Living Planet Report 2012

Biodiversity, biocapacity and better choices

European Space Agency: Observing the Earth from space

The European Space Agency (ESA) has participated in the elaboration of this year's *Living Planet Report* by providing satellite information and data with the aim of highlighting the essential importance of space for monitoring Earth as a whole and understanding the impact of human activity on our planet. ESA does not endorse the content of the *Living Planet Report*.

ESA has been dedicated to observing Earth from space since the launch of its first weather satellite in 1977. While ESA continues to develop satellites to advance meteorology, the focus today is also very much on understanding how Earth works as a system and how human activity is affecting natural processes.

Satellites offer the only practical means of monitoring Earth as a whole. Sensitive spaceborne instruments gather precise data to unravel the complexities of our planet and track changes taking place, especially those associated with the effects of climate change.

Apart from benefitting European research requirements, this also ensures that decision-makers are equipped with the information to tackle the challenges of climate change, secure a sustainable future and respond to natural and human-induced disasters.

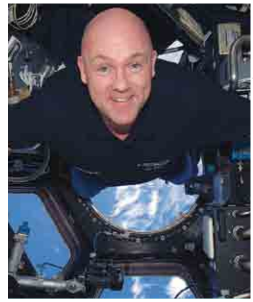
ESA's "workhorse" missions, ERS and Envisat, revealed new insight into many aspects of Earth. Each carrying a suite of instruments, these missions have led to a better understanding of air pollution and ozone holes, mapped the height and temperature of the sea surface, monitored the changing face of polar ice, and tracked the way land is used.

The Earth Explorer missions address urgent scientific questions such as Earth's gravity, ice-thickness change, the water cycle, the magnetic field, wind, the role clouds play in Earth's energy balance, and the carbon cycle.

In parallel, ESA develops missions called Sentinels to feed services for Europe's Global Monitoring for Environment and security programme. The data is used for a wide range of applications to manage the environment, such as monitoring biodiversity, natural resources, air quality, oil spills, volcanic ash, and to support humanitarian aid and emergency response in times of disaster.

EARTH NEEDS MORE SPACE!

Looking out of my window and watching Earth from space comes with my job as an astronaut. Nevertheless, I feel I am privileged.



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PromISSe is my second mission into space. This time I will live on the International Space Station for five months, unlike my first mission of 11 days in 2004. However, those 11 days in space changed my life. Seeing Earth from space provides a unique perspective. Our planet is a beautiful and fragile place, protected only by a very thin layer of atmosphere essential for life on our planet. And seemingly large forests turned out to be small and passed by very quickly. It was this perspective, and realization, that lie behind my motivation to become a WWF ambassador.

The European Space Agency is conducting research to provide information about the health of our planet. Some of the threats to a healthy planet are visible to the naked eye, while others are translated into figures stating how, where and why the world is changing. What I can see from space is reflected in the report in your hands.

In this ninth edition of the *Living Planet Report*, the key indices again show unsustainable pressures on the planet. We now know that the demands on natural resources like fish, timber and food are rocketing to a level that is impossible to replenish sustainably.

All I care about, and cherish, is on this one planet.

It is my home, the home of my family and friends, and the home of another 7 billion people. It is also the home of beautiful forests, mountains, savannahs, oceans, lakes and rivers and of all of the species living within. Our planet is beautiful, but our planet is also fragile.

We have the ability to save our home, to protect our planet. Not only for our own benefit but, above all, for generations to come. We have the solutions. Everyone can make a contribution by making better choices in how we govern, produce and consume. Taking better care of the planet is in our hands.

André Kuipers
Astronaut, European Space Agency

KEEPING THIS A LIVING PLANET


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We are all familiar with the stark array of graphs – carbon emissions, deforestation, water scarcity, overfishing – that detail how we are sapping the Earth's resources and resilience. This 2012 edition of the *Living Planet Report* tells us how it all adds up – the cumulative pressure we're putting on the planet, and the consequent decline in the health of the forests, rivers and oceans that make our lives possible.

We are living as if we have an extra planet at our disposal. We are using 50 per cent more resources than the Earth can provide, and unless we change course that number will grow very fast – by 2030, even two planets will not be enough.

But we do have a choice. We can create a prosperous future that provides food, water and energy for the 9 or perhaps 10 billion people who will be sharing the planet in 2050.

We can produce the food we need without expanding the footprint of agriculture – without destroying more forest, or using more water or chemicals. Solutions lie in such areas as reducing waste, which now claims much of the food we grow; using better seeds and better cultivation techniques; bringing degraded lands back into production; and changing diets – particularly by lowering meat consumption in high income countries.

We can ensure there is enough water for our needs and also conserve the healthy rivers, lakes and wetlands from which it comes. Smarter irrigation techniques and better resource planning, for example, can help us use water more efficiently. Most fundamentally, we need to establish water management regimes that involve a broader range of stakeholders, and that manage river basins as the complex, richly diverse living systems that they are.

We can meet all of our energy needs from sources like wind and sunlight that are clean and abundant. The first imperative is to get much more out of the energy we use – increasing the efficiency of our buildings, cars and factories can cut our total energy use in half. If we make those savings, then it is possible to meet all of our needs from renewable sources, so long as we focus on driving those technologies into the economy and ending the $700 billion in subsidies that keep us hooked on oil and coal.

20 YEARS AFTER THE MOMENTOUS EARTH SUMMIT, THIS IS A CRUCIAL OPPORTUNITY TO TAKE STOCK OF WHERE THE WORLD IS HEADING AND HOW WE'D LIKE OUR FUTURE TO TAKE SHAPE

June 2012 will see the nations of the world, businesses and a broad sweep of civil society representatives gather in Rio de Janeiro for the UN Conference on Sustainable Development. Twenty years after the momentous Earth Summit, this is a crucial opportunity to take stock of where the world is heading and how we'd like our future to take shape.

This can and must be the moment for governments to set a new course toward sustainability. It is also a unique opportunity for coalitions of the committed to step up – governments in regions like the Congo Basin or the Arctic, joining together to manage the resources they share; cities challenging and inspiring each other to reduce carbon emissions and create more liveable urban spaces; companies who are competitors in the marketplace nonetheless joining forces to drive sustainability into their supply chains and offering products that help customers use less resources; and pension funds and sovereign wealth funds investing in green jobs.

These solutions, and others articulated within this edition of the *Living Planet Report*, show that we all need to play a role in keeping this a living planet – with food, water and energy for all, and the vibrant ecosystems that sustain life on Earth.

Jim Leape
Director General
WWF International

7 BILLION EXPECTATIONS ONE PLANET

Within the vast immensity of the universe, a thin layer of life encircles a planet. Bound by rock below and space above, millions of diverse species thrive. Together, they form the ecosystems and habitats we so readily recognize as planet Earth – and which, in turn, supply a multitude of ecosystem services upon which people, and all life, depend.

Ever-growing human demand for resources, however, is putting tremendous pressures on biodiversity. This threatens the continued provision of ecosystem services, which not only further threatens biodiversity but also our own species' future security, health and well-being.

This ninth edition of the *Living Planet Report* documents the changing state of biodiversity, ecosystems and humanity's demand on natural resources; and explores the implications of these changes for biodiversity and human societies. The report highlights that current trends can still be reversed, through making better choices that place the natural world at the centre of economies, business models and lifestyles.

Chapter 1 presents the state of the planet as measured by three complementary indicators. Including data from many more species' populations than previously, the Living Planet Index continues to show around a 30 per cent global decline in biodiversity health since 1970 (Figure 1). This trend is seen across terrestrial, freshwater and marine ecosystems, but is greatest for freshwater species, whose populations show an average 37 per cent decline. The tropical freshwater index declined even more precipitously, by 70 per cent. Overall, the global tropical index declined by 60 per cent since 1970. In contrast, the index for temperate regions increased by 31 per cent over the same period. However, this does not necessarily mean that temperate biodiversity is in a better state than tropical biodiversity, as the temperate index disguises huge historical losses prior to the start of the analysis.

The Ecological Footprint shows a consistent trend of over-consumption (Figure 2). In 2008, the most recent year for which data are available, the footprint exceeded the Earth's biocapacity – the area of land and productive oceans actually available to produce renewable resources and absorb CO2 emissions – by more than 50 per cent. The carbon footprint is a significant driver of this "ecological overshoot" – the term used to describe when, at a global level, the Ecological Footprint is larger than biocapacity.

THE LIVING PLANET INDEX CONTINUES TO SHOW AROUND A 30 PER CENT GLOBAL DECLINE SINCE 1970

Figure 1: Global Living Planet Index
(WWF / ZSL, 2012)

Key

Global Living Planet Index

Confidence limits

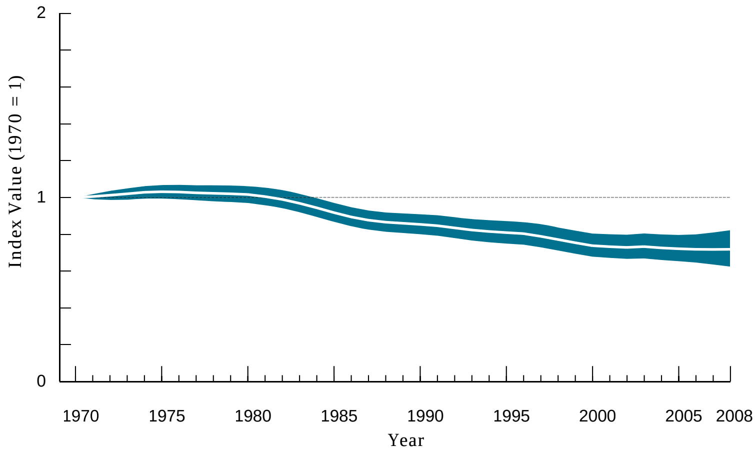
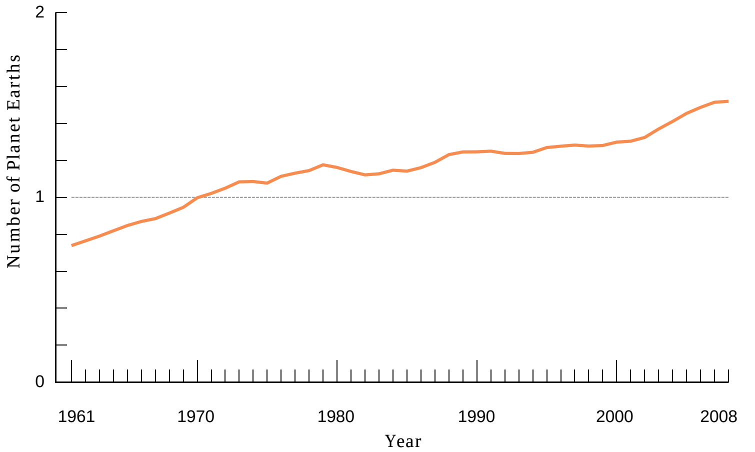


Figure 2: Global Ecological Footprint
(Global Footprint Network, 2011)



A new analysis of consumption trends in BRIICS (Brazil, Russia, India, Indonesia, China and South Africa) countries as well as in different income and development groups, together with population and urbanization trends, underline the worrying potential for humanity's footprint to increase even more in the future.

The Water Footprint of Production provides a second indication of human demand on renewable resources. For the first time, this report includes an analysis of water availability throughout the year in the world's major river basins. This shows that 2.7 billion people around the world already live in catchments that experience severe water shortages for at least one month a year.

Chapter 2 highlights the links between biodiversity, ecosystem services and people. The impacts of human activities on three ecosystems – forests, freshwater and marine – are examined in more detail, as well as specific analysis of ecosystem services they provide. Competing claims on natural resources such as commercial pressures on agricultural land in developing countries are also discussed.

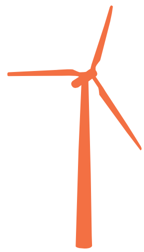
The Living Planet Report offers a view on the planet's health. WWF also looks beyond the data to understand the human expectations and struggles, demands and contributions that are driving change on Earth. In this edition of the *Living Planet Report*, Kenyan farmer Margaret Wanjiru Mundia will help us do just that. Margaret will be introduced in Chapter 2. In contrast to this individual perspective, we also take a view of the world through extraordinary images from the European Space Agency (ESA).

Chapter 3 looks at what the future might hold. Possible effects of climate change are examined and various scenarios are presented, including for the Ecological Footprint. These analyses indicate that continuing with "business as usual" will have serious, and potentially catastrophic, consequences. In particular, continued increases in greenhouse gas emissions will irreversibly commit the world to a global average temperature rise of well over 2°C, which will severely disrupt the functioning of almost all global ecosystems and dramatically affect human development and well-being.

Clearly, the current system of human development, based on increased consumption and a reliance on fossil fuels, combined with a growing human population and poor overall management and governance of natural resources, is unsustainable. Many countries and populations already face a number of risks from biodiversity loss, degraded ecosystem services and climate change, including: food, water and energy scarcity; increased vulnerability to natural disasters; health risks; population movements; and resource-driven conflicts. These risks are disproportionately borne by the poorest people, even though they contribute relatively least to humanity's Ecological Footprint.

While some people may be able to use technology to substitute for some lost ecosystem services and to mitigate against climate change effects, these risks will only increase and become more widespread if we keep to "business as usual". Emerging economies risk not meeting their aspirations for improved living standards, and high-income countries and communities risk seeing their current well-being eroded.

Forward-thinking governments and businesses have begun making efforts to mitigate these risks, for example by promoting renewable energy, resource efficiency, more environmentally friendly production and more socially inclusive development. However, the trends and challenges outlined in this report show that most current efforts are not enough.



FORWARD-THINKING GOVERNMENTS AND BUSINESSES HAVE BEGUN MAKING EFFORTS TO MITIGATE THESE RISKS BY PROMOTING RENEWABLE ENERGY

So, how can we reverse declining biodiversity, bring the Ecological Footprint down to within planetary limits, and effectively reduce the pace of human induced climate change and reverse the damaging impacts? And how can we do this while ensuring equitable access to natural resources, food, water and energy for a growing number of people?

Chapter 3 provides some solutions that we already have at hand: Alternative future scenarios based on changed food consumption patterns and halting deforestation and forest degradation illustrate some of the immediately available options for reducing ecological overshoot and mitigating climate change. These are expanded in Chapter 4, which presents WWF's One Planet perspective for managing natural capital – biodiversity, ecosystems and ecosystem services – within the Earth's ecological limits.

In addition to large-scale conservation and restoration efforts, this perspective seeks better choices along the entire system of production and consumption that drive the preservation of natural capital, supported by redirected financial flows and more equitable resource governance. Implementing such a paradigm shift will be a tremendous challenge, involving uncomfortable decisions and trade-offs. But our scenarios show we can reduce the Ecological Footprint, and mitigate climate change trends, using current knowledge and technologies – and begin the path to healthy, sustainable and equitable human societies.

ALL 193 MEMBER STATES OF THE UNITED NATIONS COMMITTED UNDER THE MILLENNIUM DEVELOPMENT GOALS TO END POVERTY, PROTECT BIODIVERSITY AND REDUCE GREENHOUSE GAS EMISSIONS

The *Living Planet Report* and Rio +20

Some of the most significant international agreements addressing the challenges facing our planet were developed 20 years ago when the world's leaders met in Rio de Janeiro. Among other initiatives, they signed the Convention on Biological Diversity and the UN Framework Convention on Climate Change, and set in motion the process to develop the Convention to Combat Desertification. The underlying message of the meeting was reinforced when all 193 member states of the United Nations committed under the Millennium Development Goals to end poverty, protect biodiversity and reduce greenhouse gas emissions. In June 2012, Rio +20 will be assessing what has happened since, and what fresh steps are needed to address urgent problems of environmental security, equity and resource management. The *Living Planet Report* provides important information to this pivotal meeting and delegates will be able to read a special conference summary (www.panda.org/lpr).

AT A GLANCE

Chapter 1: The state of the planet

Biodiversity has declined globally

- The global Living Planet Index declined by almost 30 per cent between 1970 and 2008.
- The global tropical index declined by 60 per cent during the same period.
- The global temperate index increased by 31 per cent; however this disguises huge historical losses prior to 1970.
- The global terrestrial, freshwater and marine indices all declined, with the freshwater index declining the most, by 37 per cent.
- The tropical freshwater index declined even more precipitously, by 70 per cent.

Human demands on the planet exceed supply

- Humanity's Ecological Footprint exceeded the Earth's biocapacity by more than 50 per cent in 2008.
- In recent decades, the carbon footprint is a significant component of this ecological overshoot.
- Biocapacity per person decreased from 3.2 global hectares (gha) in 1961 to 1.8 gha per capita in 2008, even though total global biocapacity increased over this time.
- Rising consumption trends in high-income groups around the world and in BRIICS countries, combined with growing population numbers, provide warning signs of the potential for even larger footprints in the future.

Many river basins experience water scarcity

- Examining scarcity on a monthly basis reveals many river basins that seem to have sufficient supplies based on annual averages are actually overexploited, hampering critical ecosystem functions.
- 2.7 billion people around the world live in catchments that experience severe water scarcity for at least one month a year.

Chapter 2: Why we should care

Our wealth, health and well-being are dependent on ecosystem services

- Many areas of high biodiversity also provide important ecosystem services such as carbon storage, fuel wood, freshwater flow and fish stocks. Human activities are affecting the continued provision of these services.

- Deforestation and forest degradation currently account for up to 20 per cent of global anthropogenic CO2 emissions, including losses from forest soils.
- Only a third of the world's rivers that are longer than 1,000km are free flowing and without dams on their main channel.
- A nearly five-fold increase in global marine fish catch, from 19 million tonnes in 1950 to 87 million tonnes in 2005, has left many fisheries overexploited.
- The frequency and complexity of land use competition will rise as human demands grow. Throughout the developing world, there is an unprecedented rush by outside investors to secure access to land for future food and fuel production.
- The loss of biodiversity and its related ecosystem services particularly impacts the poor, who rely most directly on these services to survive.

Chapter 3 What does the future hold?

Scenarios present a variety of plausible future alternatives

- The past few decades have been warmer than any other comparable period for at least the last 400 years.
- Limiting the global average warming to 2°C above pre-industrial levels is likely to require emission reductions larger than 80 per cent below peak levels. If emissions continue to grow, large regions probably will individually exceed a 2°C increase in average annual temperatures by 2040.
- The declining Living Planet Index and rising Ecological Footprint emphasize the need for more sustainable policies. Scenarios can help us make better informed choices for the future.
- Scenarios highlight the importance of conserving biodiversity to protect ecosystem services.

Chapter 4 Better choices for a living planet

There are solutions for living within the means of one planet

- Natural capital – biodiversity, ecosystems and ecosystem services – must be preserved and, where necessary, restored as the foundation of human economies and societies.
- WWF's One Planet perspective proposes how to manage, govern and share natural capital within the Earth's ecological limits.
- 16 "better choices" from a global One Planet perspective are highlighted, together with priority objectives for realizing these goals.

CHAPTER 1: THE STATE OF THE PLANET

This image captures the meticulously planned cultivated landscape of the autonomous communities of Aragon (west) and Catalonia in northeastern Spain. Many agricultural crops can be seen growing including wheat, barley, fruits and vegetables. The circular shape of many of the fields indicates central-pivot irrigation is being employed; a well drilled in the centre of each circle supplies water to a rotating series of sprinklers.

THE LIVING PLANET INDEX

The Living Planet Index reflects changes in the state of the planet's biodiversity, using trends in population size for vertebrate species from different biomes and regions to calculate average changes in abundance over time. It includes data from more than 9,000 different wildlife monitoring schemes collected in a wide variety of ways – ranging from counting the number of individual animals, to camera trapping, to surveys of nesting sites and animal traces.

Main image: Researcher and a polar bear, Svalbard, Norway.
Below: Rangers attach a ring tag to a baby brown booby.
Camera trap photo of a Sumatran rhinoceros, Borneo.
Whale shark tagging, Donsol, Sorsogon, Philippines.

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MONITORING GLOBAL BIODIVERSITY

Given the complexity of global biodiversity, it is very difficult to provide a complete picture of its overall health. But much as a stock market index measures the state of the market by tracking changes in market capitalization of a selection of companies, changes in abundance (i.e., the total number of individuals in a given population) across a selection of species can be used as one important indicator of the planet's ecological condition.

The Living Planet Index suggests that across the globe, vertebrate populations were on average one-third smaller in 2008 than they were in 1970 (Figure 3). This is based on trends in the size of 9,014 populations of 2,688 mammal, bird, reptile, amphibian and fish species – many more than in previous editions of the *Living Planet Report* (WWF, 2006b; 2008b; 2010a).

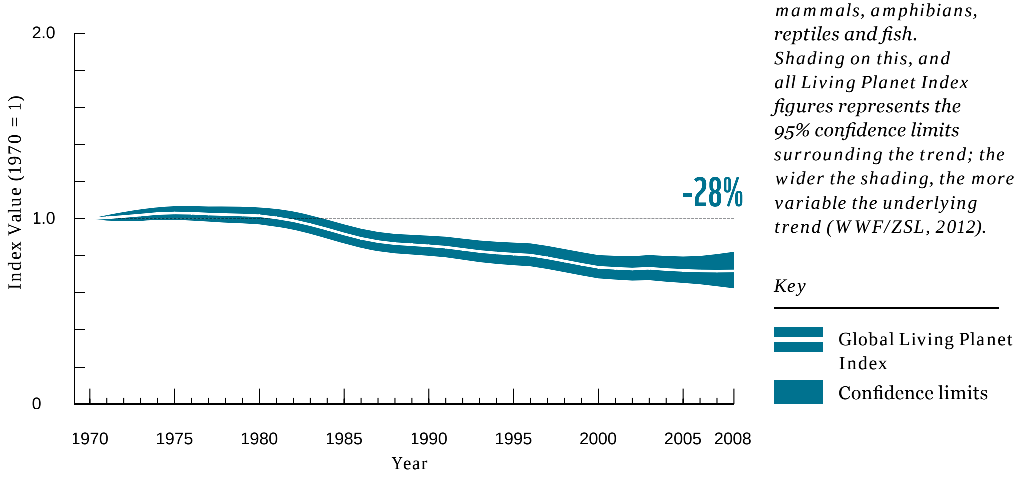


Figure 3: The Global Living Planet Index
The index shows a decline of 28% from 1970 to 2008, based on 9,014 populations of 2,688 species of birds, mammals, amphibians, reptiles and fish. Shading on this, and all Living Planet Index figures represents the 95% confidence limits surrounding the trend; the wider the shading, the more variable the underlying trend (WWF/ZSL, 2012).

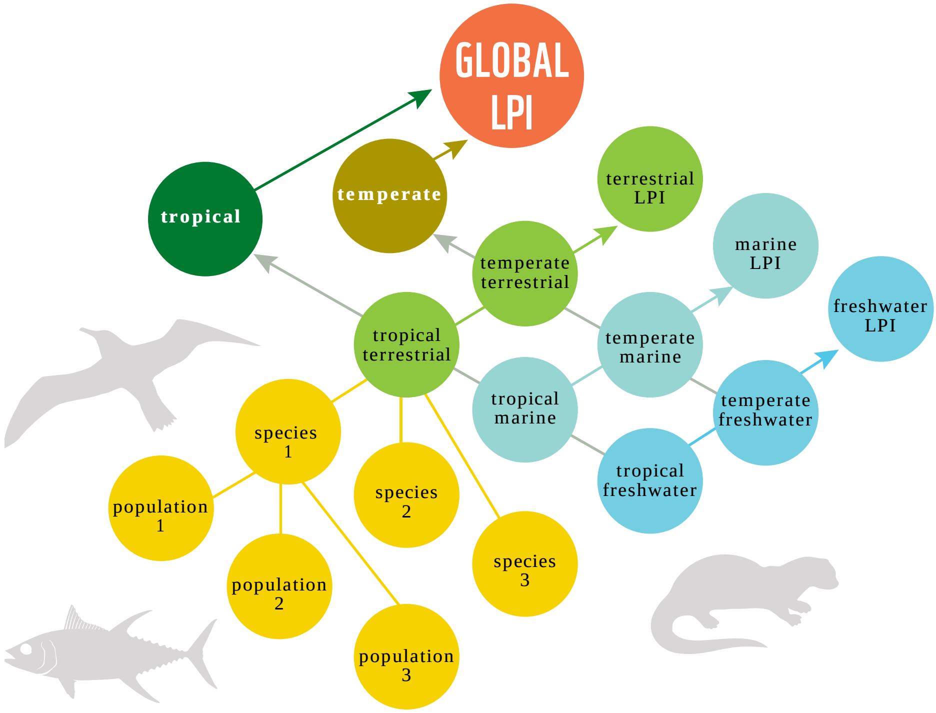


Figure 4: Turning population trends into the Living Planet indices

VERTEBRATE POPULATIONS IN THE GLOBAL LPI WERE ON AVERAGE ONE-THIRD SMALLER IN 2008 THAN THEY WERE IN 1970

Each population in the Living Planet Index is classified according to whether it is located in a temperate or tropical region, and whether it predominantly lives in a terrestrial, freshwater or marine system. These classifications are specific to the population rather than to the species, so some species are included in more than one index. For example, species with both freshwater and marine populations, such as salmon, or migratory species found in both tropical and temperate zones are recorded separately. No populations are double counted. These groups are used to comprise the temperate and tropical indices, as well as terrestrial, freshwater and marine indices, which together calculate the global Living Planet Index (Figure 4). There are more populations in the temperate index than there are in the tropical index. Therefore, to avoid biasing the global index toward population trends in temperate zones, the tropical and temperate indices are given equal weight in the global index (more details on this are included in Annex 1).

In addition, each terrestrial and freshwater species' population is classified to a realm according to its geographic location. Realm indices are calculated by giving equal weight to each species, with the exception of the Palearctic realm where, for the first time in this analysis, each family is given equal weight. This was done to reduce bias toward bird species, for which there are many more population records compared to other species in this realm.

Exploring the Living Planet Index

The Living Planet Index is a composite indicator that measures changes in the size of wildlife populations to indicate trends in the overall state of global biodiversity. Trends within a particular population only show what is happening to a species within a particular area. To create a robust index, comprehensive population data are collected for as many species and populations as possible from around the world. While some populations increased during the time they have been monitored, others have decreased. On average, however, the magnitude of population decreases exceeded that of the increases, so overall the index shows a global decline.

Figure 5: Northern bluefin tuna (Thunnus thynnus), Western Atlantic Ocean
Unsustainable levels of fishing have caused a catastrophic decline in this population since the 1970s. Because bluefin tuna has a very high commercial value, fishing pressure has continued and, as a result, the species as a whole is in danger of extinction.
Note: Data are from International Commission for the Conservation of Atlantic Tunas (ICCAT) cited in Safina and Klinger, 2008.

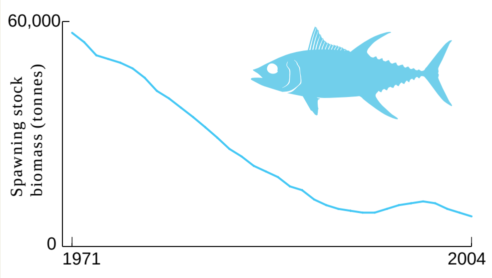


Figure 6: European otter (Lutra lutra), Denmark
After suffering serious population declines in the 1960s and '70s, improved water quality and control of exploitation helped a recovery in Denmark from 1984 to 2004, as well as in several other countries.
Note: Data are from Normander et al., 2009.

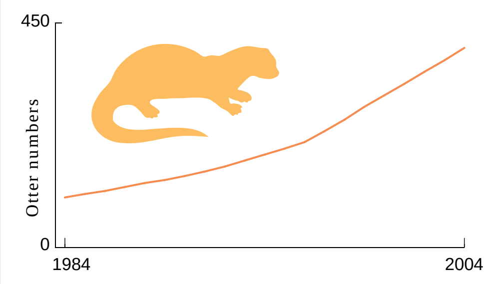
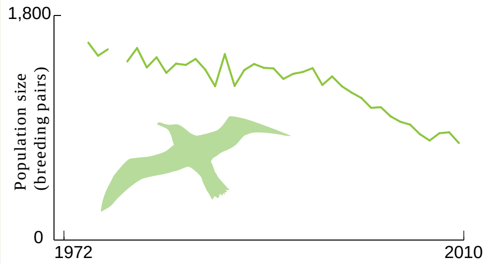
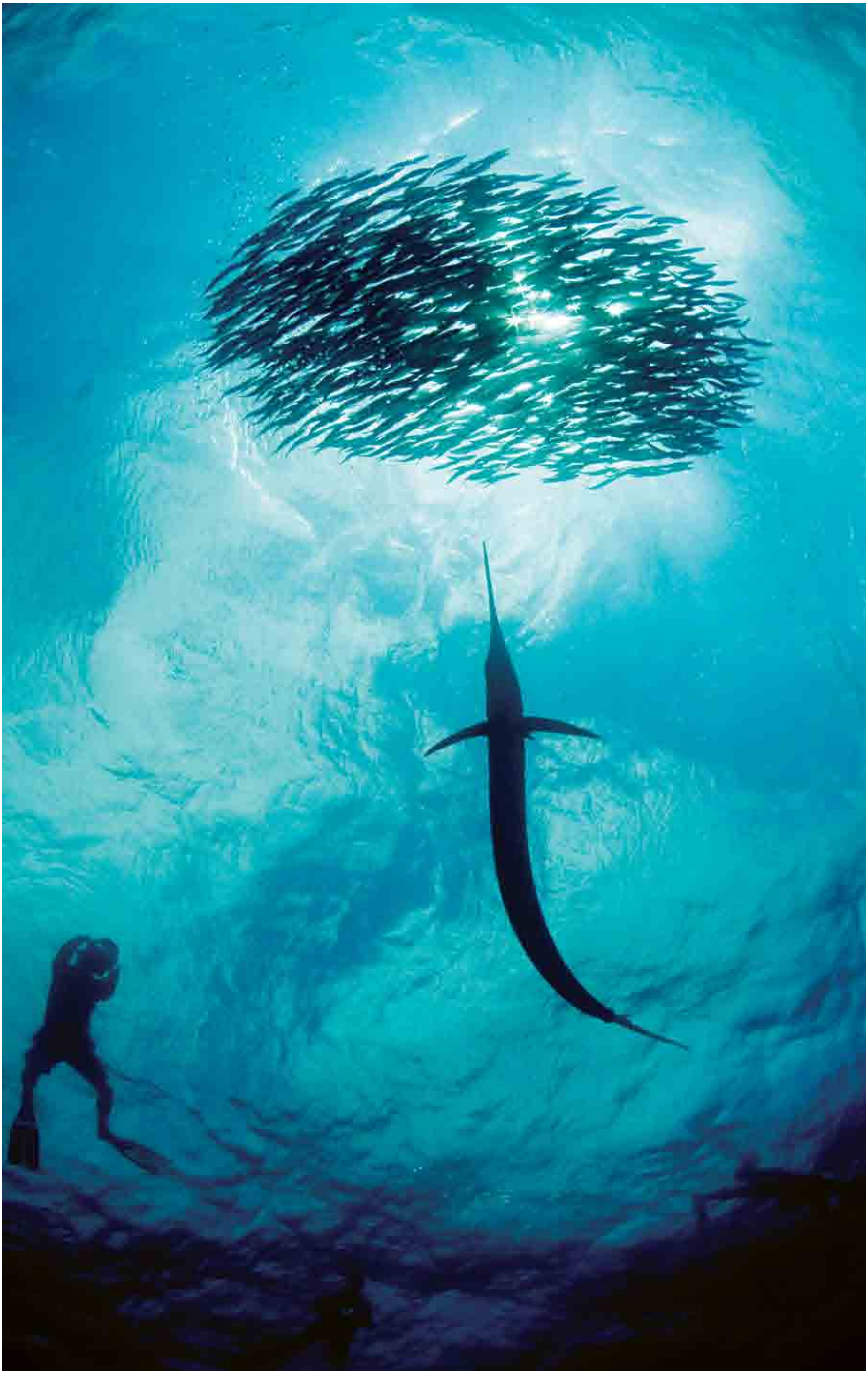


Figure 7: Wandering albatross (Diomedea exulans), Bird Island, South Georgia, South Atlantic Ocean
This population has been in steady decline since 1972. The primary cause is believed to be incidental mortality from entanglement in longline fishing equipment. One proposed measure to protect this species is to design and implement longlines that mitigate this bycatch.
Note: Based on unpublished data from the British Antarctic Servey long-term monitoring programme 2012.





