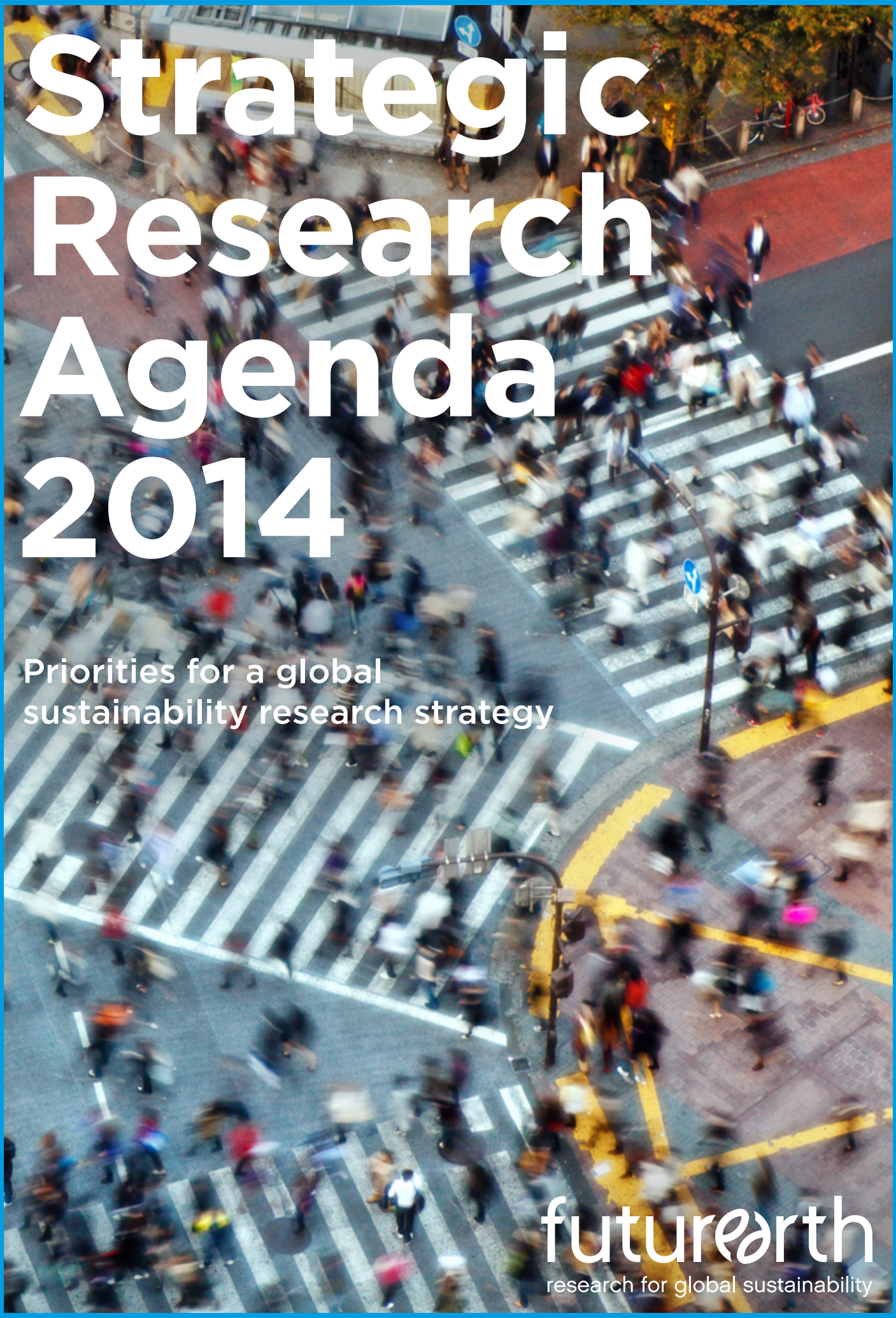


Strategic Research Agenda 2014

Priorities for a global sustainability research strategy

futureearth
research for global sustainability

Future Earth is a global research platform designed to provide the knowledge needed to support transformations towards sustainability.

