German Advisory Council on Global Change

# Factsheet No. 3 / 2011

# Global Megatrends

Humankind has become a dominant factor within the Earth System. Indeed, some researchers have coined the term Anthropocene ('The Age of Man'). However, we are rapidly approaching our planet's limits, with trends such as advancing climate change and the destruction of biological diversity jeopardising our natural life support systems. Nonetheless, there are also some positive developments, such as the shift in values towards greater environmental awareness which can be observed worldwide, as well as democratisation and a decrease in poverty. A major transformation towards a sustainable society is both necessary and feasible.

## Major global megatrends

- **Greenhouse gas emissions are increasing and climate change continues unabated. The primary cause is the growing demand for fossil fuels. Deforestation is also a contributory factor.**
- **Our $CO_2$ emissions are causing acidification of the world's oceans; this is reflected in the increased concentration of hydrogen ions in the oceans by around one-third.**
- **Natural ecosystems are being destroyed at an accelerating rate, and more and more of the world's biodiversity is being irretrievably lost.**
- **Fertile land is becoming scarce. Soils are being degraded by erosion, overgrazing, salinisation and sealing at a time of growing demand for agricultural products. This is causing more intensive competition over access to land and is driving up food prices.**
- **Around 1.1 billion of the world's people have no access to clean water. Water scarcity and water pollution are increasing worldwide.**
- **World population is projected to increase to around 9 billion by 2050, with most of this occurring in cities.**
- **Clear development progress is being achieved and poverty is decreasing. However, this progress is failing to reach around 1 billion of the world's people.**
- **The number of democracies is rising, while the number of countries with autocratic governments has fallen to less than one-third.**

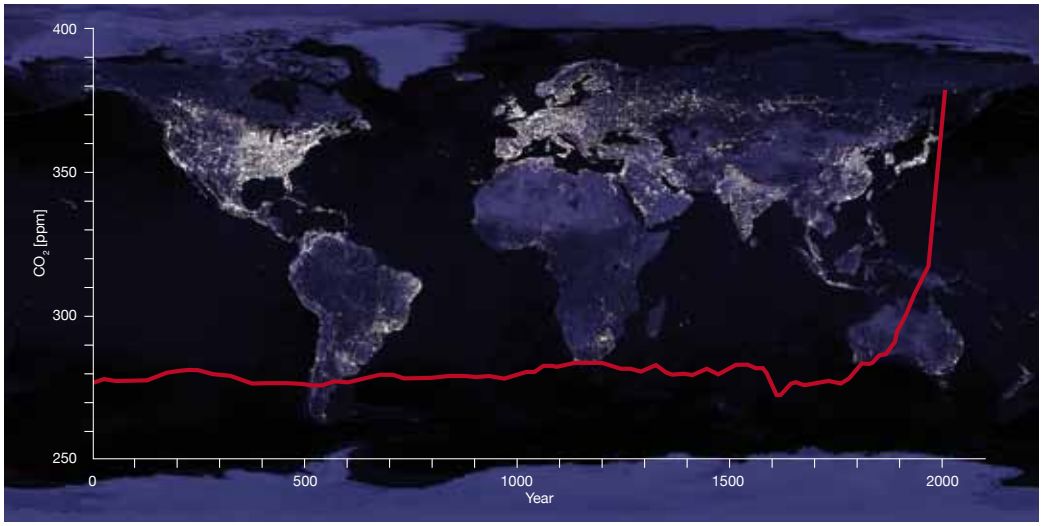


**Figure 1**
Earth's lights at night, as seen from space. The brightest areas of the Earth are those with the highest economic development and the highest energy consumption. The curve shows atmospheric $CO_2$ content over the last two millennia, determined inter alia from ice cores.
Source: WBGU, based on NASA Visible Earth, 2011; IPCC Climate Change 2007: The Physical Science Basis.

## Climate change and ocean acidification

Annual $CO_2$ emissions have increased by 40% since 1990. This is causing ocean acidification and, together with other anthropogenic greenhouse gases, further global warming.

There is a scientific consensus about the fundamental processes underlying anthropogenic global warming. As a result of human-induced emissions, atmospheric $CO_2$ content is already one-third higher than in the millennium preceding the onset of industrialisation. For reasons of basic physics, a rise in atmospheric greenhouse gases causes a warming of the climate at the Earth's surface. Since the start of the 20th century, global mean temperature has increased by 0.8°C above pre-industrial levels and this rise is unabated. It is essential to limit global warming to 2°C in order to avoid incalculable risks.

As a result of climate warming, the Arctic ice cap is melting; the area of summer sea ice during the last decades has already decreased by around 40%. Mountain glaciers are receding worldwide; in the European Alps, they have lost more than 50% of their mass since 1900. Global sea level has risen by around 20 cm over the same period and the rise is accelerating. The World Meteorological Organization has noted the exceptional number of extreme weather events during the past decade, some of which were unprecedented in their intensity and impacts.

