Scientific and Technological Community Major Group position paper for the 2021 High-level Political Forum

Sustainable and resilient recovery from the COVID-19 pandemic that promotes the economic, social and environmental dimensions of sustainable development: building an inclusive and effective path for the achievement of the 2030 Agenda in the context of the decade of action and delivery for sustainable development

Key messages

- **Impact**: ***The pandemic abruptly disrupted implementation of actions focused on achieving many of the Sustainable Development Goals (SDGs) and, in some cases, reversed hard-won progress.***[1] The measures taken to mitigate its impact caused a sudden loss of jobs and the closure of millions of enterprises and factories.[2] Globally, extreme poverty is on the rise for the first time in 20 years,[3] with the pandemic driving up acute hunger in countries already experiencing food crises,[4] creating new hunger hotspots across the globe. It has further exposed the rising threat posed by global inequality to the health, well-being and security of all people,[5] as well as the unpreparedness of societies to cascading risk.

- **Warning**: ***The pandemic is a symptom of the devastating impacts of anthropogenic activities on natural ecosystems.***[6] ***It comes as a timely warning of the need to urgently and drastically transform human actions and relations, including with nature***. Returning to the pre-pandemic normal is not an option. Profound systemic transformations are needed to stabilize the Earth system, which is currently threatened by further destruction of biodiversity, air and water pollution, destabilization of climate and general devastation of the Earth's ecosystems.[7]

- **Opportunity: The Scientific and Technological Community Major Group stresses the unique opportunity provided by the current crisis for game-changing climate action and for safeguarding and restoring the Earth's ecosystems.** In this context, recovery must not reinstate historical development pathways and economic models, and should instead focus on new investments to lock humanity into more sustainable pathways. To do otherwise risks global average temperature increases well beyond 2°C, leading to catastrophic consequences for humanity and life on Earth.

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[1] UN DESA Policy brief. 2020. Impact of COVID-19 on SDG progress: a statistical perspective
[2] ILO, FAO, IFAD and WHO Joint statement. 2020. Impact of COVID-19 on people's livelihoods, their health and our food systems
[3] The World Bank. 2020. COVID-19 to Add as Many as 150 Million Extreme Poor by 2021
[4] FAO. 2020. COVID-19 impacts driving up acute hunger in countries already in food crisis
[5] IPBES. 2020. Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., das Neves, C. et al. IPBES Secretariat, Bonn, Germany. DOI: 10.5281/zenodo.4147317
[6] Henry, C., Rockström, J. and Stern, N. 2020. Standing up for a Sustainable World. Cheltenham/Northampton: Edward Elgar Publishing.
[7] Ibid.

- **Transformation:** ***The Scientific and Technological Community Major Group calls for a truly transformative recovery that is centred on and aligned with the principles of the SDGs.*** While fighting to bring the pandemic to an end, governments must foster sustainable and equitable economic recovery, and jointly address the climate and biodiversity emergencies, while leaving no one and no place behind. Diverse scientific, engineering and technological communities have considerable knowledge and expertise which should be given a more proactive role in the pursuit of a truly transformative recovery.[8]

- **Just transition:** ***The Scientific and Technological Community Major Group calls for a recovery process that ensures a just transition to decarbonized and sustainable futures and focuses on building more creative, engaged and resilient societies better equipped to prevent, prepare for and tackle future*** **crises.** The growing risks of major planetary disruptions,[9] compounded by rising inequalities and new forms of vulnerability, pose existential threats. These multi-level risk-creation and risk-amplifying processes could dramatically undermine all attempts to achieve sustainable development and erode the social and environmental foundations on which we depend to live and thrive.[10]

- **Science-informed solutions:** ***The Scientific and Technological Community Major Group emphasizes the importance of utilizing diverse knowledge and scientific practice, from engineering and technology, through natural and life sciences, to the arts and social sciences, to help transform mindsets, leadership and action, and to craft innovative, efficient, applicable and sustainable solutions to today's urgent challenges.*** We stand ready to work with all stakeholders to devise appropriate and implementable science-informed solutions to help decision-makers and societies recover from COVID-19 and build more equitable, resilient and sustainable futures. Simultaneously, we are ready to lead on the path to more ethical and inclusive use of technology that fosters sustainable innovation and benefits society at large.

Key recommendations

- **Integrated approaches:** ***Governments must incorporate integrated approaches to achieving the SDGs.*** These are policies and measures that can advance multiple SDGs at the same time by facilitating positive and synergistic impacts and avoiding unintended negative impacts, such as nature-based solutions. Recovery packages must focus on measures and interventions that support the idea of 'planetary health'; that is, the close connection between human health and well-being, and the health of ecosystems and the rest of nature. To enhance peer learning, better knowledge about the nature, the interplay and ultimately the impact of the integrated policies and measures taken so far is needed. Integrated impact assessments, evaluations and cross-country comparative analyses could help to identify good practices to be shared during the HLPF.

- **Recovery plans**: ***Governments should use a 'sustainability stress test' to ensure that their economic recovery plans advance climate and biodiversity goals and the SDGs***. Policy- and

[8] UNESCO. 2021. Engineering for Sustainable Development: Delivering on the Sustainable Development Goals
[9] Lenton, T., Rockström, J. et al. 2019. Climate tipping points – too risky to bet against. Nature 575, 592–595. DOI: 10.1038/d41586-019-03595-0
[10] Steffen, W. et al. 2015. Planetary boundaries: Guiding human development on a changing planet. Science 347. DOI: 10.1126/science.1259855

decision-makers should ensure that recovery does not entail reinstating historical development pathways, and should instead focus on new investments to lock humanity into more sustainable pathways.

- **Transformation**: ***Governments must make use of the current window of opportunity provided by the pandemic to transform the economic, financial and productive systems, which are creating the drivers for continued unsustainability, to new models that account for the value of nature's contributions to human well-being, eliminate environmentally harmful subsidies and invest in environmentally friendly economic activities***. This requires deep changes in power dynamics, as well as in values, norms, practices, and institutions, which have been resisted so far. Identifying leveraging points is a crucial step in the transformation towards sustainability. There is an urgent need to address existing scientific evidence and move from plans to action.

- **Collective effort**: ***While governments are central players in creating the architecture for sustainability transitions, the private sector and particularly wealthy national and multinational organizations, also have a key role; their power and innovative capacities must also contribute to the achievement of the SDGs and their commitment to change will be essential to a truly transformative recovery.***

- **Good Governance**: ***Governments must work with scientific communities and other stakeholders to develop ideas for reforming current governance arrangements at all levels in light of lessons learned during the pandemic***. The aim of these reforms should be to better cope with future pandemics and environmental degradation, and to accelerate a just transition to climate-neutral and sustainable economies. In addition, to achieve sustainable development it is imperative to advance risk-informed (anticipatory) governance arrangements with a view to building whole-of-society resilience. Resources must be redirected to support this reconfiguration of governance arrangements.

- **Renewed multilateralism:** ***Governments must agree on a renewed multilateral system that would enable the world to respond collectively to shared global risks posed not only by COVID-19 and other infectious diseases, but also by ongoing environmental degradation, accelerating climate change, rapid technological change and rising inequalities.*** The new multilateral system should be more inclusive and fairer – the reform should be based on an inclusive process employing a whole-of-society approach in order to benefit from increased legitimacy and citizen ownership.

- **Investment in education**: ***Governments must invest in education and capacity development programmes in relation to SDGs across the entirety of science, engineering and society for any of the recovery responses to move forward and be successful***. In addition, there is a need to mitigate the harms of COVID-19 to education systems and to seize the opportunities to improve higher education systems around the world.

- **Engineering for sustainable development:** ***Governments, engineering educators, industry and professional institutions need to promote greater understanding of the crucial role played by engineers and engineering in creating a more sustainable world.*** Governments and policy-makers should take urgent action to encourage more young people, especially girls, to consider engineering as a career in order to address the shortfall in the number of engineers, and to

ensure the diversity of thought and inclusive participation that is essential to achieving the SDGs. In addition, building engineering capacity while employing creative approaches to learning and thinking, complex problem-solving and interdisciplinarity, is key to enhancing engineering for the SDGs.

- **Science for global transformation**: ***With less than 10 years until 2030, governments and research funders need to urgently reflect on how science is developed and applied to the global commons.*** Promoting new approaches to doing science such as transdisciplinary research and systems-based approaches will be essential to address today's sustainability challenges and accelerate transformations. Governments, research institutions and science funders should work together to accelerate the transition to inclusive open access and open science allowing a widespread dissemination of existing and emerging scientific knowledge and breakthrough tools, approaches and solutions which are key to realizing sustainable development. In addition, science organizations must establish online 'clearinghouses' to make accessible data and recommendations for the green recovery.