Future Earth seeks to build and connect knowledge to increase the impact of research in diverse contexts, to explore new development paths, and to find new ways to accelerate transitions to sustainable development.

This document identifies critical priorities for global change and sustainability research over the next 3–5 years. These priorities are the outcome of extensive discussion with scientists and societal partners globally, and are intended to provide guidance for solutions-oriented research to meet the global societal challenges identified in the *Future Earth 2025 Vision*.

The aims of the *Strategic Research Agenda 2014* are to present a framework for global change and sustainability agenda setting for researchers and funders, and to identify key priorities for the next 3–5 years which can be used as starting points for the development of research strategies and funding programmes.

The Strategic Research Agenda 2014 is intended to be used across different domains, disciplines and regions of the world, by a range of different agencies and stakeholders, to inform priority-setting for research and research funding. A new Strategic Research Agenda will be developed and published by Future Earth every few years.

Future Earth 2025 Vision

The vision of Future Earth is for people to thrive in a sustainable and equitable world.

This requires contributions from a new type of science that links disciplines, knowledge systems and societal partners to support a more agile global innovation system.

Future Earth will contribute to achieving goals on global sustainable development, as called for at the United Nations (UN) Conference on Sustainable Development (Rio+20) and subsequently articulated under the auspices of the UN General Assembly.

Future Earth will work with partners in society to co-develop the knowledge needed to support decision-makers and societal change at all scales and in diverse contexts, by focusing on three research themes — Dynamic Planet, Global Sustainable Development and Transformations towards Sustainability.

The following outlines what Future Earth needs to contribute to achieve its vision by 2025.

Why do we need Future Earth?

By 2025 Future Earth will have

Inspired and created ground-breaking interdisciplinary science relevant to major global sustainability challenges

Key focal challenges are to:

1. Deliver water, energy, and food for all, and manage the synergies and trade-offs among them, by understanding how these interactions are shaped by environmental, economic, social and political changes.
2. Decarbonise socio-economic systems to stabilise the climate by promoting the technological, economic, social, political and behavioural changes enabling transformations, while building knowledge about the impacts of climate change and adaptation responses for people and ecosystems.
3. Safeguard the terrestrial, freshwater and marine natural assets underpinning human well-being by understanding relationships between biodiversity, ecosystem functioning and services, and developing effective valuation and governance approaches.
4. Build healthy, resilient and productive cities by identifying and shaping innovations that combine better urban environments and lives with declining resource footprints, and provide efficient services and infrastructures that are robust to disasters.
5. Promote sustainable rural futures to feed rising and more affluent populations amidst changes in biodiversity, resources and climate by analysing alternative land uses, food systems and ecosystem options, and identifying institutional and governance needs.
6. Improve human health by elucidating, and finding responses to, the complex interactions amongst environmental change, pollution, pathogens, disease vectors, ecosystem services, and people's livelihoods, nutrition and well-being.
7. Encourage sustainable consumption and production patterns that are equitable by understanding the social and environmental impacts of consumption of all resources, opportunities for decoupling resource use from growth in well-being, and options for sustainable development pathways and related changes in human behaviour.
8. Increase social resilience to future threats by building adaptive governance systems, developing early warning of global and connected thresholds and risks, and testing effective, accountable and transparent institutions that promote transformations to sustainability.

What will Future Earth deliver?

By 2025 Future Earth will have

Delivered products and services that our societal partners need to meet these challenges

Key focal outputs are:

1. Open and inclusive platforms for observing and monitoring the status, trends and thresholds of the planet in a timely manner at different scales, including tracking fast-changing sentinel processes and systems.
2. Tailored metrics and evaluation tools for well-being and sustainable development.
3. A new generation of integrated Earth system models to deepen our understanding of complex Earth systems and human dynamics across different disciplines, and to underpin systems-based policies and strategies for sustainable development.
4. Science-based data, tools and resources to support improved resilience of people, communities and economies, including disaster risk reduction.
5. Scenarios for transformative development pathways that enable global sustainability, to help evaluate different strategies and options.
6. Critical contributions to key debates on global sustainability issues, including inputs to scientific assessments and decision-relevant syntheses.
7. Innovations in communicating, engaging and visualising global change and sustainability, fully exploiting the potential of new technologies and overcoming differential access to information across the world.