Some of the $CO_2$ released into the atmosphere is taken up by the oceans, resulting in acidification of the seawater. The hydrogen ion (H+) concentration (= the standard measure of acidity) has already risen by 30%. It should not increase by more than 60% above pre-industrial levels, otherwise calcium carbonate formation by key marine organisms will be disrupted. Acidification thus poses a serious threat to ocean ecosystems.

## Loss of ecosystem services and biodiversity

Human activity has a massive impact on the biosphere through land use, human-induced invasion of species and, increasingly, climate change. This is causing the ongoing loss of biodiversity.

The clearing of forests, savannas and grasslands to make way for agriculture is still continuing. Around one-third of the Earth's ice-free land surface is farmed, and the proportion is growing. Coral reefs and mangroves are also being destroyed, eutrophication of lakes is occurring due to leaching of fertilisers, rivers are being channelled, fish stocks depleted, and species invade other continents due to global transport. Unabated climate change alone would pose a threat to around a quarter of the world's species. The result of all these processes is a massive loss of biodiversity. Humankind has already increased the natural rate of species extinction one hundred- to one thousand-fold. 22% of mammal species, 14% of birds and 31% of amphibians are now endangered or have already become extinct. More protected areas are being designated and more and more nature conservation programmes launched, but this is still insufficient. The clearing of virgin forest should be stopped as a matter of urgency.

Humankind is dependent on a variety of ecosystem services, examples being coastal protection afforded by mangroves or coral reefs, water supply, soil fertility, air pollution control, and the pollination of food crops. We also rely on many different species of fauna and flora whose genetic structures are essential for the development of new crops and for medical research.

## Water, soils, food

One-third of humankind is at risk from water scarcity. More and more fertile soils are being lost due to soil erosion. At the same time, more farmland is needed to feed a growing world population.

Freshwater use increased almost eightfold during the 20th century. More than 40% of available water resources is now being used or regulated by human communities. Water pollution is also a mounting problem. Agriculture (salinisation, nutrient and sediment input), industry and households (nutrients and contaminants) are polluting lakes, rivers and coastal waters. Around 1.1 billion people have no access to clean water, and around 2.6 billion people lack access to basic sanitation.

According to UNEP, 20,000–50,000 $km^2$ of land are lost annually, mainly through soil erosion. Around one-third of the world's farmland is affected by land degradation, especially in drylands (desertification).

Clearing forest to gain new farmland is not an option due to the impacts of this process on the climate and ecosystems. And yet there is a rising demand for water resources and fertile land to feed the growing and ever more affluent world population, as well as for energy crops and renewable raw materials for industrial processes. This is causing land-use competition and driving up prices. After a lengthy period of stability, food prices have fluctuated sharply since 2006 and had more than doubled by early 2011.

## Global energy trends

Energy is a key prerequisite for human development, and global energy demand is increasing. If this demand continues to be met primarily by fossil fuels such as coal, oil and natural gas, global warming well above 2 °C will be inevitable.

The industrialised countries account for around 50% of global energy consumption, although they are home to just 20% of the world's population. Even today, 2.8 billion people in developing countries and emerging economies rely on health-damaging forms of bioenergy for cooking, and 1.4 billion people have no access to electricity. According to International Energy Agency scenarios, world primary energy demand is likely to increase by 36% by 2035, mainly in the developing and newly industrializing countries, unless targeted action is taken to counter this trend. However, these are not the only countries where investment in new energy supply infrastructure is needed; old infrastructure is being replaced in the industrialised countries as well – and because power plants have a very long operating life, this investment will determine the level of countries' $CO_2$ emissions for decades to come.

Fossil energy carriers currently account for around 85% of primary energy worldwide. Coal is the 'dirtiest' of the fossil fuels, producing the highest $CO_2$ emissions per unit of energy generated, followed by oil and natural gas. At the start of the industrial age, coal was the main source of fossil energy, but its relative significance then decreased, initially in favour of oil and later gas. Since the early part of the 21st century, there has been a substantial resurgence in the relative importance of coal. Nuclear energy is only relevant to the electricity sector, where its contribution to the global power supply peaked at 19% in the early 1990s, falling back to 13% since then. Worldwide, modern renewable energies currently account for a 19% share of the electricity supply and 10% of heat generation.

In order to mitigate climate change and overcome energy poverty, it is essential to transform our energy systems and use, mainly through energy efficiency measures and more rapid expansion of renewable energies.

## Population and urbanisation

The world's population is projected to increase from the current figure of 7 billion to around 9 billion by 2050 and is likely to stabilise and perhaps even decrease thereafter. The growth to 2050 will take place mainly in urban centres, not in rural regions.

For the first time in history, more people now live in cities than rural areas, compared with just 10–15% at the start of the 20th century. Since then, the world's urban population has increased twenty-fold, from 165 million to 3.5 billion people; with affluence also on an upward trajectory, per capita energy and resource consumption has risen substantially as a result. Urban areas account for three-quarters of global final energy consumption. The anticipated growth to 2050 means that a further 2 billion people will have to be accommodated in urban areas, mainly in the developing world. The combination of rapid urbanisation and greater affluence could reinforce the process of global warming if urbanisation continues to rely primarily on fossil-based technologies and does not pursue a low-carbon pathway from the outset. Due to its long lifetime, the urban infrastructure now being established will determine emissions for a century or more to come. That being the case, low-carbon urban development will play a key role in the transition to a sustainable society.

