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RIO+20 POLICY BRIEF #5

Interconnected risks and solutions for a planet under pressure

Transition to sustainability in the context of a green economy and institutional frameworks for sustainable development

The 2012 United Nations Rio+20 Summit must be seen in the context of a significant expansion of the scientific knowledge base since the 1992 Rio Earth Summit.

We now know definitively that humans have become a prime driver of change at the planetary level, significantly altering Earth's biological, chemical and physical processes. There is increasing evidence that humans are driving the Earth system towards dangerous thresholds or tipping points. The functioning of the Earth system as we know it is at risk. We know that solutions exist, but, as the international community contemplates action, the natural resource in shortest supply is time.

The urgent global risks and challenges facing all nations are interconnected: poverty alleviation; the financial crisis; economic development; political stability; pollution; food, water and energy security; health; wellbeing; climate change; ocean acidification; and loss of biodiversity, to name just some. Understanding this interconnectedness is crucial for tackling these challenges and improving the wellbeing of all societies.

This policy brief outlines key interconnections at a global level and makes six recommendations for lowering the risk of catastrophic change to the Earth system, achieving sustainable prosperity and wellbeing for all, and protecting natural capital (land, water, soil, biodiversity and ecosystem services). These actions underpin the shift to a green economy and the transformation of the world's institutional frameworks for sustainable development.

Rio+20 Policy Briefs
One of nine policy briefs produced by the scientific community to inform the United Nations Conference on Sustainable Development (Rio+20). These briefs were commissioned by the international conference *Planet Under Pressure: New Knowledge Towards Solutions* (www.planetunderpressure2012.net).

GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme · IHDP · DIVERSITAS an international programme of biodiversity science · WCRP World Climate Research Programme · Earth System Science Partnership · ICSU International Council for Science

Summary of key points and policy recommendations

- Reduce risk. Concerted, global and immediate action is needed to reduce the risk of fundamentally disrupting the stability of the Earth system, with consequences for global economic and political systems. The immediate priority is to stabilize the global climate at a temperature of no more than 2°C above pre-industrial levels[1]. We must reduce the carbon intensity of the global economy, undertake a massive decarbonisation of the energy sector and effectively manage Earth's carbon and radiant energy budgets. Other immediate challenges include: massive biodiversity loss, ocean acidification and disruption of the nitrogen cycle, all of which need coordinated action.
- Transform global governance to address the interconnected nature of today's challenges. While our global societal systems are increasingly interconnected, our governance systems often act independently and are slow to respond. Nations must work together to devise effective ways of protecting such globally common resources as the atmosphere, oceans, freshwater, biodiversity, the ice sheets and natural cycles for the benefit of all societies, present and future.
- Engender strong leadership. Leadership is a powerful catalyst for action. This includes:
  - Broaden accountability and empowerment from global to local levels to improve all people's access to and participation in international decision making.
  - Establish an international high-level consultative body on global sustainability. Such a body would include a chief scientific advisor or "planetary ecologist" and broad representation from the UN General Assembly, UN system, G20, International Monetary Fund, World Bank, World Trade Organization, business and civil society, as well as science and technology organizations. Part of its role would be to review regular global sustainability assessments.
  - Strengthen and upgrade the Commission on Sustainable Development; upgrade the UN Environment Programme to agency status and strengthen its links to sustainable development policy and the global economic system.
- Halt unsustainable production and consumption and value natural capital. Economic systems ignore global-scale costs and benefits to humanity (e.g. the cost of disrupting the climate system). The world's biggest market failure is to exclude the value of the stable functioning of the Earth system. Nations must adopt new measures of well-being that go beyond financial metrics to include quality of life. The successor to the Millennium Development Goals must have global sustainability at its foundation.
- Develop global knowledge systems for interconnected challenges. This includes:
  - Deploy modern communications infrastructure across all nations. Communications infrastructure has become as important to quality of life and prosperity as our transport, water and power infrastructures.
  - Launch a major international research initiative for global sustainability. This collaborative endeavour will challenge the research, policy and business communities to provide the resources, knowledge and tools required to manage global risks and navigate an increasingly interconnected world.
  - Bring cohesion to the international science–policy interface. Establish an Intergovernmental Panel on

RIO+20
United Nations Conference on Sustainable Development

Global Sustainability to ensure scientific coherence. This would produce a regular 'State of the Planet' assessment that includes socio-economic dimensions and brings together and expands upon existing assessments, strengthening links between science and policy.

- Develop an international approach for tackling emerging technologies eg. synthetic biology, geoengineering and nanotechnology.
- Ensure international treaties are dynamic enough to respond to new information effectively.
- Invest in tertiary education in developing countries. Education builds endogenous capacity to address global challenges, improves well-being and generates economic growth.
- Create a global integrated monitoring system for global sustainability.