How will Future Earth work?

By 2025 Future Earth will have

Pioneered approaches to co-design and co-produce solutions-oriented science, knowledge and innovation for global sustainable development

Key approaches for focus are:

1. Conducting fundamental and applied research in ways that engage with diverse societal partners across all regions of the world to maximise impact and responsiveness to society's needs, and monitoring the effectiveness of these new approaches to research.
2. Establishing Future Earth as a globally recognised model for engagement and collaboration in research for global sustainable development, effective in all world regions.
3. Stimulating debate, illustrating good practice and mobilising capacities for solutions-oriented science, technology and innovation for sustainability.
4. Changing international research funding practices to better support interdisciplinary and transdisciplinary research and engagement across and within regions.
5. Fostering collaboration among national and international agencies' research programmes, to maximise resources for and impacts of research towards sustainability.
6. Contributing to improved modes of sharing data about environmental change and progress towards sustainability in order to support policy and practice at different levels.

Who will Future Earth be?

By 2025 Future Earth will have

Enabled and mobilised capacities to co-produce knowledge, across cultural and social differences, geographies and generations

Key areas for focus are:

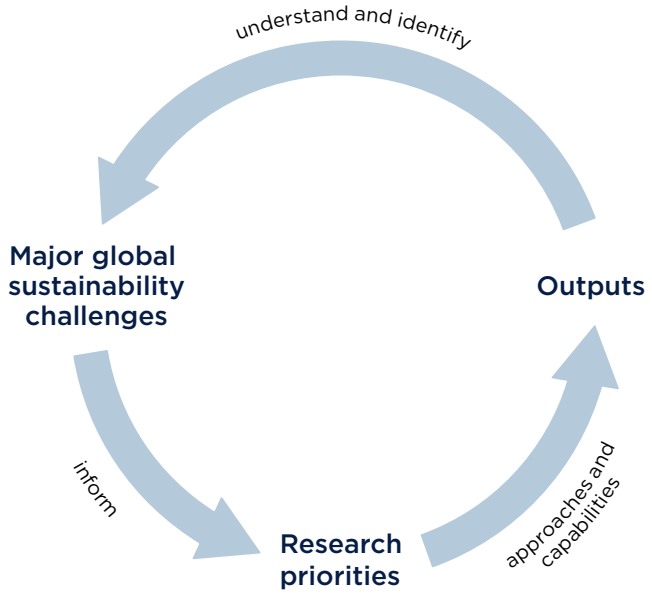
1. Inspiring and supporting a new generation of scholars and practitioners doing integrated science for global sustainability to carry forward Future Earth's vision and mission.
2. Building a diverse and connected community of participants and organisations, including scientists, policy makers, civil society practitioners, private sector actors and funders from all regions of the world.
3. Engaging influential stakeholders globally in the UN system, including major assessments and the post-2015 development agenda, key nations, business and civil society.
4. Mobilising capacities in all parts of the world to cooperate on research that connects local to global processes and promotes alternatives for sustainable development trajectories.
5. Creating a critical mass of scientists, policy makers and civil society leaders who believe in and can serve as ambassadors for Future Earth, including a body of Future Earth Fellows.

Strategic Research Agenda 2014

Priorities for a global sustainability research strategy

Research priorities linked to global challenges

The following research priorities are organised under the conceptual framework proposed in the Future Earth *Initial Design Report*. Research activities are grouped under the themes of Dynamic Planet, Global Sustainable Development, and Transformations towards Sustainability. Each priority addresses one or more of the critical global sustainability challenges set out in the Future Earth 2025 Vision (see page 6). A key to the challenges is provided on the inner back cover.



