are progressively reverting such decline through protection and restoration.

-Marine biodiversity is declining at unprecedented rates, with fishing exploitation having the largest negative impact in the past 50 years, while the impacts of climate change are accelerating. Over 40% of ocean area was strongly affected by multiple drivers in 2008, and 66% was experiencing increasing cumulative impacts in 2014. Only 3% of the ocean was described as free from human pressure in 2014. Seagrass meadows decreased in extent by over 10 per cent per decade from 1970-2000. Live coral cover on reefs has nearly halved in the past 150 years, the decline dramatically accelerating over the past 2-3 decades due to increased water temperature and ocean acidification interacting with and further exacerbating other drivers of loss. Severe impacts to ocean ecosystems are illustrated by estimation of 33% of fish stocks being classified as overexploited and greater than 55% of ocean area being subject to industrial fishing.

-Over 80 per cent of global wastewater is being discharged back into the environment without treatment, while 300–400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped into the world's waters each year. Excessive or inappropriate application of fertilizer can lead to run off from fields and enter freshwater and coastal ecosystems, producing more than 400 hypoxic zones which affect a total area of more than 245,000 km^2 as early as 2008. Since 1980, plastic pollution in oceans has increased tenfold.

-Assessed evidence indicates that at least a quarter of the global land area is traditionally owned, managed, used or occupied by indigenous peoples alone, not accounting for a diverse array of local communities. A diverse array of local communities, including farmers, fishers, herders, hunters, ranchers and forest-users, manage significant areas under various property and access regimes. Indigenous areas in particular include approximately 35 per cent of the area that is formally protected, and approximately 35 per cent of all remaining terrestrial areas with very low human intervention. Nature is generally declining less rapidly in indigenous peoples' land than in other lands, but is nevertheless declining, as is the knowledge of how to manage it. The areas managed by indigenous peoples and local communities are under increasing pressure. For the first time, authors of the global assessment collected and synthetized over 470 local social-ecological indicators used to assess the status and trends of ecosystems and biodiversity. The analysis shows that among the local indicators developed and used by indigenous peoples and local communities, 72% show signs of decline, in many cases directly affecting local livelihoods and well-being.

-Several other analyses of status and trends in drivers of change and their impact on biodiversity and ecosystems are presented in the chapters of the report and the SPM.

C2. These changes, among others, are contributing to accelerated increase in species threatened with extinction, as well as undermining the achievements of both internationally-agreed biodiversity and sustainable development goals.

- Two distinct lines of evidence, the IUCN Red List criteria and model estimations based on analysis of habitat loss/deterioration and species assessments, point to similar levels of threat to biodiversity. An average of around 25% of species in assessed animal and plant groups and 10% of insect species (greater uncertainty) are threatened, suggesting that up to 1 million species already face extinction, some within decades, unless action is taken to reduce the intensity of drivers of biodiversity loss. These include around 500,000 species (of ~2.5 million) of animal and plant species that are not insects, and around 500,000 species (of ~5.5 million) of insect species, the latter is a more tentative estimate. Figure 2A shows global extinction risk in different species groups; figure 2B shows extinctions since 1500; and figure 2C shows declines in species survival since 1980.

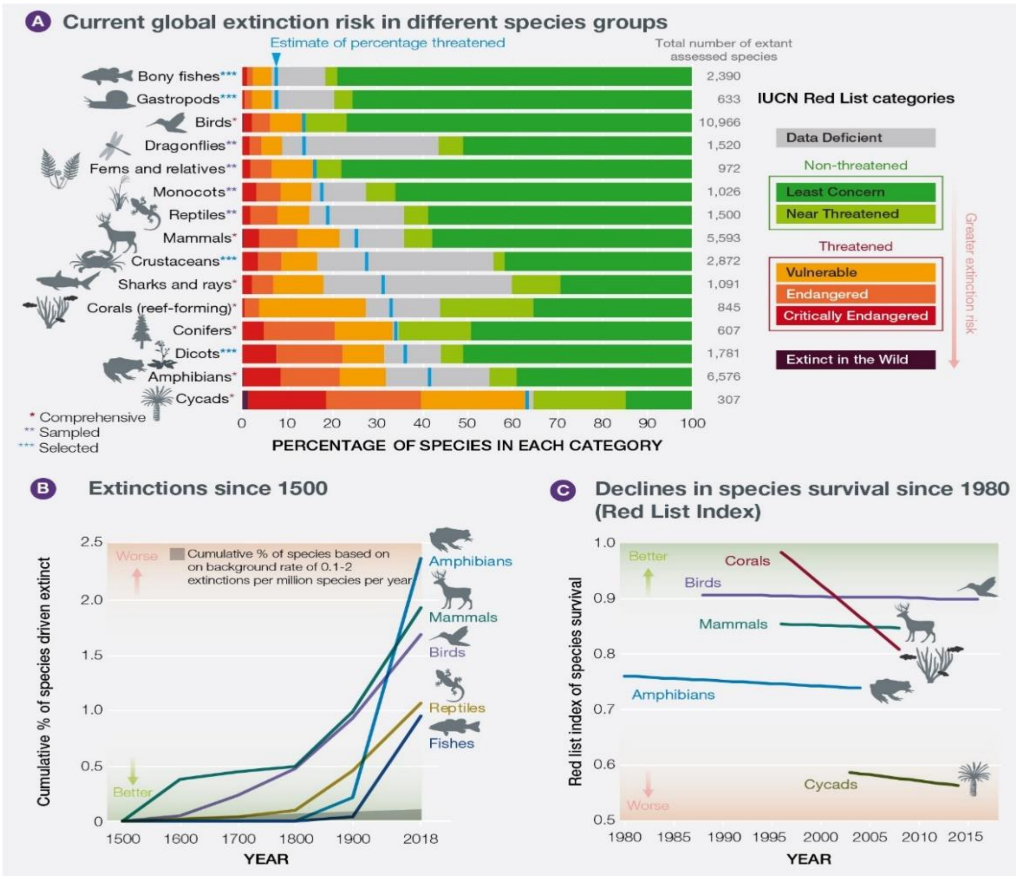

Figure 2. A substantial proportion of assessed species are threatened with extinction and overall trends are deteriorating, with extinction rates increasing sharply in the past century.

-It is important to highlight that, based on evidence, the report does not argue for or use the term 'mass extinction' to describe the current level of threat to biodiversity loss. The accepted definition of 'mass extinction' [used to describe the previous 5 extinction events] is the loss of 75% or more of all species. In the last several hundred years we have lost perhaps 1%-2% of species. Even if we lost all one million threatened species we would not be close to the threshold for calling it a mass extinction. Independent of the category used, the scientific evidence is clear about the scale and accelerated rate of extinction threats, which include for instance 40% of amphibians, 33% of reef-forming corals, and more than a third of all marine mammals.