View from below of silhouette of diver and Atlantic sailfish (*Istiophorus albicans*) attacking bait ball of Spanish sardines / gilt sardine / pilchard / round sardinella (*Sardinella aurita*) off Yucatan Peninsula, Mexico, Caribbean Sea.

Tropical and Temperate Living Planet Indices

The tropical Living Planet Index declined by just over 60 per cent from 1970 to 2008, while the temperate Living Planet Index increased by 31 per cent over the same period (Figure 8). This difference holds true for mammals, birds, amphibians and fish; for terrestrial, marine and freshwater species (Figures 9-11); and across all tropical and temperate biogeographic realms (Figures 16-20).

Due to the lack of published data prior to 1970, historic changes to biodiversity cannot be captured in the Living Planet Index and so all indices are set to an equal value of one in 1970. However, as described in more detail in the following pages, there has been considerable variation in population trends both between individual species and species that share the same broad habitats.

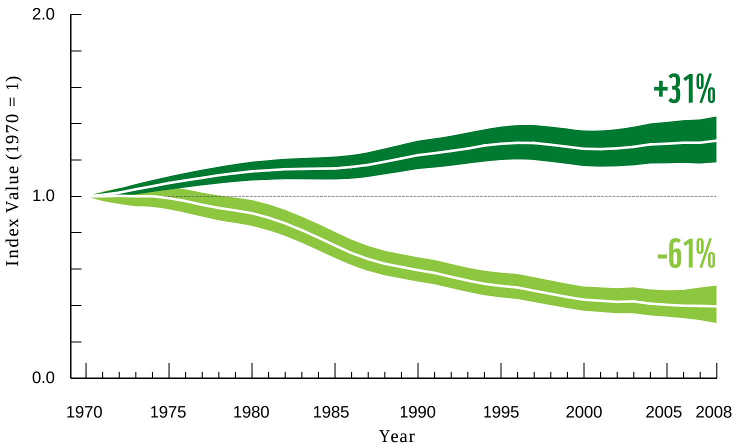


Figure 8: The tropical and temperate Living Planet indices
The tropical index is calculated from terrestrial and freshwater populations from the Afrotropical, Indo-Pacific and Neotropical realms and from marine populations between the Tropics of Cancer and Capricorn. The temperate index is calculated from terrestrial and freshwater populations from the Palearctic and Nearctic realms, and marine populations found north or south of the tropics. The global tropical index shows a decline of around 61% between 1970 and 2008. The global temperate index shows an increase of around 31% over the same period (WWF/ZSL, 2012).

Key

- Temperate Living Planet Index
- Confidence limits
- Tropical Living Planet Index
- Confidence limits

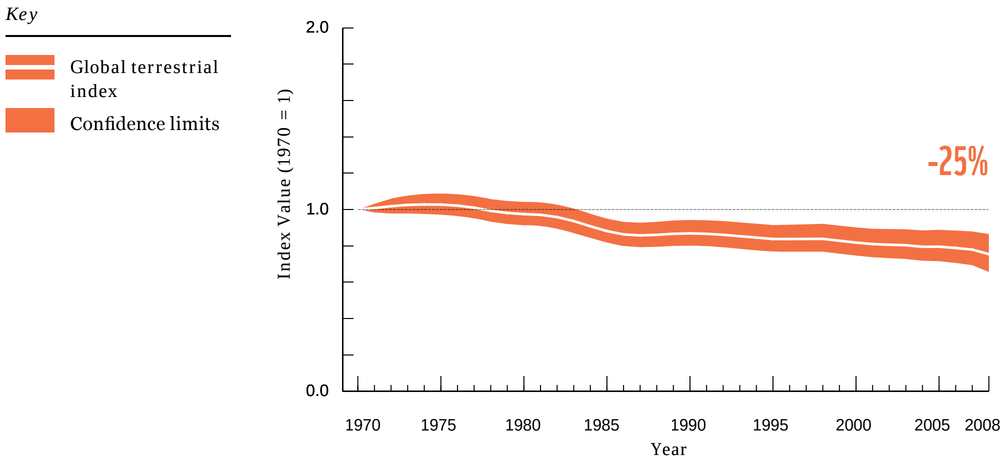
Recent average population increases do not necessarily mean that temperate ecosystems are in a better state than tropical ecosystems. The observed temperate Living Planet Index trend is the result of four intertwined phenomena: a recent baseline; differences in trajectory between taxonomic groups; notable conservation successes; and recent relative stability in species' populations. If the temperate index extended back centuries rather than decades, it would very likely show a long-term decline at least as great as that of the tropical index in recent years. Conversely, a long-term tropical index would likely show a much slower rate of change prior to 1970.

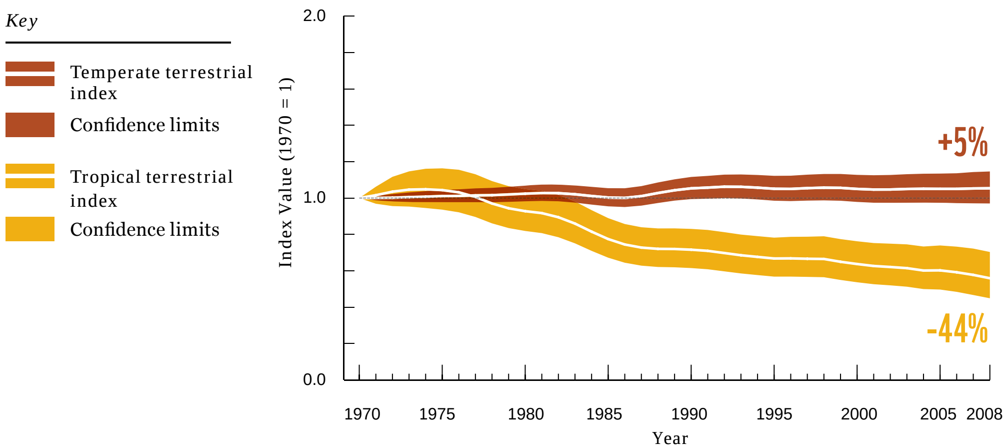
Populations of some temperate species have increased in recent years due to conservation efforts. These include US wetland birds (BirdLife International, 2008), UK breeding birds, seabirds and overwintering birds (Defra, 2010), and certain cetacean populations, such as the western Arctic population of Bowhead whales (*Balaena mysticetus*), which was estimated at 1,000-3,000 individuals at the end of commercial whaling but has since recovered to an estimated 10,545 individuals in 2001 (Angliss and Outlaw, 2006).

The Terrestrial Living Planet Index

Figure 9: The terrestrial Living Planet Index
(a) The global terrestrial index shows a decline of around 25% between 1970 and 2008; (b) The temperate terrestrial index shows an increase of about 5%, while the tropical terrestrial index shows a decline of around 44% (WWF/ZSL, 2012).

The global terrestrial Living Planet Index declined by 25 per cent between 1970 and 2008 (Figure 9a). The terrestrial index includes 3,770 populations from 1,432 species of birds, mammals, amphibians and reptiles from a broad range of temperate and tropical habitats, including forests, grasslands and drylands. The tropical terrestrial index declined by almost 45 per cent, while the temperate terrestrial index increased by about 5 per cent (Figure 9b).

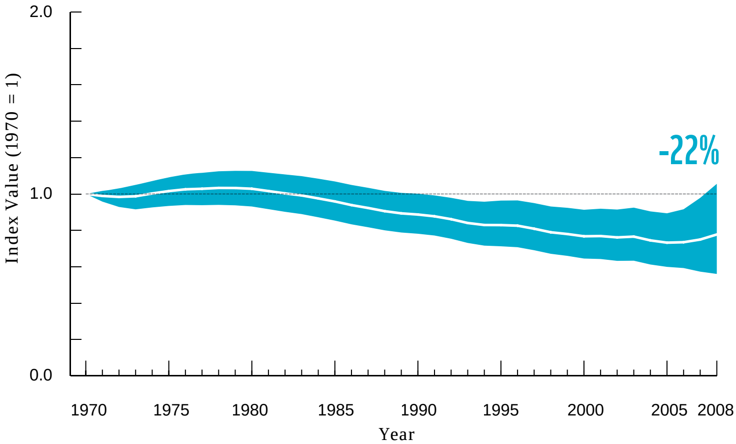




The Marine Living Planet Index

The marine Living Planet Index declined by more than 20 per cent between 1970 and 2008 (Figure 10a). The marine index includes 2,395 populations of 675 species of fish, seabirds, marine turtles and marine mammals found in temperate and tropical marine pelagic, coastal and reef ecosystems. Approximately half of the species in this index are commercially used.

Marine ecosystems exhibit the largest discrepancy between tropical and temperate species: the tropical marine index shows a decline of around 60 per cent between 1970 and 2008, while the temperate marine index increased by around 50 per cent (Figure 10b). There is evidence that temperate marine and coastal species experienced massive long-term declines over the past few centuries (Lotze *et al.*, 2006; Thurstan *et al.*, 2010); therefore the temperate



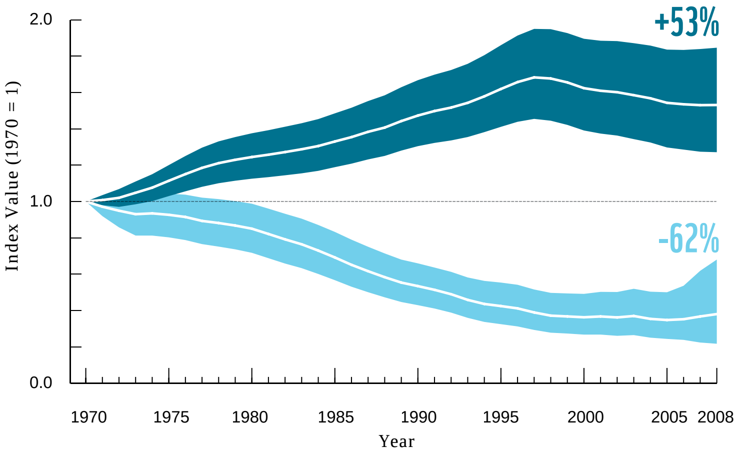


Figure 10: The marine Living Planet Index
(a) The global marine index shows a decline of about 22% between 1970 and 2008; (b) The temperate marine index shows an increase of about 53%, while the tropical marine index shows a decline of around 62% (WWF/ ZSL, 2012).

Key 10a

Global marine index

Confidence limits

Key 10b

Temperate marine index

Confidence limits

Tropical marine index

Confidence limits

marine index started from a much lower baseline in 1970 than the tropical marine index. The relative increase in temperate marine populations since then is likely a reflection of slight recovery from historic lows.

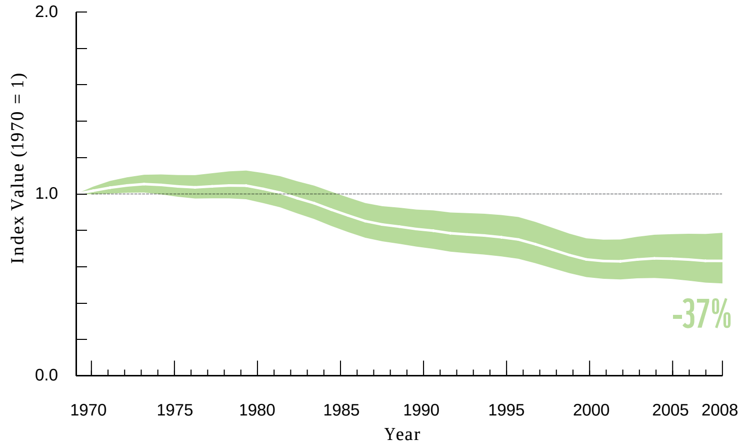
The Freshwater Living Planet Index

The freshwater Living Planet Index declined more than for any other biome. The index includes 2,849 populations of 737 species of fish, birds, reptiles, amphibians and mammals found in temperate and tropical freshwater lakes, rivers and wetlands. Overall, the global freshwater index declined by 37 per cent between 1970 and 2008 (Figure 11a). The tropical freshwater index declined by a much greater extent, 70 per cent – the largest fall of any of the biome-based indices – while the temperate freshwater index increased by about 35 per cent (Figure 11b).

Figure 11: The freshwater Living Planet Index
(a) The global freshwater index shows a decline of 37% between 1970 and 2008; (b) The temperate freshwater index shows an increase of about 36%, while the tropical freshwater index shows a decline of around 70% (WWF/ZSL, 2012).

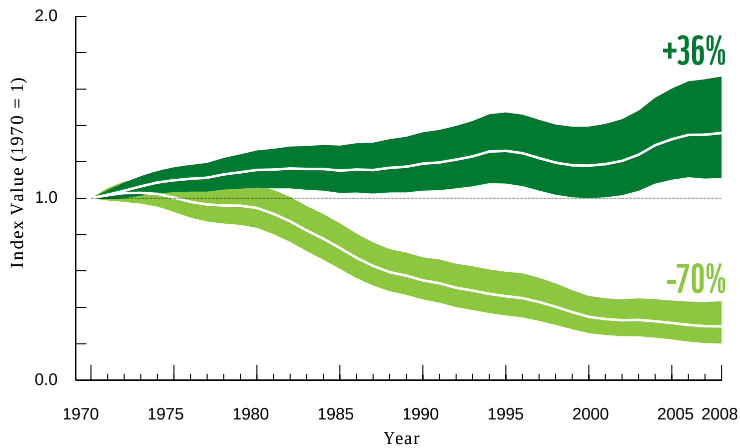
Key 11a

Global freshwater index
Confidence limits

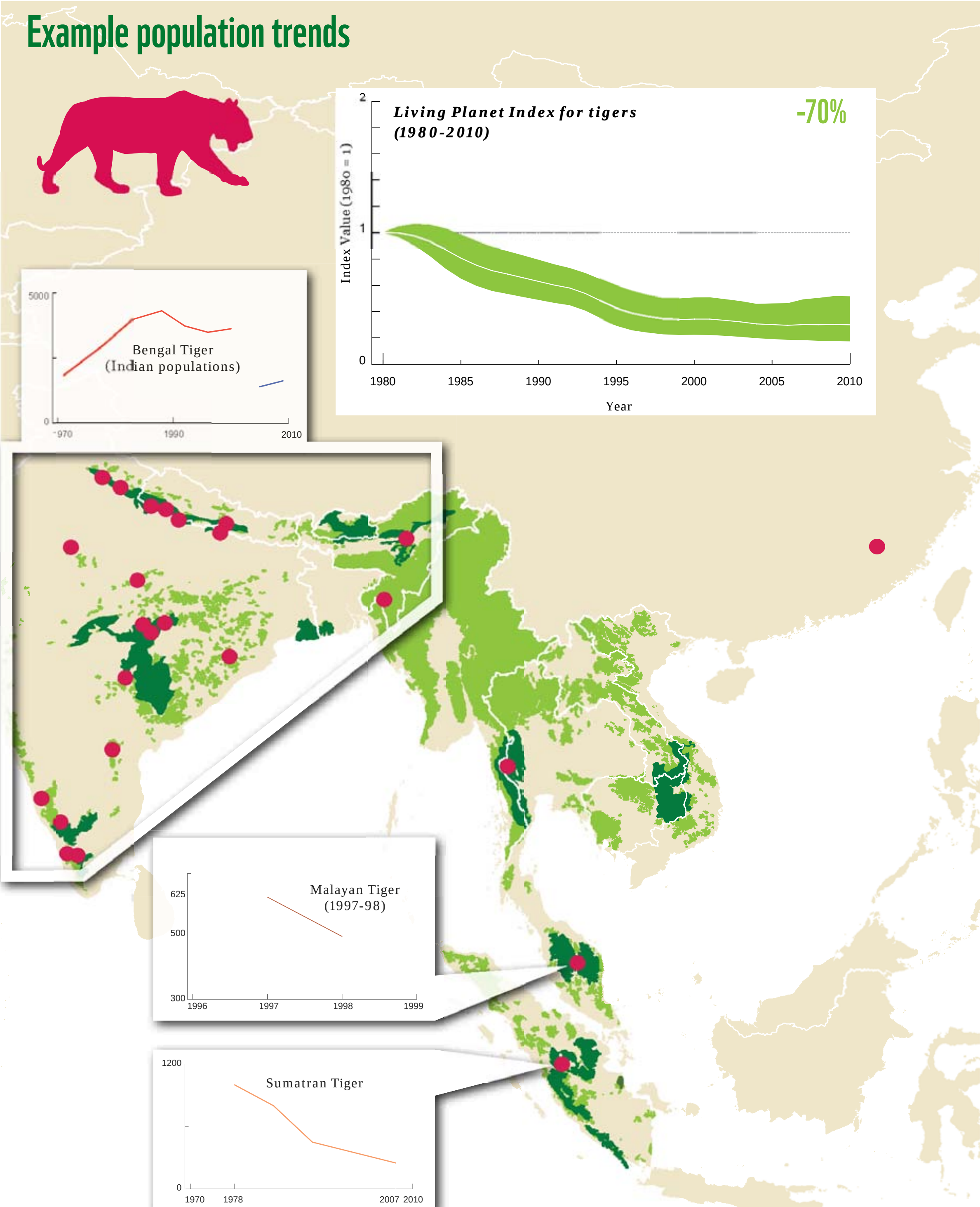


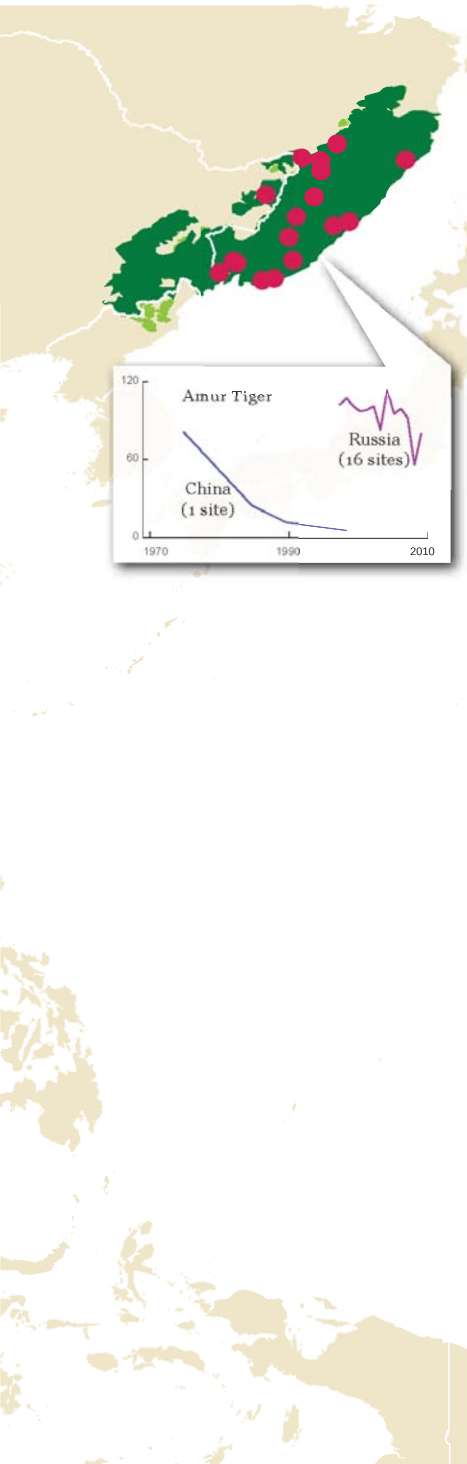
Key 11b

Temperate freshwater index
Confidence limits
Tropical freshwater index
Confidence limits



Example population trends





Case study: Tigers

Tiger (*Panthera tigris)* numbers are at an all time low. The Living Planet Index for tigers suggests that there has been a rapid decline in tiger populations: on average, a 70 per cent reduction in the last 30 years.

Forced to compete for space in some of the most densely populated regions on Earth, the tiger's range has also declined to just 7 per cent of its former extent (Sanderson *et al.*, 2006). Tigers are listed as Endangered on the IUCN Red List of Threatened Species (IUCN, 2011), and estimates endorsed by the Global Tiger Recovery Programme suggest there are only between 3,200 and 3,500 adult tigers remaining in the wild (Global Tiger Initiative, 2011).

The species is threatened by poaching, retaliatory killings, habitat loss and depletion of its prey base throughout its range. The most pronounced population declines reported in recent years are those located outside of protected areas (Walston *et al.*, 2010). Populations are more stable, and even increasing, where conservation efforts have been most intensive. Many conservation organizations, including WWF and ZSL, are concentrating efforts in the last remaining, most important habitats as the best chance of reversing dramatic declines in the short term. Overall, global efforts aim to double the wild tiger population to at least 6,000 by 2022.

Monitored sites

Priority Conservation Areas

Current range

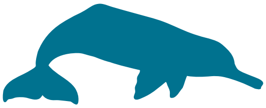
Figure 12: Tiger population trends, range and conservation priorities

(a) Current tiger distribution and recent population trends. Shaded areas denote the current range (light green) (IUCN, 2011); and priority conservation areas (dark green); the red points show the midpoint of each monitored population (time period and survey area varies between studies; the midpoints in Sumatra, Malaysia and South China represent the entire subspecies monitored from several sites), and the graphs show population changes for five of the tiger subspecies. The two trend lines on the graph for the Bengal tiger estimate in India show the result of two different survey methods; (b) A Living Planet Index for tigers. The index shows the average change in the size of 43 populations from 1980 to 2010 (with equal weight given to each of the six subspecies). The baseline is set to an index value of 1 in 1980 due to insufficient population data from the 1970s (WWF / ZSL, 2012).

Case study: River dolphins

Freshwater cetacean populations are declining rapidly. These dolphins and porpoises live in some of the world's largest rivers, including the Ganges, Indus, Yangtze, Mekong and Amazon, which are also home to an estimated 15 per cent of the planet's people.

Infrastructure development, such as dams, levees and barrages; entanglement in fishing nets; boat strikes; overexploitation of fisheries; and pollution have all contributed to rapid declines in many obligate dolphin (i.e., those that only live in rivers and lakes) populations over the past 30 years, with the likely functional extinction of one species, the Yangtze river dolphin or baiji (*Lipotes vexillifer*) (Turvey *et al.*, 2007; Figure 13). Populations of Irrawaddy dolphin (*Orcaella brevirostris*), found in both marine and freshwater habitats, have also declined. The increasing trend for the Indus river dolphin (*Platanista minor*) may be due to recovery following a ban on hunting, or immigration of dolphins from surrounding areas (Braulik, 2006); however more information is needed on this and all freshwater cetacean species to gain a better understanding of their overall status. Nevertheless, current knowledge indicates that urgent action is needed to prevent these charismatic and still little-understood animals from becoming extinct.



URGENT ACTION IS NEEDED TO PREVENT THESE CHARISMATIC AND STILL LITTLE-UNDERSTOOD ANIMALS FROM BECOMING EXTINCT

Example population trends

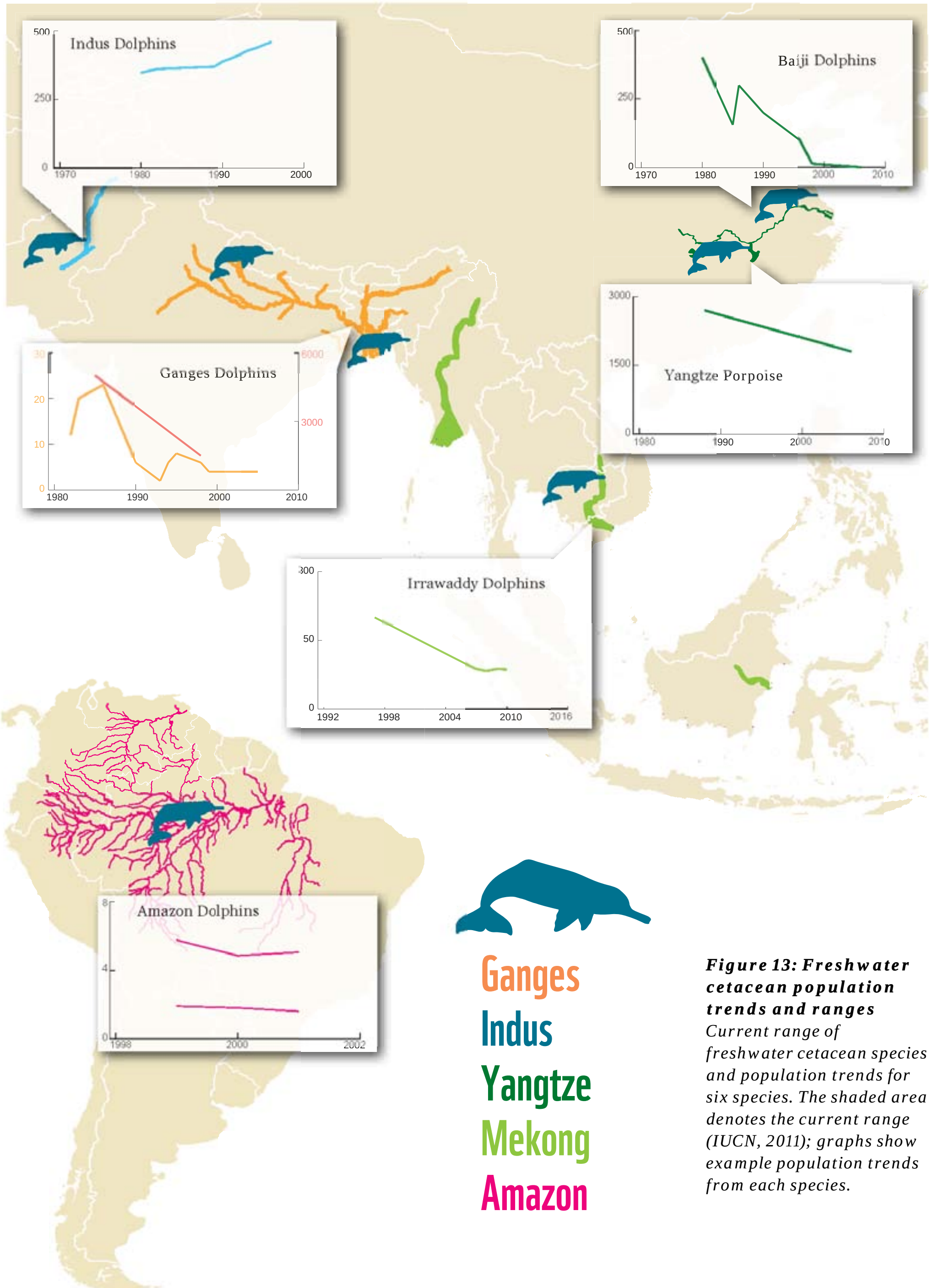


Figure 13: Freshwater cetacean population trends and ranges
Current range of freshwater cetacean species and population trends for six species. The shaded area denotes the current range (IUCN, 2011); graphs show example population trends from each species.

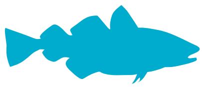
Case study: Atlantic cod

Rapid declines in Atlantic cod (*Gadus morhua*) fisheries are well documented (e.g., Roberts 2007). As a commodity in world trade, this species has been heavily exploited for several centuries (Thurstan *et al.*, 2010). Its economic importance also means that more population information is available than for most species, allowing trends in Atlantic cod stocks to be tracked back to the 1960s. Historical data for some areas go back even further; data from the Nova Scotian Shelf, Canada, for example, were collected in the 1800s.

The Living Planet Index for Atlantic cod suggests that populations have declined by an average of 74 per cent over the past 50 years (Figure 14a). Losses have been greatest in the Northwest Atlantic. The biomass of the Scotian Shelf stock is less than 3 per cent of the pre-industrial fishing level (Rosenberg *et al.*, 2005 and Figure 14c). Most assessments of changes in fish stock abundance do not take long-term historical data into account. Yet this is important because commercial fishing has been taking place for hundreds of years (Rosenberg *et al.*, 2005) and knowledge of historic baselines can aid in setting appropriate targets for recovery. Species like cod were once far more abundant; attempts to rebuild these fisheries should therefore reflect how stocks once were, not just how they appear most recently.