Introduction

The launch of the Decade of Action and Delivery for Sustainable Development in 2020 recognizes that the world has 10 years to meet the 17 sustainability goals. However, 2020 was also marked by the COVID-19 pandemic which has been called the 'most challenging crisis [humanity has] faced since the Second World War'[11] by the UN Secretary-General António Guterres. Besides generating massive adverse health and socio-economic impacts for societies around the globe, the COVID-19 pandemic has further exposed vulnerability to shocks, particularly among the poor and marginalized, feeding off existing inequalities and exacerbating them,[12] undermining the aspiration of 'leaving no one behind'. Economic gains and opportunities continue to be unequally distributed, while costs and impacts associated with climate change and biodiversity destruction are increasing exponentially and affecting disproportionately the most vulnerable and poor particularly in low-income countries.

The COVID-19 pandemic has furthermore laid bare the integrated nature of human development, well-being and planetary health and the profound reliance of human societies on a healthy and resilient biosphere providing suitable living conditions.[13] The pandemic is merely a symptom of the devastating impacts of anthropogenic activities on natural ecosystems in a world characterized by complex interactions of globalized networks of travel and trade and densely populated urban areas. This is compounded by ecological habitat and land-use change, and climate change, resulting in increased human–wildlife interactions.[14] It comes as a timely warning to urgently transform human actions and relations, including with non-human nature, to stabilize the Earth system currently threatened by further degradation of biodiversity, land, forests and oceans, air and water pollution, and destabilization of climate.[15]

In line with the focus of the High-level Political Forum (HLPF) for 2021 on sustainable and resilient recovery, this position paper brings together the latest scientific evidence and thinking from the scientific and technological community. The paper sets out ways to advance progress on the Sustainable Development Goals (SDGs) throughout the Decade of Action while living with and through the COVID-19 pandemic. It reflects on how the current context, devastating as it has been for so many, also provides a window of opportunity – a leverage point – from which to steer radical system transformation and to highlight contributions of the scientific and technological community to support transitions towards the desired outcomes.

Context

The impact of the COVID-19 crisis on the Sustainable Development Goals

The effects of the pandemic and the measures taken to mitigate its impact have generated the worst economic contraction since the Great Depression. This has exposed the structural flaws of the current growth-fixated economic system (and reliance on measures like the gross domestic product; GDP), which is creating the drivers for unsustainability, as well as the lack of

[11] UN Secretary-General at the launch of the Report on the Socio-Economic Impacts of COVID-19
[12] Folke, C. et al. 2020.Our Future in the Anthropocene Biosphere: Global sustainability and resilient societies. Beijer Discussion Paper Series No. 272.
[13] Ibid.
[14] Henry, C., Rockström, J. and Stern, N. 2020. Standing up for a Sustainable World. Cheltenham/Northampton: Edward Elgar Publishing.
[15] Ibid.

preparedness and resilience of the increasingly globalized and interconnected economy. Despite the immense wealth accumulation and economic growth during the past decades, the current economic system has failed to address the health crisis appropriately, to protect the most vulnerable and to halt the rise of inequalities. Examples of economic impacts include the high risk for nearly half of the world's 3.3 billion global workforce to lose their livelihoods, with millions of enterprises facing an existential threat;[16] and the decline of 14% in remittance flows to low and middle-income countries (LMICs) by 2021 compared to the pre-COVID-19 levels in 2019.[17] Solving the problems of the current economic and financial systems that were reinforced by the COVID-19 pandemic requires systemic and profound changes, which will need to be addressed simultaneously with the health emergency.

The COVID-19 pandemic disrupted implementation towards many of the SDGs and, in some cases, reversed hard-won progress.[18] For example, global extreme poverty (SDG 1) is expected to rise for the first time in 20 years leading to as many as 150 million being in this position by 2021.[19] With respect to SDG 2 (zero hunger) COVID-19 poses an additional threat to food systems, along with conflict and climate shocks, and is driving up acute hunger in countries already in food crisis,[20] creating new hunger hotspots across the globe.[21] In terms of SDG 3 (good health and well-being), COVID-19 has led to the interruption of childhood immunization efforts worldwide[22] and reduced services for cancer screening, family planning or non-COVID-19 infectious diseases.[23] With the pandemic hitting the most vulnerable hardest, and exerting more damaging impact on the poorest countries, SDG 10 (reduced inequalities) has become even harder to achieve. The economic downturn associated with the pandemic has led to important spin-off effects such as a substantial drop in government-spending on education (SDG 4) and a decline in access to electricity (SDG 7), and other negative impacts on well-being.[24] Besides, COVID-19 has hugely impacted national SDG monitoring systems: field data collection operations have been disrupted and funding for national statistical offices particularly in low- and lower-middle-income countries has been cut, which make it increasingly difficult to adequately monitor SDG indicators.[25] For example, ocean observation has been dramatically affected with almost all research vessels being called to their home ports. Almost all work to maintain vital mooring arrays that monitor major ocean currents and air-sea exchange has been cancelled. A number of arrays are therefore at risk of failure (SDG 14). In June 2020, this situation affected between 30 and 50% of the 300+ moorings. Some of them had already ceased to send data as batteries ran out.[26]

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[16] ILO, FAO, IFAD and WHO Joint statement. 2020. Impact of COVID-19 on people's livelihoods, their health and our food systems

[17] The World Bank. 2020. Press release. COVID-19: Remittance Flows to Shrink 14% by 2021

[18] UN DESA. 2020. UN DESA Policy brief #81. Impact of COVID-19 on SDG progress: a statistical perspective

[19] The World Bank. 2020. COVID-19 to Add as Many as 150 Million Extreme Poor by 2021

[20] FAO. 2020. COVID-19 impacts driving up acute hunger in countries already in food crisis

[21] WFP and FAO. 2021. Hunger Hotspots. FAO-WFP early warnings on acute food insecurity: March to July 2021 outlook. Rome.

[22] UN DESA. 2020. The Sustainable Development Goals Report 2020, page 30.

[23] The Lancet. 2020. Editorial: Will the COVID-19 pandemic threaten the SDGs? The Lancet Public Health 5(9), e460. DOI: 10.1016/S2468-2667(20)30189-4

[24] Antoniades, A., Widiarto, I. and Antonarakis, A.S. 2019. Financial crises and the attainment of the SDGs: an adjusted multidimensional poverty approach. Sustainability Science. DOI: 10.1007/s11625-019-00771-z

[25] UN. 2020. The Sustainable Development Goals Report 2020. https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf

[26] OC-UNESCO. 2020. Global Ocean Science Report 2020: Charting Capacity for Ocean Sustainability. Isensee, K. (ed.). Paris, UNESCO Publishing.

The effects of the pandemic emphasize the indivisible and systemic nature of the 2030 Agenda with all its 17 SDGs interacting with each other – in positive or negative ways.[27] The COVID-19 pandemic has confirmed some well-known interactions, such as the importance of providing good quality housing for good mental and physical health, as well as to reduce crowding and exposure to close-contact infectious diseases (SDGs 3 and 11). It has equally illustrated how the interaction between environmental and habitat changes induced by human agricultural activity can lead to ecosystems shifts, which in turn may intensify communicable disease transmission (SDG 3 and SDG 2).[28,29] Inversely, the crisis might impact the directionality of some SDG interlinkages: without a 'just transition' approach a low-carbon recovery might entail job losses in some sectors, leading to unemployment and indirect health and social care costs (targets 13.2 and SDGs 8, 9 and 10).[30] Applying multidisciplinary systemic thinking and focusing on interlinkages in the preparation of recovery responses and measures is therefore necessary to balance the potential short-term divergences between economic, social and environmental priorities during the transition towards more sustainable futures. This will maximize synergies and minimize trade-offs.[31]

Negative impacts of the coronavirus pandemic on the progress of many of the SDGs are reinforcing the idea that efforts to recover from the current crisis and to implement the SDGs must go hand in hand in order to build a more resilient, healthy, equitable and sustainable future for all. The SDGs have become more relevant than ever as they offer a guiding and stable framework to shape a transformative recovery from COVID-19 that is centred on inclusion, equity and sustainability. Focusing recovery plans on sustainable development will enable societies to be better equipped to prevent, prepare for and tackle future crises, by strengthening health systems, reducing the number of people living in extreme poverty, supporting a healthier natural environment, and creating more resilient societies.[32] Conversely, the pandemic could drive an additional 251 million people into poverty. By making integrated SDG investments in governance, social protection, green economy and digitalization under the 'SDG Push' scenario of the UN Development Programme (UNDP), the number of people living in extreme poverty could be reduced by 146 million in 2030 relative to the 'COVID Baseline' scenario.[33] In this context, the scientific and technological community calls for greater worldwide commitment to maintaining support for the poorest internationally and for the great wealth that still exists in the world, albeit highly concentrated, to be more evenly spread in order to reduce inequalities (SDG 10). Indeed, COVID-19 responses represent a window of opportunity for sustainable and just transitions but swift action and global support, particularly from wealthy nations and industries, is needed to fully realize this potential.