-Worrying trends are also evident for local varieties and breeds of domesticated plants and animals. By 2016, 559 of the 6,190 domesticated breeds of mammals used for food and agriculture (over 9 per cent) had become extinct and at least 1,000 more are threatened. This loss of diversity, including genetic diversity, can pose serious future risks to local and global food security by undermining the resilience of many agricultural systems to threats such as pests, pathogens and climate change.

-The assessment also shows that globally 14 of the 18 categories of contributions of nature and ecosystem services that were assessed have declined, mostly regulating and non-material contributions[5] (Figure 3). Most contributions we derive from nature are not fully replaceable, while others are irreplaceable. Furthermore, the adverse impacts of climate change on biodiversity are

[5] Data supporting global trends and regional variations come from a systematic review of over 2,000 studies. Indicators were selected based on availability of global data, prior use in assessments and alignment with 18 categories.

projected to increase with increasing warming, creating further pressures on many contributions and ecosystem services of direct implication to human wellbeing.

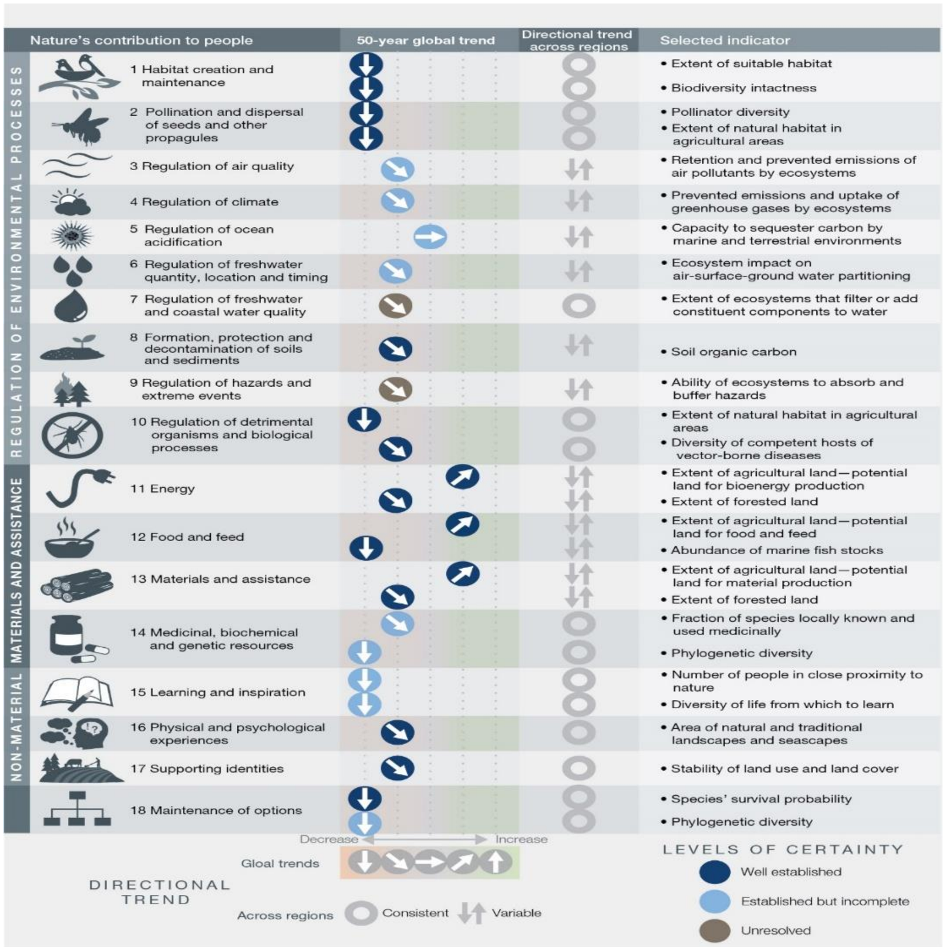

Figure 3: Trends in Nature's Contributions to People

-These trends have affected progress towards internationally-agreed biodiversity targets. In particular, overall progress towards the Aichi Biodiversity Targets has been mixed. We have made good progress towards elements of just 4 of the 20 Aichi Targets. The strongest progress has been towards identifying/prioritizing invasive alien species (Target 9), increasing protected area coverage (Target 11), bringing the Nagoya Protocol on Access and Benefit Sharing into force, i.e., increasing the number of ratifying countries (Target 16), and developing national biodiversity strategy and action plans (Target 17). However, while protected areas now cover 14.9% of terrestrial and freshwater environments and 7.44% of the marine realm, they only partly cover areas of particular importance for biodiversity, and are not yet fully ecologically representative, well-connected, and effectively and equitably managed. While some species have been brought back from the brink of extinction (contributing towards Target 12 on preventing extinctions), species are moving towards extinction at an increasing rate overall for all taxonomic groups with quantified trends. Least progress has been made towards Target 10 (addressing drivers impacting coral reefs and other ecosystems vulnerable to climate change).

-There are also other areas of progress in the Aichi Biodiversity Targets. Although diversely across countries, there has been increasing awareness of biodiversity across sectors of society (Target 1). Advances in managing and sustainably harvesting aquatic living resources (Target 6) has also been noticeable, such as expanding certification programs, integrated coastal management, co-management, preventive management, marine conservation, among others. Advances are also noticeable in relation to managing agriculture, aquaculture and forestry sustainably (Target 7).

Land under conservation-oriented, organic agriculture is increasing along with landscape level planning for multi-functional landscapes. Forest certification, reduced impact logging, controlling illegal logging, real-time deforestation monitoring, incentives to local agriculture markets, payment for ecosystem services, and reduction in harmful subsidies are contributing to positive trends in some regions.