74%

ATLANTIC COD HAS DECLINED BY AN AVERAGE OF 74 PER CENT OVER THE PAST 50 YEARS



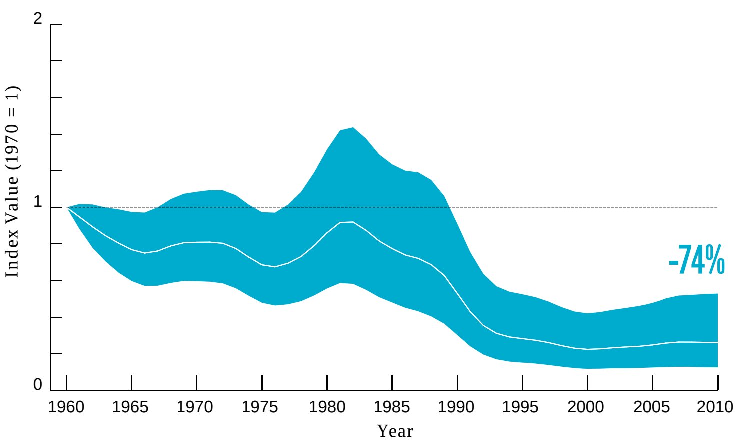
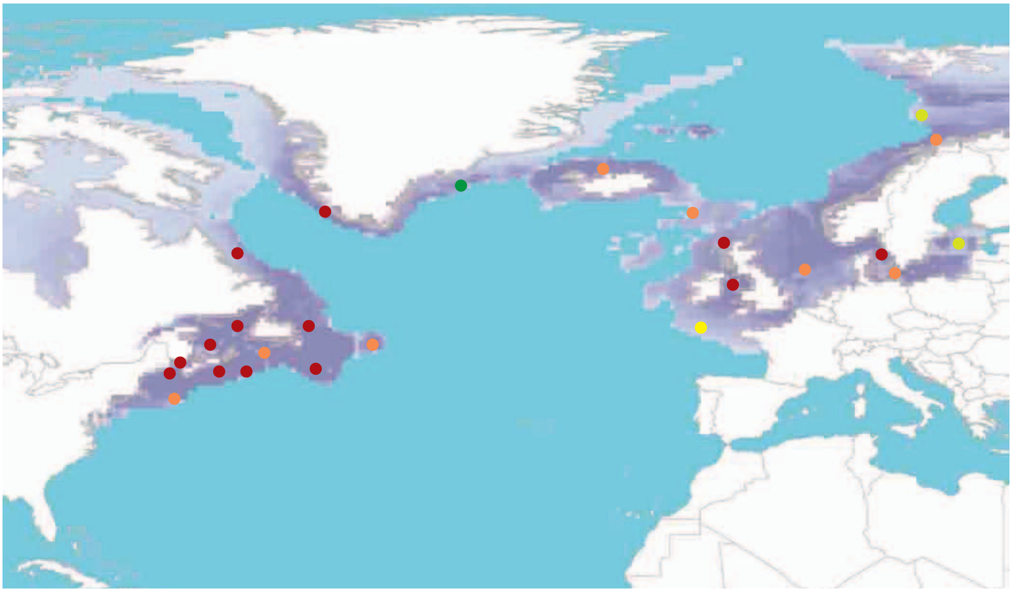


Figure 14a: Living Planet Index for Atlantic cod
The index shows the average change in the size of 25 stocks between 1960 and 2010. The baseline is set to an index value of 1 in 1960 and the final index value in 2010 is 0.26, suggesting an average 74% decline. (WWF / ZSL, 2012)

Key

Living Planet Index for Atlantic cod

Confidence limits



Population trend

- Decline
-
- Stable
-
- Increase

Figure 14b: Atlantic cod population trends
Atlantic cod distribution and rate of population change. The purple shaded area denotes the probability of occurrence throughout its range (created using AquaMaps: Aquamaps, 2010); circles show the midpoint of each stock monitored with the colour denoting the rate of population change. The length of the time-series ranges from 11 to 50 years between 1960 and 2010.

Probability of occurrence

High : 1

Low : 0

Looking back in time

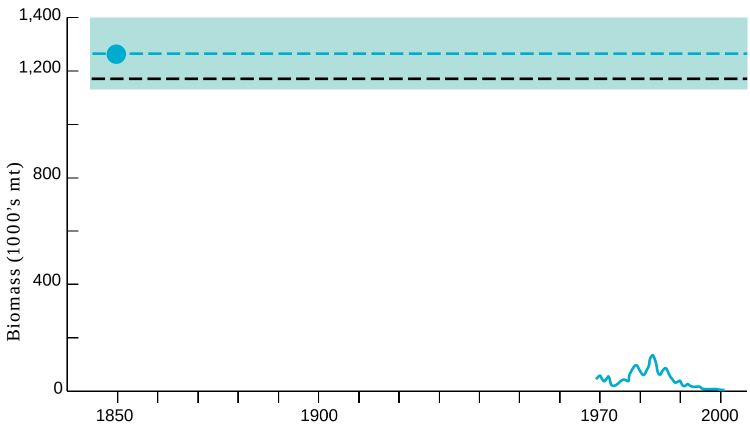


Figure 14c: Biomass estimates for Atlantic cod on the Scotian Shelf
The blue dot and blue dashed line shows the 1852 stock estimate, with blue shading showing confidence limits; the black dashed line is the estimated carrying capacity of this marine ecosystem from late 20th century data; and the solid blue line on the right shows total biomass estimates from 1970 to 2000 for adult cod, far lower than the historical highs (figure reproduced based on Rosenberg et al., 2005 and personal communication with Andrew Rosenberg and Karen Alexander).

Biogeographic realms

Biodiversity trends at a regional level can give insights into how animal populations are faring in different parts of the world.

Terrestrial and freshwater populations are assigned to five biogeographic realms (Figure 15), three of which are largely tropical (Indo-Pacific, Afrotropical and Neotropical) and two largely temperate (Palearctic and Nearctic). The Living Planet Index includes species' populations in the Antarctic, however due to a lack of data from this region, it is not yet possible to construct an index for that region alone.

Temperate realms show stable trends, while tropical realms exhibit rapid decline. The Palearctic and Nearctic indices show little change between 1970 and 2008 (Figures 16 and 17). The latter is likely due in part to effective environmental protection and conservation efforts since 1970. Individual populations in the Palearctic realm fared differently: Some, such as seabirds and wintering water birds, increased (for example, some UK wild bird populations: Defra, 2010), while others, such as saiga antelope (*Saiga tatarica*) (Milner-Gulland *et al.*, 2001) and amphibians in central Spain (Bosch and Martinez-Solano, 2006), underwent large-scale decline. The water bird trend may be due in part to better environmental protection since 1970. However, as most data come from Europe, with comparatively little data from northern Asia, trends from individual countries could provide a different picture.

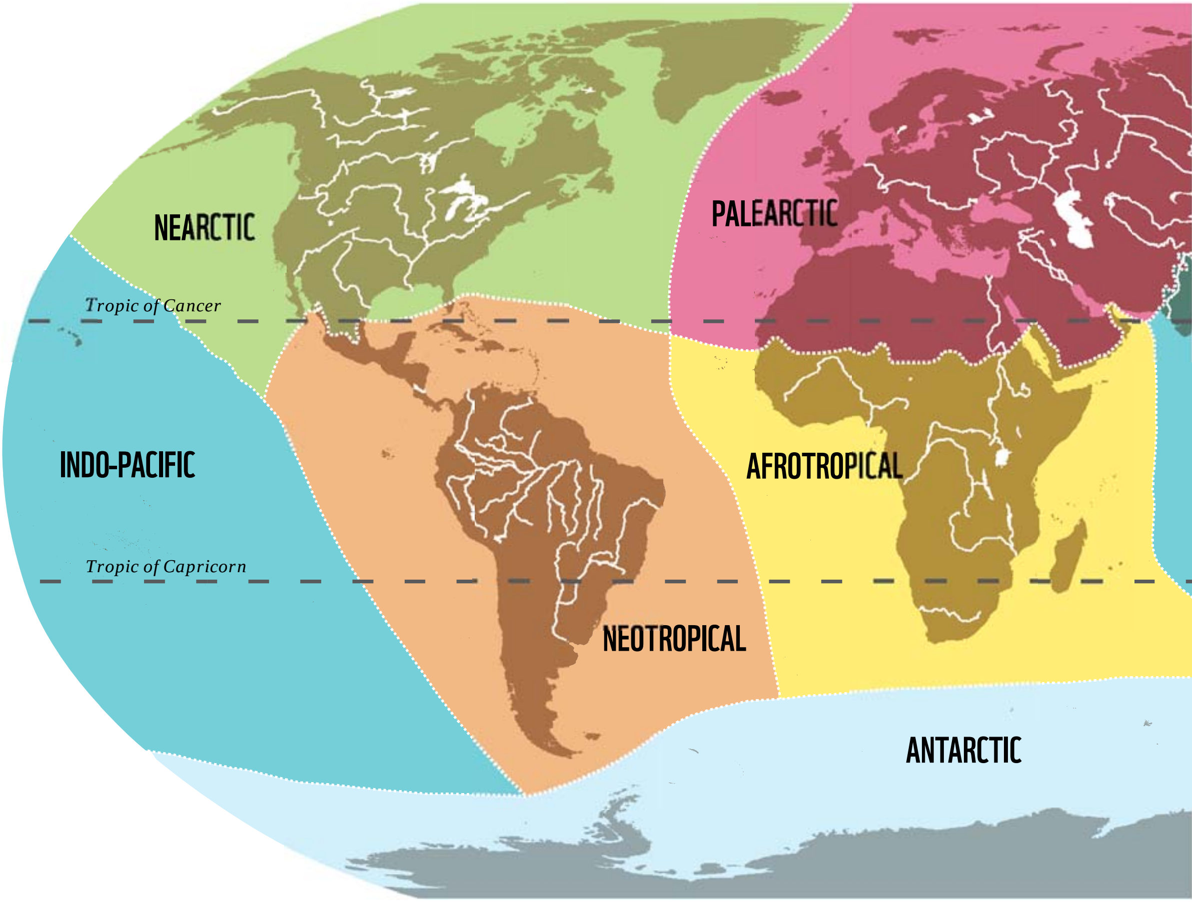
In contrast, the Afrotropical index declined by 38 per cent; the Neotropical index by 50 per cent; and the Indo-Pacific index by 64 per cent (Figures 18, 19 and 20). These declines reflect large-scale forest and other habitat loss across these realms, driven by logging, growing human populations, and agricultural, industrial and urban developments (Craigie *et al.*, 2010; Norris *et al.*, 2010; MEA, 2005; FAO, 2005; Hansen *et al.*, 2008). Tropical forest cover declined most rapidly in Southeast Asia between 1990 and 2005, with an estimated 0.6-0.8 per cent loss per year (FAO, 2005; Hansen *et al.*, 2008). The decline in the Neotropical index also reflects catastrophic declines in amphibian numbers, caused in many cases by the spread of fungal disease.

Rio Negro Forest Reserve, Amazonas, Brazil. Flooded forest during rainy season. Aerial view of floating vegetation.

Biodiversity trends around the world

What is a biogeographic realm?
Biogeographic realms are regions characterized by distinct assemblages of species. They represent large areas of the Earth's surface separated by major barriers to plant and animal migration – such as oceans, broad deserts and high mountain ranges – where terrestrial species have evolved in relative isolation over long periods of time.

Figure 15: Global biogeographic realms



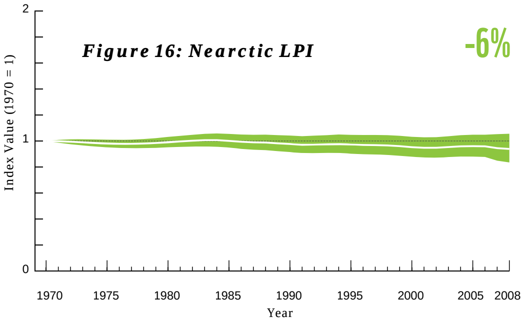


Figure 16: Nearctic LPI
-6%
Index Value (1970 = 1)
2
1
0
1970
1975
1980
1985
1990
1995
2000
2005
2008
Year

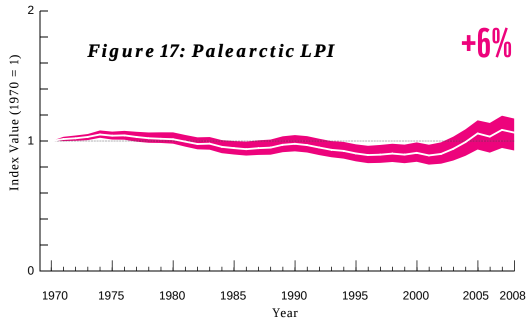
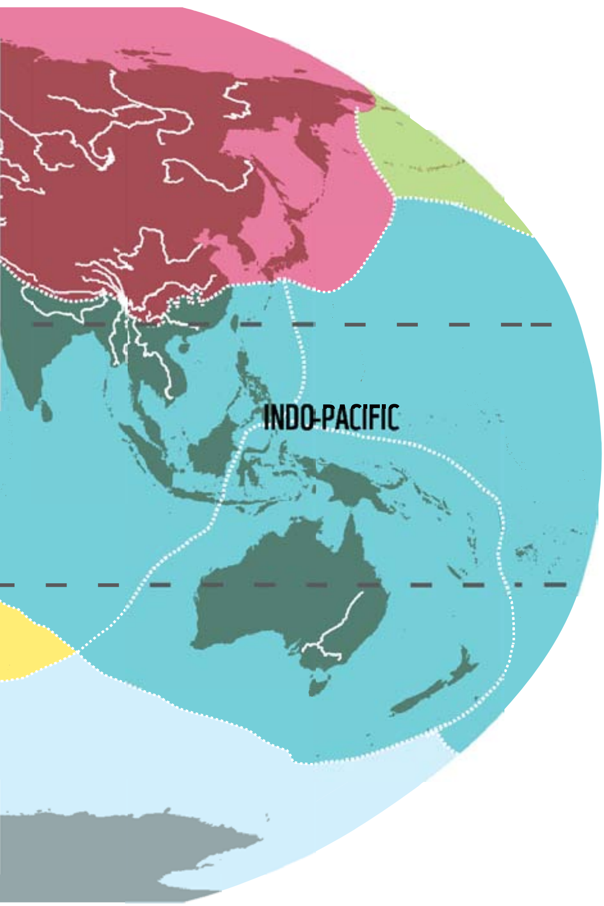


Figure 17: Palearctic LPI
+6%
Index Value (1970 = 1)
2
1
0
1970
1975
1980
1985
1990
1995
2000
2005
2008
Year


INDO-PACIFIC

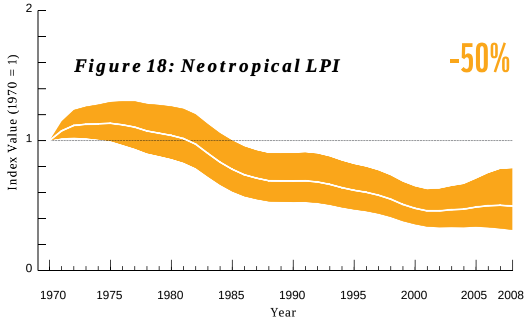


Figure 18: Neotropical LPI
-50%
Index Value (1970 = 1)
2
1
0
1970
1975
1980
1985
1990
1995
2000
2005
2008
Year

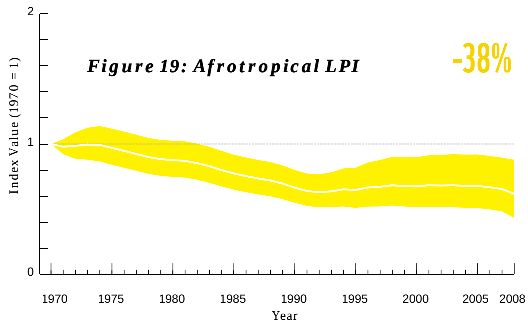


Figure 19: Afrotropical LPI
-38%
Index Value (1970 = 1)
2
1
0
1970
1975
1980
1985
1990
1995
2000
2005
2008
Year

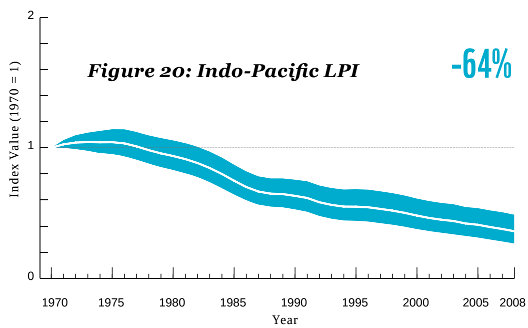
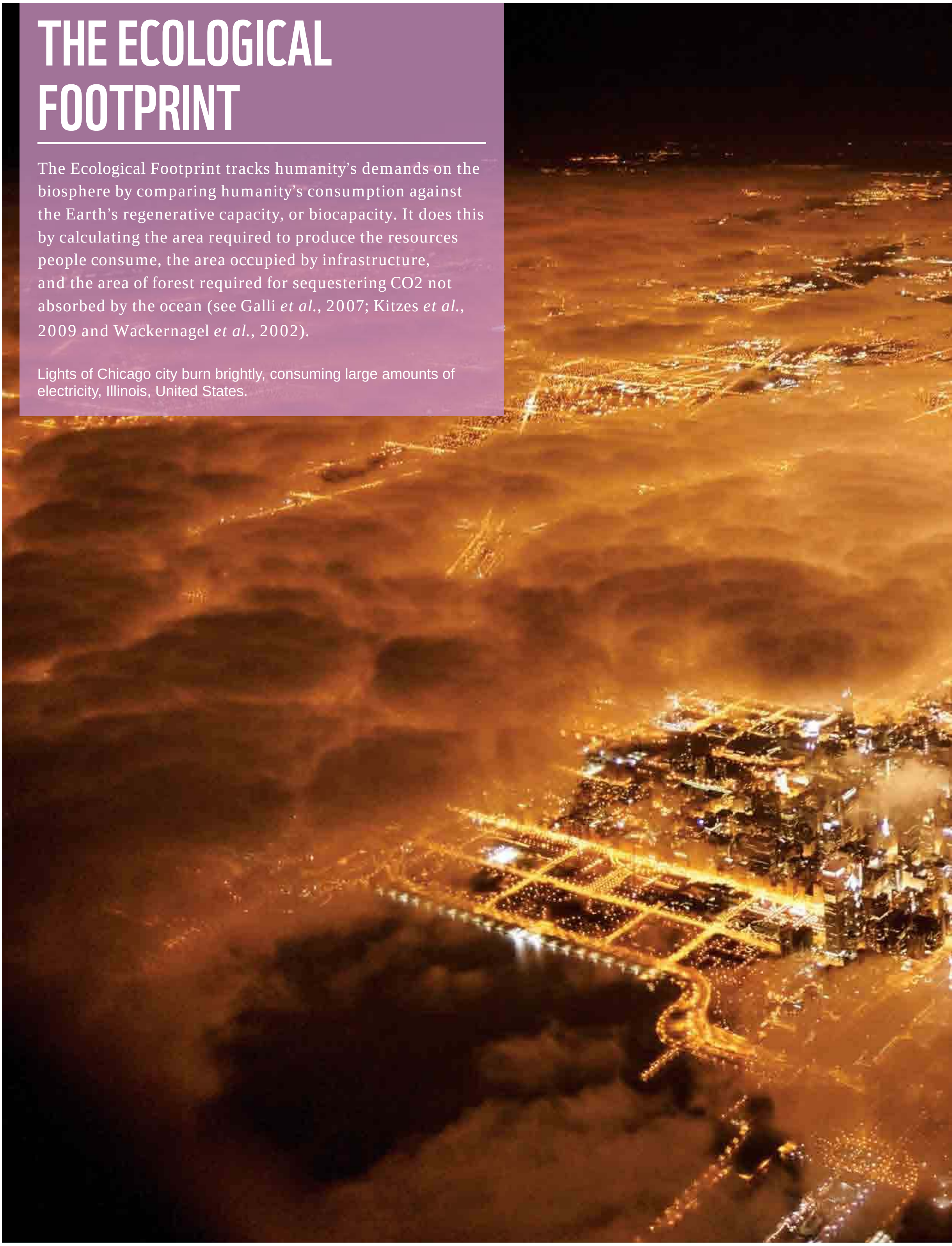


Figure 20: Indo-Pacific LPI
-64%
Index Value (1970 = 1)
2
1
0
1970
1975
1980
1985
1990
1995
2000
2005
2008
Year

THE ECOLOGICAL FOOTPRINT

The Ecological Footprint tracks humanity's demands on the biosphere by comparing humanity's consumption against the Earth's regenerative capacity, or biocapacity. It does this by calculating the area required to produce the resources people consume, the area occupied by infrastructure, and the area of forest required for sequestering CO_2 not absorbed by the ocean (see Galli *et al.*, 2007; Kitzes *et al.*, 2009 and Wackernagel *et al.*, 2002).



Lights of Chicago city burn brightly, consuming large amounts of electricity, Illinois, United States.

MEASURING HUMAN DEMAND

National Footprint Accounts (NFAs) track resources for each individual country, which together make up the global Ecological Footprint. They include crops and fish for human food and other uses; timber; and grass and feed crops for livestock. CO2 emissions are currently the only waste product tracked (Figure 21).

Biocapacity quantifies nature's capacity to produce renewable resources, provide land for built-up areas and provide waste absorption services such as carbon uptake. Biocapacity acts as an ecological benchmark against which the Ecological Footprint can be compared. The Ecological Footprint does not directly include water use; however this is intrinsic to biocapacity – as lack of water, or polluted water, has a direct impact on the availability and state of biocapacity. Both the Ecological Footprint and biocapacity are expressed in a common unit called a global hectare, where 1 gha represents a biologically productive hectare with world average productivity. In 2008, the Earth's total biocapacity was 12.0 billion gha, or 1.8 gha per person, while humanity's Ecological Footprint was 18.2 billion gha, or 2.7 gha per person. This discrepancy means it would take 1.5 years for the Earth to fully regenerate the renewable resources that people used in one year.

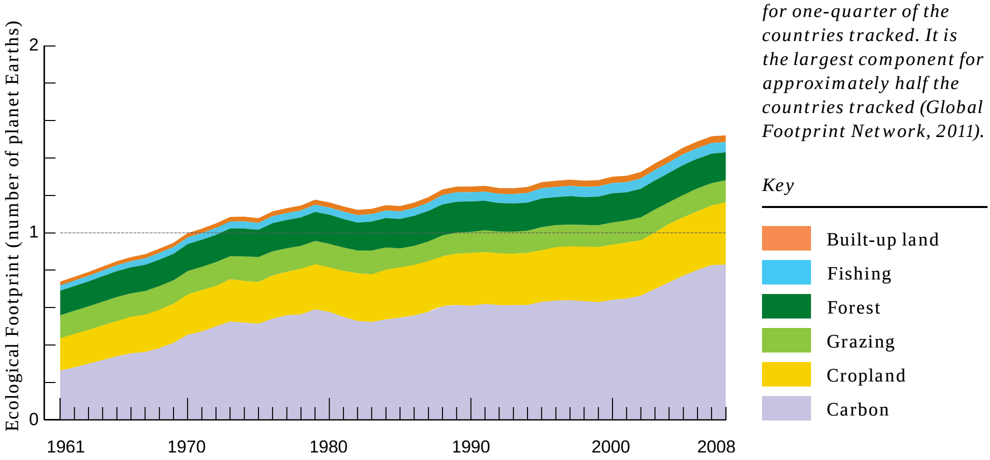


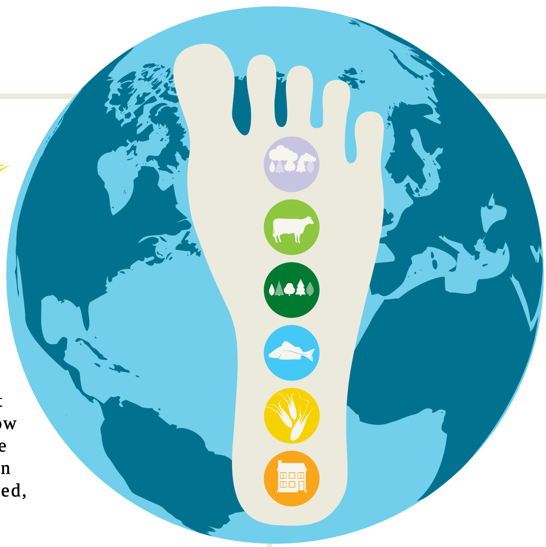
Figure 21: Global Ecological Footprint by component, 1961-2008
The largest component of the Ecological Footprint is the carbon footprint (55%). At a national level the carbon footprint represents more than half the Ecological Footprint for one-quarter of the countries tracked. It is the largest component for approximately half the countries tracked (Global Footprint Network, 2011).

Exploring the Ecological Footprint

Every human activity uses biologically productive land and/ or fishing grounds. The Ecological Footprint is the sum of these areas, regardless of where they are located on the planet (Figure 22).

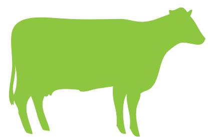
Carbon

Represents the amount of forest land that could sequester CO2 emissions from the burning of fossil fuels, excluding the fraction absorbed by the oceans which leads to acidification.



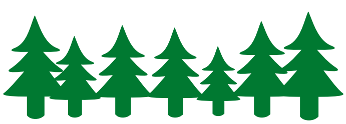
Cropland

Represents the amount of cropland used to grow crops for food and fibre for human consumption as well as for animal feed, oil crops and rubber.



Grazing Land

Represents the amount of grazing land used to raise livestock for meat, dairy, hide and wool products.

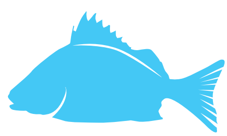


Forest

Represents the amount of forest required to supply timber products, pulp and fuel wood.

Built-up Land

Represents the amount of land covered by human infrastructure, including transportation, housing, industrial structures and reservoirs for hydropower.



Fishing Grounds

Calculated from the estimated primary production required to support the fish and seafood caught, based on catch data for marine and freshwater species.

Figure 22 : Exploring the Ecological Footprint

What does "ecological overshoot" mean?

Humanity's annual demand on the natural world has exceeded what the Earth can renew in a year since the 1970s. This "ecological overshoot" has continued to grow over the years, reaching a 50 per cent deficit in 2008. This means that it takes 1.5 years for the Earth to regenerate the renewable resources that people use, and absorb the CO2 waste they produce, in that same year.

How can this be possible when there is only one Earth? Just as it is possible to withdraw money from a bank account faster than to wait for the interest this money generates, renewable resources can be harvested faster than they can be re-grown. But just like overdrawing from a bank account, eventually the resource will be depleted. At present, people are often able to shift their sourcing when this happens; however at current consumption rates, these sources will eventually run out of resources too – and some ecosystems will collapse even before the resource is completely gone.

The consequences of excess greenhouse gases that cannot be absorbed by vegetation are already being seen, with rising levels of atmospheric CO2 causing increased global temperatures, climate change and ocean acidification. These impacts in turn place additional stresses on biodiversity and ecosystems and the very resources on which people depend.

1.5 YEARS
TO GENERATE THE RENEWABLE RESOURCES USED IN 2008

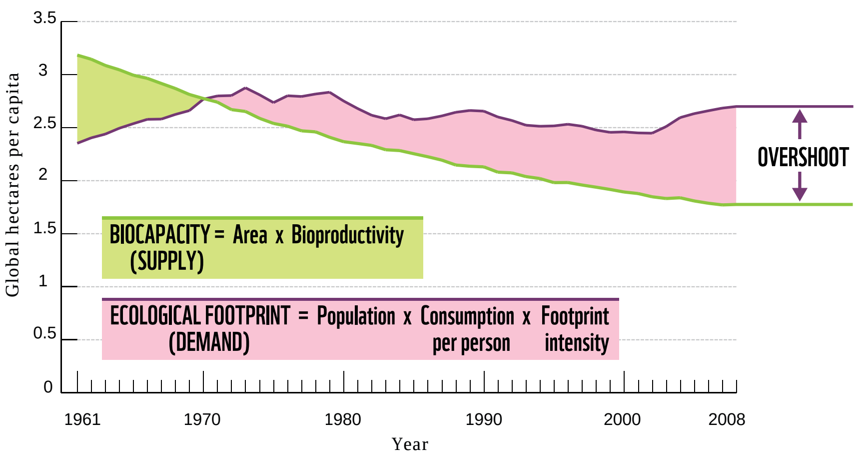


Figure 23: Trends in Ecological Footprint and biocapacity per person between 1961 and 2008

The decline in biocapacity per capita is primarily due to an increase in global population. More people have to share the Earth's resources. The increase in the Earth's productivity is not enough to compensate for the demands of this growing population (Global Footprint Network, 2011).

Biocapacity and Ecological Footprint trends

The Ecological Footprint is driven by consumer habits and the efficiency with which goods and services can be provided. The growing biocapacity deficit – defined as when a population uses more biocapacity than can be supplied and regenerated in a year – is driven by the combination of high consumption rates that are increasing more rapidly than improvements in efficiency (increasing people's footprint); and populations growing faster than the biosphere's capacity (driving down biocapacity per person).

Figure 24: Factors driving Ecological Footprint and biocapacity *(Global Footprint Network, 2011)*

Biocapacity factors

Bioproductive area: The area available of cropland, grazing land, fishing grounds and forests.

Bioproductivity per hectare: An area's productivity can vary each year and depends on factors such as ecosystem type, management and health, agricultural practices and weather. Productivity can be enhanced to achieve more biocapacity, however this often comes at the cost of a larger Ecological Footprint. For example, energy-intensive agriculture and heavy reliance on fertilizer may increase yields, but requires increased inputs and generates higher CO2 emissions.

Ecological Footprint drivers

Population growth: The growing number of consumers is a strong driver behind the increasing global footprint. The human population is forecast to reach 7.8-10.9 billion people by 2050, with a medium estimate of just over 9.3 billion (UN, 2010). Population size also affects the biocapacity available to each person.