Co-producing knowledge with society

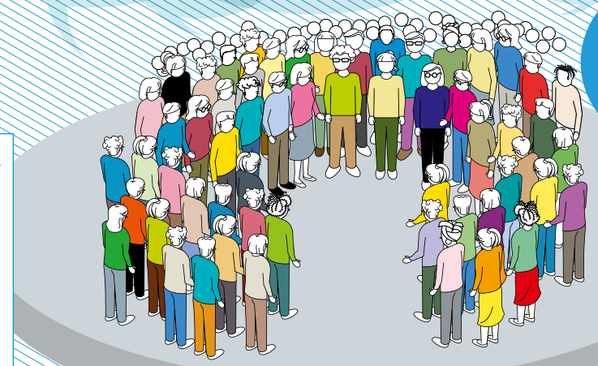
The Strategic Research Agenda 2014 advocates not just a set of research priorities, but also a novel way of doing science. This approach is detailed in the *Future Earth 2025 Vision* and includes a strong emphasis on full integration among scientific disciplines, on engagement with societal partners in co-designing and co-producing knowledge, on international collaboration, on producing knowledge that is valuable to decision-makers, and on generating the solutions that society needs.

The co-design and co-production of new knowledge, created by researchers working in collaboration with their societal partners, is critical to developing scientific insights, data and tools that can contribute to addressing the most pressing global sustainability challenges. Across all the priorities presented here, researchers and research funders are urged to work with societal partners in developing and implementing their plans. In this way science will be contributing to understanding the problems that matter to society and developing the solutions that are needed.

JANUARY 2014

Consultation with global environmental change research communities

Representatives of research communities meet in Washington D.C., USA, to propose research priorities, or key questions that need to be answered by science in the coming 3—5 years.



450 research priorities

JANUARY—MAY 2014

Desktop study

An assessment of similar research priority-setting processes related to global change and sustainable development is undertaken.

Collation of research priorities

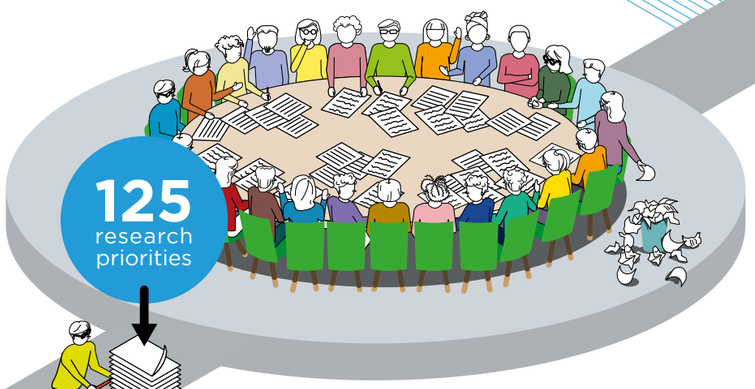
APRIL—MAY 2014

Open online consultation

An open online survey receives over 500 responses from people located in 74 countries worldwide. Survey respondents review and rank the priorities suggested so far, and suggest new priorities.

CO-DESIGN

The co-design of knowledge envisages that both researchers and societal partners are involved in defining research questions.



125 research priorities

MAY 2014

Priority setting workshop

A multi-stakeholder workshop takes place in Kyoto, Japan, to review, discuss and prioritise the results.

JUNE—AUGUST 2014

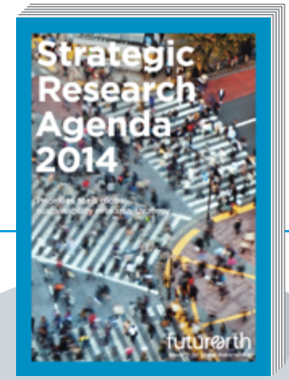
Final review

The Future Earth Science Committee and interim Engagement Committee meet in Beijing, China, to review and refine the long list to a list of 62 research priorities, ready for publication.