Goal	Target	Target element (abbreviated)		Poor	Moderate	Good
A. Address the underlying drivers	1	1.1	Awareness of biodiversity		●	
		1.2	Awareness of steps to conserve		●	
	2	2.1	Biodiversity integrated into planning		●	
		2.2	Biodiversity integrated into accounting		●	
		2.3	Biodiversity integrated into reporting	●		
	3	3.1	Harmful subsidies eliminated and reformed	●		
		3.2	Positive incentives developed and implemented	●		
	4	4.1	Sustainable production and consumption	●		
		4.2	Use within safe ecological limits	●		
B. Reduce direct pressures	5	5.1	Habitat loss at least halved	●		
		5.2	Degradation and fragmentation reduced	●		
	6	6.1	Fish stocks harvested sustainably	●		
		6.2	Recovery plans for depleted species		Unknown	
		6.3	Fisheries have no adverse impact	●		
	7	7.1	Agriculture is sustainable	●		
		7.2	Aquaculture is sustainable	●		
		7.3	Forestry is sustainable		●	
	8	8.1	Pollution not detrimental	●		
		8.2	Excess nutrients not detrimental	●		
	9	9.1	Invasive alien species prioritized			●
		9.2	Invasive alien pathways prioritized		Unknown	
		9.3	Invasive species controlled or eradicated	●		
		9.4	Invasive introduction pathways managed	●		
	10	10.1	Pressures on coral reefs minimized	●		
		10.2	Pressures on vulnerable ecosystems minimized	●		
C. Improve biodiversity status	11	11.1	10 per cent of marine areas conserved			●
		11.2	17 per cent of terrestrial areas conserved			●
		11.3	Areas of importance conserved		●	
		11.4	Protected areas, ecologically representative		●	
		11.5	Protected areas, effectively and equitably managed		●	
		11.6	Protected areas, well-connected and integrated		●	
	12	12.1	Extinctions prevented	●		
		12.2	Conservation status of threatened species improved	●		
	13	13.1	Genetic diversity of cultivated plants maintained		●	
		13.2	Genetic diversity of farmed animals maintained		●	
		13.3	Genetic diversity of wild relatives maintained		●	
		13.4	Genetic diversity of valuable species maintained		Unknown	
		13.5	Genetic erosion minimized		●	
D. Enhance benefits to all	14	14.1	Ecosystems providing services restored and safeguarded	●		
		14.2	Taking account of women, IPLCs, and other groups		Unknown	
	15	15.1	Ecosystem resilience enhanced		Unknown	
		15.2	15 per cent of degraded ecosystems restored		Unknown	
	16	16.1	Nagoya Protocol in force			●
		16.2	Nagoya Protocol operational		●	
E. Enhance implementation	17	17.1	NBSAPs developed and updated			●
		17.2	NBSAPs adopted as policy instruments		●	
		17.3	NBSAPs implemented		●	
	18	18.1	ILK and customary use respected		●	
		18.2	ILK and customary use integrated		Unknown	
		18.3	IPLCs participate effectively		Unknown	
	19	19.1	Biodiversity science improved and shared		●	
		19.2	Biodiversity science applied		Unknown	
	20	20.1	Financial resources for Strategic Plan[a] increased		●	

Figure 4: Summary of progress towards the Aichi Targets.

-Emerging evidence suggests that for Target 12, the extinction risk trends shown by the Red List Index for birds and mammals would have been worse in the absence of conservation, with at least six ungulate species. For Target 9, at least 107 highly threatened birds, mammals, and reptiles are estimated to have benefited from invasive mammal eradications on islands. One model estimate suggests that conservation investment during 1996-2008 reduced biodiversity loss (measured in terms of changes in extinction risk for mammals and bird) in 109 countries by 29% per country on average. These are encouraging signs.

-On the aggregate, however, more progress has been made in adopting and/or implementing policy responses and actions to conserve and use nature more sustainably (22 of 34 indicators show significant increases) than has been achieved in addressing the drivers of biodiversity loss (9 of 13 indicators show significantly worsening trends). As a result, the state of nature overall continues to decline (12 of 16 indicators show significantly worsening trends).

-The analyses carried out in the assessment made it clear that biodiversity, ecosystem functions and services directly underpin the achievement of several of the 2030 Sustainable Development Goals. Evidence (Figure 5) suggests that current negative trends in biodiversity and ecosystems will undermine progress towards 80 per cent (35 out of 44) of the assessed targets of goals related to poverty, hunger, health, water, cities, climate, oceans and land (Sustainable Development Goals 1, 2, 3, 6, 11, 13, 14, and 15). Important positive synergies between nature and goals on education, gender equality, reducing inequalities and promoting peace and justice (Sustainable Development Goals 4, 5, 10 and 16) were found. Land or resource tenure insecurity, as well as declines in nature, have greater impacts on women and girls, who are most often negatively impacted. Some pathways chosen to achieve the goals related to energy, economic growth, industry and infrastructure and sustainable consumption and production (Sustainable Development Goals 7, 8, 9 and 12), as well as targets related to poverty, food security and cities (Sustainable Development Goals 1, 2 and 11), could have substantial positive or negative impacts on nature and therefore on the achievement of other Sustainable Development Goals.

C3. Further evidence from the synthesis of future scenarios indicate that the negative trends in biodiversity and ecosystem functions are projected to continue or worsen to 2050 and beyond in response to indirect drivers as well as projected increase in direct drivers, such as climate change.

-Most scenarios project increasing supply and demand for material contributions with current market value (e.g., food, feed, timber and bioenergy), but decrease in regulating contributions from nature (e.g., regulation of water quantity, air, ocean acidification, habitat maintenance, pollination). These changes arise from continued human population growth, increasing purchasing power, and increasing per capita consumption, which influence the projected impacts of increasing land/and sea-use change, exploitation of organisms and climate change. Negative impacts arising from pollution and invasive alien species will likely exacerbate these trends.

-Business-as-usual is not an option if the world wants to conserve and sustainably use biodiversity. Business-as-usual will cause a continued loss of biodiversity. Scenarios that focus on economic growth and regional competition lead to an increase in material well-being, e.g., food production, but even greater loss of biodiversity. Plausible future scenarios that are more sustainable with low population growth coupled with sustainable and consumption practices, can slow, but not completely eliminate the future loss of biodiversity, in part, because climate is projected to warm in all scenarios.

Selected Sustainable Development Goals	Selected targets (abbreviated)	Recent status and trends in aspects of nature and nature's contributions to people that support progress towards target * Poor/Declining support	Partial support	Uncertain relationship
1 No poverty	1.1 Eradicate extreme poverty			U
	1.2 Halve the proportion of people in poverty			U
	1.4 Ensure that all have equal rights to economic resources			
	1.5 Build the resilience of the poor			
2 Zero hunger	2.1 End hunger and ensure access to food all year round			
	2.3 Double productivity and incomes of small-scale food producers			
	2.4 Ensure sustainable food production systems			
	2.5 Maintain genetic diversity of cultivated plants and farmed animals			
3 Good health and well-being	3.2 End preventable deaths of newborns and children			U
	3.3 End AIDS, tuberculosis, malaria and neglected tropical diseases			U
	3.4 Reduce premature mortality from non-communicable diseases	Unknown		
	3.9 Reduce deaths and illnesses from pollution	Unknown		
6 Clean water and sanitation	6.3 Improve water quality			
	6.4 Increase water use and ensure sustainable withdrawals			
	6.5 Implement integrated water resource management			
	6.6 Protect and restore water-related ecosystems			
11 Sustainable cities and communities	11.3 Enhance inclusive and sustainable urbanization			
	11.4 Protect and safeguard cultural and natural heritage			
	11.5 Reduce deaths and the number of people affected by disasters			
	11.6 Reduce the adverse environmental impact of cities			
	11.7 Provide universal access to green and public spaces			
13 Climate action	13.1 Strengthen resilience to climate-related hazards			
	13.2 Integrate climate change into policies, strategies and planning			
	13.3 Improve education and capacity on mitigation and adaptation	Unknown		
	13a Mobilize US$100 billion/year for mitigation by developing countries	Unknown		
	13b Raise capacity for climate change planning and management	Unknown		
14 Life below water	14.1 Prevent and reduce marine pollution			
	14.2 Sustainably manage and protect marine and coastal ecosystems			
	14.3 Minimize and address ocean acidification			
	14.4 Regulate harvesting and end overfishing			
	14.5 Conserve at least 10 per cent of coastal and marine areas			
	14.6 Prohibit subsidies contributing to overfishing			
	14.7 Increase economic benefits from sustainable use of marine resources			
15 Life on land	15.1 Ensure conservation of terrestrial and freshwater ecosystems			
	15.2 Sustainably manage and restore degraded forests and halt deforestation			
	15.3 Combat desertification and restore degraded land			
	15.4 Conserve mountain ecosystems			
	15.5 Reduce degradation of natural habitats and prevent extinctions			
	15.6 Promote fair sharing of benefits from use of genetic resources			
	15.7 End poaching and trafficking			
	15.8 Prevent introduction and reduce impact of invasive alien species			
	15.9 Integrate biodiversity values into planning and poverty reduction			
	15a Increase financial resources to conserve and sustainably use biodiversity			
	15b Mobilize resources for sustainable forest management			