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[27] International Council for Science (ICSU). 2017. A Guide to SDG Interactions: from Science to Implementation. Griggs, D.J., Nilsson, M., Stevance, A. and McCollum, D. (eds). International Council for Science, Paris.
[28] OECD. 2020. Building a coherent response for a sustainable post-COVID-19 recovery
[29] International Council for Science (ICSU). 2017. A Guide to SDG Interactions: from Science to Implementation. Griggs, D.J., Nilsson, M., Stevance, A. and McCollum, D. (eds). International Council for Science, Paris.
[30] OECD. 2020. Building a coherent response for a sustainable post-COVID-19 recovery
[31] Scholz, I., Kloke-Lesch, A., Lepenies, R., et al. 2020. Dealing with interlinkages – A focused approach for implementing the SDGS and overcoming the Covid-19 crisis. G20 Insights. https://www.g20-insights.org/policy_briefs/dealing-with-interlinkages-a-focused-approach-for-implementing-the-sdgs-and-overcoming-the-covid-19-crisis/
[32] Shulla, K., Voigt, B.F., Cibian, S. et al. 2021. Effects of COVID-19 on the Sustainable Development Goals (SDGs). Discover Sustainability 2, 15 (2021). DOI: 10.1007/s43621-021-00026-x
[33] UNDP. 2020. Impact of COVID-19 on the Sustainable Development Goals. https://sdgintegration.undp.org/accelerating-development-progressduring-covid-19

Common drivers of unsustainability and pandemics

Anthropogenic activities are driving ecological disruption and leading to climate change and biodiversity loss, and are also driving increased pandemic risk.[34] COVID-19 has underscored the wider tension between human production and consumption patterns and ecological balances. Our agriculture and food systems represent one of the most important interfaces between human activities and the environment.[35] Agricultural expansion and intensification to meet the needs of a growing global population is one of the biggest threats to biodiversity globally due to land-use change and habitat fragmentation and loss. Land-use change, including deforestation, human settlement in primarily wildlife habitat, the growth of crop and livestock production, and urbanization have contributed to increased wildlife–livestock–human contact. This has caused the emergence of more than 30% of new diseases reported since 1960.[36]

The recent exponential rise in consumption and trade, driven by demand in high-income countries and emerging economies, as well as by demographic pressure, has led to an increase of emerging diseases. Emerging infectious diseases tend to originate in rural communities in biodiverse low-income countries often lacking resources for early detection of outbreaks, and to combat spillover and spread. Growing population, chaotic urbanization, domestic trade networks, globalized trade and international travel patterns contribute to the spread of infectious diseases and the emergence of pandemics. High-income countries are more exposed to, and very often quickly affected by, infectious diseases emerging from biodiverse low-income countries considering their dependence on globalized trade and travel. In this context, the risk of the emergence of pandemics could be lowered by reducing anthropogenic impacts, particularly in countries that are under the highest risk of disease emergence and characterized by high biodiversity. Efforts are also needed to understand the complex and sometimes obscure interactions among drivers of disease.[37] In addition, increased surveillance, early warnings and preparedness for identifying, preventing and responding to transboundary health risks are essential to avoid future pandemics like COVID-19. To be successful this will require greater collaboration and cooperation for sustainability between states, corporations and citizens.

Climate change and biodiversity loss will continue to drive the emergence of infectious diseases and pandemics if rapid action is not taken to reduce human-caused global environmental change and to tackle these global challenges. Climate change has already been associated with disease emergence (e.g. tick-borne encephalitis in Scandinavia) and is expected to lead to increased pandemic risk by driving movement of people and animals, allowing microbes to make contact with new hosts.[38] In addition, the risk of emerging disease is increased by the decline in biodiversity associated with changes to natural landscapes, leading to increased contact between humans,

[34] IPBES. 2020. Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., das Neves, C. et al. IPBES Secretariat, Bonn, Germany, DOI: 10.5281/zenodo.4147317

[35] Sperling, F., et al. 2020. IIASA–ISC Consultative Science Platform: Resilient Food Systems. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.

[36] IPBES. 2020. Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., das Neves, C. et al. IPBES Secretariat, Bonn, Germany, DOI: 10.5281/zenodo.4147317

[37] Ibid.

[38] Ibid.

wildlife and livestock. For instance, human expansion into undeveloped areas increases the pool of pathogens that can move from animals to humans.[39] Reducing anthropogenic global environmental change by promoting responsible and sustainable consumption and production, as well as reducing unsustainable exploitation and encroachment of humans and livestock into biodiverse habitats can help prevent the spread of novel pathogens.[40]

Risks

Recovery plans should not contribute to the aggravation of ongoing environmental crises

A truly transformative recovery from COVID-19 will be one that is aligned with the principles of the SDGs which will allow governments to combine economic recovery plans with a transformative sustainability agenda that leaves no person and no place behind. COVID-19 must not become the excuse for insufficient efforts towards the SDGs. The trillions of dollars in stimulus packages announced by governments worldwide represent a unique opportunity to take decisive steps towards sustainability by channelling investments towards new sustainable growth opportunities and decent jobs while achieving the SDGs at the scale and speed necessary. However, recent analysis by the Global Recovery Observatory revealed that only 18% of recovery spending is likely to reduce greenhouse gas (GHG) emissions, while only 3% of recovery spending is deemed positive for the Earth's ecosystems and up to 17% may have negative effects on them.[41] Failure to mobilize a green and resilient recovery would further exacerbate long-term social and ongoing environmental crises. Aligning recovery packages and the SDGs will make their attainment feasible considering that annual investment requirements across all sectors to achieve the global goals have been estimated at around US$5 to $7 trillion.[42] In this context scientists have been setting out clear strategies for action. For example the German Science Platform Sustainability 2030 made several recommendations for a sustainable and resilient recovery which include strengthening the government's organizational capacities to implement its sustainability strategy, embracing comprehensive foresight measures – a '360° crisis scan' – to inform policy-making for sustainable development, and addressing the concepts of resilience and sustainability in a more integrated manner.[43]

COVID-19 response and recovery plans should give special attention to the climate and biodiversity emergencies, which are threatening the stability of the Earth system and undermining society's chances of achieving the SDGs. These emergencies are creating vulnerabilities of a similar magnitude and urgency, and are fundamentally interlaced, with climate change projected to become an increasingly important driver of biodiversity loss.[44] Environmental changes are projected to increase and accelerate in the coming decades due to further expansion of human activities, which will lead to an intensified exploitation and further degradation of our natural systems. These are

[39] Tollefson, J. 2020. Why deforestation and extinctions make pandemics more likely. Nature 584, 175–176. DOI: 10.1038/d41586-020-02341-1

[40] IPBES. 2020. Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., das Neves, C. et al. IPBES Secretariat, Bonn, Germany, DOI: 10.5281/zenodo.4147317

[41] United Nations Environment Programme, 2021. Are we building back better? Evidence from 2020 and Pathways o Inclusive Green Recovery Spending

[42] Fajans-Turner, V. 2020. Filling the finance gap

[43] WPN2030 Press release. 2020. Make sustainability a top priority to bolster resilience!

[44] Secretariat of the Convention on Biological Diversity (2020) Global Biodiversity Outlook 5. Montreal. https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf

expected to exacerbate poverty (SDG 1) particularly in low-income countries; slow down efforts to reduce inequalities within and among countries (SDG 10); and to work against both inclusive and sustainable economic growth and decent work for all (SDG 8) and the promotion of peaceful and inclusive societies (SDG 16). If current trends continue, achieving food security and improved nutrition and promoting sustainable agriculture (SDG 2) will not be feasible.[45]

Our global biodiversity is declining at alarming and unprecedented rates, while world leaders conclude that none of the 20 Aichi Targets in the Strategic Plan on Biodiversity 2011–2020 has been fully met[46]. The recent Global Assessment by IPBES[47] has shown that most indicators of the state of nature, related to the extent and integrity of ecosystems, distinctness of local ecological communities, abundance and number of wild species, and the number of local domesticated varieties, are declining.[48] This has weakened nature's capacity to provide vital benefits that are indispensable for humanity's well-being and prosperity, including regulating environmental processes such as modulating air and water quality, sequestering carbon, building healthy soils and pollinating crops.[49] In addition, recent data reveals the extent of human activities' impact on living nature: at least 70% of land surface has been altered; 1 million species of animals and plants are threatened with extinction; and forests span only 68% of their preindustrial size.[50,51] Investing in biodiversity as part of the COVID-19 policy response can help minimize the risks that its decline poses to human well-being, while also reducing the risk of future crises and improving the resilience, health and long-term viability of businesses and the economy.