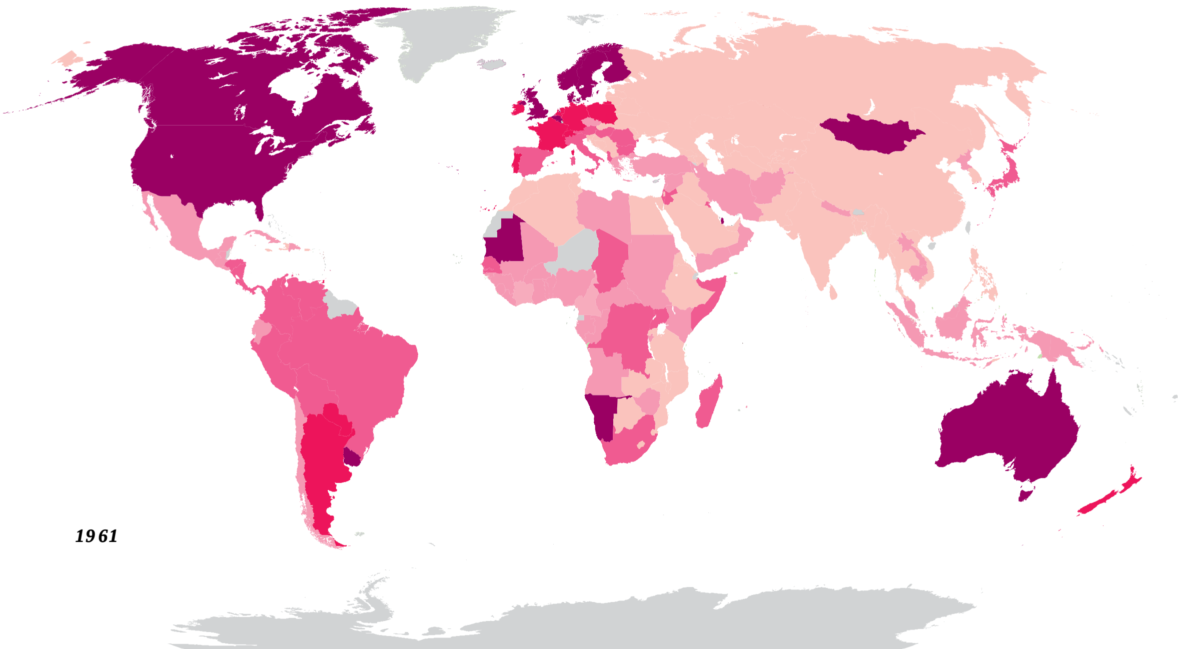
Consumption of goods and services per person: Different populations consume different quantities of goods and services, primarily based on their income level.

Footprint Intensity: The efficiency with which natural resources are converted into goods and services affects the size of the footprint of every product consumed. This varies between countries.

Mapping the Ecological Footprint

National trends for Ecological Footprint have changed over the years and generally increased. Figure 25 shows the average Ecological Footprint per person per country in 1961 (when National Footprint Accounts started) and again in 2008.

Figure 25: Changing Ecological Footprint per person
Global map of national Ecological Footprint per person in (a) 1961 and (b) 2008 (Global Footprint Network, 2011).



Gha per capita

- < 1
- 1 - 2
- 2 - 3
- 3 - 5
- 5 - 8
- Insufficient data

Different countries have different footprints

An individual's Ecological Footprint varies significantly depending on a number of factors, including their country of residence, the quantity of goods and services they consume, the resources used and the wastes generated to provide these goods and services. If all of humanity lived like an average Indonesian, for example, only two-thirds of the planet's biocapacity would be used; if everyone lived like an average Argentinean, humanity would demand more than half an additional planet; and if everyone lived like an average resident of the USA, a total of four Earths would be required to regenerate humanity's annual demand on nature.

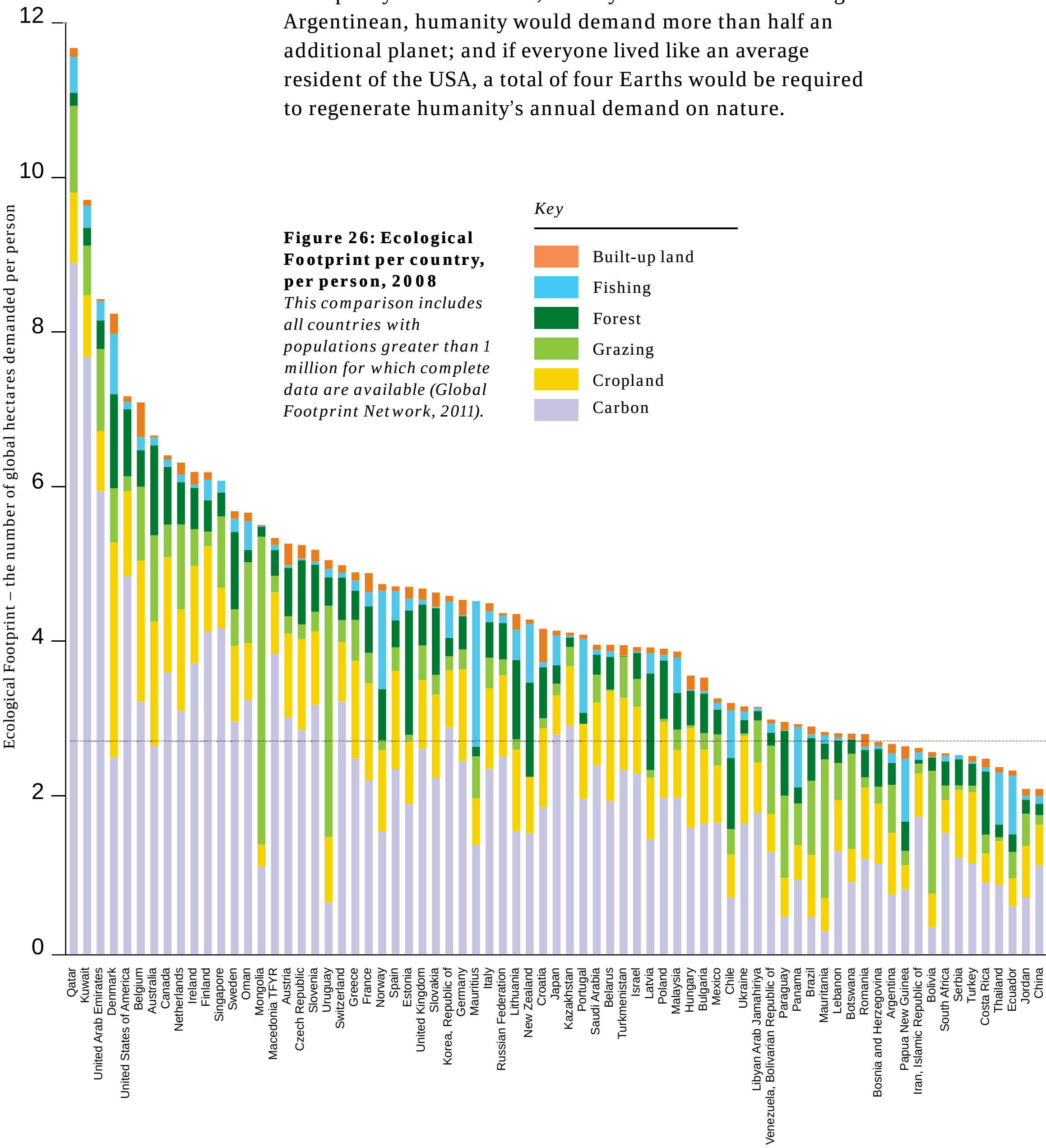


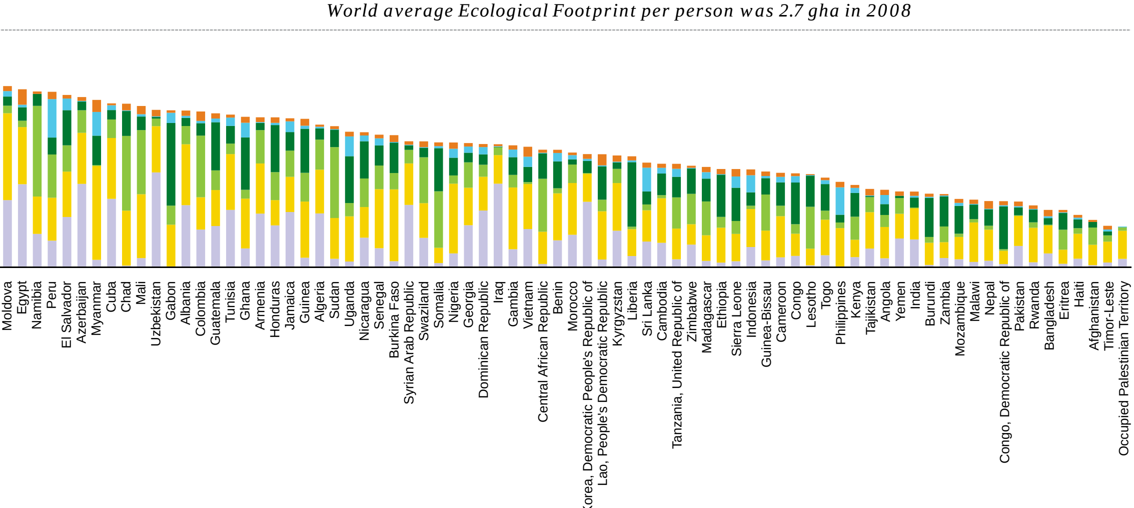
Figure 26: Ecological Footprint per country, per person, 2008
This comparison includes all countries with populations greater than 1 million for which complete data are available (Global Footprint Network, 2011).

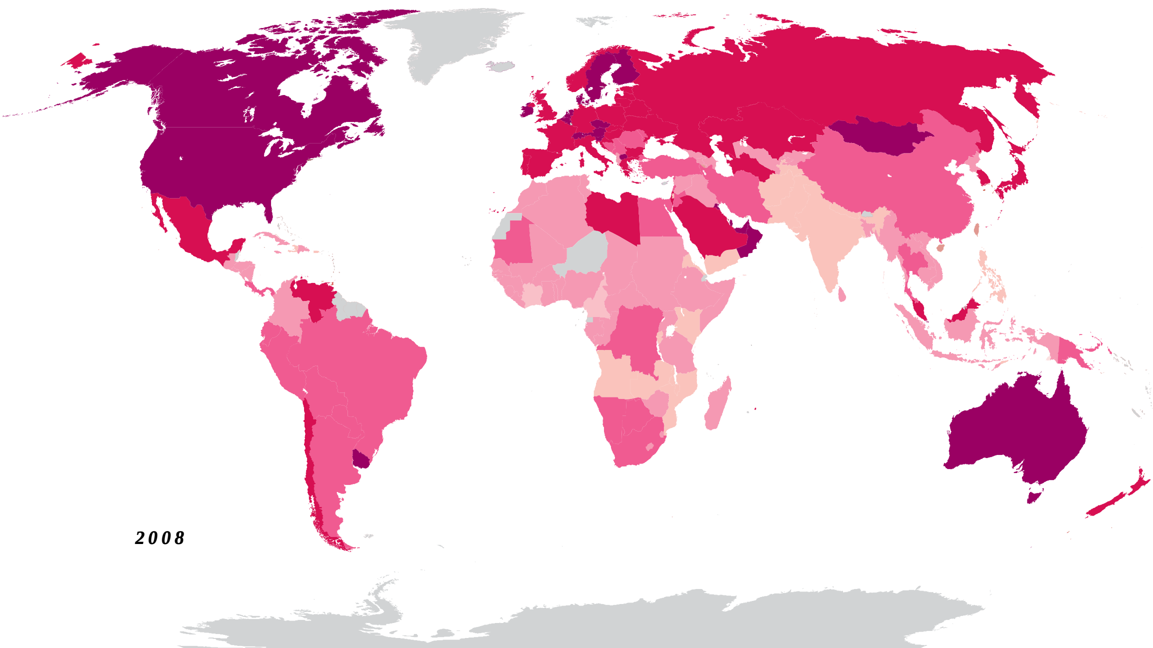
How much of a country's footprint is determined by individuals?

The size of a person's Ecological Footprint depends on development level and wealth, and in part on the choices individuals make on what they eat, what products they purchase and how they travel. But decisions undertaken by governments and businesses have a substantial influence on the Ecological Footprint too. For example, individuals generally have no direct control over the size of the built-up land footprint. The same is true for the way in which a country produces its electricity or the intensity of its agricultural production. This "inherited" part of the Ecological Footprint can be influenced through mechanisms such as political engagement, green technology and innovation, and other work toward large-scale social change. Governments and businesses therefore play an important role in reducing the Ecological Footprint of each person.

IF EVERYONE LIVED LIKE AN AVERAGE RESIDENT OF THE USA, A TOTAL OF FOUR EARTHS WOULD BE REQUIRED TO REGENERATE HUMANITY'S ANNUAL DEMAND ON NATURE

World average Ecological Footprint per person was 2.7 gha in 2008





Gha per capita

- < 1
- 1 - 2
- 2 - 3
- 3 - 5
- 5 - 8
- Insufficient data

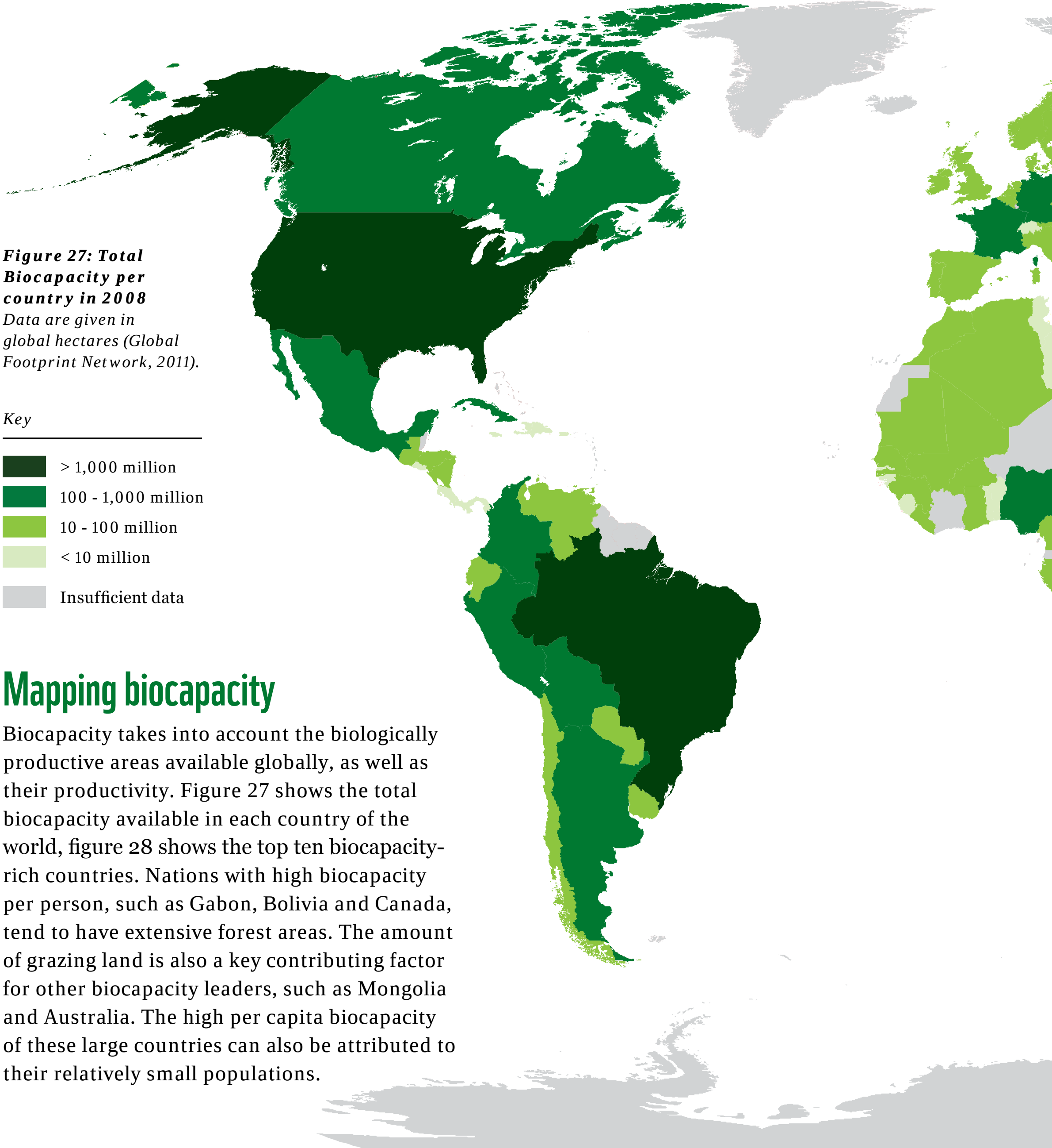


Figure 27: Total Biocapacity per country in 2008
Data are given in global hectares (Global Footprint Network, 2011).

Mapping biocapacity

Biocapacity takes into account the biologically productive areas available globally, as well as their productivity. Figure 27 shows the total biocapacity available in each country of the world, figure 28 shows the top ten biocapacity-rich countries. Nations with high biocapacity per person, such as Gabon, Bolivia and Canada, tend to have extensive forest areas. The amount of grazing land is also a key contributing factor for other biocapacity leaders, such as Mongolia and Australia. The high per capita biocapacity of these large countries can also be attributed to their relatively small populations.

Different countries, different biocapacities

Some countries with high biocapacity do not have a large national footprint. Bolivia, for example, has a per capita footprint of 2.6 gha and a per capita biocapacity of 18 gha. However it is worth noting that this biocapacity may well be being exported and utilized by other nations. For example, the Ecological Footprint of a citizen of United Arab Emirates (UAE) is 8.4 gha, but within the country there is only 0.6 gha of biocapacity available per person. The residents of UAE are therefore dependent on the resources of other nations to meet their needs. As resources are becoming more constrained, competition is growing; the disparity between resource-rich and resource-poor nations is highly likely to have strong geo-political implications in the future.

Figure 29: Biocapacity per person in 2008, by country
This comparison includes all countries with populations greater than 1 million for which complete data are available (Global Footprint Network, 2011).

Key

Built-up Land
Fishing
Forest
Grazing
Cropland

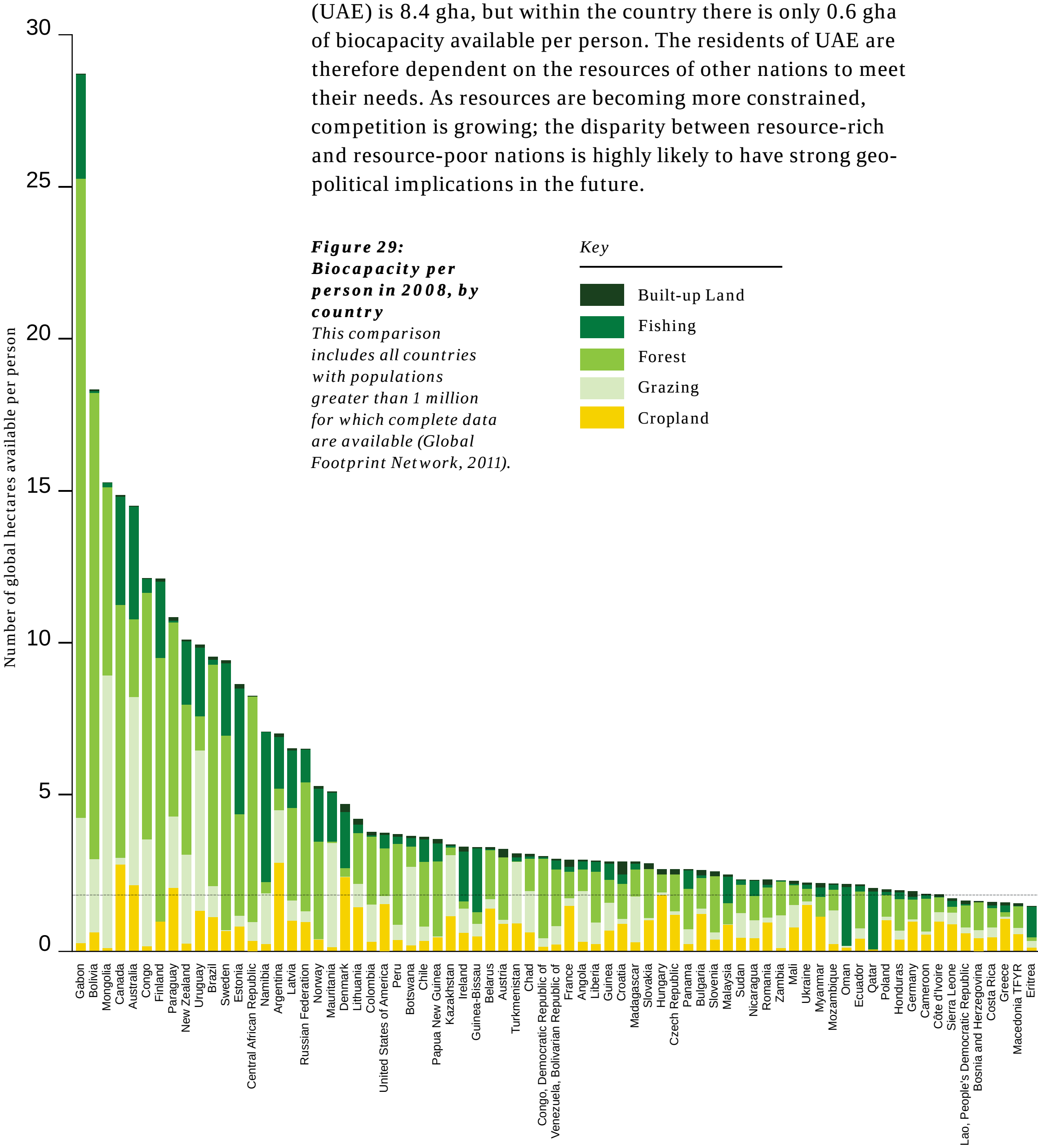
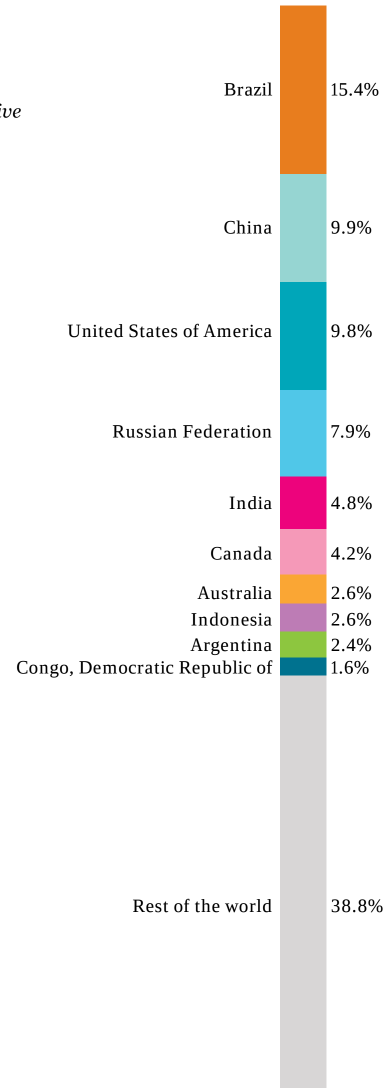
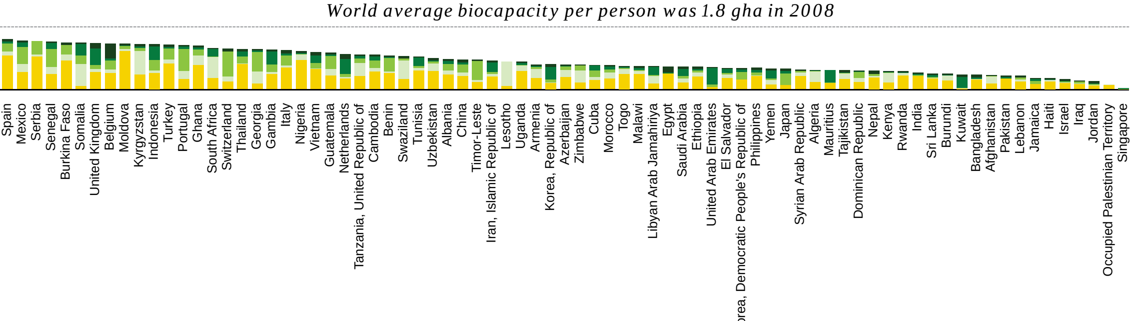
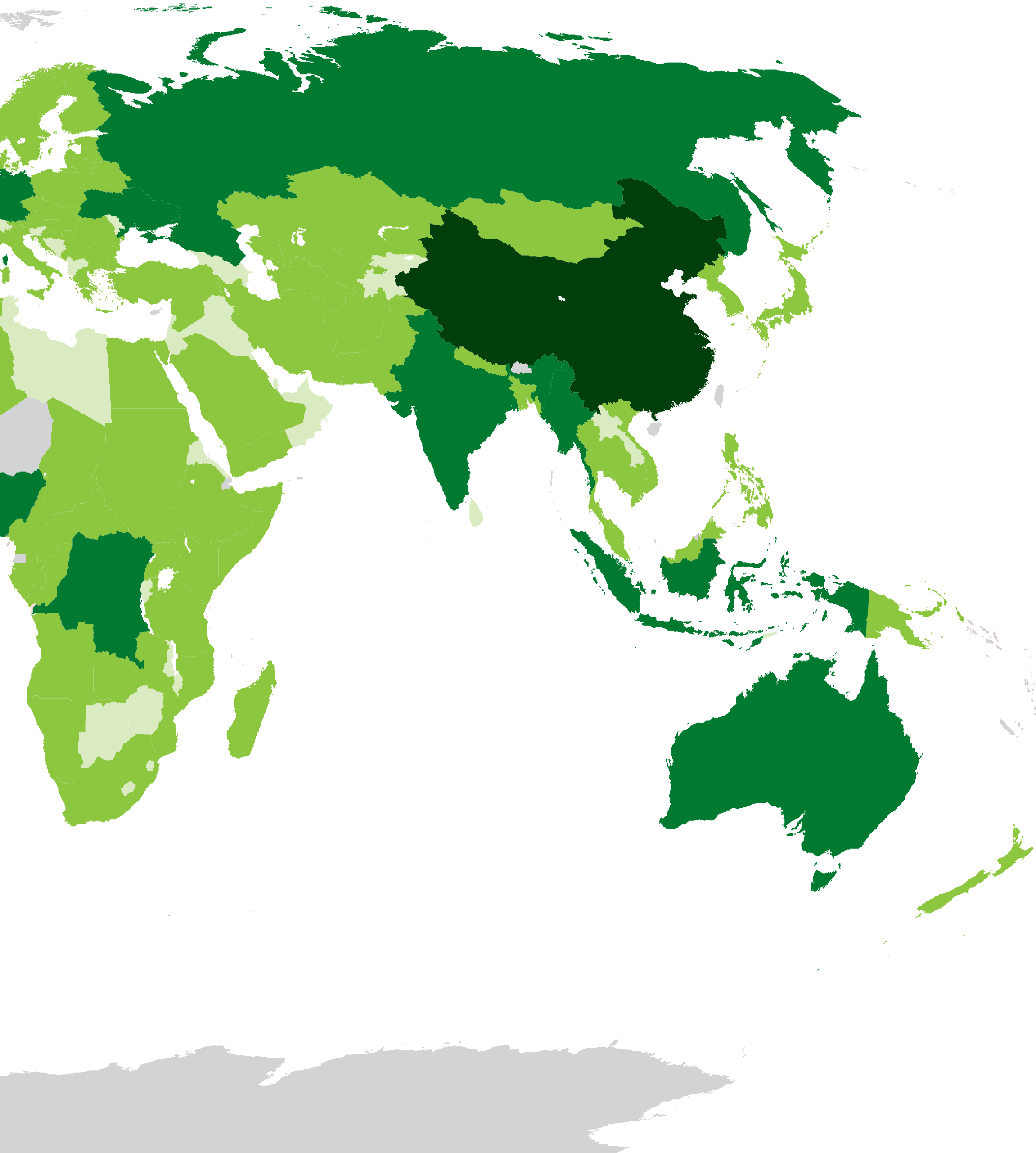


Figure 28: Top 10 national biocapacities in 2008
Ten countries accounted for more than 60% of the Earth's total biocapacity in 2008. This includes five of the six BRIICS countries: Brazil, Russia, India, Indonesia and China (Global Footprint Network, 2011).



World average biocapacity per person was 1.8 gha in 2008





A focus on emerging economies: BRIICS countries

The rapid economic expansion of Brazil, Russia, India, Indonesia, China and South Africa – the so-called BRIICS group – merit special attention when looking at the Ecological Footprint and the pressure on biocapacity. High population growth in the BRIICS group along with increasing average consumption per person are contributing to an economic transformation. As a result, the BRIICS economies are expanding more rapidly than those of high-income countries. This growth will bring important social benefits to these countries. The challenge, however, is to do this sustainably.

Figure 30 highlights BRIICS countries' consumption trends by showing the Ecological Footprint associated with the direct expenditure of an average individual or resident (also known as "household consumption") broken down into five categories: food, housing, transport, goods and services. (More information about the Consumption Land Use Matrix – or CLUM – models on which these figures are based can be found in the glossary at the back of this report). Citizens of lower-income BRIICS countries have a far larger proportion of their footprint associated with direct expenditure on food than they do on other categories. In Brazil, India and Indonesia, food accounts for more than 50 per cent of the total household footprint. The remaining portion is split almost equally among goods, transportation and housing. As the BRIICS nations become wealthier, and the average Ecological Footprint increases, consumption patterns increasingly mirror high-income countries. South Africa and China, for example, are moving toward a more equal split between each of the consumption categories, indicative of industrialisation and increased income.