- Build resilience and prepare for unavoidable changes. The great acceleration in human activity (Figure 1), seen largely since the 1950s, has committed the Earth system to substantial change, some of which is not reversible on human timescales. All nations must be ready to adapt to inevitable environmental and social changes.

[1] Evidence is mounting that even this limit carries substantial risks for societies. To avoid it will require immediate and unprecedented global action and cooperation.

A NEW PERSPECTIVE

For stated policy objectives on sustainable development to succeed, societies can no longer view the global economic system and the political systems that shape it in isolation from the Earth system. Economic development and global governance must value natural capital and respect boundaries in the Earth system, while ensuring equitable and just resource use. The time has arrived for people to become planetary stewards.

Just as the planet's systems are interconnected, the path forward hinges on an interconnected approach to policy and a rapid response. Political recognition and acceptance of the scale of the challenges has led to wide-ranging efforts to solve them. Real progress has been made in reducing poverty, tackling HIV and protecting the ozone layer, for example. But political processes have had limited success in many other areas, prompting calls for a fundamental transformation of the global governance model to make it fit for 21st-century challenges.

The next ten years are crucial for the sequence of international cooperation needed to turn world affairs in a sustainable direction. Strong leadership is a major trigger for rapid change: leadership from politicians, from society, from business and from the scientific community. The global community must establish a new compact[2] between science and society to deliver the knowledge necessary for a sustainable future.

PHOTO: ISTOCKPHOTO/OLAF LOOSE

[2] United Nations terminology for contract or agreement.