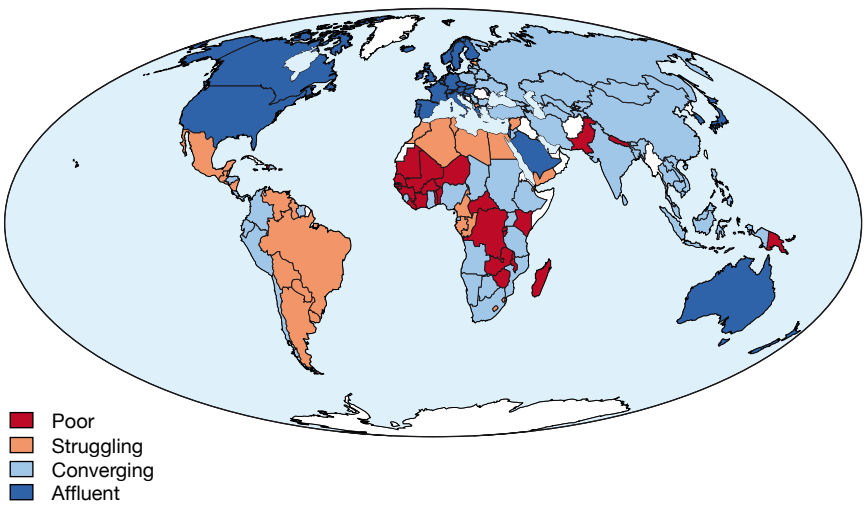


**Figure 2**
Different growth rates and levels of per capita income in countries over the past decade: the four-speed world. Due to high growth rates, per capita income has increased in many countries (converging). The number of poor countries and countries with discontinuous economic growth has decreased.
Source: OECD Perspectives on Global Development, 2010

## Development and democratisation

Over the last 20 years, substantial advances have been made in many areas of human development. Furthermore, since the 20th century in particular, a fundamental change of political systems can be observed, characterised by the transition from authoritarian to democratic systems of governance.

Today, most people live longer and are healthier, better educated, have more opportunities to meet their basic needs, and enjoy a higher level of prosperity. The countries which have made the greatest development progress not only include growth economies such as China, Indonesia and South Korea but also poor countries such as Nepal, Oman and Tunisia, where major advances have been made in sectors such as health and education. However, per capita income distribution varies widely from country to country (Figure 2).

Whereas in 1990, 1.81 billion people lived below the poverty line of US$ 1.25 a day, this had fallen to 1.38 billion people in 2005. Today, around three-quarters of the people affected by absolute poverty – close to 1 billion, giving rise to the term 'bottom billion' – live in middle-income countries, mainly India, China, Nigeria, Indonesia, Pakistan and South Africa.

In political terms, an ongoing shift towards democratic forms of governance can be observed. Since 1975, the number of democracies has almost tripled to around 90, whereas the number of countries with autocratic governments has fallen to less than one-third. This democratisation could potentially take hold in the Arab world as well since Tunisia's Jasmine Revolution in 2011. Democratic processes and institutions count among the key prerequisites for the transformation to a sustainable society. They offer the prospect of legitimate, equitable, creative and sustainable solutions to countries' problems, and, ideally, should guarantee freedom of expression, the rule of law, and inclusive participation in the political process and decision-making.

## Conclusion: A major transformation ahead

In view of the megatrends affecting the Earth System and the world's economies and societies, it is clear that a transformation towards a low-carbon, sustainable society fit for the future is essential.

The use of fossil fuels has enabled humankind to achieve an unprecedented level of affluence, but this positive development is increasingly jeopardised by a growing number of adverse effects. Without a transformation towards sustainability, critical 'planetary guard rails' in the Earth System will be transgressed, e.g. global mean temperature rise exceeding 2 °C. This would jeopardise the natural life support systems on which humankind depends and greatly curtail society's opportunities for future development. However, there are alternatives which can offer everyone the prospect of a good life within the limits of the Earth's carrying capacity. Empirical studies document a global shift in values towards greater environmental awareness, that has been ongoing for quite some time. The fossil fuel-based international economic system is also undergoing a process of fundamental restructuring. In WBGU's view, this structural change marks the start of a major transformation towards a sustainable society.

The pathway towards this successful transformation is mapped out in detail in the WBGU flagship report 'A Social Contract for Sustainability'. In this report, WBGU shows that the technological potential for comprehensive decarbonisation exists, outlines business and financing models to support the transformation, and identifies existing policy instruments for the transition to a low-carbon society. Energy systems, urban centres and land use have a key role to play in the transition to a low-carbon world, but the process also relies on far more intensive international cooperation, pro-active governments and the commitment of private citizens.

**German Advisory Council on Global Change (WBGU)**

The German Advisory Council on Global Change (WBGU) is an independent scientific advisory body set up by the German government. The WBGU provides policy-makers with recommendations for action and research. Its flagship report 'World in Transition – A Social Contract for Sustainability' can be downloaded from the WBGU website.

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