62 research priorities

Origins and process

At the end of 2013, Future Earth was asked by one of its sponsors – the International Group of Funding Agencies for Global Change Research (IGFA)/Belmont Forum – to prepare a set of priorities for global sustainability research.
The Strategic Research Agenda 2014 is a statement prepared by the Future Earth Science and Engagement Committees, on the basis of a process with three primary inputs: consultation with global environmental change research communities; engagement with societal partners; and assessment of the outputs of other recent priority setting processes relating to global change and sustainability research.



Strategic Research Agenda 2014

This theme focuses on knowledge and evidence about the physical, ecological and social mechanisms that underpin global and regional environmental changes, and understanding how these mechanisms have interacted in the past and are likely to change in the future. Our priorities here emphasise thresholds and early warnings, synthesis among disciplinary approaches, and new generations of models and their data needs. An effort is made to identify critical knowledge gaps and harness existing knowledge in support of challenges related to global sustainable development, including the United Nations (UN) post-2015 development agenda and scientific assessments relevant to diverse global, regional and local contexts.

The icons represent the 8 global challenges described in part 1 of the Future Earth 2025 vision (page 6).

A1

Observing and attributing change

1. How has the Earth system, with its ecosystems and societies, changed in the past, and what can this tell us about current responses to environmental change? What are the main patterns in regional and global environmental and social changes? What new perspectives can be obtained by including paleontological, archaeological, anthropological and historical dimensions of responses?

2. How are atmospheric emissions of pollutants and greenhouse gases changing in different regions and sectors, and how are carbon and nutrient balances affected? What is the contribution of social drivers such as population, wealth, social and technical change, and development? What is the contribution of physical drivers such as atmospheric transport and deposition, and changes in climate?

3. What models do we need to integrate global environmental and socio-economic data to support progress towards global sustainable development, particularly in less developed countries? How do we develop and implement methods that link data on climate, health, economic and institutional change with information on impacts to identify and monitor key areas of concern and opportunities for development?

4. What are the historic and current status and trends of biodiversity, ecosystems and their services at different spatial scales? What kinds of biodiversity, ecosystems, services and places exhibit the most critical trends? What are the links between human well-being and these trends?

5. What are the trends in three key topical areas of change – land-use change, landscape urbanisation and urban sustainability? What is the next generation of monitoring systems for these, including metrics and indicators that are demonstrably useful for informing decision-making?

6. How should a suite of early indicators of critical global change be established, particularly in hotspot regions (e. g. deltas, cryosphere, mountain regions, semi-arid zones and tropical rainforests)? What are the requirements for global observatories of critical systems and hotspots? How should this effort support the creation of an integrated global sustainability assessment, including thresholds and tipping points?

7. What new methods and technologies are needed to access, organise, integrate and summarise, in an open and transparent way, the large, interdisciplinary datasets covering different forms of knowledge and data, including natural and engineering science, social science, indigenous and practice-based knowledge? How can these be used to support and facilitate scientific assessments, such as IPCC and IPBES?

A2

Understanding processes, interactions, risks and thresholds

1. What spatial and temporal interactions and cascading effects (feedbacks, tele-coupled and systemic risks) occur across global food, urban and financial systems as a consequence of global change?

2. How do changes in atmospheric composition affect ecosystem structure and functioning? How do changes in atmospheric composition affect climate change, especially the distribution, intensity and frequency of extreme events, and precipitation patterns? How do changes in atmospheric composition affect air quality, carbon balances and nutrient flows in different ecosystems? How can these impacts be controlled and regulated?

3. What is the role of biodiversity at multiple scales in affecting other global environmental changes? At what levels, and to what extent, does biodiversity contribute to the resilience and adaptability of socio-ecological systems to global environmental change? What level of protection or restoration of biodiversity is needed globally?

4. How are evolutionary processes – in particular the selection of different kinds of organisms directly or indirectly by humans – influenced by global environmental change? What are the feedbacks to human well-being, for example, through effects on food security, biological invasions, resistance to antibiotics and pesticides, and pollution?

5. What are the critical levels of biodiversity change that impact ecosystem goods and services, and where can they be found? What are the main drivers (past and present) of change in biodiversity, ecosystems and their services, and do they interact additively or non-additively? What are the instrumental and non-instrumental values of biodiversity at a range of spatial scales?