The world is failing to meet its commitments to limit environmental damage and is set to miss the Paris Agreement targets to keep warming well below 2°C and to stabilize global warming at 1.5°C.[52] The substantial drops in GHG emissions during lockdowns are unlikely to have any significant long-term impact on global emission trajectories.[53] Recovery must not entail reinstating historical development pathways, and should instead focus on new investments to lock humanity into more sustainable pathways. To do otherwise risks global average temperature increases well beyond 2°C, which would lead to sea level rise, threatening the infrastructure, livelihood and safety of many coastal cities and millions of people around the world, and damage to coastal ecosystems. Marine ecosystems, including coral reefs, are already experiencing the combined effects of warming, changing currents and ocean acidification. This warming would also be accompanied by observed

[45] United Nations Environment Programme. 2021. Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi. https://www.unep.org/resources/making-peace-nature

[46] Secretariat of the Convention on Biological Diversity. 2020. Global Biodiversity Outlook 5. Montreal. https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf

[47] IPBES. 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Brondizio, E.S., Settele, J., Díaz, S. and Ngo, H.T. (eds). IPBES Secretariat, Bonn, Germany.

[48] Diaz, S. et al. 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. Science 366(6471). DOI: 10.1126/science.aax3100

[49] Ibid.

[50] Ibid.

[51] Intergovernmental Panel on Climate Change (IPCC). 2019. IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems, A. Arneth et al., (eds.).

[52] United Nations Environment Programme. 2021. Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi, UNEP.

[53] Future Earth, The Earth League and WCRP. 2021. 10 New Insights in Climate Science 2020. Stockholm, Future Earth.

increases in intensity and frequency of extreme weather and climate events, including heatwaves on land and in the oceans (marine heatwaves); extreme bushfire weather; and heavy rainfall. All of these have significant impacts on the health and well-being of our communities and ecosystems as well as infrastructure and economies.[54,55] As well as supporting recovery from the pandemic, stimulus packages must be aimed at restricting global warming to 1.5°C, including reducing the risk of some irreversible impact and addressing the loss and damages that have been incurred. Research has shown that decarbonization is compatible with economic recovery. Besides the positive impacts of decarbonization on population health, green projects create more jobs, deliver higher short-term returns on investment, and lead to higher long-term cost savings.[56] To do otherwise would be a false economy, providing short-term fixes which would exacerbate long-term impacts.

Responses

COVID-19 and the existential challenges humanity is currently facing call for new governance arrangements that advance a strengthened social contract, systemic and social resilience and just transitions

The COVID-19 pandemic has revealed the deficiencies and vulnerabilities of the current multilateralism system.[57] It has emphasized the need to build effective governance structures that would enable the world to respond collectively to shared global risks posed not only by COVID-19 and other infectious diseases, but also by ongoing environmental degradation, accelerating climate change, rapid technological change and rising inequalities.[58] The response to such global challenges requires not only global cooperation, but also global solidarity – the COVID-19 pandemic offers a great opportunity to reconfigure the current multilateral system to become more inclusive and fairer.[59] As described by the UN Secretary-General, this renewed multilateralism must be geared towards the overarching goals of peace and security, human rights and sustainable development.[60] Shaping the new multilateral system needs to be based on an inclusive process employing a whole-of-society approach in order to benefit from increased legitimacy and citizen ownership. A recent report, Renewing multilateralism for the 21st century[61], highlighted some

[54] IPCC, 2019. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press. IPCC 1.5

[55] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., et al. (eds.)]. In Press.

[56] IAP. 2020. Global Green Recovery After COVID-19: Using scientific advice to ensure social equity, planetary and human health, and economic benefits. https://www.interacademies.org/sites/default/files/2020-07/IAP_Green_Recovery.pdf

[57] Future Earth, The Earth League and WCRP. 2021. 10 New Insights in Climate Science 2020. Stockholm, Future Earth.

[58] IIASA-ISC . 2020. Enhancing governance for sustainability. https://council.science/wp-content/uploads/2020/06/IIASA-ISC-Reports-Governance.pdf

[59] Foundation for European Progressive Studies. 2020. Renewing multilateralism for the 21st century. The role of the United Nations and the European Union. https://www.iai.it/sites/default/files/9782930769455.pdf

[60] UN News. 2020. COVID-19 highlights need for renewed, inclusive multilateralism. https://www.un.org/en/desa/covid-19-highlights-need-renewed-inclusive-multilateralism

[61] Foundation for European Progressive Studies. 2020. Renewing multilateralism for the 21st century. The role of the United Nations and the European Union. https://www.iai.it/sites/default/files/9782930769455.pdf

fundamental principles that align with the goals of the SDGs, including: focus on well-being for all and on a new relationship with the planet and nature, according to the One Health principle; focus on reducing intra-country, inter-country and inter-generational social inequalities; being inclusive of all human beings, assuming the same fundamental rights for all; as well as developing a knowledge-intensive governance using consultation, participation, cooperation, joint learning and artificial intelligence.

Current events offer important opportunities to rethink the very foundations of our societies and to move away from existing economic and social systems that produce and reinforce vulnerabilities, social inequality and systemic risks.[62] To achieve sustainable development it is imperative to advance risk-informed (anticipatory) governance arrangements with a view to building whole-of-society resilience. This implies uncertainty management, risk prevention, risk–benefit balancing, risk communication and compensation for risks. Fulfilling the SDGs efficiently requires specific attention to risks and more multi-faceted and rigorous analyses of risk governance, starting from the identification of the most relevant types of risk.[63] COVID-19 recovery packages must therefore focus on risk governance, integrate sustained investments into SDGs and SDG-wide resilience to maximize the potential to lead to longer-term transformations.

The IIASA–ISC Consultative Science Platform on Enhancing Governance for Sustainability[64] **put forward a set of recommendations for enhancing governance arrangements at all levels to enable the necessary shift towards sustainability and resilience in view of increasing compound and systemic risk.** At the global level, the Platform recommends building processes that allow international organizations to be more cooperative and proactive in identifying and redressing key drivers of risk before they even manifest themselves. A series of concrete actions have been identified including establishing regular exchange and coordination platforms among institutions with similar or connected mandates and objectives; strengthening global science–policy–society interfaces to enable evidence-informed, participatory decision-making; and upgrading accountability and transparency provisions allowing more integrated approaches. It also underscores, in view of the deep connectedness of our world, the need to boost awareness and understanding of compound and systemic risks across governance arrangements at all levels, which could be achieved through a global socio-ecological resilience and risk dialogue engaging a wide range of stakeholders. In addition, the report emphasizes the need to elevate resilience as a core government priority within nation states in the process of making systemic transformations towards sustainability.[65] Such reconfiguration of governance arrangements requires that resources are redirected to support them.

Recovering from COVID-19 and achieving 'peaceful, just and inclusive' societies as pledged by SDG 16, while addressing ongoing and emerging sustainability challenges, requires trusted and

[62] Future Earth, The Earth League and WCRP. 2021. 10 New Insights in Climate Science 2020. Stockholm, Future Earth.
[63] Lyytimaki, J., Primeer, E., Lepenies, R. et al. 2019. Sustainable development needs comprehensive risk awareness. Peer Policy Brief. https://www.peer.eu/files/user_upload/user_upload/projects/TRISD/PEER-TRISD_PolicyBrief_2019_update_may2020.pdf
[64] Mechler, R. et al. 2020. IIASA–ISC Consultative Science Platform: Enhancing governance for sustainability. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.
[65] Ibid.

effective governance institutions.[66] A recent report entitled Governance and COVID-19[67] underscores that building effective, accountable and transparent institutions (SDG 16.6) at all levels of governance is key to tackling poverty, reducing inequality and providing the effective and inclusive public services demanded by citizens. This is equally essential for developing the transformative long-term policies needed to stabilize the climate, protect the environment and defend all societies against catastrophic risks such as antimicrobial resistance or emerging infectious diseases. Building a new social contract is one of the overarching missions for governance in the coming decade put forward by the abovementioned report. At the national level this means strengthening social protection systems, including cementing social protection measures introduced during the pandemic; creating more spaces for dialogue and participation in governance; promoting the inclusive engagement of all society sectors; and tackling the drivers of mistrust in public institutions, such as corruption, as COVID-19 response plans have focused less on governance and corruption-related risks.