* There were no targets that were scored as good/positive status and trends

Figure 5: Summary of recent status of, and trends in, aspects of nature and nature's contributions to people that support progress towards achieving selected targets of the Sustainable Development

-Scenarios show that there are large projected regional differences in the patterns of future biodiversity and ecosystem functions and loss and changes in nature's contributions to people. Figure 6 shows a global-scale projection of changes in biodiversity and nature's material and regulating benefits, due to climate & land use change by 2050, while Figure 7 shows regional differences. While regions worldwide face further declines in biodiversity in future projections, tropical regions face combined risks of declines due to interactions of climate change, land-use change and fisheries exploitation. Marine and terrestrial biodiversity in boreal, subpolar and polar regions is projected to decline mostly because of warming, sea ice retreat and enhanced ocean acidification. The magnitude of impacts and the differences between regions are much greater in scenarios with rapid increases in consumption or human population than in scenarios based on sustainability. Acting immediately and simultaneously on multiple indirect and direct drivers has the potential to slow, halt and even reverse some aspects of biodiversity and ecosystem loss.

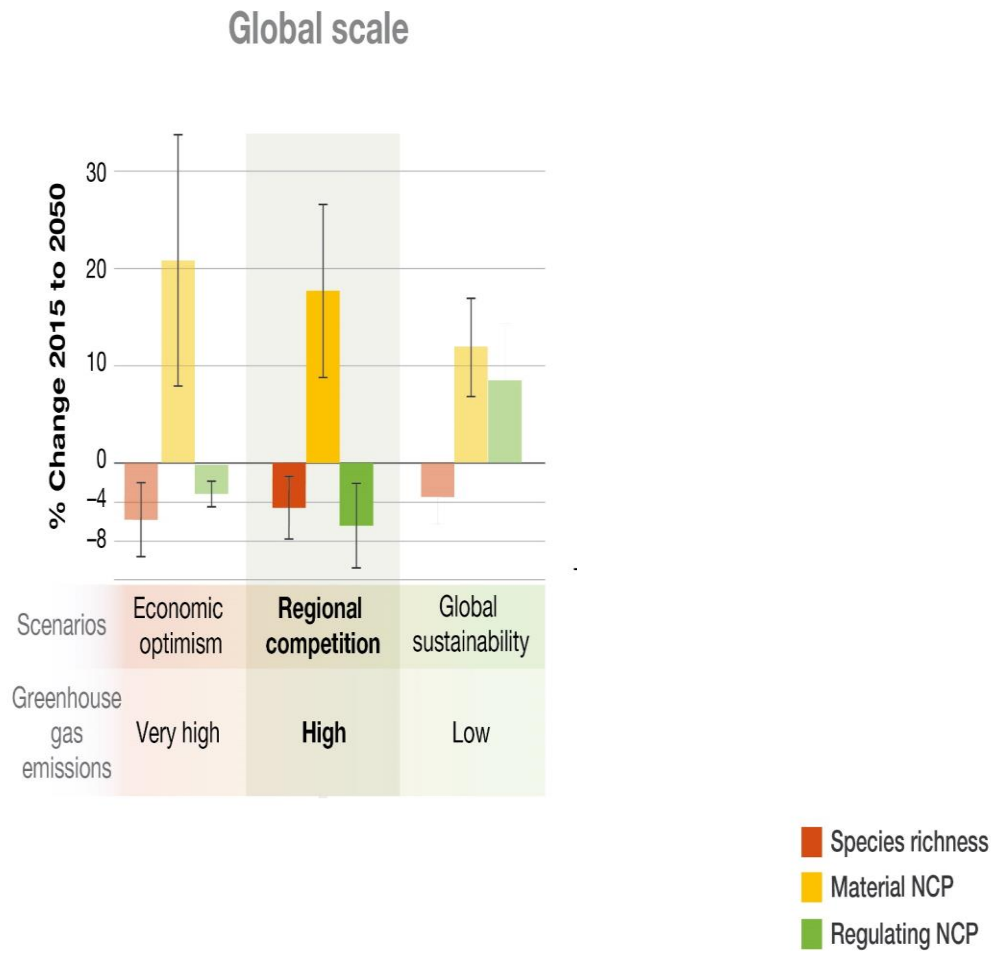

Figure 6: Global projections of impacts of land use and climate change on biodiversity and nature's material and regulating contributions to people between 2015 and 2050.

-Scenarios also show that while climate change is already having an impact on biodiversity and ecosystem functions, such impact is projected to intensify with the degree of global warming. For instance, a synthesis of many studies estimates the fraction of species at climate change related risk of extinction is 5% at 2°C warming, rising to 16% at 4.3°C warming. Projected climate change poses a growing risk owing to the accelerated pace of change and interactions with other direct drivers. Shifts in species distribution, changes in phenology, altered population dynamics and changes in the composition of species assemblage, or the structure and function of ecosystems, are evident and accelerating in marine, terrestrial and freshwater systems. Even for global warming from 1.5 to 2 degrees, the majority of terrestrial species ranges are projected to shrink profoundly. However, it should be noted that with the current and projected emissions of greenhouse gases, assuming the Paris agreement pledges are met, the world is on a pathway to an increase in global mean surface temperature of 3.0-3.5^{o}C.