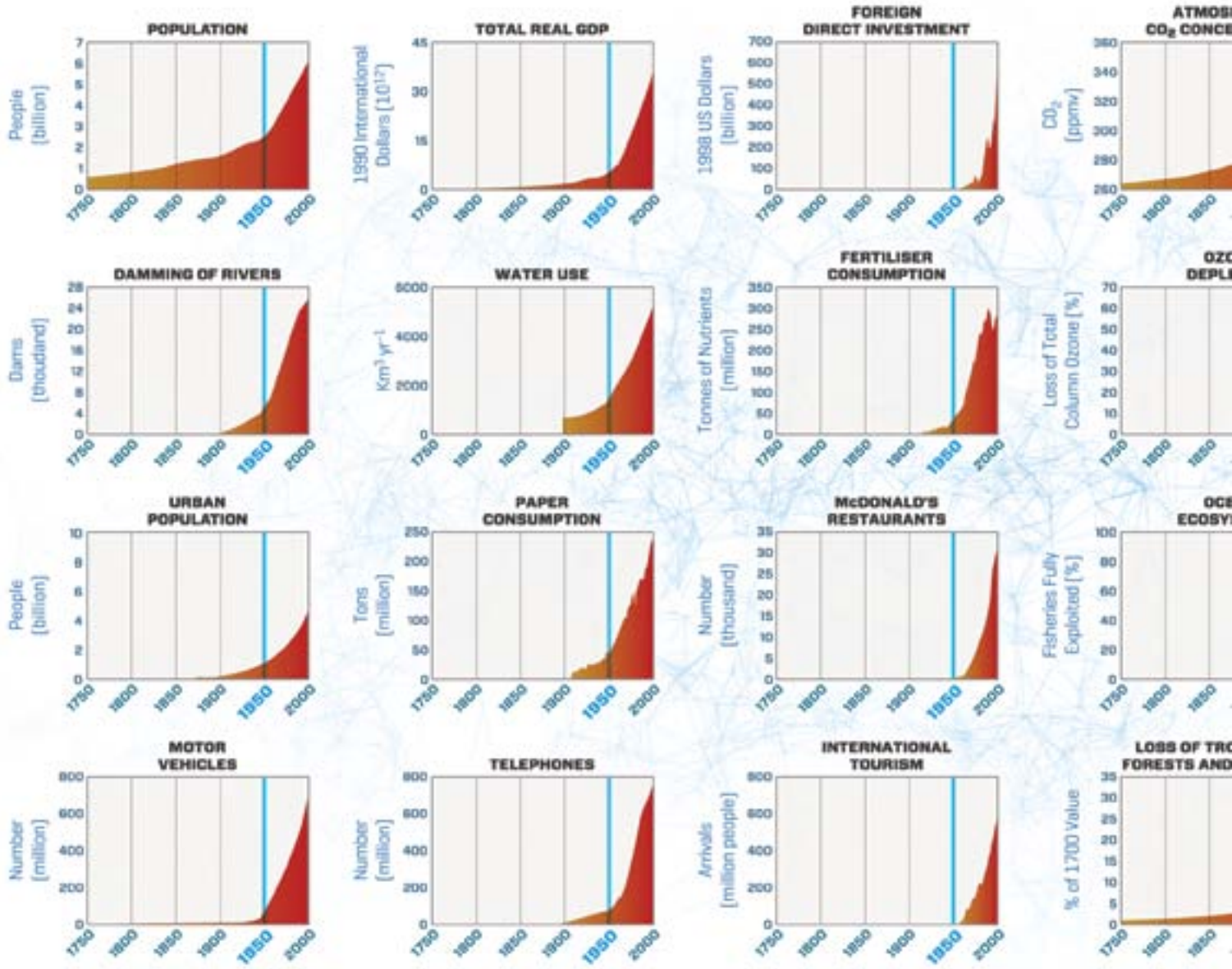


Figure 1. The Great Acceleration. The graphs above illustrate how the post-World War 2 socio-economic boom, mainly in Europe and North America but now gathering pace elsewhere, has affected components of the Earth system.
Source: Steffen et al (2004).

A PLANET UNDER PRESSURE

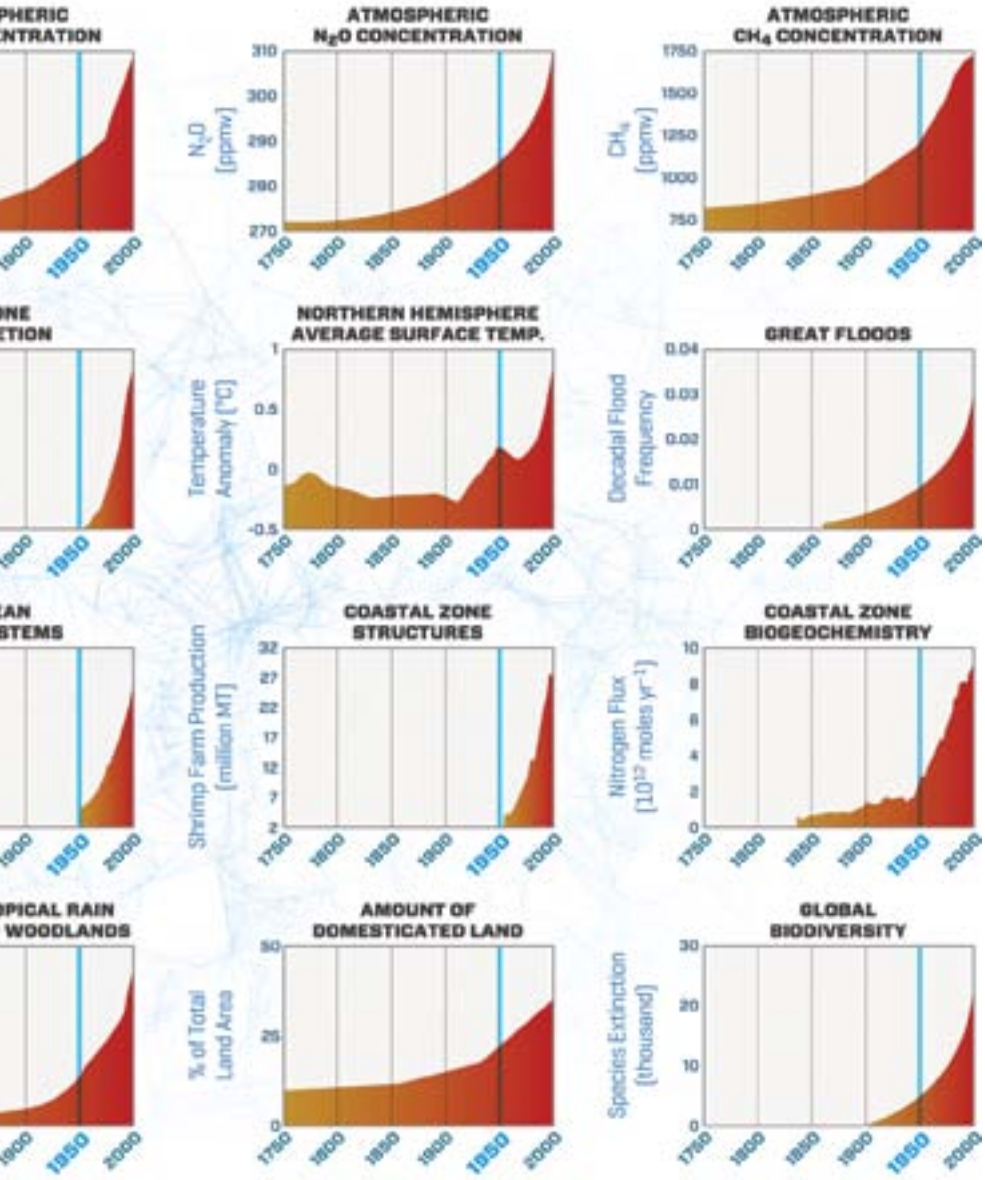
"It is not the strongest of species that survive, nor the most intelligent, but the ones most responsive to change"

Charles Darwin

The conditions in the natural world that have allowed civilization to flourish are changing rapidly as a direct result of human activities. Many nations face economic, social, environmental and other shocks. In 2010, the International Council for Science stated: "Humanity has reached a point in history at which a prerequisite for development – the continued functioning of the Earth system as we know it – is at risk." In 2011, the World Economic Forum noted that the world is in "no position to face major, new shocks".