The COVID-19 crisis provides an opportunity to drive just transitions towards climate-neutral and sustainable economies, which can ensure environmental sustainability as well as decent work, social inclusion and poverty eradication.[68] The transition to environmentally sustainable economies and societies presents both major opportunities and challenges for countries. However, there is growing consensus that the positive impacts of a green economy can prevail over negative consequences[69] if managed properly and fairly with the full engagement of governments, workers and employers' organizations in a broad social dialogue.[70] Such a transition could offer some major opportunities, including net gains in total employment, by creating additional decent jobs through investments in environmentally sustainable production and consumption and the management of natural resources; improving job quality and incomes on a large scale; and enabling social inclusion through improved access to affordable, environmentally sustainable clean energy with health benefits for all.[71]

COVID-19 has brought to the fore the symbiotic nature of the human and planetary health relationship, therefore providing an opportunity to use planetary health as a new guiding development narrative.[72] The degradation of Earth's natural systems and changes to the environment including climatic change, ecosystem degradation, water scarcity, overexploitation of fisheries and biodiversity loss pose serious risks to human civilization and health and are likely to become increasingly dominant in the Anthropocene.[73] The global developments and environmental changes, which have created the conditions for COVID-19 to emerge, have revealed health as a

[66] Steven, D. and Williams, M. 2021. Governance and COVID-19: a Background Paper for the 2021 SDG16 Conference. https://530cfd94-d934-468b-a1c7-c67a84734064.filesusr.com/ugd/6c192f_70a36614cf6f445c8d73a781dd1dad3e.pdf
[67] Ibid.
[68] Just Transition Centre. 2017. Just Transition: A Report for the OECD.
[69] Hepburn, C., O'Callaghan, B., Stern, N., Stiglitz, J., and Zenghelis, D. 2020. 'Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?', Smith School Working Paper 20-02.
[70] ILO. 2013. Sustainable Development, Decent Work and Green Jobs. International Labour Conference, 102nd Session, Report V. Geneva, International Labour Organization.
[71] UNFCCC. 2020. Technical Paper. Just Transition of the Workforce, and the Creation of Decent Work and Quality Jobs
[72] De Paula, N. and Willetts, E. 2021. COVID-19 and Planetary Health: How a Pandemic Could Pave the Way for a Green Recovery. IISD Earth Negotiations Bulletin.
[73] Whitmee, S., Haines, A., Beyrer, C. et al. 2015. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. The Lancet 386(10007), 1973–2028. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60901-1/fulltext#bib32

common denominator across all sectors and disciplines, suitable for an integrative approach towards multiple interlinked SDGs. Hence policy-makers need to design and promote recovery packages, measures and interventions based on WHO's 'One Health'[74] approach recognizing that the health of humans is intimately connected to the health of animals and the environment. Adopting such an 'I, we, planet' approach requires the appropriate valuing of care, care for ourselves, each other and non-human nature.

Improving the understanding of the complex interrelationships between ecosystems and their biodiversity, topography and landforms, which are shaped in part by the underlying geology and geological processes on the land surface and subsurface, is key to improving health and well-being (SDG3). This will require increased collaboration between earth scientists, ecologists and health professionals. UNESCO Global Geoparks provide one opportunity to protect geodiversity, and explore, develop and celebrate the links between geodiversity and public health, as well as poverty alleviation, education and sustainable tourism. In this context, governments must endorse the call to create an International Geodiversity Day to raise awareness of the essential role of Earth science knowledge.

Recovery packages should support and invest in integrated and consistent approaches to deal with the challenges posed by climate change, biodiversity loss and achieving a sustainable, equitable and resilient future. These would facilitate positive and synergistic impacts, helping ensure that multiple objectives are achieved simultaneously while avoiding unintended negative impacts. These policies and measures are called synergy drivers.[75] By advancing multiple goals at the same time, synergy drivers have the potential to save resources in achieving the SDGs, a high priority in the post-pandemic era of shrinking resources. The primary principle for the green recovery should be to seek co-benefits for social equity, planetary and human health, as well as for the economy.[76] For instance, focusing recovery plans on promoting and investing in nature-based solutions[77] can provide simultaneously economic, social and environmental benefits and help build resilience.[78] Recent research has shown their potential to provide around one-third of the net reductions in GHG emissions required to keep climate change below 1.5°C. Nature-based solutions also enhance a wide range of ecosystem services, including water filtration, flood and coastal protection, soil health, healthy diets and food security, as well as contributing to the conservation and sustainable use of biodiversity.[79] In addition, recent economic analysis indicates that industry actions that have a

[74] https://www.who.int/westernpacific/news/q-a-detail/one-health

[75] Alcamo, J., Thompson, J., Alexander, A., Antoniades, A., Delabre, I., Dolley, J., Marshall, F., Menton, M., Middleton, J. and Scharlemann, J. 2020. Analysing interactions among the sustainable development goals: findings and emerging issues from local and global studies. Sustainability Science 15, 1561–1572.

[76] IAP. 2020. Global Green Recovery After COVID-19: Using scientific advice to ensure social equity, planetary and human health, and economic benefits. https://www.interacademies.org/sites/default/files/2020-07/IAP_Green_Recovery.pdf

[77] Nature-based solutions are actions that protect, sustainably manage, and restore ecosystems in ways that address societal challenges to provide both human well-being and biodiversity benefit. IUCN. Nature-based solutions. http://www.iucn.org/theme/nature-based-solutions/about

[78] European Commission (EC). 2015. Towards an EC research and innovation policy agenda of nature-based solutions and re-naturing cities. European Commission (EC), Brussels.

[79] Secretariat of the Convention on Biological Diversity. 2020. Global Biodiversity Outlook 5. Montreal. https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf

positive impact on nature could generate as much as $10.1 trillion in new opportunities for business and 395 million new jobs by 2030.[80]

Additional examples of synergy drivers include specific interventions in the food system:[81,82] for example, crop residue recycling, improved livestock management, agroforestry, increasing soil organic carbon content, reducing post-harvest losses and food waste, and dietary changes. These actions increase food security and therefore advance SDG 2 on zero hunger. They support climate goals, including SDG 13 on climate action, by either reducing emissions or increasing resilience in the food system, and sometimes both. In some cases, these interventions are effective strategies for combating land degradation and deforestation (SDG 15).

With more than half of the world's population now living in cities and a further 1 billion urban inhabitants projected to join urban settlements by 2030, urban areas must necessarily facilitate sustainability, and should be considered as a key player in creating sustainable responses. More than 150 cities have begun to 'localize' the 2030 Agenda proving that urban governments and other actors have a critical role to play in partnering for and implementing the SDGs. The University of Melbourne's Connected Cities Lab is partnering with the City of Melbourne, Australia with the aim of developing a state-of-the-art SDG localization framework tailored to the city's existing data collection processes, strategic planning environment and governance settings. Another example is the city of Medellín, Colombia, which has developed a strategy for the implementation of SDGs called Agenda Medellín 2030; the city has become an important benchmark for many cities in the region and in the Global South. The administration found 16 goals, 110 targets and 190 indicators to be applicable to the context of the city.[83] These examples prove how local actors can exceed national efforts on the SDGs; sub-national agencies can not only accelerate national government efforts in areas such as climate action, but also have a clearer 'line of sight' to those who are vulnerable or 'left behind' at a local scale.

Science indicates the need for radical system change

Transitions toward sustainability which encompass mitigating climate change, restoring biodiversity and reversing recent declines, as well as solving other societal challenges, are only possible with urgent, and fundamentally transformative, change.[84,85] A global transformation is required to rewire all sectors of society, from food production to energy supply, transport, consumption and production patterns, and health systems. It implies simultaneously and holistically

[80] WEF (World Economic Forum). 2020b. The Future of Nature and Business Policy Companion: Recommendations for policy-makers to reset towards a new nature economy. In Collaboration with SYSTEMIQ. July.
[81] Smith, P. et al. 2020. Which practices co-deliver food security, climate change mitigation and adaptation, and combat land degradation and desertification? Global Change Biology 26, 1532–1575.
[82] Kanter, D. and Brownlieb, W. 2019. Joint nitrogen and phosphorus management for sustainable development and climate goals. Environmental Science and Policy 92, 1–8.
[83] Mejía-Dugand, S. and Pizano-Castill, M. 2020. Touching down in cities: Territorial planning instruments as vehicles for the implementation of SDG strategies in cities of the Global South. Sustainability 12, 6778. DOI: 10.3390/su12176778
[84] Diaz, S. et al. 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. Science 366(6471). DOI: 10.1126/science.aax3100
[85] Henry, C., Rockström, J. and Stern, N. 2020. Standing up for a Sustainable World. Cheltenham/Northampton: Edward Elgar Publishing.

reshaping these systems and the interactions between them. To build sustainable futures, existing narratives about the causes of inequality, environmental urgencies and pandemics must be challenged with scientific evidence and revised. Reconstructing new narratives will allow the development of policies that address the underlying causes of the challenges we face. Transformative changes therefore need to be supported by fair and participatory governance systems and processes bringing together the voices of all relevant stakeholders on an equal footing.