-Regarding the relative impact of climate change and land use, for terrestrial systems, most studies indicate that South America, Africa and parts of Asia will be much more significantly affected than other regions, especially in scenarios that are not based on sustainability objectives. That is due in part to regional climate change differences and in part to the fact that scenarios generally foresee the largest land use conversions to crops or bioenergy in those regions. Regions such as North America and Europe are expected to have low conversion to crops and continued reforestation.

-Our future oceans and our dependent livelihoods will strongly depend on the amount of greenhouse gases emitted today and in the coming decades. Mean sea surface temperature is projected to increase by +2.7°C in 2090-2099 as compared to 1990-1999 (or ca. 3.7°C above pre-industrial level) for the high emission scenario (RCP8.5, also considered as a "business as usual" scenario), whereas the warming is limited to +0.71°C for the more stringent RCP2.6 emission scenario (or ca. 1.7°C above pre-industrial level). At the regional scale, stronger warming occurs in the tropics, in the North Pacific and in the Arctic Ocean, with the sea surface warming more than +4°C at the end of the 21st century under RCP8.5. As global temperatures rise, so does the mean sea level due primarily to the thermal expansion of ocean water and by melting of glaciers, ice caps and ice sheets. Under the high emission scenario (RCP8.5), sea level rise (SLR) is projected to reach 52-131 cm by 2100 relative to year 2000. A broadly uniform decrease of the mean sea surface pH of -0.33 pH units by the 2090s relative to the 1990s is predicted under high emission scenario (RCP8.5), which will severely impact the growth of shells or skeletons of many calcifying marine organisms. Models also project decreasing global ocean oxygen due to climate change. The mechanisms at play are a reduction of oxygen solubility due to ocean warming and the combination of increased stratification and reduced ventilation that prevents the penetration of oxygen into the deep ocean. Deoxygenation will continue over the 21st century irrespective of the future scenario, with decreases of global O2 of -1.8% and -3.45% under RCP2.6 and RCP8.5, respectively, with a stronger drop for the North Pacific, the North Atlantic, and the Southern Ocean.

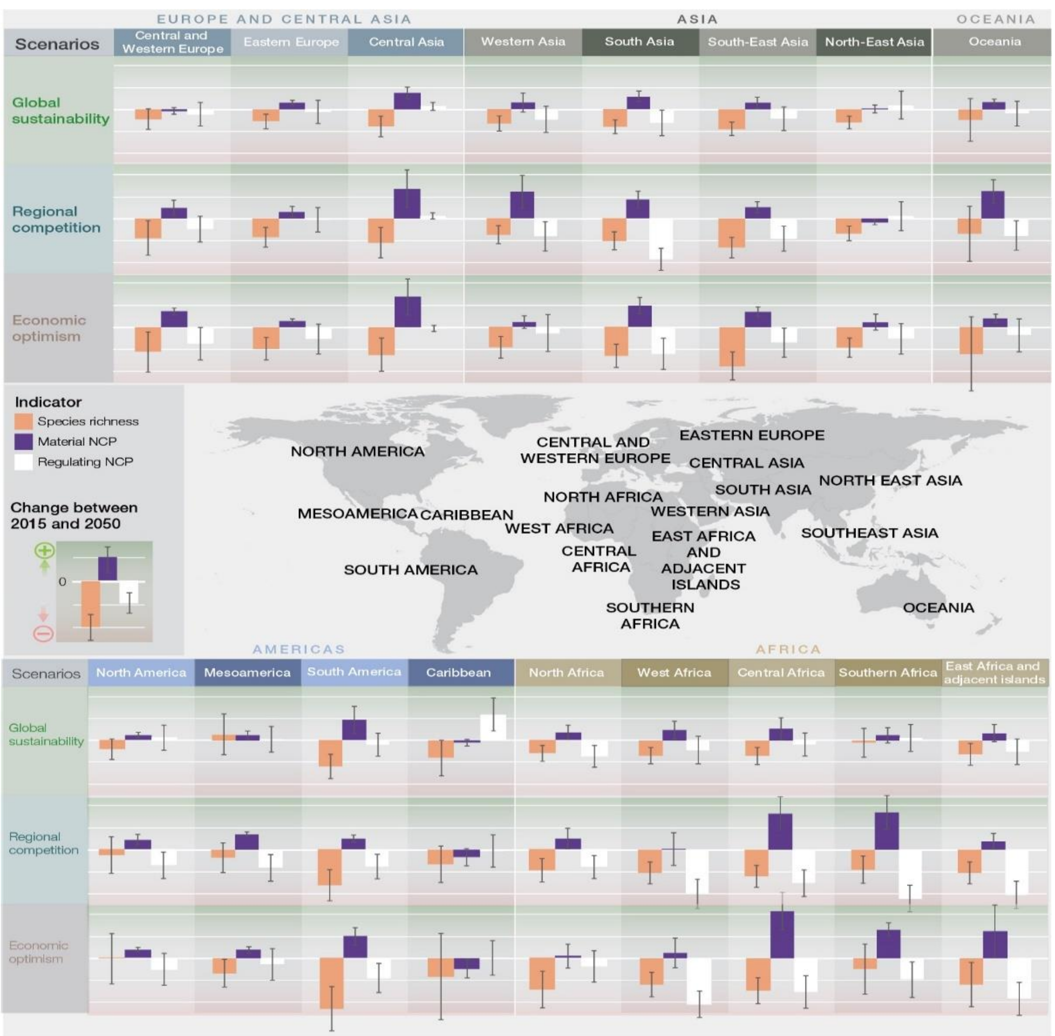

Figure 7: Projected changes in biodiversity and nature's material and regulating benefits, due to climate & land use change by 2050 by region

Future climate change will hence alter marine habitats and modify biogeochemical cycles, producing more hostile conditions and threatening vulnerable ecosystems and species with low adaptive capacity. By the end of the century, climate change is projected to decrease net primary production (by ca. 3.5% under the low greenhouse gas emissions scenario, RCP2.6 and up to 9% in the high emissions scenario, RCP8.5), and secondary production up to fish (by 3% to 23% under RCP2.6 and RCP8.5, respectively), as well as top predator. Fish populations and catch potential are projected to move poleward due to ocean warming with a mean latitudinal range shift of 15.5 km to 25.6 km per decade to 2050 (under RCP2.6 and RCP8.5, respectively), leading to high extirpation rates of biomass and local species extinctions in the tropics. However, that does not necessarily imply an increase in biodiversity in the polar seas, because of the rapid rate of sea ice retreat and the enhanced ocean acidification of cold waters in the Arctic and Southern Oceans. Along coastlines, the upsurge in extreme climatic events and sea level rise is expected to cause increased fragmentation and loss of habitats. Climate change is projected to become increasingly important as a direct driver of changes in nature and its contributions to people in the next decades. Scenarios project mostly adverse climate change effects on biodiversity and ecosystem functioning, which worsen with incremental global warming. They show that limiting global warming to well below 2°C plays a critical role in reducing adverse impacts on nature and its contributions to people. For example, coral reefs are particularly vulnerable to climate change and are projected to decline to 10-30 % of former cover at 1.5°C warming and to less than 1 % at 2°C warming.