Welcome to the Anthropocene

Human societies have always altered their environment, particularly since the advent of agriculture 10,000 years ago. The industrial revolution, though, spurred remarkable and rapid change. And more recently, since around the 1950s, revolutions in science,



The Earth system

The term 'Earth system' refers to the Earth´s interacting physical, chemical and biological processes, and includes humanity. The system consists of the Earth's land, oceans, atmosphere and ice. It includes the planet's natural cycles – carbon, water, nitrogen, phosphorus, sulphur and others – and the geophysical processes that occur deep below the Earth's surface. Life itself is an integral part of this system.

Our interconnected social and economic systems are part of the Earth system. Many human systems are now driving change in the Earth system. While the system has always changed, what is happening right now is unique.

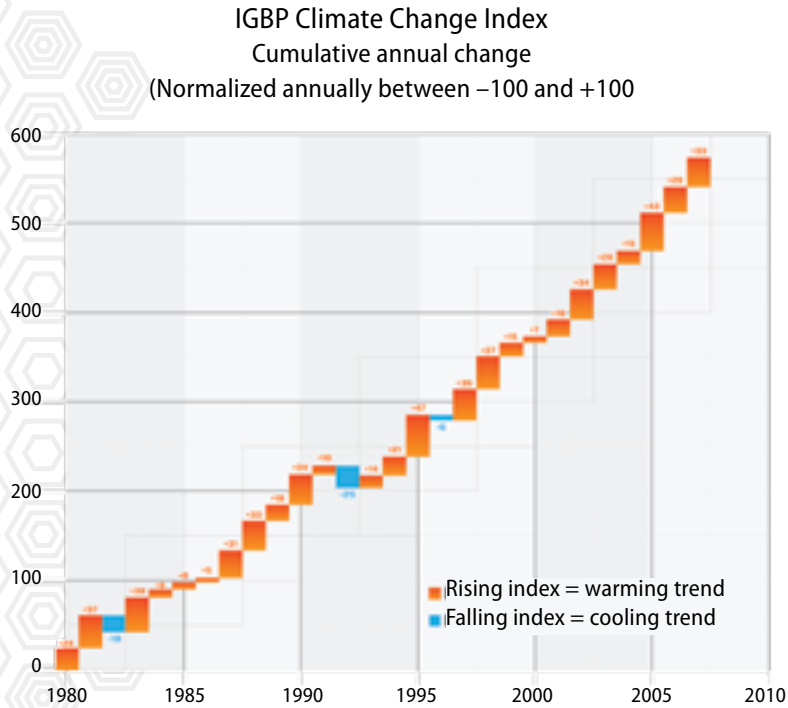


Figure 2. Climate change index. The IGBP climate-change index brings together four interconnected climate parameters: surface temperature, sea level, atmospheric carbon dioxide levels and Arctic summer sea-ice minimum. The index reveals the underlying trend often masked by natural variability: a rapidly changing climate affecting all aspects of the Earth system.
Source: International Geosphere-Biosphere Programme

industry and international politics have catalyzed an explosion in the human population and consumption. In just 50 years, humanity has become a prime driver of planetary change, leading to major disturbances in the Earth's key biological, physical and chemical processes.

This new development has led some scientists to propose that we have recently entered a new geological epoch, one dominated by humans: the Anthropocene. This profound shift in perception follows from the direct evidence of society's impact on the functioning of the Earth system, particularly during the past 60 years – just one lifetime.

In 2011, the global population will pass seven billion, from just three billion in 1960 and one billion in 1800. We are on track to reach between eight and ten billion by 2050. Meeting the basic needs of this growing population is dependent on a healthy environment and, in particular, a stable Earth system. It is clear that the unsustainable consumption patterns witnessed since the middle of the 20th century will need to change. This will require a multipronged approach, including family planning, non-consumptive models for enhancing well-being, technological change and more equitable access to resources.

Tipping points and systems thinking

'Systems thinking' accepts that parts of a system can be best understood in the context of their relationships with each other. Complex interconnected systems like the internet, the human brain or the Earth possess in-built mechanisms for self-correction, which can confer remarkable stability. Complex systems can also reach thresholds or tipping points and transform into new states, often unexpectedly and sometimes rapidly and irreversibly.