Recent scientific reports and assessments have proposed transformation frameworks underscoring key systemic areas of intervention, as well as levers of change, that would yield and drive large-scale changes towards sustainability. There is an urgent need to act on scientific evidence and move from these frameworks to action. Identifying barriers to change as well as leveraging points is a crucial step in the transformation to sustainability process. The 2019 UN Global Sustainable Development Report (UN GSDR) highlights six entry points for transformations: human well-being and capabilities; sustainable and just economies; energy decarbonization and access; food systems and nutrition patterns; urban and peri-urban development; and global environmental commons, and four levers of change: governance; economy and finance; individual and collective action; and science and technology.[86] The TWI2050 report[87] and Sachs et al. (2019)[88] provide similar actionable transformation frameworks. The 2019 IPBES Global Assessment[89] underscores five main 'levers': incentives and capacity-building; cross-sectoral cooperation; pre-emptive action; decision-making in the context of resilience and uncertainty; and environmental law and implementation, and eight leverage points: visions of a good life; total consumption and waste; values and action; inequalities; justice and inclusion in conservation; externalities and telecoupling; technology, innovation and investment; and education and knowledge generation and sharing.[90]

Any transformation framework must take into account the dynamic, interdependent and multi-level nature of social and environmental systems, not least the close relationship between sustainability and equity, and questions of power and politics. Operationalizing frameworks such as those offered in the GSDR 2019, TWI 2050 report and the 2019 IPBES Global Assessment will require transformative alliances between researchers, governments, business, civil society and other actors, to ensure that chosen pathways enable those who typically have less power to be meaningful actors in the visioning and process of change. Creating enduring transformative change will require concerted top-down strategies, such as changes in the rules that govern the global economy and redistributive measures such as labour and market regulations, progressive tax regimes, universal health and education access. Simultaneous, bottom-up experiments and collective actions are also required to achieve and sustain impact, including community-based management of land, forests, fisheries or waste.[91] Furthermore, different combinations of state-led, market-led, technology-led

[86] Independent Group of Scientists appointed by the Secretary-General. 2019. Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development. United Nations, New York.
[87] TWI2050 - The World in 2050. 2018. Transformations to Achieve the Sustainable Development Goals. Report prepared by The World in 2050 initiative. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. DOI: 10.22022/TNT/07-2018.15347
[88] Sachs, J.D., Schmidt-Traub, G., Mazzucato, M. et al. 2019. Six transformations to achieve the Sustainable Development Goals. Nature Sustainability 2, 805–814. DOI: 10.1038/s41893-019-0352-9
[89] https://ipbes.net/global-assessment
[90] IPBES. 2019. Summary for policy-makers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Díaz, S., Settele, J., Brondízio, E.S. et al. (eds.). IPBES Secretariat, Bonn, Germany.
[91] Leach M. et al. 2018. Equity and sustainability in the Anthropocene: a social–ecological systems perspective on their intertwined futures. Global Sustainability 1, e13, 1–13. DOI: 10.1017/sus.2018.12

and citizen-led strategies towards sustainability transformations will need to be adapted to national and regional settings to reflect the diverse nature of economies, societies and political systems.[92]

To create and steer true systems change, strategic collaborations must identify and act on opportunities to affect the whole system. **Donella Meadows identified twelve leverage points – places in complex systems where relatively small changes can lead to potentially transformative systemic changes – requiring collaborative efforts:** the power to transcend paradigms; the mindset or paradigm out of which the system – its goals, structure, rules, delays, parameters – arises; the goals of the system; the power to add, change, evolve or self-organize system structure; the rules of the system (such as incentives, punishments, constraints); the structure of information flows (who does and does not have access to information); the gain around driving positive feedback loops; the strength of negative feedback loops, relative to the impacts they are trying to correct; the lengths of delays, relative to the rate of system change; the structure of material stocks and flows (such as transport networks, population age structures); the sizes of buffers and other stabilizing stocks, relative to their flows; and constants, parameters and numbers (such as subsidies, taxes and standards).[93]

A key element of sustainable pathways is the shift of the global economic and financial system to a model that can sustainably increase well-being by decoupling economic activities from the negative effects of resource use and recoupling humanity's existence with natural ecosystems. Incorporating the multiple values of ecosystem functions and of non-human nature's contributions to people into economic incentives has proved to enable better ecological, economic and social outcomes.[94] Current social, economic and financial systems fail to account for the value of nature's contributions to human well-being and hence fail to provide incentives to manage ecosystems in a sustainable manner and maintain their value. Science has shown that it is possible to do things differently, for instance, aligning private incentives with social and environmental objectives could be the first step in this regard. Such a shift could be enabled through stricter taxes on environmentally harmful activities, the abolition of subsidies that have negative effects on the environment and that damage global commons, as well as payments for ecosystem services or tax breaks for environmentally friendly economic activities.[95] In addition, governments must strengthen and enforce environmental regulations and develop sustainable, evidence-informed policies for the protection and use of natural resources and biodiversity.[96]

Progress can no longer be defined in terms of economic growth and should instead serve the broader objective of well-being.[97] GDP and its associated economic model simultaneously overvalues and over-rewards production (financial) capital while undervaluing and under-rewarding human and natural capital. Redefining current measures of economic performance to become more

[92] Scoones, I., Leach, M. and Newell, P. (eds). 2015. The Politics of Green Transformations. London: Routledge.
[93] Meadows, D.H. 2009. Thinking In Systems: A Primer. London; Sterling, VA: Earthscan.
[94] IPBES. 2019. Summary for policy-makers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Díaz, S., Settele, J., Brondízio, E.S. et al. (eds.). IPBES Secretariat, Bonn, Germany.
[95] Ibid.
[96] Global Young Academy. 2020. Position statement from the Global Young Academy 2020 Virtual International Conference of Young Scientists. Heal the Earth: Sustainable Development Goals in a Changing World. https://globalyoungacademy.net/wp-content/uploads/2020/09/Heal-the-Earth-conference-statement-1.pdf
[97] Global Young Academy. 2020. GYA-ISC Dialogue on Rethinking Human Development. https://globalyoungacademy.net/gya-isc-dialogue-on-rethinking-human-development/

holistic and therefore powerful levers to achieve a just and prosperous society[98] requires deep changes in power dynamics and status quo, as well as in values, norms, practices and institutions, which have been actively resisted so far.

Transforming our world's food systems and accelerating the energy transition are essential pillars of a sustainable and resilient recovery

With the looming risk of future pandemics, shocks associated with climate change, and the global environmental and socio-economic challenges that are compounding local pressures, the way food systems are framed needs to change.[99] The COVID-19 crisis has proven to be a crisis of the poor, underlining that resilience building and poverty alleviation efforts are intrinsically linked.[100] The current prevailing focus of food systems on efficiency must be counter-balanced by an emphasis on sustainability principles with a particular focus on equity and resilience for the food system to meet intertwined social, economic and environmental challenges. The IIASA–ISC Consultative Science Platform on Food Systems[101] has identified a set of key action areas to empower a systemic shift toward resilience and equity which include:

- expanding the benefits, reach and duration of social safety nets and giving people employed informally a pathway to join social security structures to mitigate the impact of future unemployment and crisis situations;
- promoting sustainable farm models, recognizing sociocultural heterogeneity and specific development and environmental contexts;
- strengthening the technical and financial support for smallholder farmers for poverty alleviation and to enable transitions towards more secure livelihoods;
- and re-configuring supply chains and trade dependencies, based on an evaluation of their likely capacity to absorb and adapt to socio-economic and environmental shocks.

The transformation of food systems is imperative to limit the emergence of threats similar to COVID-19[102] and to reduce their pressure on the environment: food systems are currently contributing approximatively 30% of global GHG emissions.[103] Research has shown how adaptations in cultivation or animal rearing practices could minimize the overall pressure on ecosystems and the environment. For instance, increasing crop yield and livestock conversion efficiency is achievable in many regions of the world and could both reduce GHG emissions and improve global food security. Enhancing soil organic carbon through conservation farming practices can generate win–win solutions for food security by increasing the land carbon sink and increasing

[98] Potočnik, J., Dixson-Declève, S. and Stuchtey, M.R. 2020. A System Change Compass: Implementing the European Green Deal in a Time of Recovery. SYSTEMIQ and the Club of Rome.
[99] Jackson, P., Rivera Ferre, M.G., Candel, J. et al. 2021. Food as a commodity, human right or common good. Nature Food 2, 132–134. DOI: 10.1038/s43016-021-00245-5
[100] Sperling, F., et al. 2020. IIASA–ISC Consultative Science Platform: Resilient Food Systems. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.
[101] Ibid.
[102] Ibid.
[103] Watts, N., Amann, M., Arnell, N. et al. 2021. The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. Lancet 397, 129–170.

crop productivity.[104] In addition, placing human and planetary health at the centre of food systems is essential to limit the emergence of threats similar to COVID-19. Concrete actions in this regard put forward by the IIASA–ISC Consultative Science Platform on Food Systems[105] include:

- adopting ambitious biodiversity and ecosystem conservation targets to guard human and environmental health across scales;
- accelerating the shift toward affordable, healthy and environmentally sustainable diets, and associated production;
- prioritizing investments in improving water access and sanitation;
- providing protection for the essential agricultural and food system workforce; and
- strengthening environmental regulations, monitoring capacities and enforcement mechanisms.