6. How will biophysical, ecological, economic and social factors interact in the future in creating and maintaining ecosystem services at different scales?

7. What are the main drivers of human vulnerability to hazards and environmental degradation in coastal areas, and what factors foster resilient approaches to development in coastal cities and other critical zones, particularly deltas, estuaries, coastal wetlands, islands, the Arctic, and coral reefs?

8. What are the patterns and drivers of urbanisation, ranging from megacities to rural settlements across geographical regions? To what extent are they globally consistent and connected? How can integrated knowledge help inform decisions about sustainable human settlement? What are the interactions, trade-offs and tipping points towards sustainability in urban systems?

9. How is health influenced by changes in ecosystem services and climate, including changing disease vectors, water-borne diseases and zoonoses? What factors mediate the diffusion of environmentally-related health impacts from local to global levels?

10. What are the thresholds and tipping points in critical social, ecological and climatic systems? How predictable are they, and what are the linkages between them? What influences the degree to which thresholds can be detected and quantified?

A3

Exploring and predicting futures

1. How can current Earth system models be improved to better capture the dynamics of human-environment interactions and support predictions of risks and adaptation on decadal and longer timescales? Key priorities are: to improve the coupling and feedbacks among aerosols, clouds and pollutants; to improve simulations of the distribution and intensity of precipitation and cryosphere changes; to increase regional downscaling and modelling of urban systems; and to integrate land-use practices and ecosystem services.

2. How will climate variability, including extreme events, change in the future and how will these changes influence vulnerable regions and people? How predictable are changes in the frequency and intensity of extreme climate-related events at seasonal to decadal scales? How can society use such predictions to reduce risks and create development opportunities for people, infrastructure and environment?

3. What are plausible future scenarios of change in biodiversity, ecosystems, their services and potential social implications in different biomes, resulting from different underlying and proximate drivers of change?

4. What predictive models are needed to project the consequences of the emergence of new diseases and health threats linked to global environmental change? How can these models help to assess alternative strategies to prevent the emergence of these diseases and threats or manage their impacts at national, regional and global levels?

5. What new socio-economic models are needed to project alternative scenarios of sustainable production and consumption, identify obstacles and trade-offs, and assess risks – whether systemic or non-linear, and social or environmental – and related interventions?

6. How can computational models of human individual and collective behaviour be integrated into Earth system models of global environmental change? What new aspects need to be developed, combining neuroscience, psychology, anthropology, sociology and economics? How do such models alter our understanding of future behaviours, risks and trade-offs?

B

Global Sustainable Development

This theme focuses on critical knowledge gaps in ways of managing specific sustainable development challenges today, including meeting basic needs, and responding to emerging priorities in the UN post-2015 development agenda. Among other issues, these priorities emphasise integrated, co-produced knowledge to examine the effects of global environmental change on poor people, the nexus among basic needs for human well-being, growth strategies in relation to sustainable production and consumption, urbanisation, and governance for global sustainability

The icons represent the 8 global challenges described in part 1 of the Future Earth 2025 vision (page 6).

B1

Meeting basic needs and overcoming inequalities

1. How does access to water affect health, livelihoods and economic activity in different regions of the world? What are the biggest threats to water security in megacities and how do they affect different social groups?

2. What are the lifecycle implications of different energy sources, including biofuels, and energy technologies in terms of greenhouse gas emissions, water use and pollution, ecosystem services, and human health, equity and well-being? How can comprehensive, integrated energy assessments taking into account these different dimensions be developed from the global to the household scale?

3. What are the different development pathways of cities, in terms of settlement patterns, infrastructure and service provisioning, air and water quality, waste management, governance, economic growth, urban lifestyles and well-being? How are these pathways related to risks, and to urban, regional and global sustainability?

4. How can local, national and global food security be met, taking account of water, energy and other ecosystem demands? What is the impact of agricultural intensification on ecosystems, ecosystem functions and human well-being? What are the trade-offs between different agricultural and fisheries practices for ecosystem services and human well-being?