BRIICS ECONOMIES ARE EXPANDING RAPIDLY – THE CHALLENGE IS TO DO THIS SUSTAINABLY

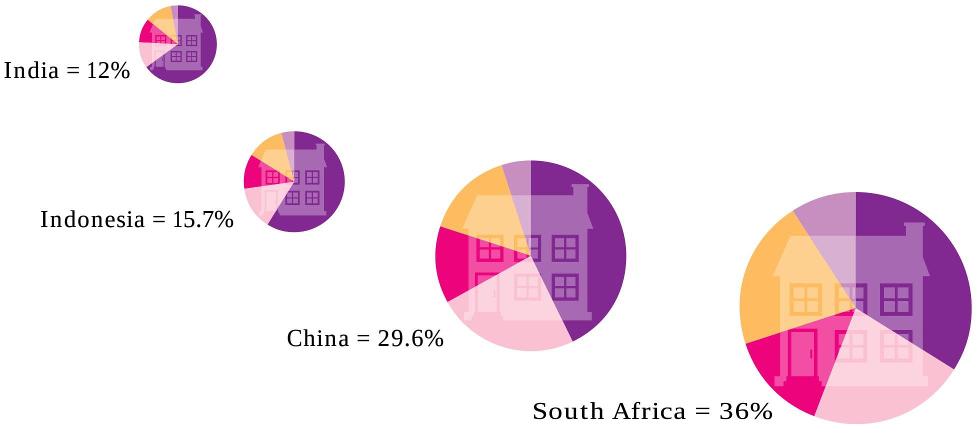
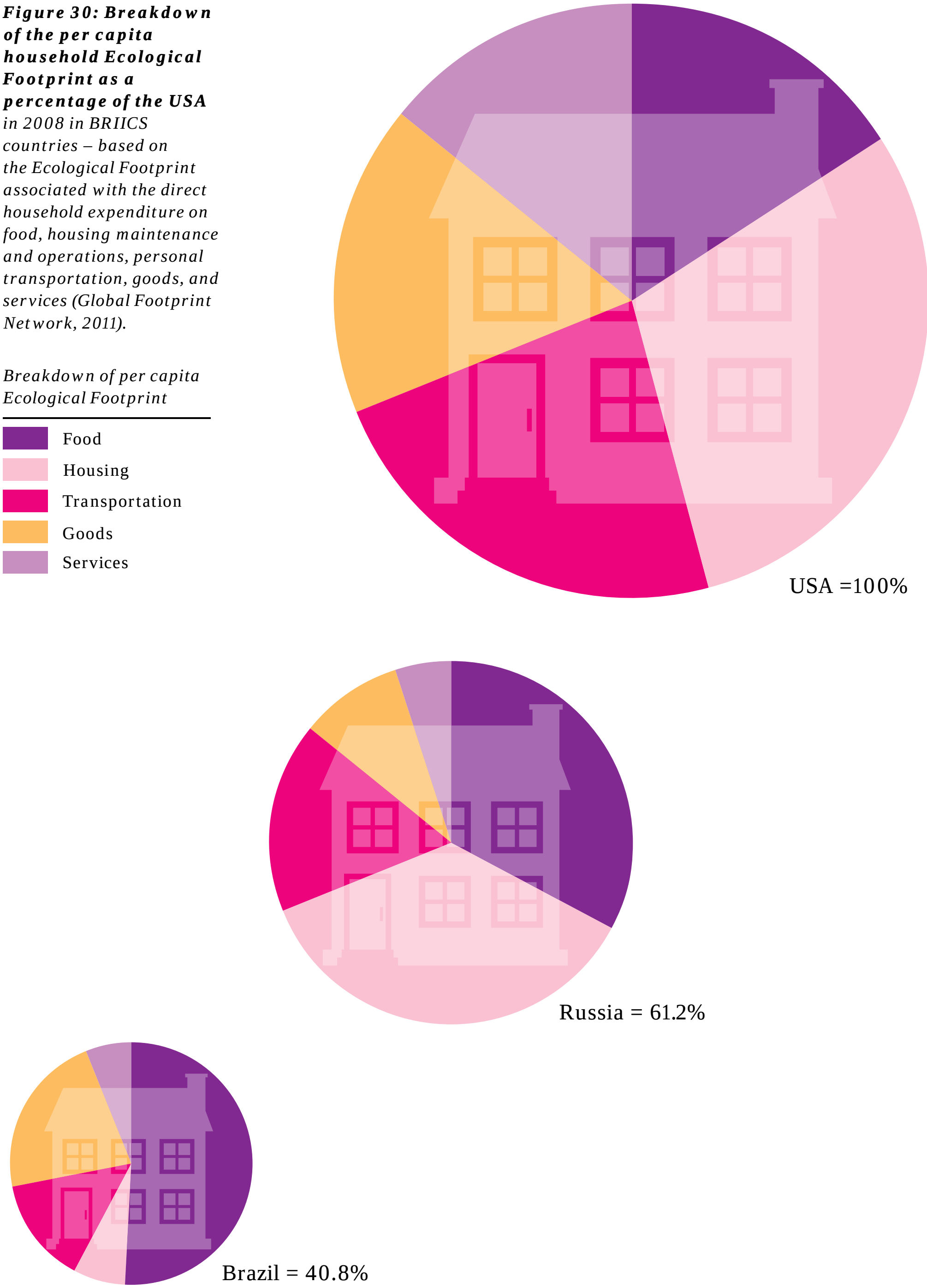
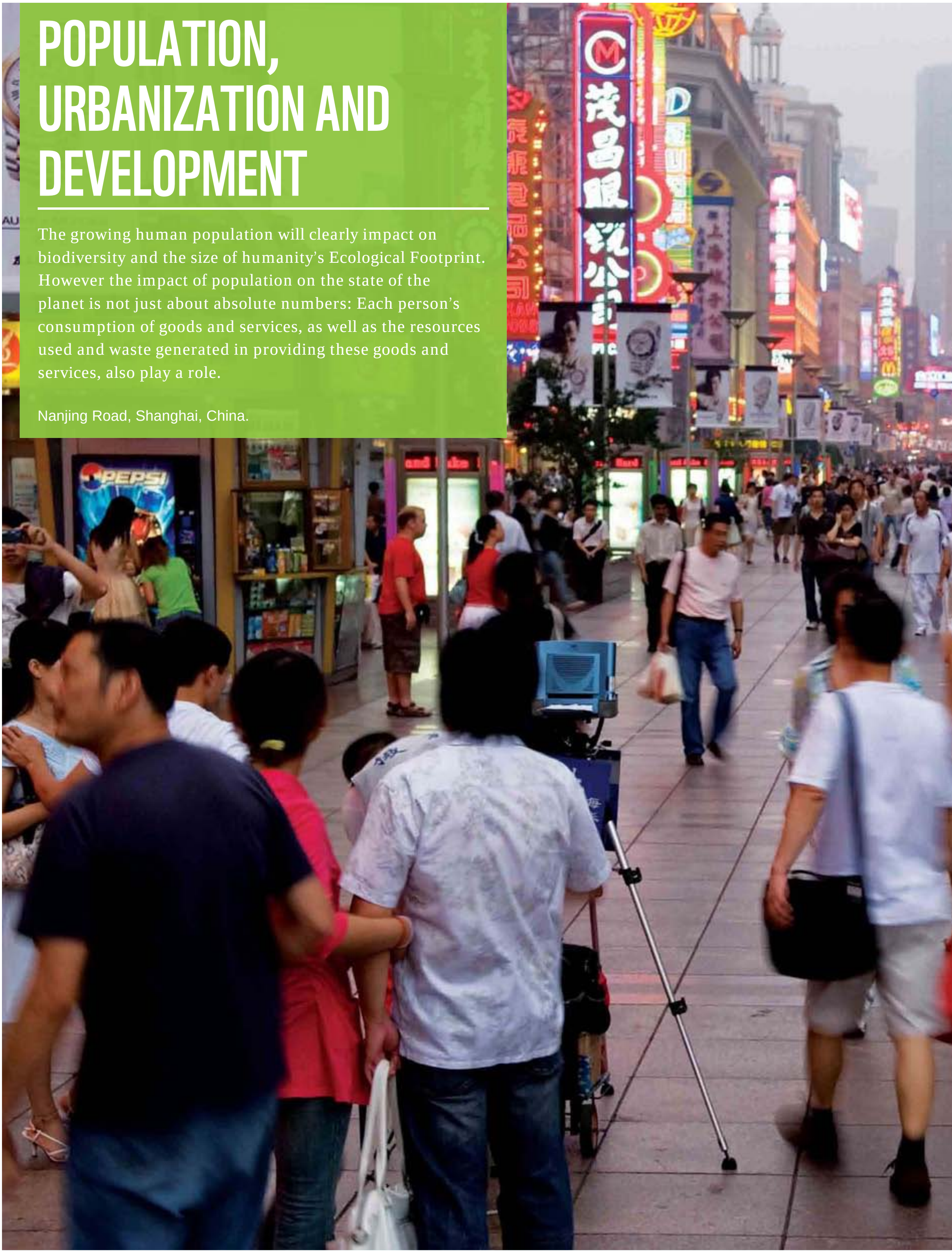


Figure 30: Breakdown of the per capita household Ecological Footprint as a percentage of the USA *in 2008 in BRIICS countries – based on the Ecological Footprint associated with the direct household expenditure on food, housing maintenance and operations, personal transportation, goods, and services (Global Footprint Network, 2011).*



POPULATION, URBANIZATION AND DEVELOPMENT

The growing human population will clearly impact on biodiversity and the size of humanity's Ecological Footprint. However the impact of population on the state of the planet is not just about absolute numbers: Each person's consumption of goods and services, as well as the resources used and waste generated in providing these goods and services, also play a role.



Nanjing Road, Shanghai, China.

© Susetta Bozzi / WWF-China

POPULATION, DEVELOPMENT AND URBANIZATION

Human population dynamics are a major driving force behind environmental pressure. One aspect of this is the overall size of the global population, which has more than doubled since 1950 – to 7 billion in 2011 and is forecast to reach just over 9.3 billion people by 2050 (UN, 2010; median estimate). Much of this increase is projected to come from countries with high fertility – primarily in Africa and Asia, but also in Latin America and North America (UNFPA, 2011; Figure 31).

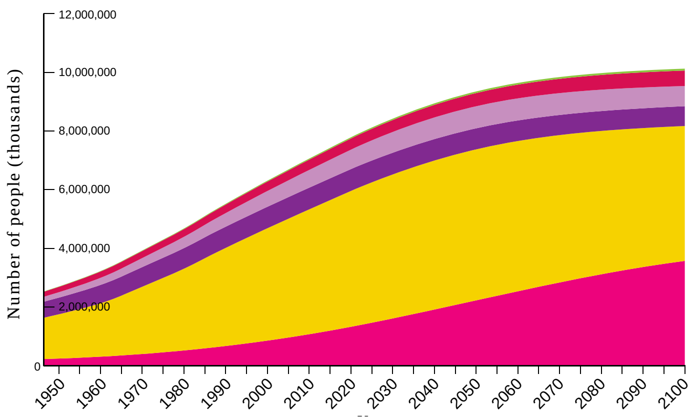


Figure 31: Regional and global population growth between 1950 and 2100

Projected population by region, medium variant between 1950 and 2011 (UNFPA, 2011). In 2011, the global population reached 7 billion people. Based on estimated birth rates, Asia will remain the most populous region during the 21st century, but Africa will gain ground as its population more than triples, passing from 1 billion in 2011 to 3.6 billion in 2100. Africa's population has been growing at 2.3% per year, more than double the rate of Asia's population (1% per year). The rate of population growth is expected to slow after 2050. Note that in this figure, Asia includes the Middle East and Oceania is displayed separately.

Key

- Oceania
- Northern America
- Latin America & The Caribbean
- Europe
- Asia
- Africa

Population, income and Ecological Footprint

On a global scale, both population and the average per capita footprint have increased since 1961. However, the relative contribution of each to the overall increased Ecological Footprint is different in different regions (Figure 33).

The largest per capita footprint increases between 1961 and 2008 were in the European Union and the Middle East/Central Asia, which increased by 1.2 and 1.1 gha per person, respectively. Despite North America having a smaller increase (0.6 gha per person), it maintained the highest regional footprint over this period (7.1 gha per capita).

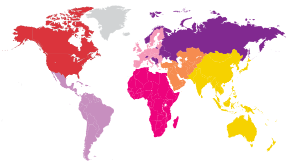


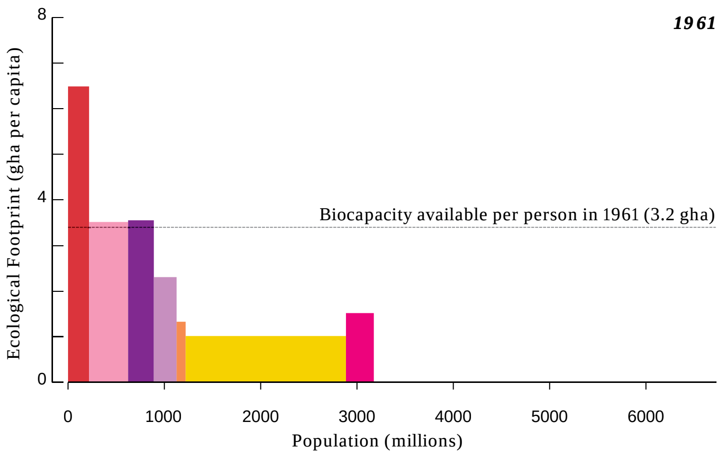
Figure 32: Global geographic groupings

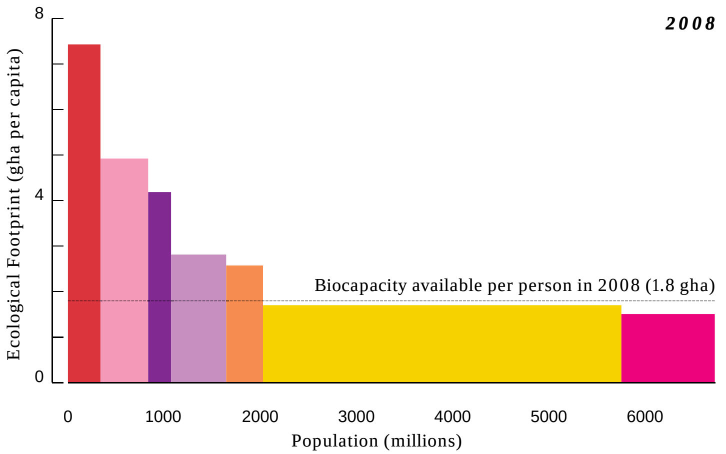
In the Asia-Pacific region, the footprint grew by 0.6 gha per person, but more significantly the population doubled from 1.6 billion people in 1961 to 3.7 billion in 2008. Similarly, although the average per person footprint in Africa decreased by 0.07 gha per person between 1961 and 2008, rapid population growth led to a much larger overall footprint, over triple the value of 1961.

Figure 33: Ecological Footprint by geographic grouping, in 1961 and 2008
Change in the average footprint per person and population for each of the world's regions (Figure 32). The area within each bar represents the total footprint for each region (Global Footprint Network, 2011).

Key

- Northern America
- EU
- Other Europe
- Latin America
- Middle East/ Central Asia
- Asia-Pacific
- Africa





People with different incomes have different footprints

The per capita Ecological Footprint of high-income nations dwarfs that of low- and middle-income countries. High-income countries have historically had the most rapid increase in per capita footprint. This was principally due to growth in the carbon component of the per capita footprint – by 1.6 times between 1961 and 1970.

In contrast, middle- and low-income countries had demanded less than the average per capita biocapacity available globally, until 2006 when middle-income countries exceeded this value.

Middle-income countries include many of the world's emerging economies, including the BRIICS countries: Brazil, Russia, India, Indonesia, China and South Africa. Overall, population has more than doubled since 1961, while the footprint per person has increased by 65 per cent, largely associated with increased industrialization. Although population growth is slowing in some places, further population increases, together with a rise of middle class consumption patterns in emerging economies, have the potential to increase humanity's global footprint dramatically in the near future.

The citizens of low-income countries have, on average, a smaller footprint today than they had in 1961 – a reduction of 0.01 gha per person. However, rapid population growth in these countries (4.3 times, since 1961) has led to an overall 323 per cent increase in the total Ecological Footprint of low-income countries since 1961.

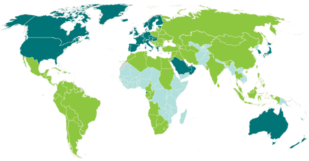


Figure 34: Countries in high, middle and low income categories

Key

- High Income
- Middle Income
- Low Income

THE ECOLOGICAL FOOTPRINT OF LOW-INCOME COUNTRIES HAS INCREASED BY 323 PER CENT SINCE 1961 DUE TO RAPID POPULATION GROWTH

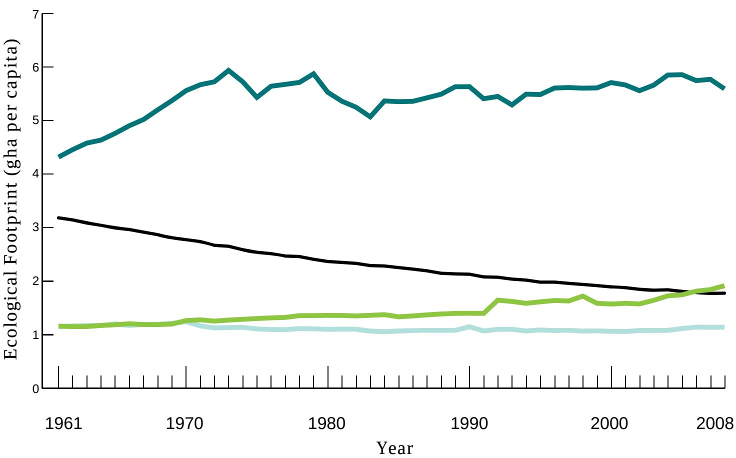


Figure 35: Changes in the Ecological Footprint per person in high-, middle- and low-income countries between 1961 and 2008
The black line represents world average biocapacity in 2008 (Global Footprint Network, 2011).

Key

- High Income
- Middle Income
- Low Income

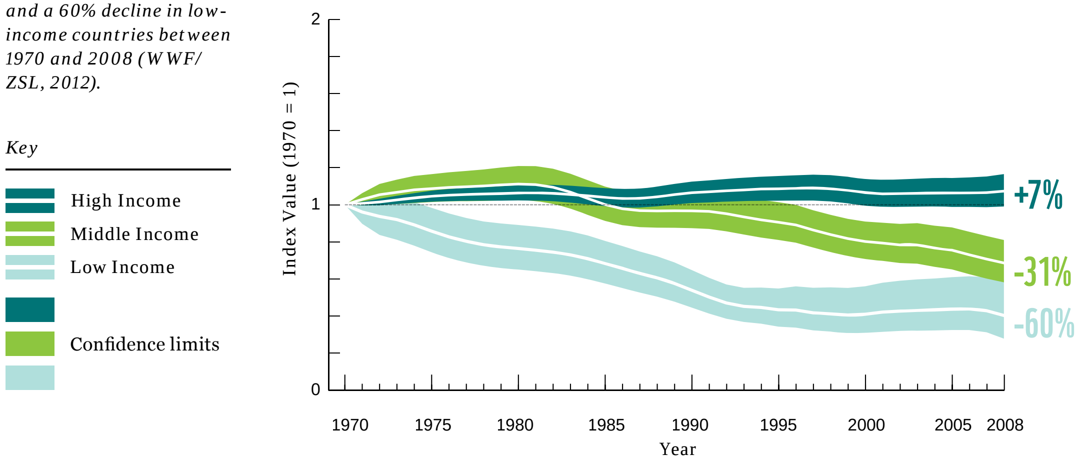
THE LIVING PLANET INDEX FOR LOW-INCOME COUNTRIES HAS DECLINED BY 60 PER CENT

The Living Planet Index shows that declines in biodiversity are greatest in low-income countries. The analyses presented earlier in this report show strong geographic differences in biodiversity loss, particularly between tropical and temperate regions. To demonstrate that these differences are not only geographic or biophysical in nature, species' population data (except for marine populations in international waters) were divided into three country income categories (see "Country Income Categories" in Annex 3).

The Living Planet Index for high-income countries shows an increase of 7 per cent between 1970 and 2008 (Figure 36). This is likely to be due to a combination of factors, not least of which being that these nations are able to purchase and import resources from lower-income countries, thereby simultaneously degrading the biodiversity in those countries while maintaining the remaining biodiversity and ecosystems in their own "back yard".

In stark contrast, the index for middle-income countries has declined by 31 per cent, and most alarmingly the index for low-income countries has declined by 60 per cent. The trend in low-income countries is potentially catastrophic, not just for biodiversity but also for the people living there. While everyone depends ultimately on the biodiversity that provides ecosystem services and natural assets, the impact of environmental degradation is felt most directly by the world's poorest people, particularly by rural populations, and forest and coastal communities. Without access to land, clean water, adequate food, fuel and materials; vulnerable people cannot break out of the poverty trap and prosper.

Figure 36: Living Planet Index by country income group
The index shows a 7% increase in high-income countries, a 31% decline in middle-income countries and a 60% decline in low-income countries between 1970 and 2008 (WWF/ZSL, 2012).



Expanding cities, increasing footprints

More than 50 per cent of the global population now lives in urban areas. This figure is expected to increase, as the world is rapidly urbanizing, particularly in Asia and Africa. Urbanization usually comes in tandem with increasing income, which in turn leads to growing Ecological Footprints, particularly through growth in carbon emissions (Poumanyvong and Kaneko, 2010). For example, the average Ecological Footprint of a Beijing resident is nearly three times larger than the China average (Hubacek *et al.*, 2009).

Globally, urban residents are already responsible for more than 70 per cent of the fossil fuel related CO2 emissions. However, well planned cities can also reduce direct carbon emissions by good management of the density and availability of collective transport. For example, per capita emissions in New York City are 30 per cent less than the United States average (Dodman, 2009).

According to forecasts, the global urban population will almost double to 6 billion by 2050 (UNFPA, 2007) and US$350 trillion will be spent globally on urban infrastructure and usage over the next three decades. If this investment follows "business as usual", this growth will appropriate more than half of humanity's carbon budget for the next 90 years – in just 30 years (WWF, 2010b; Höhne and Moltmann, 2009).

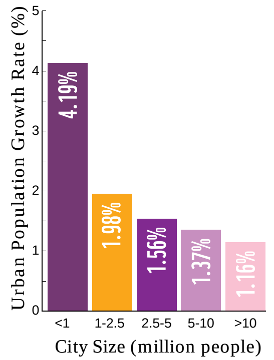
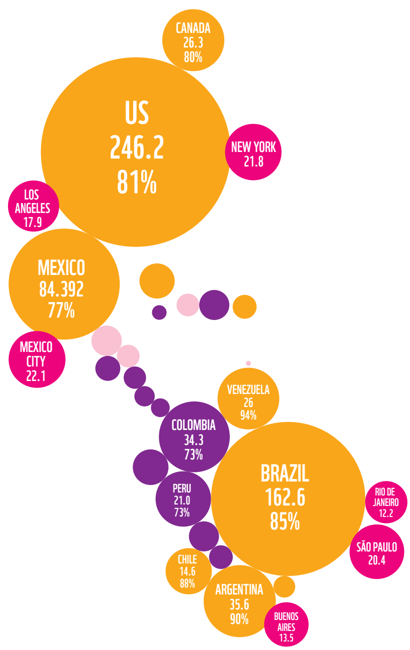


***Figure 37*: Projected urban population growth rates by city size (2009-2025)**
Source: UN Population Division; Booz & Company analysis (WWF, 2010b).

The growth of small cities

Cities with fewer than 1 million inhabitants already account for more than 60 per cent of urban dwellers globally (UNFPA, 2007). Figure 37 shows that the bulk of urban population growth will not occur in well-known and mature megacities such as Beijing, London, Los Angeles, Mexico City and Mumbai (all with more than 10 million people). Instead, it will occur in smaller cities (fewer than 1 million). For example, the population of Gaborone, the capital of Botswana, rose from 17,700 in 1971 to more than 186,000 in 2007. By 2020, its population is expected to exceed 500,000.



IN 2050, TWO OUT OF EVERY THREE PEOPLE WILL LIVE IN A CITY (UN, 2009)

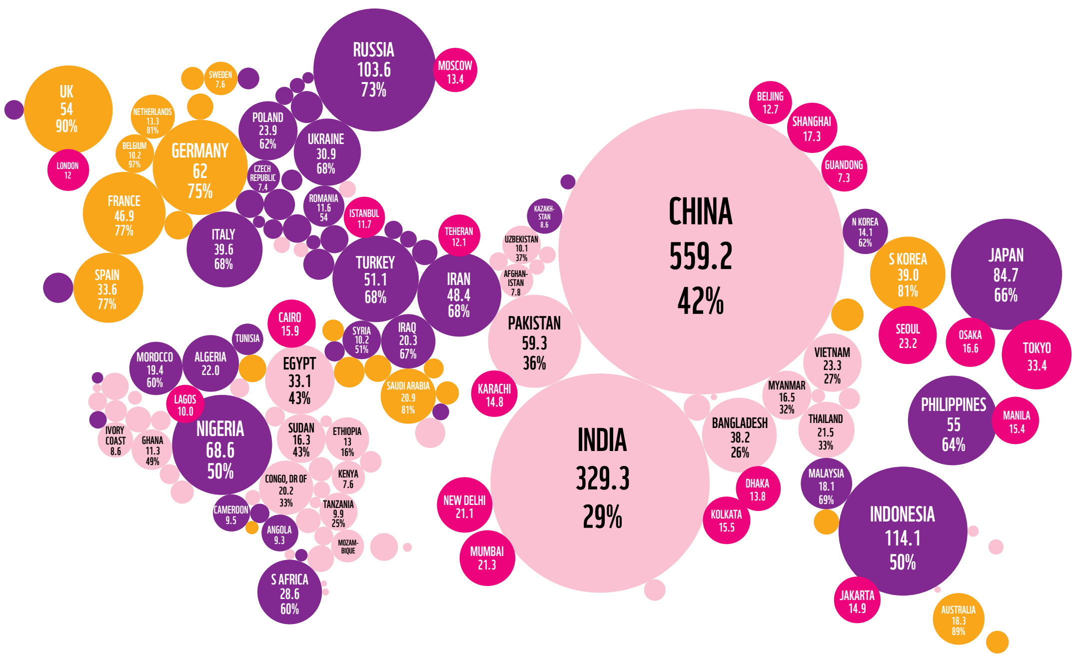
TODAY'S URBAN POPULATION:

3,307,905,000

Key

- Cities over 10 million people (greater urban area)
- Predominantly urban 75% or over
- Predominantly urban 50 - 74%
- Urban 0 - 49%

Figure 38: The number of people living in cities in each country of the world in 2010, together with the percentage of the population in countries with large urban populations.
In the developed world, the proportion of people living in cities is typically higher than 75%, and often exceeds 85%. The largest urban population in the developed world is in the USA (246 million). However, in China, even though the proportion of people living in cities is under 50%, the total number of urban dwellers is greatest (559 million). In India, by comparison, the number is 329 million (UN population division). (Figure drawn by the World Business Council for Sustainable Development in WBCSD, 2012, based on data from the UN Population Division UN, 2010)



Ecological Footprint and sustainable development

Is a high level of consumption necessary for a high level of development? Currently the most widely used indicator for development is the United Nations Development Programme's (UNDP) Human Development Index (HDI) which – by combining per capita income, life expectancy and educational attainment – compares countries' economic and social development (UNDP, 2009. For the latest report see, UNDP, 2011). The world's average HDI has increased by 41 per cent since 1970, reflecting large improvements in life expectancy, school enrolment, literacy and income.

Some low-income countries are able to increase their HDI at a relatively fast rate, primarily because they have such a small HDI in the first place and can rapidly capitalize on many improvements that can be implemented. However, some low-income nations are stagnated at their current HDI level (for example, Zimbabwe). The tendency is for the transitional economies to have the largest improvements in their HDI. Figure 39 below shows the HDI of each country plotted against its Ecological Footprint.

Like all averages, the HDI conceals disparities in human development in individual countries and does not take into account other important variables, such as inequality.

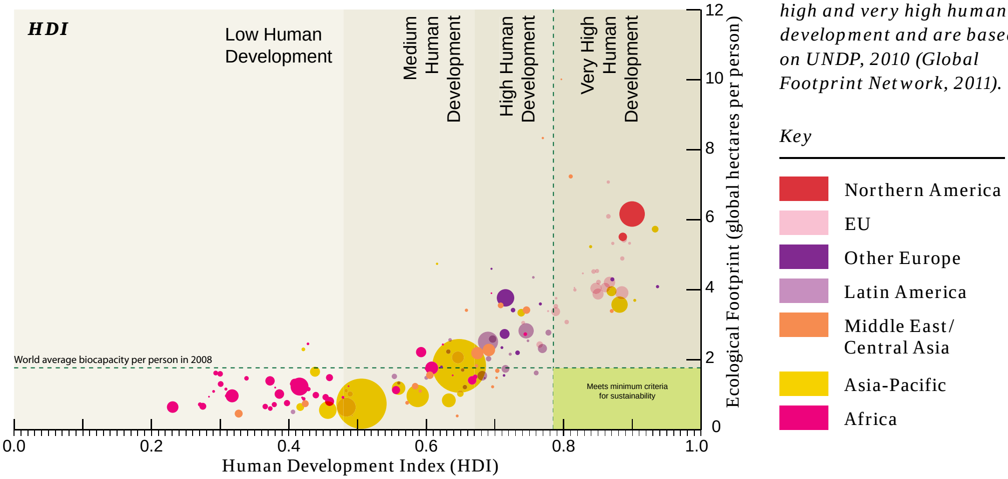


Figure 39: The Ecological Footprint for each country versus the Human Development Index, 2008
The dot representing each country are coloured according to their geographic region and are scaled relative to its population The shading in the background of this figure and in figure 40 indicates the HDI thresholds for low, medium, high and very high human development and are based on UNDP, 2010 (Global Footprint Network, 2011).

Development within one planet boundaries

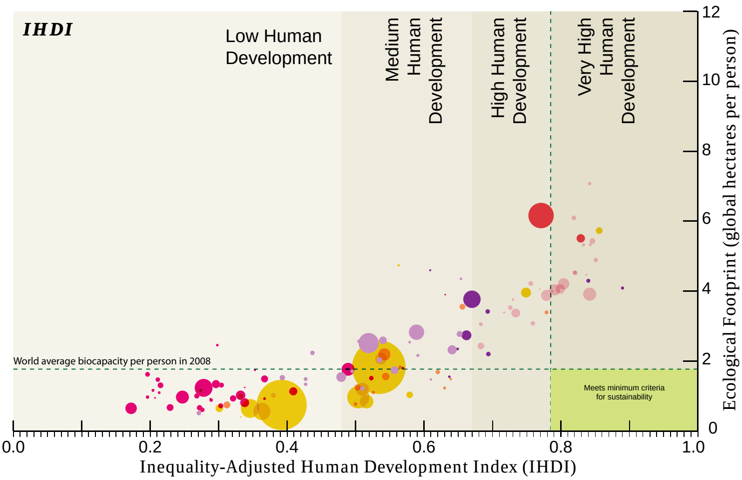
A new version of the HDI developed for the 2011 Human Development Report allows the HDI to take into account how achievements in health, education and income are distributed (UNDP, 2011). This new version of the index – called the Inequality-adjusted Human Development Index or IHDI – is a measure of human development that accounts for societal inequality.