Natural and social systems are increasingly interconnected and changes in one may lead to a tipping point in another: an earthquake tips a financial crisis, or human activity drives a slow decline in a once-healthy ecosystem that suddenly disappears entirely.

In some cases, we seek to harness tipping points, such as when an online video or advertisement 'goes viral', exploding overnight from single-digit viewing figures into a global phenomenon. In other cases, we want to avoid them: the onset of collective neural activity triggering an epileptic seizure, for example, or potentially catastrophic regime shifts in the Earth's climate.

Complex systems can contain feedback loops that accelerate change. Now, the global socio-economic system – itself part of the Earth system – is pushing the Earth system and many ecosystems within it towards planetary-scale tipping points. Feedback loops in the socio-economic system cause emissions to accelerate. For example, as more people use commercial airlines, the price of flying drops, allowing even more people to fly. And feedbacks in the climate system can cause other natural systems to release additional carbon dioxide into the atmosphere, accelerating global warming.

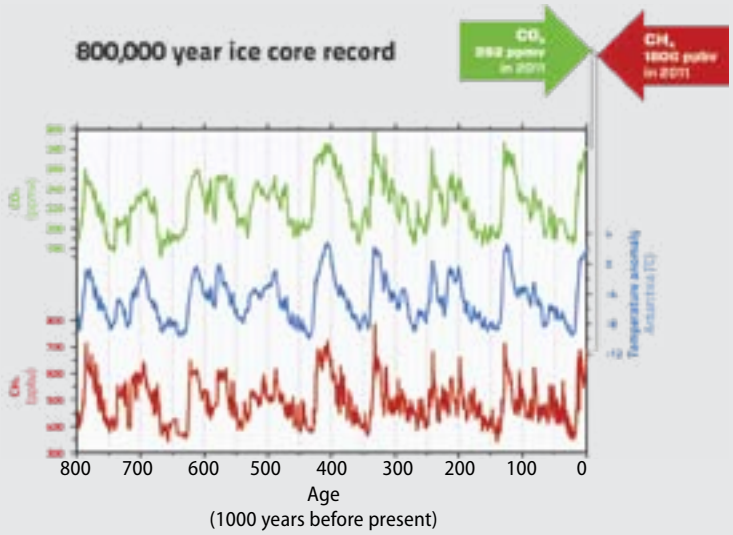


Figure 3. The Earth system. Putting the present in perspective. The figure shows current atmospheric carbon dioxide and methane levels compared with the last 800,000 years[1]. The graph illustrates components of the natural functioning of the Earth system. Modern humans appeared 200,000 years ago.
Source: International Geosphere-Biosphere Programme. Modified from Loulergue et al. (2008) and Lüthi et al. (2008).

[1] Pre-1950 values (individual data points not shown) have been reconstructed from measurements on ice cores from Antarctica (EPICA). 2011 values for carbon dioxide and methane come from direct instrumental measurements. The temperature anomaly indicates the extent to which reconstructed temperature deviates from the mean temperature during the past 1000 years.

PLANETARY BOUNDARIES

The Earth system responds in complex ways to external forces. The most obvious external force is the energy from the sun, which changes over time. On timescales of hundreds of thousands of years, the Earth's position relative to the sun alters slightly, changing the amount of energy we receive. The Earth system responds to this external force by cycling between ice ages and warm periods in a regular pattern.

PHOTO: GLOBAÍA/FÉLIX PHARAND-DESCHÊNES

After the last ice age, which finished 12,000 years ago, the Earth system settled into a relatively stable warm period that has allowed human society to grow and develop, eventually becoming a global force. Without significant external interference, this period would have likely persisted for several thousand years to come.