Innovation and adoption of better technologies and practices are essential to shape sustainable and resilient food systems, while at the same time increasing agricultural production to feed a growing and increasingly wealthy population. The pandemic illustrated how digital technologies can help some supply chains to rapidly adapt to the shock of the global lockdown. During the recovery process, actions such as financial support, knowledge transfer and training, and collaborative mechanisms for low-income countries need to be deployed to avoid a widening technology and capacity gap between countries. These actions need to be coupled with a focus on greater diversification of agricultural production including opening up new and alternative food sources and support for livelihood opportunities through appropriate education and skills development. In addition, advancing innovation will require the proper enabling environment for private-sector engagement, including a fresh look at public–private partnerships and interactions with the research community.[106]

Accelerating sustainable energy transitions is key to meeting the global goal of limiting temperature increases well below 2°C and therefore avoiding the destabilization of climate and general devastation of nature. Choices made in the recovery process concerning the energy system will increase or decrease vulnerability in other key systems such as health, food and cities, and will either advance or undermine efforts to reach the SDGs.[107] In its Communiqué on global green recovery after COVID-19[108] the InterAcademy Partnership (IAP) underscored a series of actions aimed at accelerating the energy transition, including concomitant investment in electricity networks including storage (batteries, hydrogen and synthetic fuels) and smart systems to manage the flexibility of the grid. The paper highlights that technological advances, if effectively integrated with other rural development initiatives, can create new possibilities to increase incomes, provide services and empower communities while providing sustainable and affordable power. In addition to

[104] Sperling, F., et al. 2020. IIASA–ISC Consultative Science Platform: Resilient Food Systems. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.
[105] Ibid.
[106] Ibid.
[107] Zakeri, B. et al. 2020. IIASA–ISC Consultative Science Platform: Rethinking energy solutions. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.
[108] IAP. 2020. Global Green Recovery After COVID-19: Using scientific advice to ensure social equity, planetary and human health, and economic benefits. https://www.interacademies.org/sites/default/files/2020-07/IAP_Green_Recovery.pdf

technology availability, achieving decentralized energy provision requires local capacity-building and coordinated policy frameworks.[109]

The transformation of energy systems must be based on three essential pillars identified by the IIASA-ISC Consultative Science Platform on Rethinking energy solutions: harnessing the power of collective responsible behaviour; science and engineering innovation; and ensuring a just energy transition.[110] Public information campaigns encouraging more sustainable energy and transport practices can be an effective option for governments seeking to create long-term shifts in energy and travel demand, while bottom-up pressure from the public can push governments to create the infrastructure required to transform energy and mobility habits and decarbonize those same sectors. Research and innovation will be critical elements in achieving the objectives of numerous governments and companies to reach net-zero carbon emissions in the coming decades, with social sciences playing a key role in understanding attitudes, norms, incentives and politics that favour unsustainable practices. Engineers have a role to play in informing choices by adopting systemic approaches that put forward mature, immediately available technologies.[111] In addition, fair transition mechanisms focusing on the people, regions and sectors most affected by the energy and climate transitions can help create new jobs and new economic activities through a combination of education and retraining, social support, local economic development tools for communities, and support for the creation of new businesses, among other things.[112]

The IIASA-ISC Consultative Science Platform on Rethinking energy solutions[113] underscores three areas for policy intervention toward a sustainable energy transition in the light of COVID-19 impacts: reimagining consumption through the advancement of a circular and sharing economy and citizen engagement; reinventing urban space, infrastructure and mobility; and advancing decentralized and resilient energy systems, including energy efficiency improvement measures. The report advances a series of actions in each area of intervention in the short-, medium- and long-term, including:

- implementing policies to promote sustainable consumption and production;
- promoting circular economy;
- applying policies to trigger behavioural change toward more energy- and resource-efficient and low-carbon consumption patterns;
- promoting digital innovations;
- making sustainable products and services accessible and affordable to low-income and vulnerable populations;
- designing cities as urban villages and compact neighbourhoods with access to essential services within a short distance;

[109] Holmes. J. 2017. The Smart Villages Initiative: Findings 2014-2017. www.e4sv.org
[110] Zakeri, B. et al. 2020. IIASA–ISC Consultative Science Platform: Rethinking energy solutions. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.
[111] UNESCO. 2021. Engineering for sustainable development: delivering on the Sustainable Development Goals. https://unesdoc.unesco.org/ark:/48223/pf0000375644.locale=en
[112] Henry, M.S., Bazilian, M.D. and Markuson, C. 2020. Just transitions: Histories and futures in a post-COVID world. Energy Research & Social Science 68, 101668. https://www.sciencedirect.com/science/article/pii/S2214629620302437?via%3Dihub
[113] Zakeri, B. et al. 2020. IIASA–ISC Consultative Science Platform: Rethinking energy solutions. Thematic Report of the International Institute for Applied Systems Analysis (IIASA), Laxenburg, and the International Science Council (ISC), Paris.

- promoting shared mobility services for different target groups, including underserved low-income populations; reducing or eliminating fossil fuel subsidies;
- promoting diversification of investments in low-carbon assets and increasing transparency through corporate climate disclosures;
- removing barriers to renewable energy and green technologies; and
- expanding and strengthening energy safety nets to enable vulnerable low-income populations access to essential modern energy services.

Call for action: Transforming science systems and engineering to effectively respond to 21st century global challenges

The pandemic revealed that despite decades of economic growth globally and enormous scientific strides, science systems need to be strengthened to be able to generate solutions to tackle complex challenges and the knowledge necessary to support and steer transformational changes towards a sustainable and equitable world. The COVID-19 pandemic has put science under the spotlight and has stimulated strong public interest in and enthusiasm for science.[114] Scientific communities have been mobilized by governments worldwide to generate insights on a wide range of issues – from advances in epidemiology, clinical care, identifying treatments and developing vaccines to investigating underlying causes of the pandemic and its socio-economic impacts – and to shape response strategies that would take account of the multidimensional nature of the crisis. However, the pandemic also revealed deficiencies in the scientific research environment related to the capacity of science systems to respond to new priorities in a timely manner, while limiting the disruption to ongoing research. Perennial issues of persistent inequalities in science[115] and limitations of the current system of publication and peer-review were also brought to the fore.[116]

With less than 10 years until 2030, it is time for an urgent reflection on how science is developed and applied to the global commons. Current linear approaches to addressing the underlying challenges of the global commons are not effective. **The existing science system composed of the agendas of different disciplines cannot solve current existential challenges and cannot address national issues either.[117]** The pandemic and the different environmental challenges demonstrate that national interests are best served by more global and connected approaches to the delivery of science, while it is also important to support science specific to a country context. The lack of a mechanism to identify the key priorities and actions by which science can address the urgent issues of sustainability in a coordinated way is a great issue that needs to be urgently addressed. There is an obvious gap that needs new approaches, new funding and new mechanisms.

There is a need to identify the issues where a collective scientific approach is urgently needed, to determine the knowledge barriers to sustainability and to collectively support that in a mission-led approach. The second meeting of the Global Forum of Funders, convened by the International

[114] The Lancet. 2020. Editorial – Science during COVID-19: where do we go from here? The Lancet 396(10267), 1941. DOI: 10.1016/S0140-6736(20)32709-4

[115] Myers, K.R., Tham, W.Y., Yin, Y. et al. 2020. Unequal effects of the COVID-19 pandemic on scientists. Nature Human Behaviour 4**,** 880–883. DOI: 10.1038/s41562-020-0921-y

[116] Rovenskaya, E., Kaplan, D. and Sizov, S. 2021. Strengthening Science Systems. Thematic Report. In: Transformations within reach: Pathways to a sustainable and resilient world. IIASA-ISC.

[117] International Network for Government Science Advice. 2021. Peter Gluckman, Opening Address to the Global Forum of Funders 2021. https://www.ingsa.org/ingsa-news/pdg-funders-forum-21/

Science Council (ISC) and its partners, bringing together public, private, philanthropic and development aid sectors, presented the preliminary findings of the soon-to-be-released report, *A Framework to Unleash Mission-Oriented Science.* These outlined the need to focus on five key Global Science Missions – food, energy and climate, health and well-being, water, and urban areas – if we are to avoid systems collapse within the century. To achieve this, the report recommends bringing together the best of global science to work together with policy-makers, the private sector and civil society actors to deliver jointly on the five missions. Co-design, co-production, co-delivery and co-implementation would be crucial to their success.[118]

Employing new approaches to doing science such as transdisciplinary research and promoting a systems-based approach will be essential to address today's sustainability challenges and accelerate transformations. Transdisciplinary research is the only way to make real progress on the sustainability agenda as it allows us to better understand the multiple underlying drivers, interdependencies and complexities of the current global challenges**.** This new way of thinking and doing research means framing research questions through multiple lenses, engaging framers and stakeholders from the outset.