Under perfect equality, the IHDI is equal to the HDI; but it progressively falls below the HDI as inequality rises. In this sense, the IHDI is the actual level of human development, while the HDI can be viewed as an index of the potential human development that could be achieved if there is no inequality. The IHDI "discounts" each dimension's average value according to its level of inequality. Countries with less human development tend to have greater inequality in more dimensions – and thus larger losses in human development.

The average loss in the HDI due to inequality is about 23 per cent – that is, adjusted for inequality, the global HDI of 0.682 in 2011 would fall to 0.525.

What does the relationship between the Ecological Footprint and this new index mean? Linking Ecological Footprint and IHDI reinforces the conclusion that the majority of countries with high IHDI have improved the well-being of their citizens at the expense of a larger footprint. Lower IHDI nations, which strive toward higher development levels, have smaller footprints, but they have higher inequality, making their development goals harder to meet. Concerted, collective efforts are needed to provide the environmental space for countries to pursue sustainable development objectives.

Figure 40: The Ecological Footprint for each country (in 2008) versus the Inequality-adjusted Human Development Index (in 2011)
The Inequality-adjusted HDI (IHDI) accounts for inequality in each of the three dimensions of the HDI – education, life expectancy and income per capita – by "discounting" the average value of each one according to its level of inequality. Therefore, although the general shape of this graph is the same as in Figure 39, many countries have moved to the left. Countries with less human development tend to have greater inequality in more dimensions – and thus see larger losses in their HDI value. Note: The development thresholds are the same in both this figure and Figure 39 to make it easier to compare the two of them. The IHDI values shown here are from 2011 - for more information see UNDP, 2011 (Global Footprint Network, 2011).



THE WATER FOOTPRINT

The Water Footprint provides a global indicator of both direct and indirect freshwater use. The focus on freshwater is important because it is scarce; making up only 2.5 per cent of the water on the planet, 70 per cent of which is locked up in the ice and snow of mountainous regions, the Arctic and Antarctic. Whereas the Ecological Footprint calculates the amount of biocapacity (global hectares) needed to sustain a population, the Water Footprint of Production represents the volume of freshwater (in cubic metres per year, m^3/y) used directly or indirectly to produce goods and services.

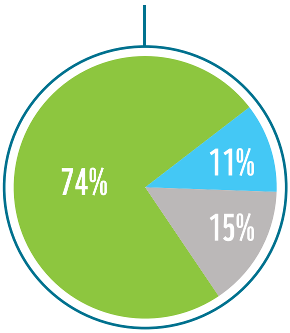
Crops on a farm are watered using irrigation equipment.

THE WATER FOOTPRINT

The average global Water Footprint between 1996 and 2005 was over 9,000 billion m^3 per year; with agricultural production accounting for 92 per cent of this total. Although out-of-sight, rainwater stored in soil (Green Water Footprint) was by far the largest Water Footprint component (74 per cent), while blue water resources accounted for 11 per cent (Hoekstra and Mekonnen, 2012). The Water Footprint can be presented as a single number, or be broken down into its different components (Figure 41).

Figure 41: Three ways of presenting the Water Footprint
(a) In total and broken down into its three components; (b) Calculated for specific areas, such as a river basin, and (c) during different times in the year (adapted from Chapagain A.K. and Tickner, 2011; global Water Footprint data from Hoekstra and Mekonnen, 2012).

a. Total Water Footprint of global production (9087 billion m^3/yr)

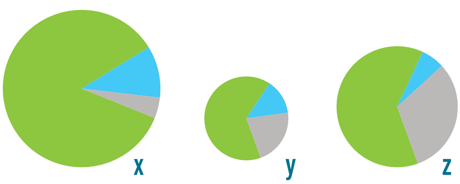


Green Water Footprint: Rainwater that evaporates during the production of goods. For agricultural products, this is the rainwater stored in soil that evaporates from crop fields.

Blue Water Footprint: Freshwater withdrawn from surface or groundwater sources that is used by people and not returned; in agricultural products this is mainly accounted for by evaporation of irrigation water from fields.

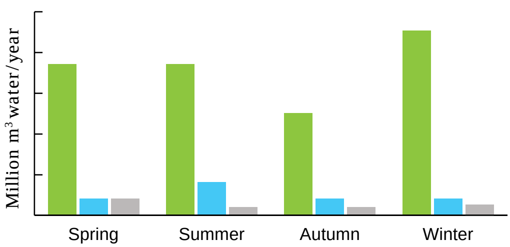
Grey Water Footprint: Water required to dilute pollutants released in production processes to such an extent that the quality of the ambient water remains above agreed water quality standards.

b. Water Footprints can be calculated for different locations (e.g., x, y, z)



The Water Footprint and its components vary according to location. Locations can be measured regionally, nationally or for individual river basins.

c. Water Footprints can now be calculated for different times of the year



Within each location the components can be measured from season to season and month to month (Figure 44).

Blue Water Footprint Versus Blue Water Availability

AT LEAST 2.7 BILLION PEOPLE LIVE IN RIVER BASINS THAT EXPERIENCE SEVERE WATER SCARCITY DURING AT LEAST ONE MONTH OF THE YEAR

At least 2.7 billion people live in river basins that experience severe water scarcity during at least one month of the year. To provide a more refined insight into water availability and demand than is generally considered, a recent study (Hoekstra *et al.*, 2012) has analysed the monthly Blue Water Footprint of 405 major river basins, in which 65 per cent of the global population reside. A precautionary approach was taken based on natural flows (the estimated flow through the river basin before any water is taken out), and the presumed environmental flow requirement (the amount of water needed to maintain the integrity of freshwater ecosystems), assumed to be 80 per cent of monthly natural run-off (Richter *et al.*, 2011).

If more than 20 per cent of the natural flow is being used by people, then the Blue Water Footprint is greater than the amount of blue water available and water stress will occur. Figure 42 shows the number of months during the year in which blue water scarcity exceeded 100 per cent in the world's major river basins between 1996 and 2005; meaning that, during these months, more than 20 per cent of the natural flow is being used by people.

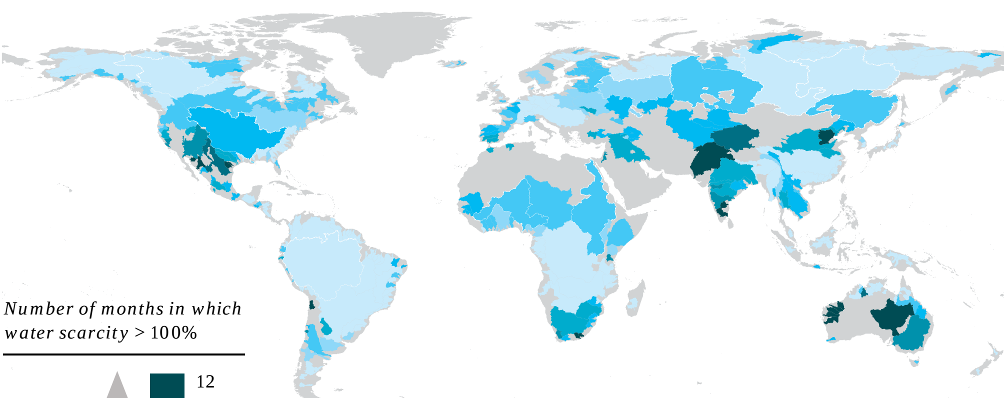


Figure 42: Blue water scarcity in 405 river basins between 1996 and 2005

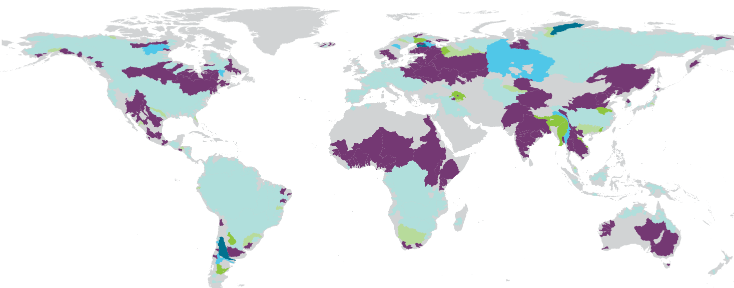
The darkest blue shading indicates river basins where more than 20% of water available in the basin is being used throughout the year. Some of these areas are in the most arid areas in the world (such as inland Australia) however other areas (such as western USA) have many months of water scarcity because significant amounts of water within these basins are being channelled into agriculture (Hoekstra et al., 2012).

Water scarcity depends on the amount of water available and levels of consumption in a river basin, not only the absolute size of the Blue Water Footprint. For example, even though the Blue Water Footprint is not particularly large in eastern European and Asian river basins in February or March, these basins (including the Dniepr, Don, Volga, Ural, Ob, Balkhash and Amur) experience high water scarcity in these months as the river flows are low during this period (Figure 43).

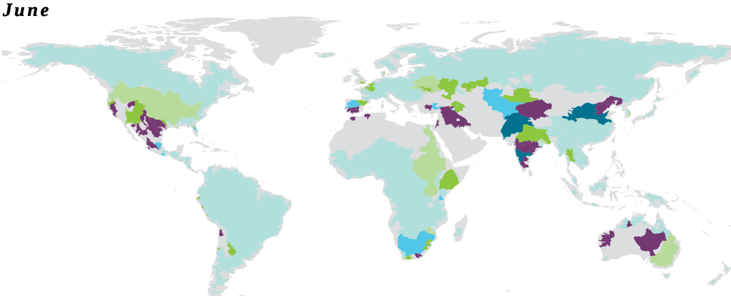
Industrial and domestic water supply is impacted if water flows cannot be maintained. In the Yellow and Tarim river basins in China, the most severe water scarcity is in early spring, when run-off is low and water demand for irrigation is high. South Africa's Orange and Limpopo river basins experience water scarcity in September and October, and the Mississippi River basin in the US in August and September, when the Blue Water Footprint is highest and run-off is lowest (Hoekstra *et al.*, 2012). A careful water allocation mechanism that takes into account current and predicted future water uses and environmental requirements on monthly basis, not on the basis of annual averages, is therefore necessary.

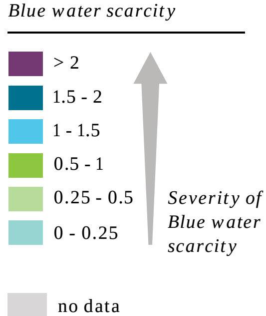
Figure 43: Water scarcity in the world's major river basins in February and June
Light blue shading indicates low water scarcity, meaning that presumed environmental flow requirements are not compromised and monthly run-off is unmodified or only slightly modified; bright blue shading indicates moderate water scarcity (i.e., the Blue Water Footprint is 20-30% of natural run-off) and environmental flow requirements are not fully met; dark blue shading indicates significant water scarcity (i.e., the Blue Water Footprint is 30-40% of natural run-off); purple shading indicates severe water scarcity (i.e., the Blue Water Footprint exceeds 40% of natural run-off). The differences in water scarcity in the two months for many river basins highlights the importance of understanding water scarcity at monthly time scales (Hoekstra et al., 2012).

February



June





Recently, for the first time, the Water Footprint Network has been able to estimate the Blue Water Footprint at a high spatial resolution (at 5 by 5 arc minutes, which is a grid of about 9km by 9km at the equator and decreasing gradually toward the poles), on a monthly basis. This detail of data on water availability throughout the year at river basin level provides water planners and users with an important planning tool to ensure they make the most of this vital renewable resource. One example is given here and more can be found in Hoekstra *et al.*, 2012.

Tigris-Euphrates Basin

The Tigris-Euphrates River Basin extends over four countries: Turkey, Syria, Iraq and Iran. Almost all of the run-off in the two rivers is generated in the highlands of the northern and eastern parts of the basin in Turkey, Iraq and Iran. Precipitation in the basin is largely confined to the winter months of October to April, with high waters occurring from March to May – as snow melts in the highlands. The typical low water season occurs from June to December. The basin faces severe water scarcity for five months of the year (June to October). Most of the Blue Water Footprint (52 per cent) is due to evaporation of irrigation water in agriculture, mostly for wheat, barley and cotton.

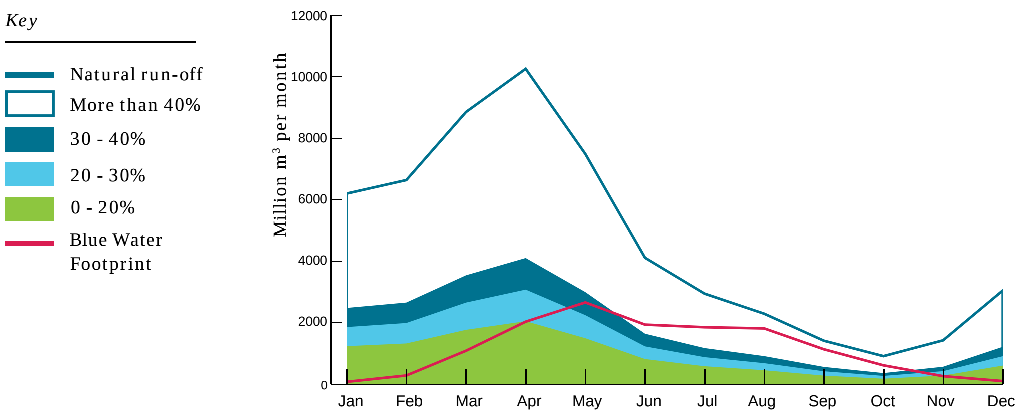


Figure 44: Water scarcity over the year for the Tigris-Euphrates Basin (monthly average for the period 1996-2005) *The river run-off is divided into four zones – green, bright blue, dark blue and white – based on presumptive environmental flow requirements. The actual Blue Water Footprint is plotted over this hydrograph as a solid thick red line. If the line falls in the green zone, the water scarcity is low, meaning that there is no abstraction from the environmental quota. However, if it moves up into the bright blue, dark blue or white zones, water scarcity becomes moderate, significant or severe in that part of the year.*

CHAPTER 2: WHY WE SHOULD CARE

A satellite image features the heart-shaped northern tip of the western half of the Large Aral Sea (or South Aral Sea) in Central Asia. Once the world's fourth-largest inland body of water, the Aral Sea has been steadily shrinking over the past 50 years since the rivers that fed it were diverted for irrigation. In 2005, a dam was built between the sea's northern and southern sections to help improve water resource management and reverse the man-made environmental disaster. The dam allowed the river to feed the northern Aral, which has begun to recover. It hasn't solved the entire problem though, as the southern section is expected to dry out completely by 2020. The whitish area surrounding the lakebed is a vast salt plain, now called the Aralkum Desert, left behind by the evaporating sea. It comprises some 40,000 sq km zone of dry, white salt and mineral terrain. Each year violent sandstorms pick up at least 150,000 tonnes of salt and sand from Aralkum and transport them across hundreds of kilometres, causing severe health problems for the local population and making regional winters colder and summers hotter.

© USGS / ESA

LINKING BIODIVERSITY, ECOSYSTEM SERVICES AND PEOPLE

Biodiversity is vital for human health and livelihoods. Living organisms – plants, animals and microorganisms – interact to form complex, interconnected webs of ecosystems and habitats, which in turn supply a myriad of ecosystem services upon which all life depends. Although technology can replace some ecosystem services and buffer against their degradation, many cannot be replaced.

Understanding the interactions between biodiversity, ecosystem services and people is fundamental to reversing the trends outlined in Chapter 1 and achieving the better choices presented in Chapter 4 – and so safeguarding the future security, health and well-being of human societies.

All human activities make use of ecosystem services – but can also put pressure on the biodiversity that supports these systems.

Recent scientific analyses (Naidoo *et al*., 2008; Larsen et al., 2011; Strassburg *et al*., 2010) show a measureable correspondence between ecosystem services and biodiversity, while global analyses such as The Economics of Ecosystems and Biodiversity (TEEB), the Millennium Ecosystem Assessment (MEA) and the Stern Report underline how humanity is wholly reliant on well functioning ecosystems to supply essential services (Millennium Ecosystem Assessment, 2005a; b; c; Stern, 2006; TEEB, 2010).

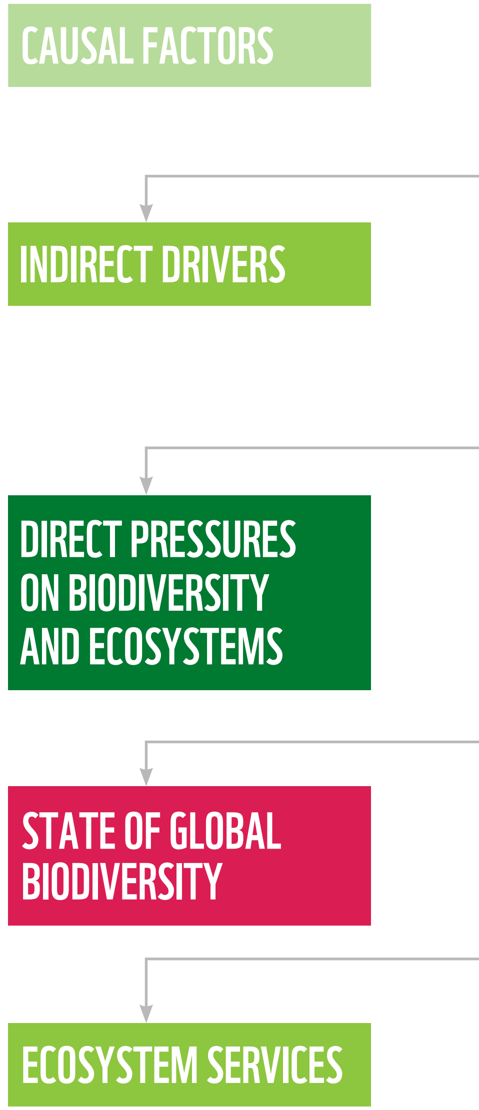
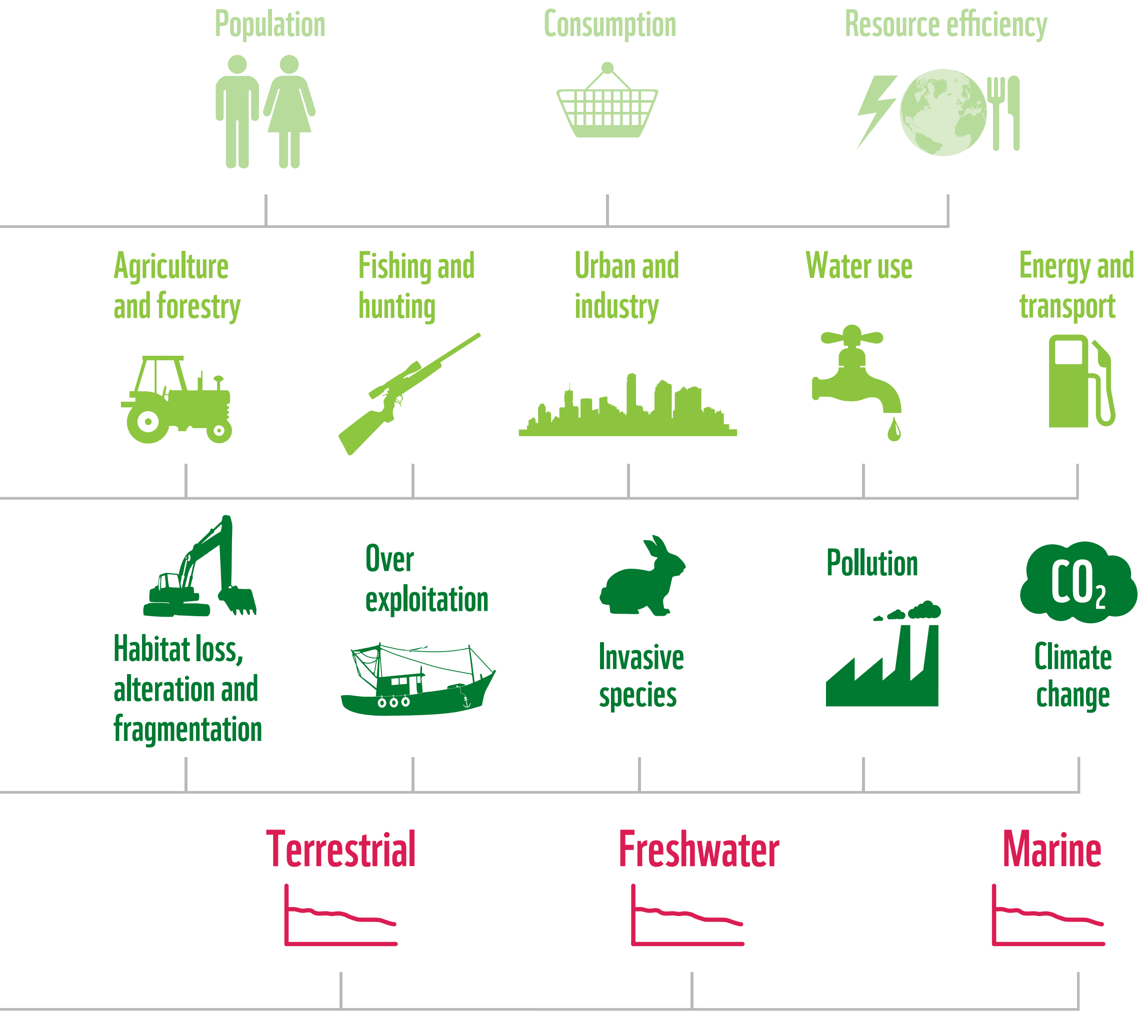


Figure 45:
Interconnections between people, biodiversity, ecosystem health and provision of ecosystem services



The benefits that people obtain from ecosystems

Provisioning services

- food
- medicine
- timber
- fibre
- bioenergy

Regulating services

- water filtration
- waste decomposition
- climate regulation
- crop pollination
- regulation of some human diseases

Supporting services

- nutrient cycling
- photosynthesis
- soil formation

Cultural services

- enriching
- recreational
- aesthetic
- spiritual

MARGARET'S STORY

For many people living in the industrialized and urban regions, "nature" is a place to visit. Food comes from shops, and water from the tap. But for a large part of the planet's population, the connection to nature and its services is more direct. The livelihood opportunities of Margaret Wanjiru Mundia, a farmer in central Kenya, depend directly on the natural environment surrounding her. But her needs are the same as those of city dwellers. And all of these needs find their origin in what nature provides. Can understanding Margaret's challenges and hopes help us better understand the risks and opportunities facing our planet?

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FORESTS: CARBON STORAGE AND CLIMATE

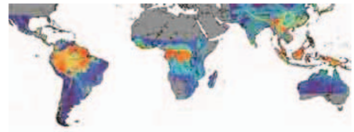


Figure 46: Regional patterns of forest above-ground biomass in tropical forests
This map illustrates regional patterns and provides methodologically comparable estimates of forest above-ground biomass (circa 2000) for 75 tropical countries (Saatchi et al., 2011).

Above ground biomass (Mg/ha)

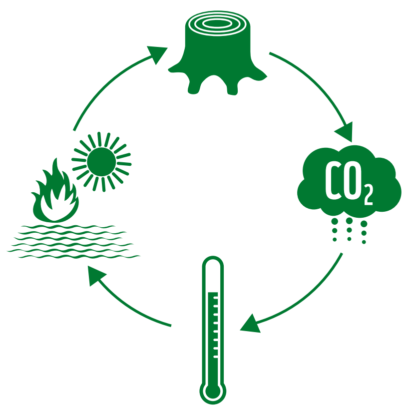
- 0 - 25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 150
- 151 - 200
- 201 - 250
- 251 - 300
- 301 - 350
- 351 - 400
- >400

The carbon storage service provided by the world's forests is vital for climate stabilization. The amount of carbon stored in different forests varies: Tropical forests store the most carbon, with current estimates suggesting the above-ground biomass stores of these forests is 247 Gt C (Chavez *et al.*, 2008; Lewis *et al.*, 2009; Mahli *et al.*, 2006; UNEP, 2010), which is five times more than the current global carbon emissions of 47 Gt per year (UNEP, 2010). Almost half of this above-ground carbon is in the forests of Latin America, 26 per cent in Asia, and 25 per cent in Africa (Saatchi *et al.*, 2011) (see Figure 46).

The vast northern boreal conifer and broadleaved forests are also important carbon stores (Potapov *et al.*, 2008). Temperate forests have been decimated over the centuries, but are now expanding in Europe and the United States, and so are building carbon stores (FAO, 2010a). In some parts of the world, forests grow on peatlands, where there can be more carbon in the soil than in the forest (Malhi *et al.*, 1999).

Recognizing the importance of forests in climate stabilization, the United Nations Framework Convention on Climate Change (UNFCCC) is currently negotiating a mechanism known as REDD+ to address some of the impacts addressed in the previous section. If agreed, REDD+ (Reducing Emissions from Degradation and Deforestation) would provide a strong incentive for developing countries to conserve their forests while safeguarding against

DEFORESTATION AND FOREST DEGRADATION DRIVE CLIMATE CHANGE
CLIMATE CHANGE IN TURN CAN DAMAGE FORESTS AND THE SERVICES THEY PROVIDE



biodiversity loss, ensuring the livelihoods of forest dependent peoples and investing in low carbon paths to sustainable development (WWF, 2011c). The proposed REDD+ policy mechanism needs to contain important safeguards to ensure that carbon conservation does not harm biodiversity and that livelihoods for people are not compromised by REDD+ actions to conserve forest carbon.

Conservation actions aimed at conserving carbon in forests include avoiding forest fragmentation; preventing conversion of old-growth natural and semi-natural forests into industrial agricultural and tree farms (plantations); encouraging sustainable use and responsible forest management; conserving forests within protected areas; improving forest connectivity; managing natural disturbance regimes such as fires; preventing and when necessary controlling invasive species; and slowing climate change.

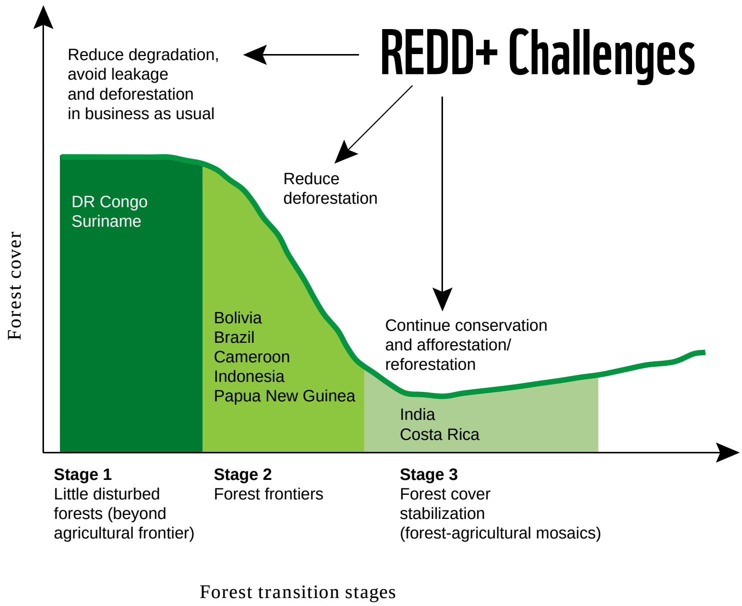


Figure 47: Generalized model of forest transition that outlines some of the challenges associated with REDD+ in different countries
This figure presents an empirical model of forest cover change over time in response to economic development. Different REDD+ challenges are also highlighted; starting from the need to reduce forest degradation and deforestation in the early stages of forest transition (Stage 1) and even more importantly as deforestation proceeds (Stage 2). Following deforestation, forest cover tends to regrow or is replanted and climate benefits mainly arise from continued conservation, carbon stock enhancement and afforestation and reforestation (Stage 3). (Modified from Wertz-Kanounnikoff and Kongphan-apira, 2009. Note that Meyfroidt and Lambin, 2011, contest that forest transitions follow generic pathways. They state that countries do not follow a predictable sequence of forest cover change).

Overlaying carbon and biodiversity

The world's forests are being cleared and degraded through various human activities, releasing greenhouse gases, especially CO2, into the atmosphere. Globally, around 13 million ha of forest were lost each year between 2000 and 2010 (FAO, 2010a). Deforestation and forest degradation currently account for up to 20 per cent of global anthropogenic CO2 emissions, the third-largest source after coal and oil (IPCC, 2007a). This makes forest conservation a vital strategy in global efforts to drastically cut greenhouse gas emissions.

Recognizing areas that have important biodiversity and ecosystem services values can help to identify where conservation is important for society and economic development. In the case of carbon storage, Strassburg *et al.*, 2010 used global data sets on terrestrial biodiversity and carbon storage to map and investigate potential synergies between management aimed at both carbon and biodiversity conservation. A strong association between carbon stocks and species' richness suggests that such synergies are high but unevenly distributed. Many areas of high value for biodiversity could be protected by carbon management policies, and others could receive complementary funding due to their carbon stock. However, not all high-biodiversity regions would benefit from carbon-focused conservation, and some areas important for biodiversity could come under increased pressure if forest carbon conservation is implemented without considering biodiversity.

Such studies have important policy implications. They provide guidance on places where ecosystem services should be sustained alongside biodiversity because of the importance of ecosystem services for society and economic development. More specifically, conserving the carbon content of tropical forests and working to reduce tropical deforestation and degradation, is a major global strategy for the UNFCCC and its REDD+ policy mechanism.

Definitions of deforestation and degradation

WWF uses the following definition of degradation: "Secondary forest that has been lost through human activities; its structure, function, and species' composition or production normally associated with the forest type expected at that site. Hence, degradation delivers a decreasing supply of goods and services from the given site and maintains only limited biodiversity." (Source: Convention of Biological Diversity).

There are different estimations of the percentage contribution of deforestation and degradation to global CO2 emissions: for example, 20% (IPCC, 2007); 12% of total anthropogenic CO2 emissions and 15% if peat degradation is included (van der Werf *et al.*, 2009).

Matécho forest near Saül in the centre of French Guiana. Tree distribution showing disturbances, old and new. The gaps will be filled in once new trees, such as those in the foreground, are growing.

FORESTS: PROVIDERS OF WOOD FUEL

In addition to climate regulating services, the world's forests provide essential provisioning services for billions of people, including the supply of fuel, timber, fibre, food and medicines. Across much of the developing world, for example, the primary way in which people cook and keep warm is by burning woody biomass from their local environment. The two regions most dependant on wood fuel are Asia and Africa, which together account for 75 per cent of global use (World Resources Institute, 2011).