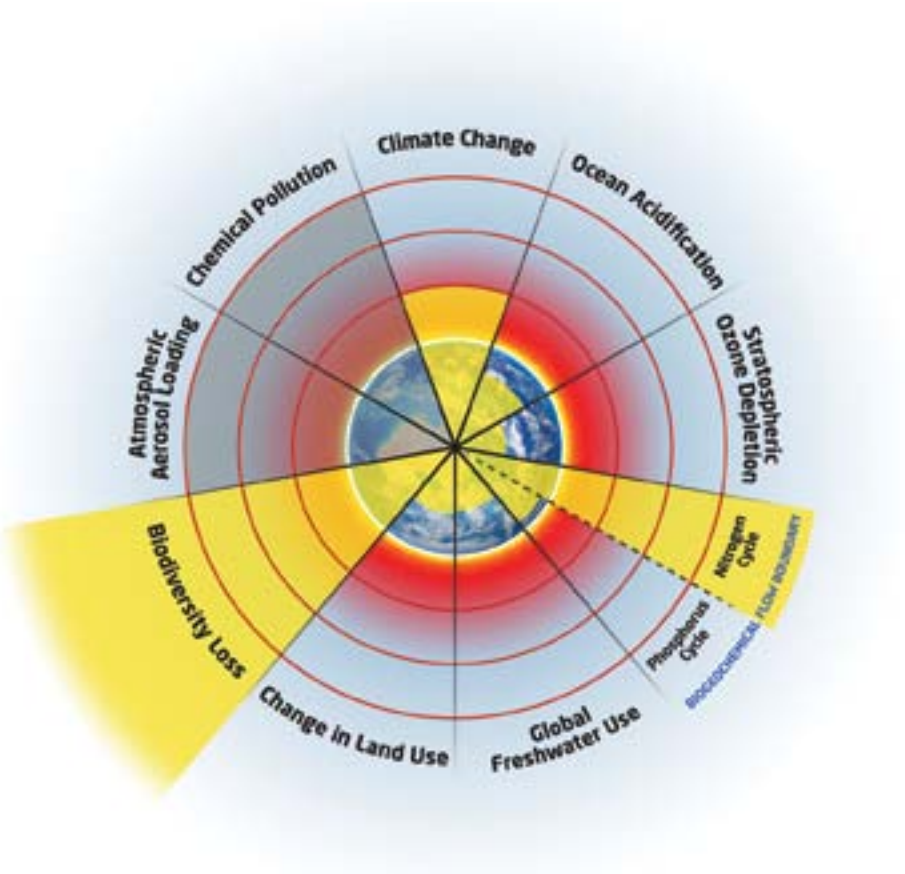


Figure 4. Planetary boundaries. Researchers recently identified nine planetary boundaries, which they argue collectively delineate a safe operating space for humanity. According to their analysis, three boundaries have already been crossed associated with climate change, disruption of global cycles and, most notably, loss of biodiversity. Although this concept is being refined, it has the potential to develop into a useful tool for policymakers.
Source: modified from Rockström et al. (2009).

In 2009, researchers made the first attempt to define planetary boundaries associated with thresholds or tipping points in the Earth system that threaten the current state. They identified nine interconnected boundaries (Figure 4). Ensuring these boundaries are respected, the authors argue, will reduce the risk of crossing dangerous thresholds that push the Earth system into a new state. But the authors also state that human activity has already driven the Earth system across three boundaries: climate, biodiversity loss and nitrogen use[1].

The boundaries concept is still in its infancy and is expected to be refined in the coming years to explore its full implications. However, it is a useful communication tool. It moves the discussion beyond sustainable resource use to focus on fundamental and uncontrolled changes to Earth's biological, chemical and physical processes, prompting society to rethink definitions of sustainable development. Furthermore, it has the potential to help policymakers take an interconnected approach to managing planetary risks.

[1] Nitrogen and phosphorus represent one boundary in this analysis.

GROWING INTERCONNECTIVITY

Globalization is often defined in terms of the global economy. This narrow definition captures some important aspects of globalization and a growing interconnectivity – international trade policy, global financial markets, worldwide flow of goods and services, transnational corporations and foreign direct investment – but ignores the political and cultural dimensions, including the rise in global communications.

Globalization has altered the rates and scale of events that were once confined to smaller areas or spheres of influence. Our global interconnected system can move rapidly from one state to another, for example from apparent economic stability to a financial crisis. The 2008 global financial crisis had local beginnings through banks granting high-risk mortgages, but it quickly spread globally, driven by the world's vast interconnected financial system.

Disease epidemics are particularly susceptible to increasing connectivity. Urbanization, increased human mobility and changing land use all affect the global spread of new, and the resurgence of older, diseases that in the past could have been controlled locally. Over 300 infectious diseases new to medicine emerged between 1940 and 2004, including HIV/AIDS, Severe Acute Respiratory Syndrome (SARS), Ebola Fever, Lyme Disease and a new strain of cholera. Much of the effort to understand and monitor new diseases is found in wealthy nations, but risk maps point to developing countries as the more likely source of new outbreaks.

The impacts of natural catastrophes now reverberate around the globe through financial, political and communication systems. There is a shift towards more frequent