5. How does inequality influence household, community and state capacities to achieve sustainable development? How do changes in efforts to mitigate and adapt to climate change influence human vulnerability or well-being, particularly among the world's poorest peoples?

6. What are the consequences of different economic growth strategies for social and economic outcomes (e. g. poverty, inequality, employment and quality of life) and for the environment (e. g. climate stabilisation, ecosystem health and resilience)?

7. Which measures and metrics of human well-being and progress should support the UN post-2015 development agenda? What scientific evidence and analysis is needed to monitor and evaluate sustainable development goals at different scales?

8. What are the changing structures, dynamics and prospects for global extractive industries on land and at sea? How can non-renewable resource use be made more sustainable in terms of environmental and social impacts, including efficiency gains and recycling? What are the dynamics of emerging sustainable and renewable business sectors? What is their contribution to global sustainability?

B2

Governing sustainable development

1. What are the major environmental threats in global and regional commons, such as the high seas and polar regions? How can governance mechanisms for managing these commons be strengthened?

2. What new global and intergovernmental governance mechanisms, including financial instruments, are needed to ensure that human development and economic growth are equitable and respect environmental limits?

3. What are the strengths and weaknesses of different decision-making approaches for balancing trade-offs inherent in socio-environmental systems from local to global scales? What are their impacts on the provision and regulation of ecosystem services?

4. What are the most effective mechanisms for increasing the transparency and accountability of governments, multinational companies and financial institutions in order to promote sustainable development? How can these be implemented and scaled up?

5. How can mechanisms best be designed to address market and policy failures (e. g. by pricing ecosystem services or the social cost of pollution) that are effective and can also reach the global scale? What are their distributive social effects?

6. How do local communities and organisations participate in global environmental change activities? How can participation be made more effective and legitimate in reducing impacts, and increasing resilience to global environmental change?

7. What sustainable development strategies work in different public and private contexts? How do public and private sustainability strategies influence each other? What role do evidence and analysis, and interests and alliances, play in these strategies?

B3

Managing growth, synergies and trade-offs

1. How can the growing demand for food (terrestrial and marine), water and energy be met through integrated production and consumption strategies that significantly increase the efficiency of water, energy and nutrient use? What are the synergies and trade-offs between food production, water use and energy use? How can these be managed to secure equitable access?

2. How can potential conflicts over resource use be identified, mapped, predicted, and avoided or resolved under projected demographic and environmental change?

3. What pathways to decarbonised energy systems are available for different countries and business sectors? Which of these are economically, socially and environmentally feasible, and how can they be achieved? What are the trade-offs, synergies and issues of access in relation to energy and economic growth?

4. What are the long-term economic and social costs and benefits of different approaches to mitigating or adapting to climate change and other global environmental changes (compared to inaction)?

5. What are the synergies and trade-offs among different ecosystem services? What tools can be developed to assess these trade-offs robustly at a range of spatial scales, and how should preferred solutions be chosen when trade-offs exist?

6. What are the implications of different land-use changes on biodiversity, ecosystems and their services?

7. How does urbanisation impact rural communities and ecosystems across scales? What are the spatial and temporal flows (supply and demand) of energy, materials and ecosystem services between urban and rural systems? What are effective and equitable management strategies?

8. What are the implications of demographic changes for sustainable development and human well-being?

This theme addresses critical knowledge gaps in how societies might address global environmental and sustainability challenges through transformative change. It helps to identify socio-cultural, economic, institutional and political barriers and opportunities, and the mechanisms needed to promote sustainable development pathways linking economic prosperity with social justice and a healthy biosphere. The questions posed here address observation and assessment of societal transformations, the trade-offs and conflicts inherent to transformation processes, and factors influencing transformation pathways in different contexts.

The icons represent the 8 global challenges described in part 1 of the Future Earth 2025 vision (page 6).

C1

Understanding and evaluating transformations

1. What are the underlying assumptions (particularly regarding demand and distribution, poverty, technology and behaviour) associated with existing models and scenarios of food and energy production and consumption? How do diverse ideologies and visions of development influence research programmes and social/public policies? How can an appreciation of diverse visions of sustainability translate into the identification of plausible alternative models for action?