In Africa, 80-90 per cent of rural energy comes from wood fuel obtained within a few kilometres of people's homes (Chomitz *et al.*, 2007). More than 70 per cent of the urban population rely on wood fuel for cooking, mainly charcoal (DeFries *et al.*, 2010; Mwampamba, 2007; WWF, 2011b). Charcoal is an increasingly popular wood fuel among urban dwellers. Produced from natural woodlands and forests, and transported to towns for sale, millions of tonnes of charcoal enter cities in developing countries every year. Much of this charcoal production is unsustainable (Ahrends *et al.*, 2010), leading to net deforestation and forest degradation, additional CO2 emissions, and thus to climate change, as well as significant biodiversity loss. Although wood can be a sustainable resource, this level of demand, coupled with growing populations, is having a major impact on forests throughout the continent.

75%

ASIA AND AFRICA TOGETHER ACCOUNT FOR 75 PER CENT OF GLOBAL USE OF WOOD FUEL

Case study: Wood fuel impacts on biodiversity

Forest degradation is expanding in waves from Africa's major cities, leading to significant forest degradation and loss of forest biodiversity.

In Tanzania, for example, logging has advanced 120km from Dar es Salaam in just 14 years, depleting all high-value timber trees within 200km of the city. This first wave of degradation was followed by a second that removed medium-value timber, and a third that consumed the remaining woody biomass for charcoal production.

Moving away from the city at a speed of around 9km per year, these degradation waves have severely impacted biodiversity and ecosystem services. Forests close to the city contain 70 per cent fewer tree species (Figure 48) and store 90 per cent less carbon per hectare than less disturbed forests 200km away (Ahrends *et al.*, 2010).

The progressive removal of high-value trees and the increasing distance travelled to locate fresh supplies suggest a "logging down the timber value" scenario akin to the "fishing down the food web" pattern observed in the oceans. A lack of affordable alternatives for charcoal and rising demand for construction timber means that in the absence of sustainable fuel sources, forest degradation will continue to expand from Africa's growing cities.

Figure 48: Waves of forest degradation spreading out from Dar es Salaam (DES) between 1991 and 2005
Map of the degradation waves of dominant forest use in the study area in 1991 and 2005. Charcoal burning has moved a road distance of 30km from DES in this time period, and medium-value timber logging has moved 160km (Ahrends et al., 2010).

Key

- Dominant forest use charcoal burning
- Dominant forest use logging of low/ medium-value timber
- Dominant forest use logging of high-value timber

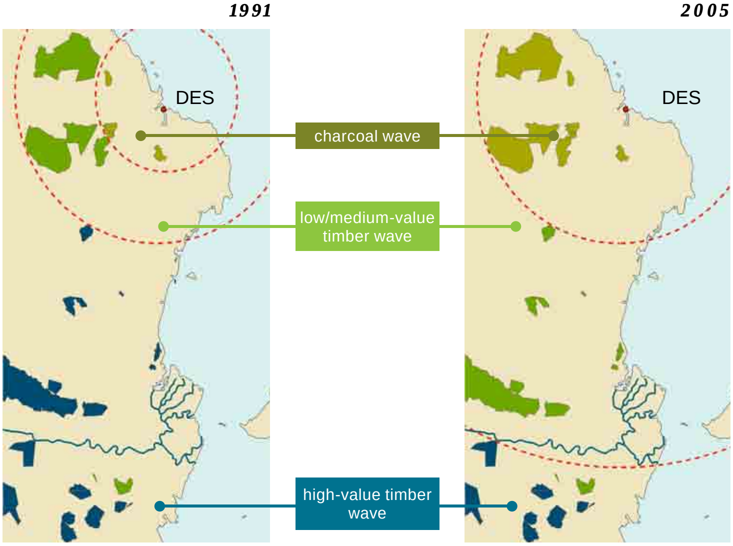
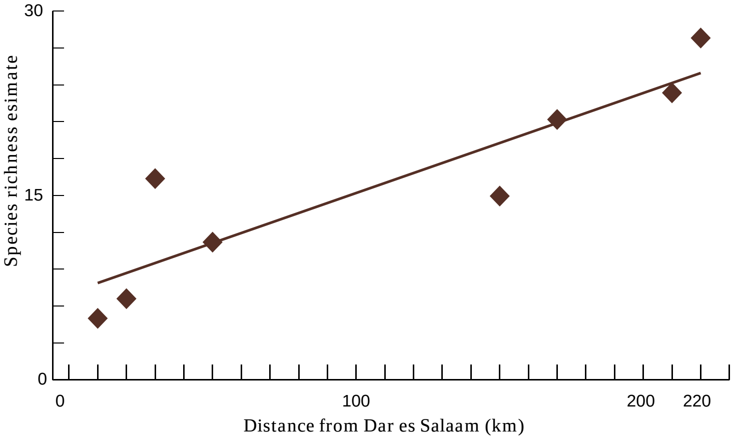
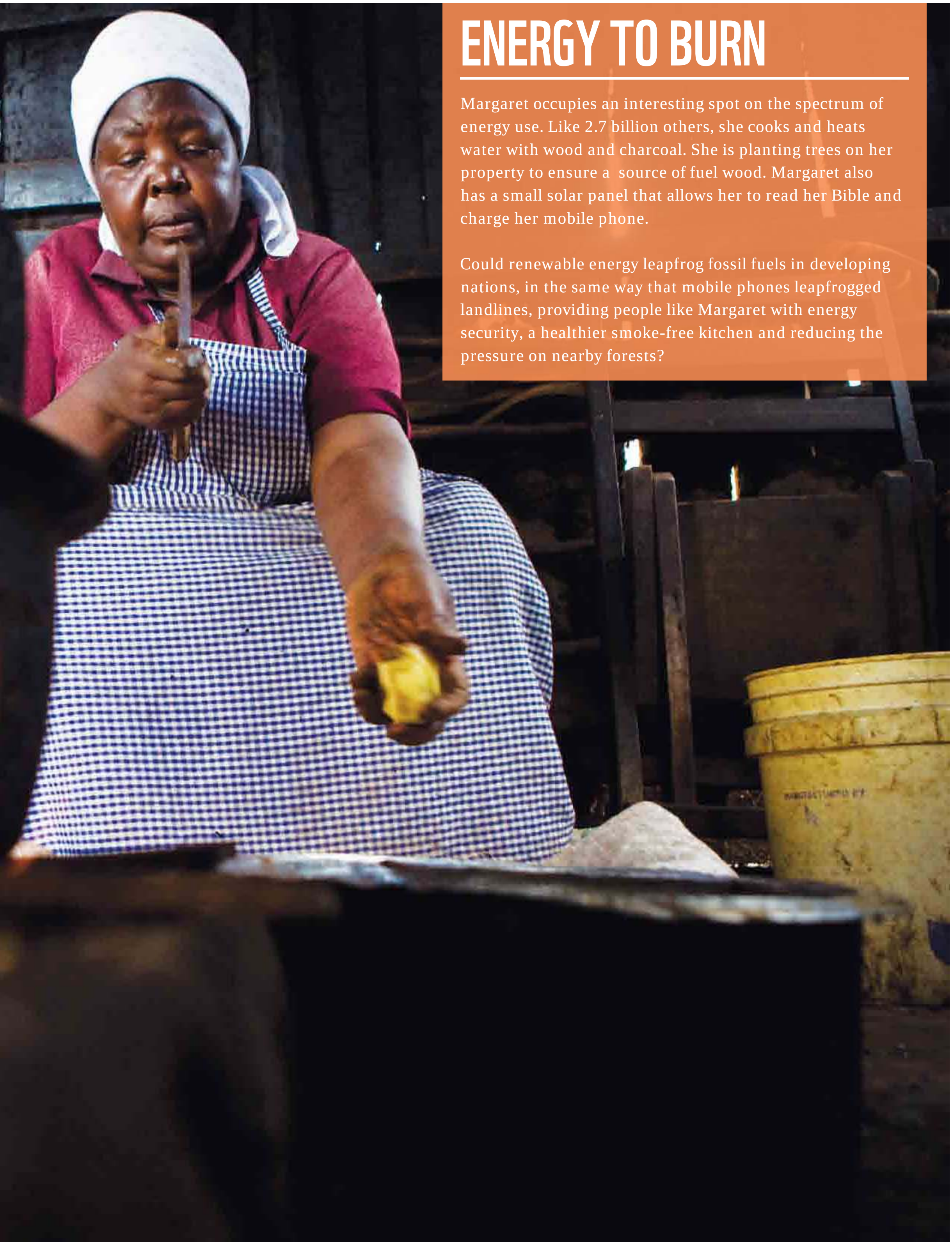


Figure 49: Biodiversity impact of logging around Dar es Salaam
The impact on biodiversity, indicating how species richness increases with distance from DES. Forests further away from the city are less impacted by logging and cutting for charcoal production and so are more species rich than those closer to it (Ahrends et al., 2010).





ENERGY TO BURN

Margaret occupies an interesting spot on the spectrum of energy use. Like 2.7 billion others, she cooks and heats water with wood and charcoal. She is planting trees on her property to ensure a source of fuel wood. Margaret also has a small solar panel that allows her to read her Bible and charge her mobile phone.

Could renewable energy leapfrog fossil fuels in developing nations, in the same way that mobile phones leapfrogged landlines, providing people like Margaret with energy security, a healthier smoke-free kitchen and reducing the pressure on nearby forests?

RIVERS: IMPACTED BY INFRASTRUCTURE

Freshwater ecosystems occupy approximately 1 per cent of the Earth's surface yet are home to around 10 per cent of all known animal species (Abramovitz, 1996; McAllister *et al.*, 1997). By virtue of their position in the landscape, these ecosystems connect terrestrial and coastal marine biomes and provide services vital to the health and stability of human communities, including fisheries, water for agricultural and domestic use, hydrological flow regulation, navigation and trade, pollution control and detoxification services (Millennium Ecosystem Assessment, 2005c). But numerous pressures, including land use change, water use, infrastructure development, pollution and global climate change, working individually and collectively, are impinging on the health of rivers and lakes around the world.

The rapid development of water management infrastructure – such as dams, dykes, levees and diversion channels – have left very few rivers entirely free flowing. Of the approximately 177 rivers greater than 1,000km in length, only a third remain free flowing and without dams on their main channel (WWF, 2006a). While clearly this infrastructure provides benefits at one level, such as hydropower or irrigation, there is often a hidden cost to aquatic ecosystems and the wider ecosystem services that they provide.

In order to sustain the wealth of natural processes provided by freshwater ecosystems – such as sediment transport and nutrient delivery, which are vital to farmers in floodplains and deltas; migratory connectivity, vital to inland fisheries; and flood storage, vital to downstream cities – it is imperative to appreciate the importance of free flowing rivers, and developing infrastructure with a basin-wide vision.

OF THE APPORXIMATELY 177 RIVERS GREATER THAN 1, 000 KM IN LENGTH, ONLY A THIRD REMAIN FREE FLOWING

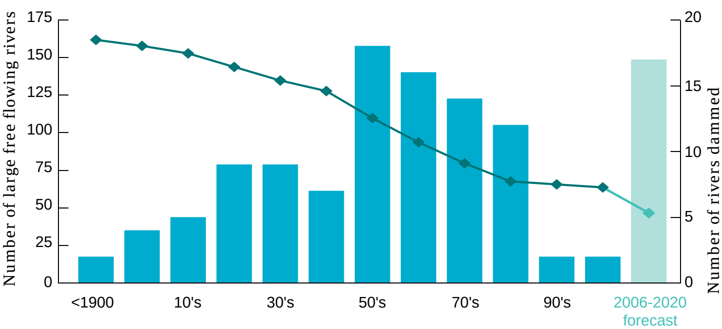
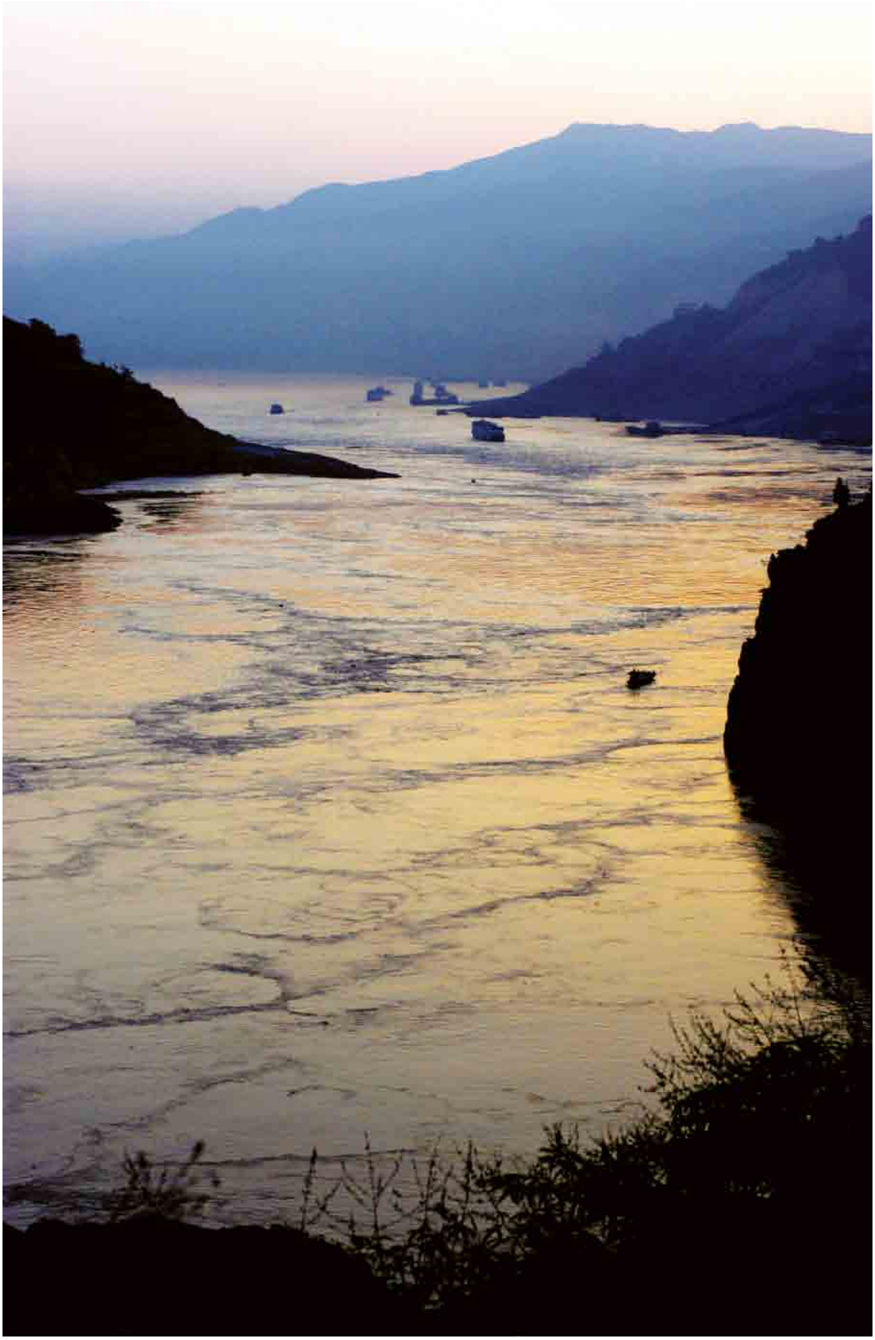


Figure 50: Trends in number of global free-flowing rivers greater than 1,000km in length
Trends from pre-1900 to the present day and estimated to 2020 (line), in comparison with the number of rivers dammed over time (bars) (WWF, 2006a).

Key

Rivers dammed

Number of free flowing rivers

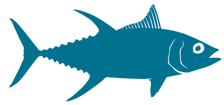


The Yangtze River is home to some of China's most spectacular natural scenery, a series of canyons the Qutang Gorge, Wuxia Gorge and Xiling Gorge, collectively known as the Sanxia, or Three Gorges. Coursing over a distance of 6,380 kilometers, the mighty Yangtze is the longest river in China and the third longest in the world after the Amazon in South America and the Nile in Africa. It is also a cradle of ancient Chinese civilization.

OCEANS: SOURCE OF FOOD, ENERGY AND MATERIALS

The world's oceans provide critical services for billions of people, but are threatened by overexploitation, greenhouse gas emissions and pollution. Oceans supply fish and other seafood that form a major source of protein for billions of people, and provide seaweed and marine plants used for the manufacture of food, chemicals, energy and construction materials. Marine habitats such as mangroves, coastal marshes and reefs, form critical buffers against storms and tsunamis and store significant quantities of carbon. Some, especially coral reefs, support important tourism industries. Ocean waves, winds and currents offer considerable potential for creating sustainable energy supplies. These services have a huge value in terms of direct food production, providing incomes and by preventing loss and damage to property, land, human life and economic activities.

Over the past 100 years, however, the use of the sea and its services has intensified, from fishing and aquaculture, to tourism and shipping, oil and gas extraction and seabed mining.



OCEAN ACIDITY HAS INCREASED BY 30% SINCE THE INDUSTRIAL REVOLUTION

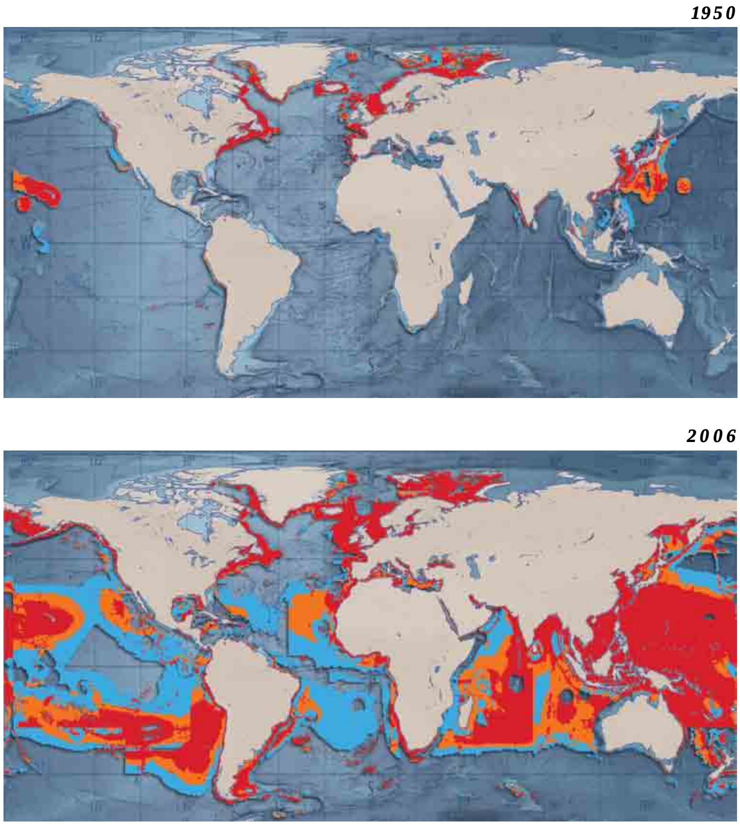
Fisheries: Impacts on marine ecosystems

The consequences of increased fishing intensity have been dramatic for the marine environment. Between 1950 and 2005, "industrial" fisheries expanded from the coastal waters of the North Atlantic and Northwest Pacific southward into the high seas and the Southern Hemisphere.

Improved fishing technology allowed deep-sea trawling, purse seining and long-lining in waters several kilometres deep, reaching populations that are long lived, late maturing and very sensitive to overfishing. One-third of the world's oceans and two-thirds of continental shelves are now exploited by fisheries, with only inaccessible waters in the Arctic and Antarctic remaining relatively unexploited.

A nearly five-fold increase in global catch, from 19 million tonnes in 1950 to 87 million tonnes in 2005 (Swartz *et al.*, 2010), has left many fisheries overexploited (FAO, 2010b). In some areas fish stocks have collapsed, such as the cod fisheries of the Grand Banks of Newfoundland (FAO, 2010b). Catch rates of some species of large predatory fishes – such as marlin, tuna and billfish – have dramatically declined over the last 50 years, particularly in coastal areas of the North Atlantic and the North Pacific (Tremblay-Boyer *et al.*, 2011). This continuing trend also applies to sharks and other marine species.

Targeted fishing of top predators has changed whole ecological communities, with increasing abundance of smaller marine animals at lower trophic levels as a consequence of the larger species being removed. This in turn has an impact on the growth of algae and coral health.



Key

At least 10% PPR extraction

At least 20% PPR extraction

At least 30% PPR extraction

PPR is a value that describes the total amount of food a fish needs to grow within a certain region.

Figure 51: The expansion and impact of world fishing fleets in a) 1950 and b) 2006

The maps show the geographical expansion of world fishing fleets from 1950 to 2006 (the latest available data). Since 1950, the area fished by global fishing fleets has increased ten-fold. By 2006 100 million km^2, around 1/3 of the ocean surface, was already heavily impacted by fishing. To measure how intensively these areas are fished, Swartz et al., (2010) used the fish landed in each country to calculate the primary production rate (PPR) of each region of the ocean. PPR is a value that describes the total amount of food a fish needs to grow within a certain region. In the areas in blue, the fleet extracted at least 10% of this energy. Orange indicates a minimum of 20% extraction and red shows least 30%, highlighting the most intensively and potentially overfished, areas. WWF and the Sea Around Us project collaborated to produce an animated map showing these changes over time and also the expansion of the EU fishing fleet, see http://www.wwf.eu/fisheries/cfp_reform/external_dimension/

GIVE TO GET

As competition for land increases, it is all about improving efficiency and preventing negative impacts on the natural environment. In many cases there are win-win solutions for people and nature. In April 2010, Margaret reoriented her farm and implemented basic conservation measures to improve soil and water retention. Her yields shot up, while run-off into the Turasha River dropped. Her neighbours have taken note, and are making the same changes on their land. With increased productivity, the same farms are supporting more people. Margaret, a farmer with virtually no safety net, took a chance on change. It's time for others to be as brave.

SCRAMBLE FOR LAND: COMPETING CLAIMS AND COMMERCIAL PRESSURE

Land use decisions are invariably complex, involving many stakeholders with different priorities. Productive land may be simultaneously in demand by communities (e.g., homelands and sacred sites), or for food production, forest products, biodiversity conservation, urban development or carbon storage. Renewable energy demands add an extra dimension, through use of land for bioenergy feedstock production. The situation is further complicated by the interdependence between the production and consumption of key resources such as food, fibre, energy and water. Agriculture requires land, water and energy; water extraction and distribution require energy; and energy production often requires water (World Economic Forum, 2011). All require ecosystem services, and one land use decision can affect the provision of many different services. Moreover, the poorest and most vulnerable people are most affected by the consequences of poor land use choices, while being the least able to influence such decisions.

The frequency and complexity of land use competition is expected to rise as human demands grow.

THE POOREST AND MOST VULNERABLE PEOPLE ARE MOST AFFECTED BY THE CONSEQUENCES OF POOR LAND-USE CHOICES

Scramble for land: Food and fuel

Throughout the developing world, external investors are scrambling to secure access to agricultural land for future food production. Since the mid-2000s, it is estimated that an area almost the size of Western Europe has been transferred in land allocation deals. The latest rush for farmland was triggered by the food crisis of 2007-08, but long-term drivers include population growth; increased consumption by a global minority; and market demands for food, biofuels, raw materials and timber (Anseeuw *et al.*, 2012).

Recent research shows that deals reported as approved or under negotiation worldwide amounted to a total of 203 million hectares: 134 million hectares of this total are located in Africa; 43 million hectares in Asia and 19 million hectares in Latin America. Of these, deals for 71 million hectares have so far been cross-referenced, confirming the unprecedented scale of the land rush over the past decade (Anseeuw *et al.*, 2012).

The best agricultural land is often targeted for this acquisition. The rural poor are frequently being dispossessed of

AN AREA ALMOST THE SIZE OF WESTERN EUROPE HAS BEEN TRANSFERRED IN LAND ALLOCATION DEALS SINCE MID-2000 land and water resources they have held under customary tenure. Many cases show how the resource base of rural livelihoods is being squeezed through the loss of access to grasslands, forests and marshlands that are customarily held as common property. The poor are bearing disproportionate costs, but reaping few benefits, largely because of poor governance. The land rush is also leading to extensive conversion of natural ecosystems with accompanying losses of ecosystem services and biodiversity (Anseeuw *et al.*, 2012).

Case study: Papua New Guinea

5.2 MILLION
HECTARES OF LAND IN PAPUA NEW GUINEA HAS BEEN ACQUIRED FOR LONG-TERM LEASES

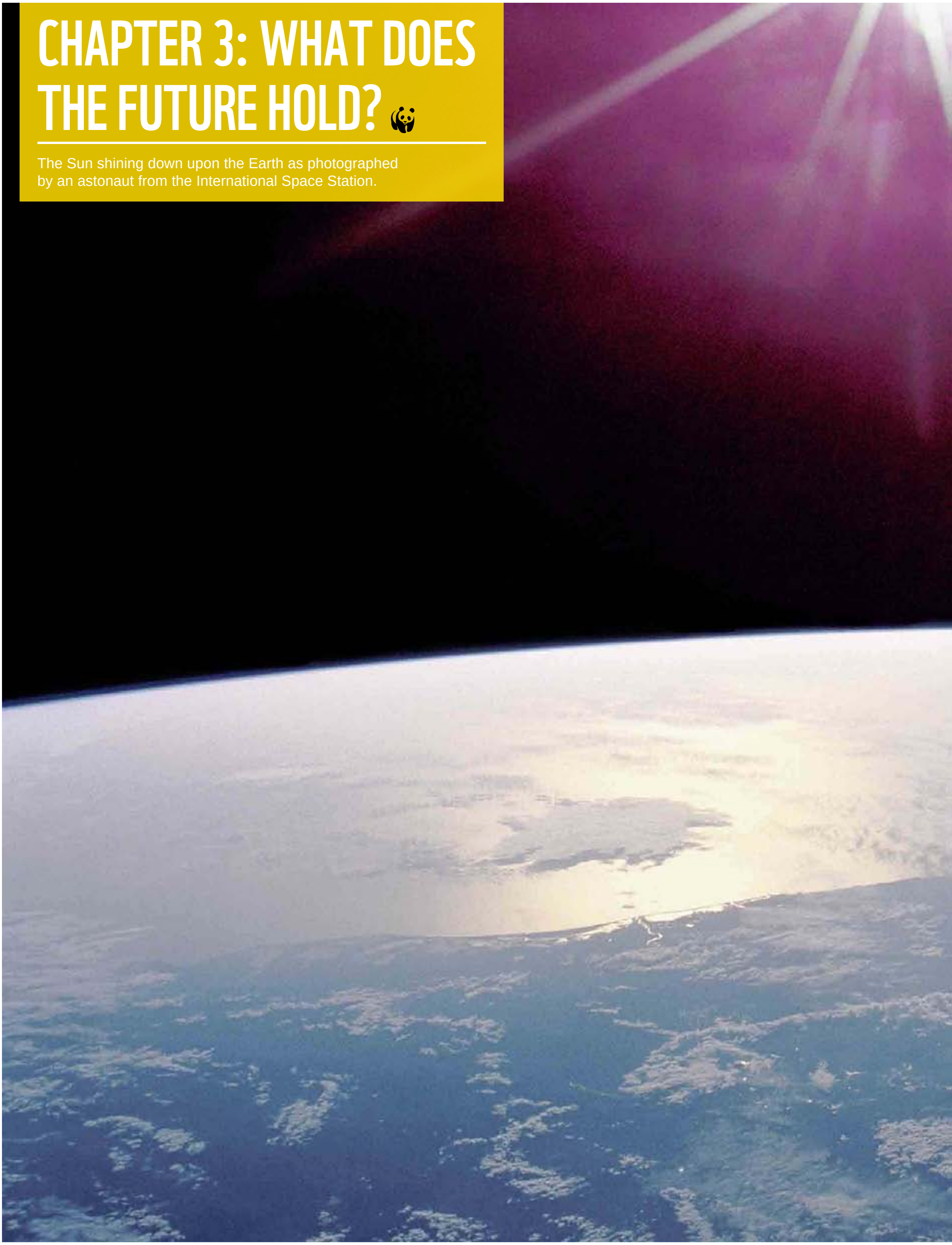
In the last five years, 5.2 million hectares of land in Papua New Guinea has been acquired for long-term leases – termed Special Agricultural and Business Leases (SABLs). These now encompass 15 per cent of the country's land area. Nearly all of these leases have been handed to foreign investors or multinational corporations – mostly for logging and oil palm plantations. Under existing SABLs, around 2 million hectares of forests are allowed to be legally cleared. In a number of cases, the leases appear to have been granted without the free and prior consent of a majority of the traditional landowners, which is a legal requirement in Papua New Guinea. In response to a growing domestic and international outcry, the government declared a temporary moratorium on SABLs, but this offers only a temporary respite to one of the most serious and immediate threats to the country's forests and biodiversity (Laurance, 2012, in press).

The sheer pace of change demonstrated by this example underlies an urgent challenge: to stop dispossession and land allocations that do not serve a genuine public interest; to legally recognize the rights of the rural poor; and to steer toward more equitable models that give a key role to existing land users (Anseeuw *et al.*, 2012).