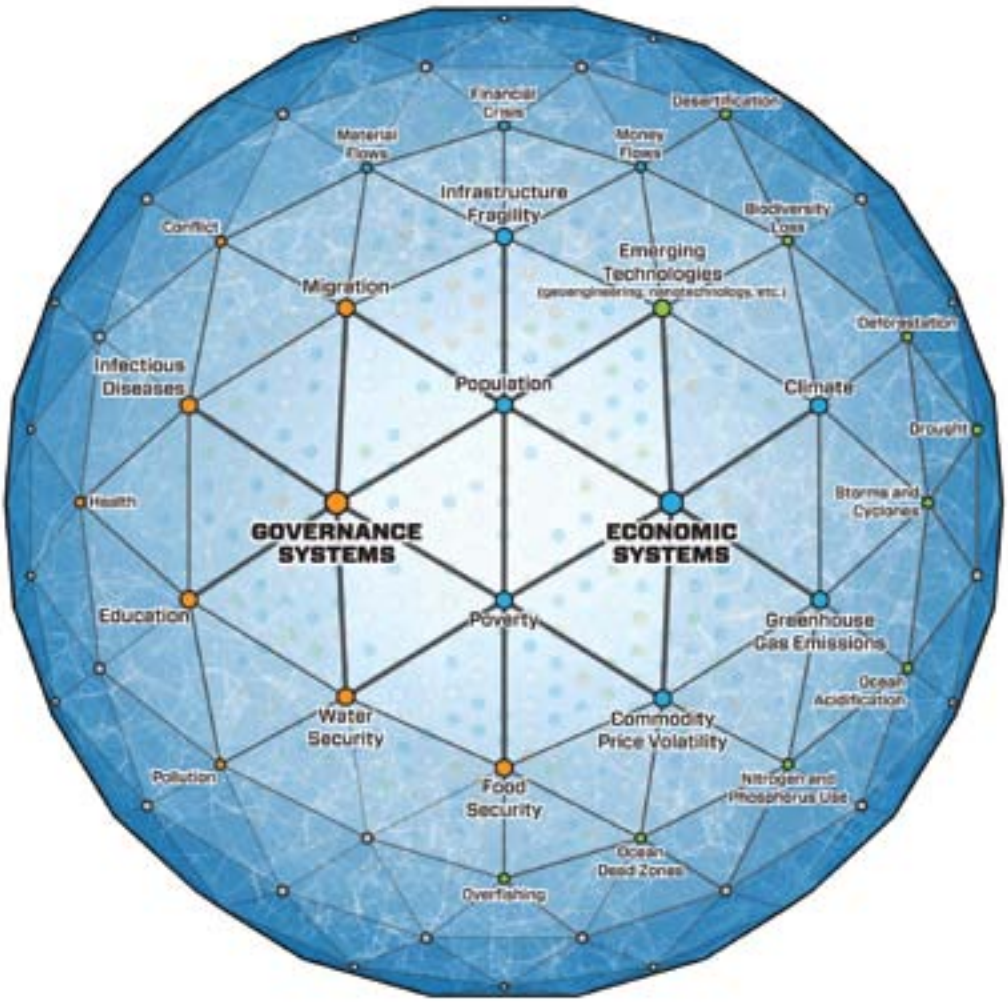


Figure 5. Interconnected global challenges. Many of our global challenges and institutions are interconnected. If we do not solve climate change, we will not solve food security. If we do not solve food security, we will not solve water security. If we do not solve water security, we will not solve poverty. If we do not solve poverty, we will not solve economic disparity and equity. If we do not solve economic disparity and equity, we will not solve climate change. Sensitivity to these interconnections can help design more effective policies while avoiding unintended consequences.
Source: International Geosphere-Biosphere Programme, adapted from World Economic Forum, Global Risks Report (2011)

weather-related natural catastrophes involving floods, droughts and storms, even when adjusted for rising populations and prosperity (Munich Re, 2011). During 2010, there were 950 natural catastrophes, 90% of which were weather-related. With social and ecological systems becoming increasingly connected, the potential for crises to spread grows ever greater.

Two mechanisms often lie at the root of the problem. Firstly, global drivers can compete or overtake local drivers as the dominant force in systems such as river basins, deltas, drylands, fishing grounds and national economies. Global drivers increase pressure on these types of systems. As they buckle under the pressure of multiple stresses, the impacts propagate outwards with knock-on effects in far off places, increasing the reach and scale of disasters. Secondly, increased connectivity enables local disturbances to spread farther and faster, occasionally turning local disasters into global crises. Increased connectivity also means there is a greater risk that management responses in one system will lead to unintentional and undesirable changes elsewhere.

2010 Natural catastrophes

Nine out of ten natural catastrophes in 2010 were weather-related (droughts, storms, floods, etc). By July 2011, Munich Re announced that 2011 was already a record-breaking year for financial losses.

	2010	30-year average (1980–2009)
No. of catastrophes	950	615
Overall losses (US dollars)	130 billion	95 billion
Fatalities	295,000	66,000

Source: Munich Re (2011).

GLOBAL GOVERNANCE

The last major breakthrough in international governance followed World War 2, when the victors sought to prevent the recurrence of such conflicts in the future. Since the existing international systems could not deal with the altered geopolitical landscape, new systems were conceived and developed. The systems promoted globalization and spurred unprecedented economic growth in parts of the world. But they are no longer adequate to tackle today's interconnected challenges and the massive pressures on our planet and so need extensive reform. The transformation, however, should be mindful of the principles of justice and equality.