C4. Considering the changes and challenges described above, the global assessment has carried out a nexus-based analyses of possible pathways to evaluate synergies and trade-offs for achieving different goals[6].

The global assessment makes it evident that the challenges posed by climate change, nature deterioration, and achieving a good quality of life for all are interconnected, and, they need to be addressed synergistically, from local to global levels. More importantly, the report recognizes the rich array of response, approaches, and instruments developed at all levels in response to social and environmental problems. As clearly noted in the report, building upon and improving existing approaches and initiatives can have immediate positive outcomes. Likewise, the deployment of existing policy instruments can have in itself a significant impact, along with the review and renewal of existing agreed environment-related international goals and targets based on the best available scientific knowledge. It also recognizes the need for sustaining and increasing in funding incentives for conservation, ecological restoration, and in support of sustainable use actions by all actors.–Along with existing options, the report calls for promoting new initiatives that evoke individual and corporate sustainability values, supporting and linking local actions, advance multi-sectoral planning and implementation, and supporting new frameworks for private sector investment and innovation.

The report also makes evident the importance of advancing governance approaches that are integrated, inclusive, informed, and adaptive in the face of new types of environmental risks and uncertainties, and possibilities for societal responses (Figure 8). Finally, it shows that it is equally important is to recognize the knowledge, innovations and practices, institutions and values of indigenous peoples and local communities, and their effective inclusion and participation in environmental governance. Such recognition and involvement enhance their quality of life, as well as nature conservation and sustainable use, relevant to broader society.

[6] The assessment report makes a distinction between the terms scenarios and pathways; while scenarios use narratives to explain outcomes generated by a model, pathways are possible trajectories toward the achievement of specific outcomes, for instance biodiversity conservation goals and targets in the context of the SDG.

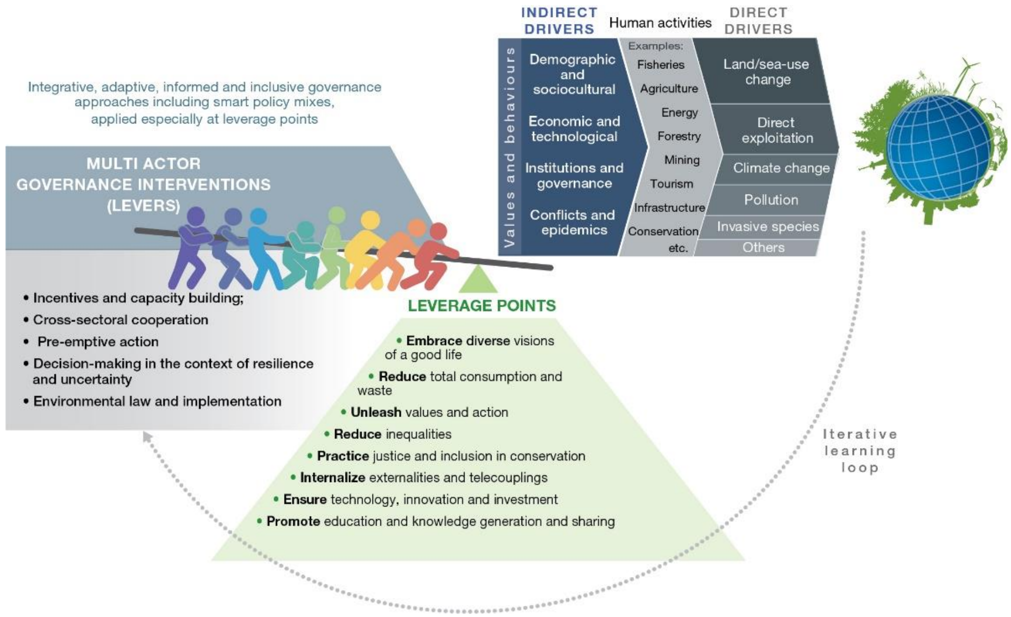

Figure 8. Transformative change in global sustainability pathways. Collaborative implementation of priority governance interventions (levers) targeting key points of intervention (leverage points) could enable transformative change from current trends towards more sustainable ones

→Cross-sectoral approaches are needed to promote sustainable pathways in food, materials, and energy production, conservation and restoration of freshwater, marine, and terrestrial environments, effective climate change mitigation and adaptation, and resilient urban systems and infrastructure.

-Feeding humanity and enhancing the conservation and sustainable use of nature are complementary and closely interdependent goals. Pathways to sustainable food systems entail land use planning and sustainable management of both the supply/producer and the demand/consumer sides of food systems. These options include, depending on context, for instance integrated pest and nutrient management, organic agriculture, agroecological practices, soil and water conservation practices, conservation agriculture, agroforestry, silvopastoral systems, irrigation management, small or patch systems, and practices to improve animal welfare. These practices could be enhanced through well-structured regulations, incentives and subsidies, the removal of distorting subsidies, and--at landscape scales--by integrated landscape planning and watershed management. Ensuring the adaptive capacity of food production incorporates measures that conserve the diversity of genes, varieties, cultivars, breeds, landraces and species which also contribute to diversified, healthy and culturally-relevant nutrition. Some incentives and regulations may contribute to positive changes at both the production and consumption ends of supply chains, such as the creation, improvement and implementation of voluntary standards, certification and supply-chain agreements (e.g., the Soy Moratorium) and the reduction of harmful subsidies.

-Expanding and effectively managing the current network of protected areas, *including terrestrial, freshwater and marine areas, is important for safeguarding biodiversity, particularly in the context of climate change.* This include implementing existing and developing new mechanisms for conserving areas. This suggests that strengthening advances in area-based conservation entail planning ecologically representative networks of interconnected protected areas to cover key biodiversity areas and managing trade-offs between societal objectives that represent diverse worldviews and multiple values of nature. Other important measures include enhancing monitoring and enforcement systems, managing biodiversity-rich land and sea beyond protected areas, addressing property rights conflicts and protecting environmental legal frameworks against the pressure of powerful interest groups, building capacity and enhancing stakeholder collaboration, involving diverse stakeholders as well as indigenous peoples and local communities to establish and manage protected areas using instruments such as landscape-scale and seascape-scale participatory scenarios and spatial planning, including transboundary conservation planning. Implementation beyond protected areas includes combating wildlife and timber trafficking through effective enforcement and ensuring the legality and sustainability of trade in wildlife.