2. What opportunities and risks might arise from new technologies (e. g. nanotechnology, biotechnology, bioengineering and geoengineering)? What are the trade-offs and implications associated with new technologies, including their distributive social effects in the context of environmental change? How can the impacts of new technologies, products and services on global and local sustainability outcomes be assessed?

3. How are transformations initiated in social systems? What is the role of human agency and collective action in influencing transitions in socio-ecological and socio-technological systems? How can transformative change in complex socio-ecological systems be observed and modelled?

4. What are possible 'withdrawal strategies' (e. g. for coastal communities, cities, low-lying islands, mountain refugia) when limits to adaptation are reached? What are the social, political and ethical implications of these limits, and what are the implications for justice and equity?

5. How should society prioritise the management of natural resources: (a) conservation, (b) restoration of systems where resources have been degraded or exhausted, or (c) improving the design and efficiency of systems to maximise benefits or reduce impact? What is the relative importance of these management approaches at different scales and in different contexts for the transition towards sustainable use of natural resources?

6. How do global and regional political economies influence transformations to sustainability in different domains? What are the governance challenges in dealing with path dependency and the inertia of incumbent regimes? How can structural changes motivate innovative sustainable solutions under conditions of power inequalities and uncertainty?

C2

Identifying and promoting sustainable behaviours

1. How can sustainable consumption be defined and measured in different social and economic contexts? What are the drivers behind socially and ecologically unsustainable consumption practices and patterns? How can these drivers and practices be transformed?

2. In what ways are cultural values, beliefs, world views and ethics evolving in the context of global environmental change? How do they influence and shape individual and collective attitudes and behaviour relating to the environment, including lifestyle choices, and practices? How do individual values relevant to sustainability relate to shared values?

3. How transferable are innovative and sustainable practices in different socio-economic and cultural contexts? How does technological, social, institutional and cultural innovation in private, community and public sectors shape sustainability transitions? What incentives and political processes are needed to strengthen systems of innovation to respond to global environmental and social change?

4. How are gradual and sudden environmental changes and events perceived and acted upon in different social and cultural contexts, including diverse urban environments? How are new forms of learning and information sharing evolving in response to global environmental change, and in what ways are these influencing perceptions, collective action and policy responses?

5. How do communication and networking technologies facilitate information exchange, collaboration and collective action for promoting systemic change towards sustainability? In what ways can these technologies promote social inclusion and participation of diverse groups in societal responses to climate change?

C3

Transforming development pathways

1. How are new forms of valuing biodiversity and ecosystem services influencing macro-economic policies at national and regional levels? What approaches can help balance the economic and non-economic values of biodiversity and ecosystem services, and inform the development of ecosystem management strategies?

2. What are the potentials and possibilities for adapting and transforming infrastructure and services in urban and rural areas, in diverse socio-economic contexts, given the constraints and interdependence of these systems? What types of planning processes and tools can contribute to integrated urban and rural sustainable development?

3. In what ways do changing socio-economic conditions, such as changes in income or access to education and health care, affect attitudes and actions towards the environment, including consumption practices? How can alternative models of prosperity and growth influence sustainability pathways? What are the most promising policy approaches to decoupling economic growth from environmental degradation? What is the role of business and the market?

4. What is the nature and role of narratives (particularly around development, futures, justice, risk and disasters, conflicts) in driving human behaviour and social change, including decision-making? In what ways might these narratives influence risk mitigation and inspire transformative action towards sustainability?

5. What novel types of institutions and approaches to governance can help societies transition to sustainability? What are the strengths and limitations of different institutional arrangements for these transitions? What are the gaps and mismatches between institutions designed to govern the global commons and those designed at the regional and local levels? How can different governance systems enabling transformations to sustainability be evaluated and promoted in different contexts?

Key

- Nexus
- Decarbonisation
- Natural Capital
- Cities
- Rural Futures
- Health
- Consumption
- Governance

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