Such a process must begin with an ambitious roadmap for institutional change, leading to fundamental reform of international governance. A starting point should be improving accountability and legitimacy, so allowing Earth system governance to be undertaken collectively, with strong leadership from governments and public participation in international decision-making. In the absence of large-scale reform, some immediate improvements in the current system would help.

Recommendations

(see Brief No. 3: *Institutional Frameworks*)

- Strengthen international environmental treaties and connections between treaties
- Ensure that future treaties rely on qualified majority voting
- Strengthen and upgrade the UN Commission on Sustainable Development and upgrade the UN Environment Programme to "Organization" status
- Place environmental goals at the foundation of all global economic institutions
- Address equity concerns within and among countries.

PHOTO: ISTOCKPHOTO/KRIS HANKE

VIVE LA DIFFERENCE!

Unsurprisingly, some rules in ecology apply to our own social systems. We have toiled to create a stable environment for economic growth by dampening down natural variability (as in large-scale monoculture of rice or soy) and creating single governance and economic systems. Our desire to suppress natural variation in social and ecological systems can backfire, destroying our capacity to weather the storms and sowing the seeds for larger crises to come. Diversity in social and ecological systems can engender resilience and should be nurtured where appropriate. Similarly, instead of seeking one ideal governance solution, we should explore a 'polycentric approach'. Such multiple independent governance arrangements provide a diversity of approaches to a crisis, providing backup if one fails.

THE GREEN ECONOMY

Future growth and effective risk management in an increasingly interconnected world will require an overhaul of the economic system. This will include integrating environmental values in economic institutions (see Brief No. 4: *Biodiversity and Ecosystem Services*). Beyond human well-being and global sustainability, there is a substantial incentive to reform: a green economy, according to some analyses, will grow faster than the existing 'brown', or polluting, economy.

But a green economy must encompass more than just green technology. To reduce global risk, the green economy must also address the underlying socioeconomic drivers of change and operate in harmony with the planet's biological, physical and chemical processes. An immediate starting point is to monitor progress towards sustainability and increased well-being through new metrics that go beyond income and material wealth (see Briefs No. 6: *Well-being* and 7: *The Green Economy*).

Recommendations

(See Briefs No. 4: *Biodiversity and Ecosystem Services*, 6: *Well-being*, and 7: *The Green Economy*)

- Fix market failures. The value of natural capital must lie at the foundation of consumption and production patterns and all global economic institutions and systems. The world's biggest market failure is to exclude the value of the stable functioning of the Earth system. Economic systems ignore the costs and benefits relating to the environment, including such globally common resources as the Earth's carbon, water and nitrogen cycles, the oceans, and atmosphere and ecosystem services.
- Cut greenhouse gas emissions and use energy efficiently.
- Remove subsidies for unsustainable energy, water and food production systems, particularly subsidies for fossil fuels.
- Spark investment in cleaner, greener products. In addition, the global trade system should include harmonized systems that allow for discriminating between products on the basis of production process.
- Focus on urban areas. More than half the world's population live in urban areas and consume 75% of global energy. By 2050, 70% of the world's population will live in cities and other urban areas. Cities are the action arm of civilization. As such, they must be given incentives to spearhead a revolution in green living. Initiatives such as the C40 cities should be encouraged to expand.
- Prioritize government spending on stimulating green growth across economic sectors.

GLOBAL CITIZENS BECOME PLANETARY STEWARDS

We are beginning to understand and navigate our interconnected world. A key part of this is thinking and acting across scales, from local to national to global. But political legitimacy and accountability at the international level is much weaker than that at the local and national level. This is hampering progress. Could it be about to change?

Most of the tools required to achieve global sustainability already exist, but we need to overcome inertia. Planetary stewardship should be undertaken cooperatively, with strong leadership from governments. For this to happen through open political processes, people everywhere must be able to participate meaningfully in global decisions. This depends upon a basic awareness of the actual or potential consequences of failing to manage our impact on the Earth system effectively. For this we need to improve the collective understanding of the Earth system. People need to ask: 'What are, or may be, the consequences of fundamental changes in the Earth system for our society, for others and for future generations?'

Globalization and two decades of incredible innovation in information technology have given us the internet and mobile telecommunications. These advances have allowed individuals across the planet to connect in new and profound ways. We are already witnessing how this can foster rapid change. We are reaching a historical tipping point in global communications with far-reaching implications for global governance and citizen participation. We are on the cusp of becoming responsible stewards of our planet, but we need to act globally...and soon.

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2. Water Security
3. Institutional Frameworks for Sustainable Development
4. Biodiversity and Ecosystems
6. Wellbeing
7. Green Economy
8. Energy Security
9. Health

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