-Sustaining and conserving fisheries and marine species and ecosystems through integrated management on land, in freshwater and in the oceans. Multilevel coordination across stakeholders, accountability throughout the supply chain. It also entails policy action to apply sustainable ecosystem approaches to fisheries management, spatial planning (including the implementation and expansion of marine protected areas) and, more broadly, to address drivers such as climate change, pollution. Scenarios show that pathways to sustainable fisheries entail conserving, restoring and sustainably using marine ecosystems, rebuilding overfished stocks (including through targeted limits on catch or fishing efforts and moratoria), reducing pollution (including plastics), managing destructive extractive activities, eliminating harmful subsidies and illegal, unreported and unregulated fishing, adapting fisheries ma g the environmental impact of Aquaculture.

-Sustaining freshwater in the context of climate change, rising demand for water extraction and increased levels of pollution involves both cross-sectoral and sector-specific interventions that improve water use efficiency, increase storage, reduce sources of pollution, improve water quality and minimize disruption and foster restoration of natural habitats and flow regimes. Promising interventions include practicing integrated water resource management and landscape planning across scales; protecting wetland biodiversity areas; guiding and limiting the expansion of unsustainable agriculture and mining; slowing and reversing de-vegetation of catchments; and mainstreaming practices that reduce erosion, sedimentation and pollution run-off and minimize the negative impact of dams. Sector-specific interventions include improved water-use efficiency techniques (including in agriculture, mining and energy), decentralized (for example, household-based) rainwater collection, integrated management (e.g., ‘conjunctive use’) of surface and groundwater, locally developed water conservation techniques and water pricing and incentive programs (such as water accounts and payment for ecosystem services programs). With regard to watershed payment for ecosystem services programs, their effectiveness and efficiency can be enhanced by acknowledging multiple values in their design, implementation and evaluation and setting up impact evaluation systems.

-Land-based climate change mitigation activities can be effective and support conservation goals but can also can come with negative side effects for biodiversity and ecosystems, as well as for society. Integrated, context-specific, and inclusive planning, is important. The large-scale deployment of bioenergy plantations and afforestation of non-forest ecosystems can come with negative side effects for biodiversity and ecosystem functions. Nature-based solutions with safeguards are estimated to provide 37 per cent of climate change mitigation until 2030 needed to meet the 2°C Paris goal with likely co-benefits for biodiversity. Therefore, land-use actions are indispensable, in addition to strong actions to reduce greenhouse gas emissions from fossil fuel use and other industrial and agricultural activities. However, the large-scale deployment of intensive bioenergy plantations, including monocultures, replacing natural forests and subsistence farmlands, will likely have negative impacts on biodiversity and affect food and water security as well as local livelihoods, including by intensifying social conflict.

-Integrated city-specific and landscape-level planning, nature-based solutions and built infrastructure as well as responsible production and consumption can all contribute to sustainable and equitable cities and make a significant contribution to the overall climate change adaptation and mitigation effort. Urban planning approaches to promote sustainability include encouraging compact communities, designing nature-sensitive road networks and creating low impact (from an emissions and land use perspective) infrastructure and transportation systems, including active, public and shared transport, which is already growing around the world. However, given that most urban growth between now and 2030 will take place in the Global South, major sustainability challenges include addressing, creatively and inclusively, the lack of basic infrastructure (water, sanitation and mobility), the absence of spatial planning and limited governance capacity and financing mechanisms. There are opportunities for complementarity of 'green' and 'gray' infrastructure, and sustainable technologies. Those challenges also offer opportunities for locally-developed innovation and experimentation, creating new economic opportunities.

D. Final considerations

The synthesis of evidence (indirect and direct drivers of change) indicates that moving away from current projections towards more sustainable pathways entails a broader process of evolution of the global financial and economic systems towards building a global sustainable economy. These include, *inter alia*, introducing and improving standards and systems, including relevant regulations, aimed at internalizing the external costs of production, extraction and consumption (such as pricing wasteful or polluting practices, including through penalties), promoting resource efficiency, circular and other economic models, voluntary environmental and social certification of market chains and incentives for sustainable practices and innovation. Actions that help to unleash, voluntarily, existing social values of responsibility in the form of individual, collective and organizational actions towards sustainability can have a powerful effect in shifting behavior and cultivating stewardship as a normal social practice.

There is also a need to eliminate agricultural, energy and transportation subsidies that are harmful to the environment, and to introduce short- term economic incentives to stimulate sustainable production and consumption. The economic system needs to evolve from one only focused on Gross Domestic Product (GDP), and be complemented by one that recognizes and incorporates the value of natural capital into economic accounting and incorporates the monetary and non-monetary values of biodiversity and its contributions to people into decision-making. Rarely do decision makers recognize the importance of nature's regulating services, i.e., the regulation of the climate, pollution, pollination, flood control, storm surges, and water purification - these all have significant non-market economic value and some of these services are irreplaceable. And of course, there is the wide range of social values associated with nature, which cannot be fully captured in economic terms.

There are, at all levels, many positive societal responses and successful examples. In many sectors, rapid transformative change is already happening. In the USA, for instance, individual awareness of the environmental impact of wasteful consumption is increasing, actions by individual, collectives, and the private sectors are seeking to develop innovative institutions, as well as new technologies that support sustainability goals. States, counties, rural communities, and cities are developing measures to improve resilience to issues such as flood, droughts, extreme weather events, wildfires, and extreme temperatures in the face of climate change. Consumers are contributing to promote more sustainable production systems and increasingly expecting corporate social and environmental responsibility to extend across the supply chain. Initiatives promoting sustainable production and resource management are expanding in sectors such as agriculture, forestry, and fisheries. New decentralized and low impact technologies for waste treatment, energy production, and water treatment are being developed and disseminated. The expansion of organic and conservation-focused food production is contributing to strengthening local economies and good environmental practices. In sum, transformative changes are already happening around the country and the world and can be further advanced through increasing connectivity of efforts, alignment of institutional arrangements, and incentives that recognize efforts at all levels. The global assessment sends a sobering, but optimistic message: Nature can be conserved, restored and used sustainably while simultaneously meeting other global (and local) societal goals, but urgent and concerted efforts fostering transformative change towards sustainability are called for.

Because loss of biodiversity and climate change are environmental, development, economic, security, social, and equity issues they must be addressed together. This means that these issues are not just the domain of environment ministers, but of equal importance for ministries of agriculture, forestry, energy, finance, transportation, water and tourism. Therefore, Government departments are encouraged to work together to realize a sustainable world.