Global efforts are urgently needed in capacity-building for global science leadership for the next generation. Covid-19 has impacted young scientists particularly harshly, leading to a potentially lost generation of scholars.[119] Young scientists must be better supported to both engage in research and become active at the science–society–policy interface. The emergence of a growing number of national young academies is an example of such developments that should be supported. In addition, there is a need to mitigate the harms of COVID-19 to education systems and to seize on the opportunities to improve higher education systems around the world. The IAP and the Global Young Academy (GYA) issued a joint communiqué[120] providing a set of recommendations to university administrators, higher education policy-makers, research funding agencies, academies and scholars, including: to promote Open Education and research collaboration; to expand digital connectivity and access to hardware; and to incorporate relevant local expertise in relation to higher education policy reforms and investments at the national and regional levels.

Open Science is crucial to increase the capacity of science to understand and tackle complex and urgent issues, while a widespread dissemination of existing and emerging scientific knowledge and breakthrough tools, approaches and solutions is key to fully revealing their transformational potential.[121] Member States, research institutions and science funders should work together to accelerate the transition to inclusive open access and open science based on community-owned infrastructures, recognizing their potential to facilitate interdisciplinary research, support the science–society and science–policy interface, and so deliver on the SDGs, in particular as a key means of achieving SDG target 17.6. The African Open Science Platform is a concrete example aimed

[118] ISC. 2021. ISC convenes successful 2nd Global Forum of Funders. https://council.science/current/news/isc-convenes-successful-2nd-global-forum-of-funders/

[119] IAP-GYA Joint Communiqué. 2021. COVID-19 threatens to lead to a 'lost generation' of researchers. https://globalyoungacademy.net/covid-19-threatens-to-lead-to-a-lost-generation-of-researchers-iap-and-gya-issue-joint-communique/

[120] Ibid.

[121] ISC and WFEO. 2020. Scientific and Technological Community Major Group position paper on the theme of the 2020 High-level Political Forum. Accelerated action and transformative pathways: realizing the decade of action and delivery for sustainable development. May 2020. https://council.science/wp-content/uploads/2020/06/Position-Paper-STC-29-June.pdf

at boosting the impact of open data for science and society. The GYA is also coordinating a new global working group on Open Science and has recently launched a call to stop delaying the sharing of scientific information.[122]

The pandemic brought to the fore the challenging but essential relationship between science, policy and society, highlighting some major shortcomings in how science has been used, instrumentalized, misused or ignored in the face of this novel threat. There is a need for improvement, including in countries equipped with highly capable and institutionalized science advisory ecosystems.[123,124] A recent INGSA – ISC submission, *Lessons learned from COVID-19 for the Science-Policy Society Interface*, to the IATT report for the 2021 Science, Technology and Innovation Forum underscores that the pandemic has dismissed some of the most common misperceptions about science–policy–society interfaces (SPIs) and revealed some relevant truths[125]. The report highlights a number of lessons essential for future crisis preparedness: SPIs require a more sophisticated understanding of their functioning; SPI approaches must be dynamic to respond to different policy stages and conditions of the evolving issue or set of interrelated issues; and it is important that SPIs connect nationally, internationally and globally.[126] The report puts forward a series of recommendations to strengthen SPIs which include: developing knowledge-sharing platforms with data interoperability and accessibility; establishing permanent national expert panels in key areas of sustainable development; investing in sustainability science which brings together scientific, practical and indigenous worldviews; and investing in science diplomacy to encourage global research cooperation. In addition, early- to mid-career scholars should be more actively involved at the science–policy–society interface because they have important insights to contribute, including a strong interdisciplinary lens. They are also among the generations ultimately impacted by the policy reforms and decisions made.

COVID-19 recovery packages should enable science to achieve its full potential and to generate new knowledge on which system-change transformations can be grounded, as well as seek to transform and strengthen science and science systems to be more inclusive, accessible, reliable and open. Access to high-quality, robust and relevant scientific knowledge from the full range of disciplines including health sciences, natural and social sciences, and the humanities, is essential in these pressing times when creative, rapid and critical decisions need to be made. A truly transformative and successful COVID-19 recovery that will shift the world onto a sustainable path must be informed by scientific knowledge and solutions that are co-designed and co-developed with various stakeholders from business, policy-makers, civil society and indigenous people, among others. The ability of governments to leverage the power of science in support of a better COVID-19 socio-economic recovery and a more equitable, healthy and sustainable future will be crucial.

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[122] GYA. 2020. Beyond Boundaries: A global message from young scientists on COVID-19. https://globalyoungacademy.net/wp-content/uploads/2020/03/GYA-COVID19-Position-Statement-26.03.2020-2.pdf

[123] Colglazier E.W. 2020. Editorial – Response to the COVID-19 Pandemic: Catastrophic Failures of the Science-Policy Interface. Science & Diplomacy. https://www.sciencediplomacy.org/editorial/2020/response-covid-19-pandemic-catastrophic-failures-science-policy-interface

[124] Roehrl, R.A., Liu, W. and Mukherjee, S. 2020. UN/DESA Policy Brief #62: The COVID-19 pandemic: a wake-up call for better cooperation at the science–policy–society interface. UN/DESA Policy Brief, 22 April.

[125] IATT. 2021. Emerging science, frontier technologies, and the SDGs: Perspectives from the UN system and science and technology communities. Report for the Multi-stakeholder Forum on Science, Technology and Innovation for the Sustainable Development Report 2021, pages 35–38.

[126] Ibid.

As underscored in a recent UNESCO report, Engineering for Sustainable Development, engineering needs to undergo transformative developments worldwide to address the multifaceted challenges facing humanity and achieve the SDGs. Engineering practice needs to become more diverse and inclusive so that it provides innovative solutions that are relevant to all, and ensure that future engineering solutions avoid bias and discrimination, while at the same time tackle social injustice. Although significant progress has been achieved, much more needs to be done to further improve diversity and inclusiveness in the engineering profession, and a more interdisciplinary approach is vitally important to achieving this ambition. The engineering community needs to further strengthen its collaborations with multiple sectors of society to address the SDG challenges in a more balanced and holistic way, while ensuring that progress made against one goal is simultaneously balanced with respect to the other goals.[127]

Meeting the challenges of the SDGs necessitates a shift in engineering education curricula and learning approaches towards a much broader interdisciplinary and complex problem-solving approach that combines societal and sustainable problem analyses with academic technical knowledge and solutions.[128] UNESCO's report, Engineering for Sustainable Development, puts forward a set of recommendations in this regard which include:

- changing the engineering education curricula and learning approaches through the creation of comprehensive blended education models developed in cooperation with industry and other societal actors;
- promoting and supporting engineering education studies to develop pedagogy, teaching and learning at a systemic level;
- increasing the focus on interdisciplinary curricula, sustainable development and professional competencies and combining them with funding models that support these needs; and
- improving and strengthening STEM education in school.

Expanded engineering capacity-building – technical, institutional and community – from local to global levels is needed. Efforts are ongoing by the World Federation of Engineering Organizations (WFEO) in collaboration with the International Engineering Alliance (IEA) to support capacity-building for engineers to develop sustainable infrastructure in Africa and Asia.[129] Other efforts on climate change education in Small Island Developing States in collaboration with the UNESCO Office of Climate Change Education concern building capacity at the primary and secondary school level for resilience against climate change impacts in the future.[130] Additionally, the WFEO Committee on Engineering Capacity Building and Committee on Women in Engineering provide good examples of technical and community capacity-building, and the UN should encourage similar efforts. WFEO's Engineering 2030 Plan[131] commits to expanded efforts to strengthen engineering education and capacity-building worldwide to support implementation of the SDGs.

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[127] UNESCO. 2021. Engineering for sustainable development: delivering on the Sustainable Development Goals. https://unesdoc.unesco.org/ark:/48223/pf0000375644.locale=en

[128] Ibid.

[129] International Engineering Alliance, WFEO and UNESCO. 2019. Declaration: Global Engineering Education Standards and Capacity Building for Sustainable Development. http://www.wfeo.org/wp-content/uploads/declarations/UNESCO_IEA_WFEO_Declaration_Global_Engg_Education.pdf

[130] WFEO. 2019. WFEO Biennial Report 2017–2019, p. 50. https://www.wfeo.org/wp-content/uploads/governing_documents/WFEO_Biennial_Report_2017-2019.pdf

[131] WFEO. 2018. WFEO Engineering 2030: A Plan to advance the achievement of the UN Sustainable Development Goals through engineering. https://www.wfeo.org/wp-content/uploads/un/WFEO-ENgg-Plan_final.pdf

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