Curriculum Vitae
Sir Robert Tony Watson, CMG, FRS

My career has evolved from a Ph.D. student at QMC, London University; a post-doctoral fellow at University of California, Berkeley and University of Maryland, USA; a research scientist at the Jet Propulsion Laboratory, California Institute of Technology, USA; a Federal Government program manager/director at the US NASA; a scientific advisor in the Office of Science and Technology Policy (OSTP), White House, USA; a scientific advisor, manager and chief scientist at the World Bank; chief scientific advisor to the UK Department of Environment, Food and Rural Affairs; Sir Louis Matheson Fellow, Monash Sustainability Institute (MSI), Monash University, Australia, to my present part-time position as a Professor of Environmental Sciences and strategic director for the Tyndall Center at the University of East Anglia, UK. In parallel to my formal positions I have chaired, co-chaired or directed a number of national and international scientific, technical and economic assessments, including WMO/UNEP stratospheric ozone depletion assessments, Global Biodiversity Assessment, Millennium Ecosystem Assessment, UK National Ecosystem Assessment and its Follow-on, Intergovernmental Panel on Climate Change, the Intergovernmental Assessment of Agricultural Scientific and Technology for Development, and the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services. I have also been awarded a number of honours, including (2012 - Knights Bachelor – UK, and 2003 - "Companion of the Order of Saint Michael and Saint George" - UK); fellowships (2011 – Fellow of the Royal Society, UK), and awards, including 2014 – UN Champion of the World for Science and Innovation, 2010 - Asahi Glass Blue Planet Prize, 2008 – American Association for the Advancement of Science Award for International Scientific Cooperation, and I contributed to the 2007 - Nobel Peace Prize for the IPCC, which I chaired from 1997-2002.

Current Position

- Part time Professor of Environmental Sciences at the University of East Anglia and Director for Strategic Development, Tyndall Center, Department of Environmental Sciences, University of East Anglia, Norwich, Norfolk

Previous Positions (include):

- Sir Louis Matheson Fellow, Monash Sustainability Institute (MSI), Monash University, Clayton Campus, Melbourne, Australia (2013-2016)
- Chief Scientific Advisor for the UK Department of Environment, Food and Rural Affairs (DEFRA): September 2007-September 2012
- Chief Scientist, and Senior Advisor for Sustainable Development, World Bank: July 2006 – July 2007; Chief Scientist, and Senior Advisor for Environmentally & Socially Sustainable Development, World Bank: April 2003 – July 2006; Chief Scientist, and Director for Environmentally & Socially Sustainable Development, World Bank: January 2000 – April 2003; Director, Environment Department, World Bank, Washington D.C., August 1997 - December 1999; Senior Advisor for Environment, Environment Division, World Bank, Washington D.C., May 1996 - June 1997
- Associate Director for Environment, November 1993 - May 1996: Office of Science and Technology Policy, White House, Washington D.C. 20506

- Director, Science Division and Chief Scientist - April 1993 - November 1993: Office of Mission to Planet Earth, National Aeronautics and Space Administration (NASA), Washington, D.C.

Special Positions/Experience (include)

- Chair and member of the Bureau of the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) – 2015-2019; Vice-chair and member of the Bureau of the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) – 2012 – 2015
- Member of the US National Academy of Science Panel on Policy and Global Affairs – 2015 to present
- Chair of the Interim Engagement Committee for Future Earth 2013-2014
- Co-chair of the UK National Ecosystem Assessment Follow-On – 2012 – 2014
- Co-chair of expert panel for the Convention on Biological Diversity on Geo-engineering and Biodiversity – 2011- 2012
- Co-chair of the UK National Ecosystem Assessment – 2010-2011
- Director of the International Assessment of Agricultural Science and Technology for Development: 2003 - 2008
- Co-chair of the Board of Directors of the International Millennium Ecosystem Assessment: 2000 - 2005
- Co-chair: International WMO/UNEP Scientific Assessments of the Current Knowledge of the Processes Controlling the Abundance and Distribution of Atmospheric Ozone, 2002, 2002, 1998, 1994, 1991, 1989, 1988, and 1985
- Chairman, UNEP/WMO Intergovernmental Panel on Climate Change September 1997- April 2002
- Co-chair: Intergovernmental Panel on Climate Change (IPCC) Working Group II (Impacts, Adaptation, and Mitigation) - 1993 – September 1997
- Chair: UNEP Global Biodiversity Assessment - 1993 to 1995
- Chair of the Science and Technical Advisory Panel to the Global Environmental Facility (World Bank, United Nations Development Program, and United Nations Environment Programme) 1991- November 1993
- Chaired Chapter on Greenhouse Gases for the IPCC Scientific Assessment for Working Group I (1990 and 1992). Member of Steering Group for IPCC WG #1, 1990 and 1992.
- Testified many times before U.S. Senate and U.S. House of Representatives Committees and Sub-Committees on Ozone, Global Warming, and other Global Change Research issues

Education

- Ph.D., (Gas Phase Chemical Kinetics), 1973, Queen Mary College, London University, London, England
- B.Sc. 1st class (chemistry), 1969, Queen Mary College, London University, London, England

Honorary Academic Degrees

- 2010 – Fellow of Queen Mary College, London University, England
- 2009 - Honorary Doctor of Science, Cranfield University, England
- 2003 - Honorary Doctor of Science, University of East Anglia, England
- 2003 - Honorary Doctor of Science, UMIST, England

Honours and Decorations

- 2012 - Knights Bachelor – United Kingdom
- 2003 - Honorary “Companion of the Order of Saint Michael and Saint George” - United Kingdom

Fellowships

- 2011 – Fellow of the Royal Society, UK

Awards include

- 2015 – British Ecological Society Ecological Engagement Award
- 2014 – UN Champion of the World for Science and Innovation
- 2012 – UK Royal Society for the Protection of Birds Medal
- 2010 - Asahi Glass Blue Planet Prize
- 2008 – American Association for the Advancement of Science Award for International Scientific Cooperation
- 2007 – I contributed to the IPCC being awarded the Nobel Peace Prize - I chaired from 1997-2002
- 2006 – I contributed to the Millennium Ecosystem Assessment being awarded the Zayed science award - I was the board co-chair: it was given to the authors of the Millennium Assessment for Scientific and Technological Achievements in Environment
- 2005 - Recognized by the Rolling Stone magazine as one of 25 movers and shakers for the environment
- 2003 – Global Green Award for International Environmental Leadership – US chapter of the Green Cross International formed by Mikhail Gorbachev
- 1993 - American Association for the Advancement of Science Award for Scientific Freedom and Responsibility
- 1993 - American Meteorological Society Special Award "for notable efforts in organizing and conducting international assessments in ozone depletion and global change"
- 1992 – U.S. National Academy of Sciences Award for Scientific Reviewing
- 1991 - American Geophysical Union's Edward A. Flinn, III Award established to recognize individuals who personify the American Geophysical Union's motto of unselfish cooperation in research through their facilitating coordination and implementing activities (first recipient)
- 1989 - Designated member of UNEP's "The Global 500: The Roll of Honor for Environmental Achievement"

Ten US Government Awards

Publications: Over 45 Refereed Journal Publications, 60 Refereed National and International Scientific Assessments and Reviews, 4 key World Bank Publications, and 3 Book Chapters