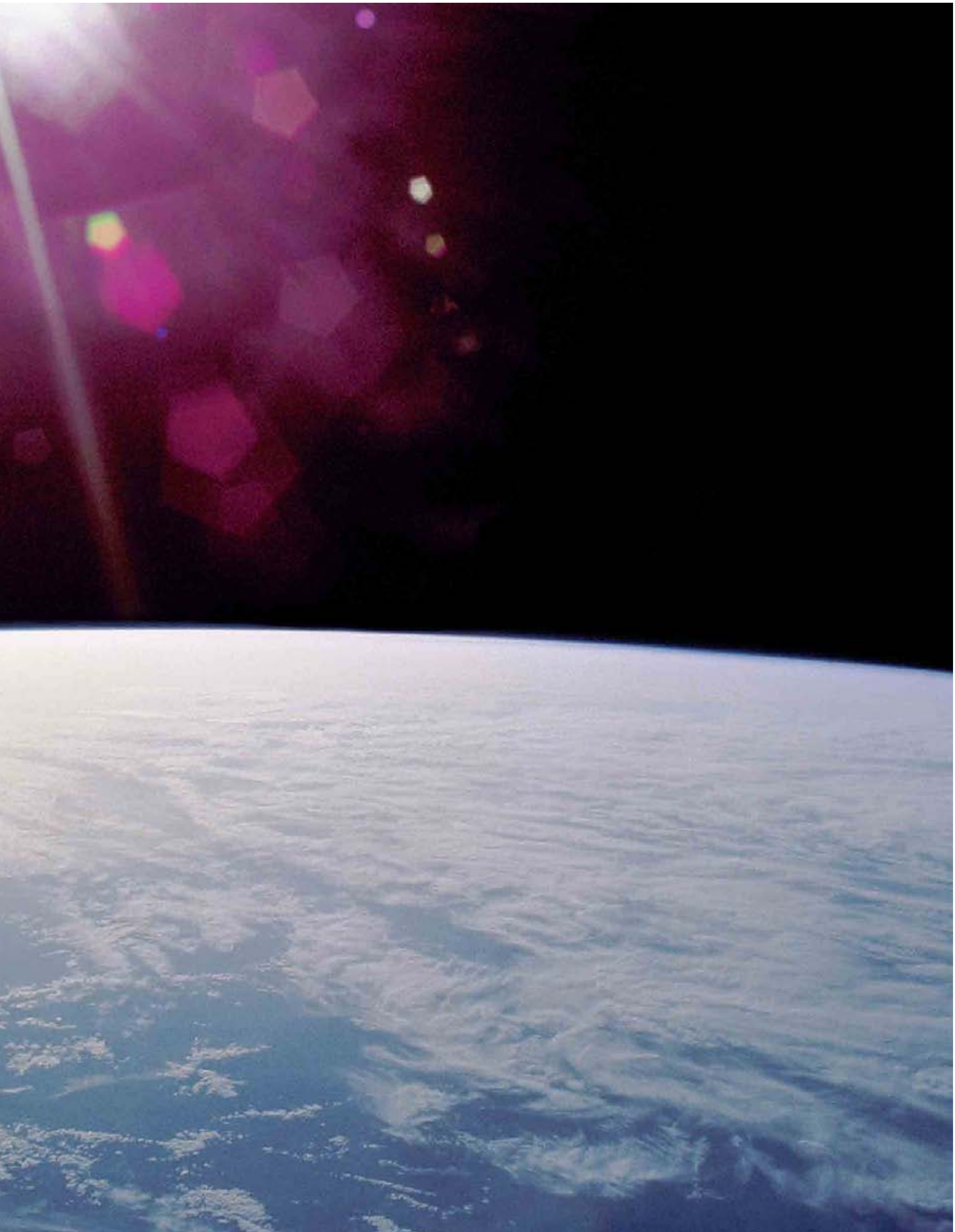
The Land Matrix

The Land Matrix is an online public database of large-scale land deals. It is facilitated by a partnership of organizations with an interest in promoting transparency and accountability in decisions over land and investment through open data. The Land Matrix aims to provide a permanent observatory to which any user can contribute information. www.landportal.info/landmatrix

CHAPTER 3: WHAT DOES THE FUTURE HOLD?



The Sun shining down upon the Earth as photographed by an astonaut from the International Space Station.



THE EMERGING IMPACTS OF RISING GREENHOUSE GAS EMISSIONS

Average global surface temperatures were 0.8ºC warmer during the first decade of the 21st century than during the first decade of the 20th century, and the most pronounced warming has been over the past 30 years. According to the National Research Council (NRC) of the US National Academies, "the past few decades have been warmer than any other comparable period for at least the last 400 years, and possibly for the last 1,000 years or longer" (National Research Council, 2010).

The principle culprits driving the long-term global warming trend are rising atmospheric concentrations of greenhouse gases, especially carbon dioxide (CO2), from fossil fuel use. Additional lesser amounts of greenhouse gases have come from deforestation and from other land use and land cover changes. Emissions of CO2 from fossil fuel use have been rising since the Industrial Revolution (i.e., since the mid-1700s); and by the 1950s, the atmospheric concentration of CO2 had risen from pre-industrial levels of 284 parts-per-million (ppm) to 300 ppm – the highest level in at least 800,000 years (Luthi, 2008). By 2010, emissions of CO2 from fossil fuels had risen to the highest level in history: 9.1 billion tonnes of carbon (Oak Ridge National Laboratory, 2011), and atmospheric concentrations followed suit, reaching 388.5 ppm that year (and 390.5 ppm in 2011) (NOAA/ESRL).

CO_2

BY 2010, EMISSIONS OF CO2 FROM FOSSIL FUELS HAD RISEN TO THE HIGHEST LEVEL IN HISTORY

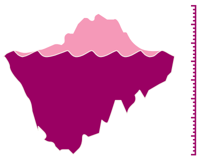
"WARMING OF THE CLIMATE SYSTEM IS UNEQUIVOCAL ... MOST OF THE OBSERVED INCREASE IN GLOBAL AVERAGE TEMPERATURES SINCE THE MID-20TH CENTURY IS VERY LIKELY DUE TO THE OBSERVED INCREASE IN ANTHROPOGENIC GREENHOUSE GAS CONCENTRATIONS ... ANTHROPOGENIC WARMING OVER THE LAST THREE DECADES HAS LIKELY HAD A DISCERNIBLE INFLUENCE AT THE GLOBAL SCALE ON OBSERVED CHANGES IN MANY PHYSICAL AND BIOLOGICAL SYSTEMS" (IPCC 2007A).

Warming oceans

CO_2 levels would have increased even more, were it not for the fact that about one quarter of CO_2 is being absorbed by the global grasslands and forests, and another quarter by the oceans. The result has been a 30 per cent increase in the acidity of the oceans relative to pre-industrial levels. At the same time, oceans have absorbed 80-90 per cent of the heating from rising greenhouse gas concentrations over the last half-century, driving up ocean temperatures (National Research Council, 2010). Sea surface temperatures affect a range of climate variables including air temperatures and humidity, precipitation, atmospheric circulation and storm attributes. The warmer oceans also expand, accounting for 50-60 per cent of the sea level rise observed since the mid-1800s (National Research Council, 2010). In the 20th century, the rate of sea level rise – 2.1mm per year – was faster than for any century in 2,000 years (Kemp *et al.*, 2011).

The rising temperatures of both the atmosphere and oceans are altering worldwide weather patterns. Colder temperatures are increasingly edged-out by warmer temperatures. Heat waves are becoming more common and intense. Precipitation patterns are changing and heavy precipitation events are becoming more frequent. There are changes in the frequency and severity of droughts. Storm tracks and intensity are changing, including a rise in the intensity of tropical storms over the North Atlantic Ocean (IPCC, 2007a).

Biodiversity impacts



THE VOLUME OF ARCTIC SEA ICE DROPPED TO A RECORD LOW IN 2011

In 2007 the Intergovernmental Panel on Climate Change (IPCC) concluded with "very high confidence" that "recent warming is strongly affecting terrestrial biological systems"; and stated with "high confidence" that "observed changes in marine and freshwater ecological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation" (IPCC, 2007a).

Some of the most dramatic and important impacts are evident in the Arctic, where the warming has been particularly pronounced (see box overleaf). The Arctic holds a vast quantity of land-ice (concentrated in Greenland), as does the Antarctic and other regions with glaciers, such as the Himalayas. Rising temperatures are shrinking the amount of ice – releasing immense quantities of freshwater into the oceans, and contributing to rising sea levels (National Research Council, 2010).

Impacts in the far northern latitudes, including the Arctic, are of particular concern. Dieback of boreal forests, along with thawing permafrost and methane deposits, could release large quantities of greenhouse gases. Similarly, more frequent severe droughts in the Amazon region – as occurred twice over the last decade (2005 and 2010) – can shift carbon from the Amazon's forests to the atmosphere (see box below) (Davidson *et al.*, 2012; Lewis *et al.*, 2011; Ma *et al.*, 2012; Xiao *et al.*, 2011; Schuur and Abbott, 2011).

Arctic rapidly warms, sea ice precipitously declines

Surface temperatures have been rising rapidly in the Arctic since the late 1970s and were at a record high in 2011 (Figure 52). In addition there has been a precipitous decline in Arctic sea ice, which dropped to the second lowest extent in the satellite record in September 2011 – just short of the record set in 2007. At the same time the sea ice is thinning and the volume of Arctic sea ice dropped to a record low in 2011. The decline is unprecedented for the past 1,450 years (Kinnard, 2011). The rapid sea ice decline has negatively affected people living and working in the Arctic, as well as wildlife. The decline in sea ice combined with rising sea surface temperatures also is affecting weather patterns from the Arctic to the mid-latitudes (USGCRP, 2009; Jaiser, 2012).

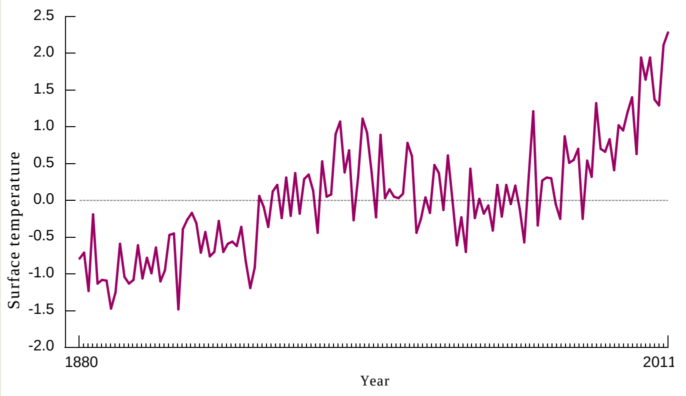


Figure 52: Surface temperature trends in the Arctic

TWO RECENT AMAZON DROUGHTS DEMONSTRATE A MECHANISM BY WHICH REMAINING INTACT TROPICAL FORESTS OF SOUTH AMERICA CAN SHIFT FROM BUFFERING THE INCREASE IN ATMOSPHERIC CARBON DIOXIDE TO ACCELERATING IT

Extreme droughts in the Amazon

Scientists are concerned that climate change may bring increasingly arid conditions (along with more frequent extreme droughts) to the Amazon, resulting in net carbon losses from the region's forests to the atmosphere (Davidson *et al.*, 2012; Lewis *et al.*, 2011; Zhao and Running, 2010). Those concerns were highlighted in 2005 when a "once in a century" drought affected the Amazon, with impacts so severe the government declared a state of emergency for much of the area. The drought resulted in a massive release of 0.8-2.6 Gigatons (billion metric tonnes) of carbon to the atmosphere. This can be compared to global emissions of CO_2 from fossil fuels in 2005 of 7.4 Gigatons of carbon (Lewis *et al.*, 2011).

In 2009, WWF identified the prospect of more frequent extreme droughts in the Amazon and the related rainforest dieback as being among the "tipping points" that could be passed in coming decades as climate changes, with "significant impacts within the first half of this century" (Lenton *et al.*, 2009). The very next year, in 2010, another extraordinary drought afflicted the region, this time with perhaps even greater emissions, estimated at between 1.2 and 3.4 Gigatons of carbon. "The two recent Amazon droughts demonstrate a mechanism by which remaining intact tropical forests of South America can shift from buffering the increase in atmospheric carbon dioxide to accelerating it," said researchers in the 4 February 2011 issue of *Science*. "If drought events continue, the era of intact Amazon forests buffering the increase in atmospheric carbon dioxide may have passed." (Lewis *et al.*, 2011).

A matter of degrees: Future impacts tied to CO_2 emissions

The IPCC in 2007 projected a warming of about 0.2°C per decade over the following two decades with subsequent warming increasingly depending on specific emissions scenarios (IPCC 2007). The NRC reported in 2011 that limiting the ultimate global average warming to 2°C above pre-industrial levels likely would require that atmospheric CO2 concentrations be stabilized at around 430 ppm. Stabilizing concentrations "for a century or so" at that level – or at any level – will require emissions reductions larger than 80 per cent below peak levels, but the NRC says that "even greater reductions in emissions would be required to maintain stabilized concentrations in the longer term" (National Research Council, 2011).

With concentrations already exceeding 390 ppm and emissions at record levels, warming is likely to exceed 2°C in the long term unless a sharp and sustained decline of at least 80 per cent in emissions by 2050 compared to 1990 is underway before 2020. If emissions continue to grow, large regions probably will individually exceed a 2°C increase in average annual temperatures by 2040. Under "business as usual" emissions scenarios, the 2°C warming is likely to be reached globally by 2060 or earlier, and temperatures will continue rising well beyond that time (Joshi *et al.*, 2011; Rogelj et al., 2011).

"THE WORLD IS ENTERING A NEW GEOLOGIC EPOCH, SOMETIMES CALLED THE ANTHROPOCENE, IN WHICH HUMAN ACTIVITIES WILL LARGELY CONTROL THE EVOLUTION OF EARTH'S ENVIRONMENT. CARBON EMISSIONS DURING THIS CENTURY WILL ESSENTIALLY DETERMINE THE MAGNITUDE OF EVENTUAL IMPACTS AND WHETHER THE ANTHROPOCENE IS A SHORT-TERM, RELATIVELY MINOR CHANGE FROM THE CURRENT CLIMATE OR AN EXTREME DEVIATION THAT LASTS THOUSANDS OF YEARS." (NATIONAL RESEARCH COUNCIL, 2011).

THE IPCC CONCLUDES THAT DURING THIS CENTURY "IT IS VERY LIKELY THAT HOT EXTREMES, HEAT WAVES AND HEAVY PRECIPITATION WILL BECOME MORE FREQUENT" AND THAT "IT IS LIKELY THAT FUTURE TROPICAL CYCLONES (TYPHOONS AND HURRICANES) WILL BECOME MORE INTENSE, WITH LARGER PEAK WIND SPEEDS AND MORE HEAVY PRECIPITATION." (IPCC, 2007A).

The rising global temperatures and atmospheric CO2 concentrations will bring dangerously disruptive changes to both the oceans and climate. Researchers warned in March 2012 that "the current rate of (mainly fossil fuel) CO2 release stands out as capable of driving a combination and magnitude of ocean geochemical changes potentially unparalleled in at least the last ~300My [million years] of Earth history, raising the possibility that we are entering an unknown territory of marine ecosystem change." (Honisch et al., 2012). Sea levels could rise 0.75-1.9 meters above 1990 levels by 2100 (Vermeer and Rahmstorf, 2009). Increases in the frequency and severity of floods and droughts are likely (IPCC, 2007a).

The IPCC describes in unambiguous terms and with high confidence the implications for ecosystems: "During the course of this century the resilience of many ecosystems (their ability to adapt naturally) is likely to be exceeded by an unprecedented combination of change in climate, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification) and in other global change drivers (especially land-use change, pollution and over-exploitation of resources), if greenhouse gas emissions and other changes continue at or above current rates ..." (IPCC, 2007c).

These and other impacts on systems and sectors are summarized in Figure 55 for a range of average global temperature increases relative to 1980-1999 temperatures (which were already 0.5°C above pre-industrial levels).

WHAT DOES THE FUTURE HOLD? THE USE OF SCENARIOS

Scenarios are a recognized planning tool for generating different models of how the world "might" look in the future. They are used to improve understanding of the future consequences of today's actions, against a range of possible outcomes.

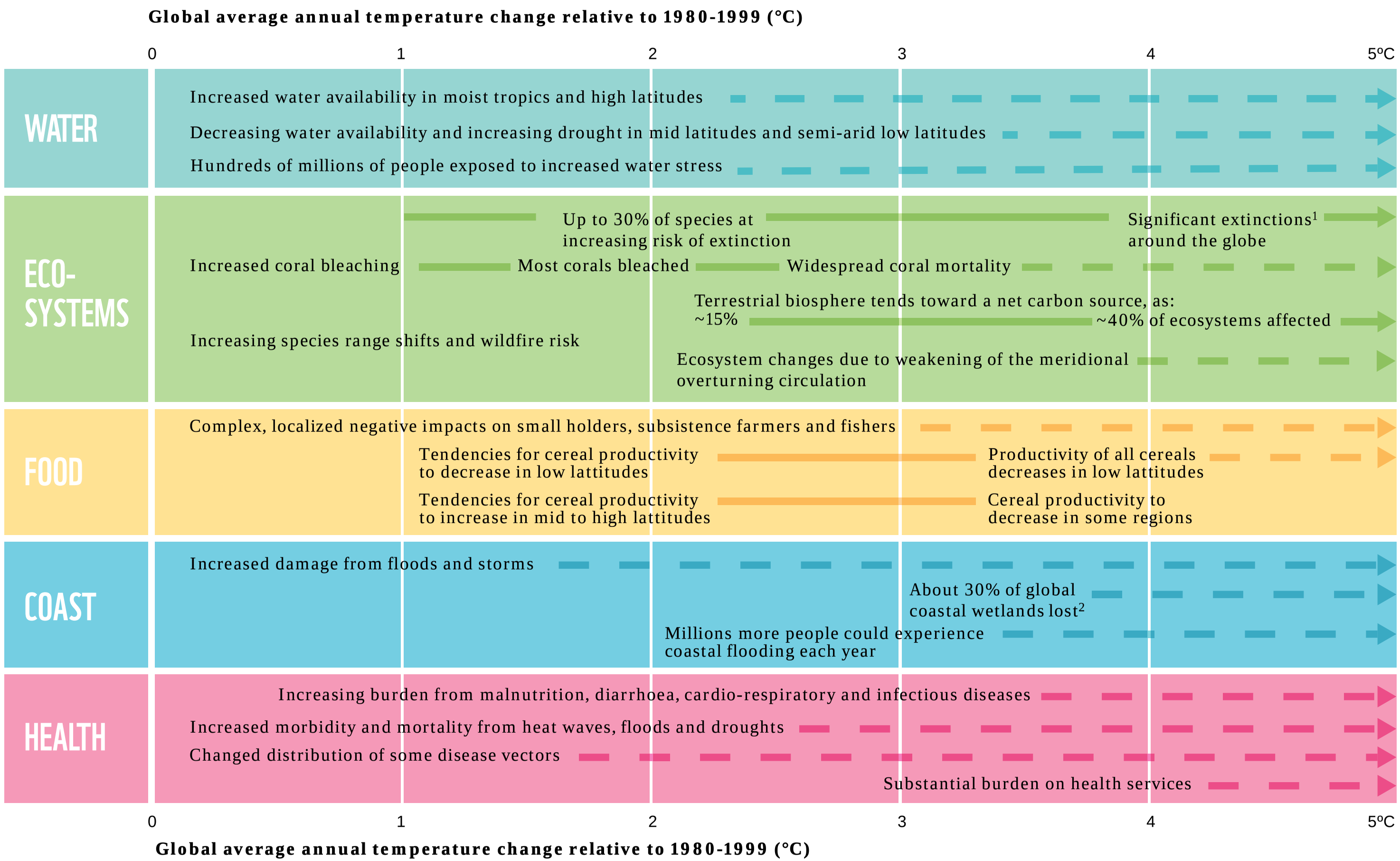
Scenarios are not predictions or forecasts; they simply represent a variety of future alternatives. They are not intended to illustrate preferable developments or undesirable progressions, but instead to describe possible futures. They can be used to further our understanding of how systems evolve, develop, behave and interact, as well as the potential impacts of specific policies.

The IPCC has produced scenarios that contrast the climate impacts of a future of slow economic growth with reliance on traditional technologies, against a future of high economic growth and the rapid spread of new, more efficient technologies. As can be seen in Figure 53, under these scenarios, future global temperature increases, and the impacts of climate change, are very different. In the same way, scenarios can suggest how the Ecological Footprint and ecosystem service delivery might change in the future, and can highlight the choices needed to ensure a sustainable existence.

SCENARIOS CAN BE USED TO FURTHER UNDERSTANDING OF HOW SYSTEMS EVOLVE, DEVELOP, BEHAVE AND INTERACT

Figure 53 (opposite): Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century (IPCC 2007c)
The solid lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of the text indicates the approximate onset of a given impact. Quantitative entries for water stress and flooding represent the additional impacts of climate change relative to the conditions projected across the range of Special Report on Emissions Scenarios (SRES) scenarios A1FI, A2, B1 and B2 (for more information about these scenarios see IPCC 2007, and for the sources used to create this figure, see 2007c). Adaptation to climate change is not included in these estimations. All entries are from published studies recorded in the chapters of the Assessment. Confidence levels for all statements are high.

[1] *Significant is defined here as more than 40%*
[2] *Based on average rate of sea level rise of 4.2mm/year from 2000 to 2080*


Global average annual temperature change relative to 1980-1999 (°C)
0
1
2
3
4
5ºC
WATER
Increased water availability in moist tropics and high latitudes
Decreasing water availability and increasing drought in mid latitudes and semi-arid low latitudes
Hundreds of millions of people exposed to increased water stress
ECO-SYSTEMS
Up to 30% of species at increasing risk of extinction
Significant extinctions[1] around the globe
Increased coral bleaching
Most corals bleached
Widespread coral mortality
Terrestrial biosphere tends toward a net carbon source, as: ~15%
~40% of ecosystems affected
Increasing species range shifts and wildfire risk
Ecosystem changes due to weakening of the meridional overturning circulation
FOOD
Complex, localized negative impacts on small holders, subsistence farmers and fishers
Tendencies for cereal productivity to decrease in low lattitudes
Productivity of all cereals decreases in low lattitudes
Tendencies for cereal productivity to increase in mid to high lattitudes
Cereal productivity to decrease in some regions
COAST
Increased damage from floods and storms
About 30% of global coastal wetlands lost[2]
Millions more people could experience coastal flooding each year
HEALTH
Increasing burden from malnutrition, diarrhoea, cardio-respiratory and infectious diseases
Increased morbidity and mortality from heat waves, floods and droughts
Changed distribution of some disease vectors
Substantial burden on health services
0
1
2
3
4
5ºC
Global average annual temperature change relative to 1980-1999 (°C)

PROJECTING THE ECOLOGICAL FOOTPRINT TO 2050

According to the United Nations Food and Agriculture Organization (FAO), demand for food, feed and fibres could grow by 70 per cent by 2050 (FAO, 2009). This has considerable implications for land use and natural ecosystems, and also for the size of humanity's Ecological Footprint.

The Ecological Footprint Scenario Calculator uses footprint data between 1961 and 2008 as a baseline, and projects the size of each component of the footprint in 2015, 2030 and 2050 (Moore *et al.*, 2012; WBCSD, 2010). The calculator uses data and projections from other scenario models for population, land use, land productivity, energy use, diet and climate change, and translates them into corresponding trends in Ecological Footprints and biocapacity. The datasets and parameters used in the "business as usual" scenario are included in the figure legend below.

The "business as usual" scenario for humanity's Ecological Footprint shows more and more pressure being placed on the planet. By 2050 humanity would require an equivalent of 2.9 planets to support the "business as usual" assumptions (Figure 54).

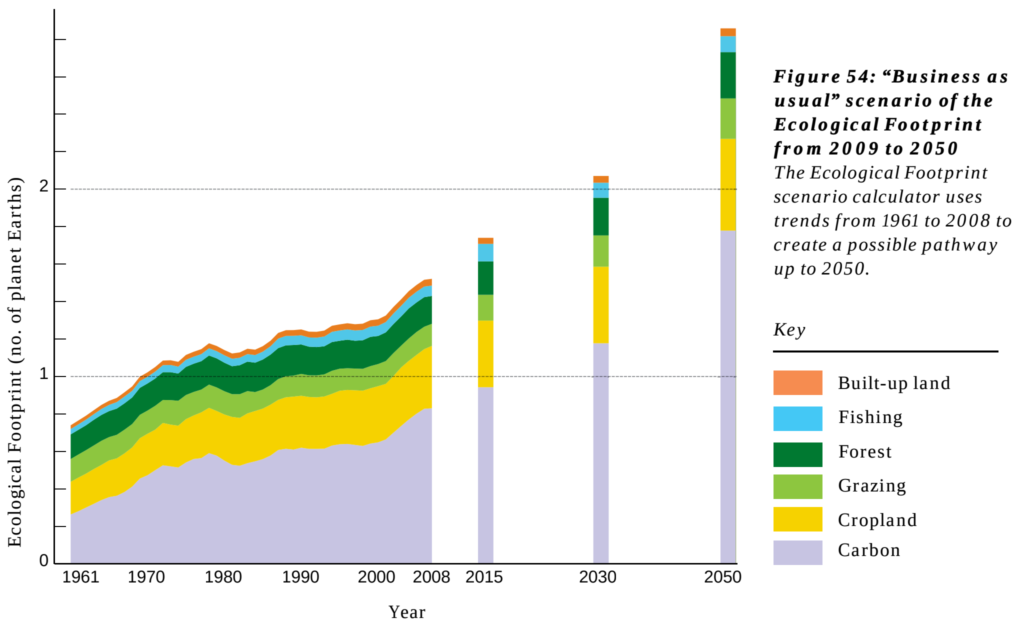


Figure 54: "Business as usual" scenario of the Ecological Footprint from 2009 to 2050
The Ecological Footprint scenario calculator uses trends from 1961 to 2008 to create a possible pathway up to 2050.

MODELLING NATURAL CAPITAL IN SUMATRA

Scenarios can help outline the choices where investment in natural capital can enhance human development and conservation.

New software called InVEST, developed by WWF and partners, allows comparisons of important areas for biodiversity conservation and ecosystem services provision. This enables ecosystem services to be better integrated into the operational work of WWF and its partners.

InVEST was recently used in Sumatra, Indonesia, to map the co-occurrence of important areas for tiger conservation, the stock of terrestrial carbon and erosion prevention across the landscape. High quality tiger habitat overlaps with high soil carbon stocks in the eastern peatlands. In the mountainous west of the island, forested slopes contain tiger habitat and substantially reduce erosion, which helps provide clean water to downstream users.

Ecosystem services were quantified and mapped for two alternative scenarios of the future in central Sumatra: a "green" scenario of sustainable land use, and a "business as usual" scenario representing land use plans proposed by the Indonesian government. InVEST results demonstrated that the "green" scenario would yield higher levels of habitat and services relative to the government plan. There is considerable variation in the distribution of services and their expected change across the landscape.

Local governments are using these results to prioritize and spatially target policy mechanisms, such as forest carbon and watershed conservation projects, to improve both wildlife conservation and human welfare.

Figure 55: Overlap between conservation areas and ecosystem services (carbon stocks and erosion prevention) in Sumatra, Indonesia
The maps illustrate the overlay between tiger landscapes (red outlines) and areas of (a) high sediment retention (erosion and run-off prevention) and (b) carbon storage in central Sumatra in 2008 (Bhagabati et al., 2012).

Map right (a)

Tiger conservation landscapes

Total sediment retained (annual average)

high

low

Map far right (b)

Tiger conservation landscapes

Carbon stock (metric tonnes / ha)

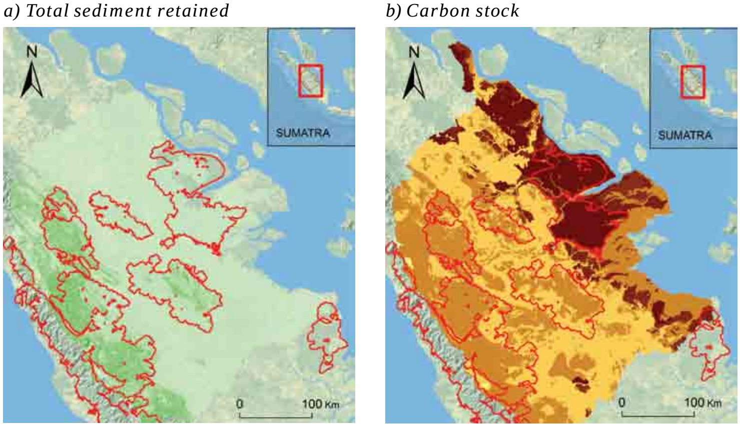
1 - 50

50 - 200

200 - 1,000

> 1,000

a) Total sediment retained *b) Carbon stock*



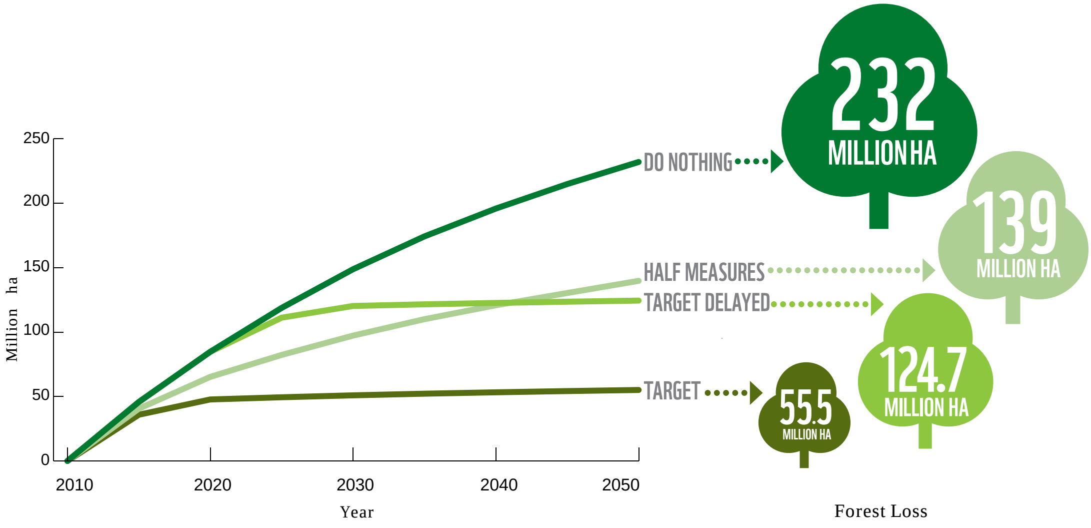
THE LIVING FORESTS MODEL

The Living Forests Model, developed by WWF with the International Institute for Applied Systems Analysis (IIASA) is being used to project forest loss and other land use changes under different scenarios (WWF, 2011a; b; c).

Starting from the reference (a) Do Nothing Scenario, the model projects changes if measures were introduced to rein-in deforestation and forest degradation and to increase biodiversity conservation. A number of scenarios have been developed for reductions in forest loss and degradation: (b) Target Scenario – Zero Net Deforestation and Forest Degradation (ZNDD – see definition in glossary) by 2020 and maintained at that level indefinitely; (c) Target Delayed Scenario – ZNDD by 2030 and maintained at that level indefinitely; and (d) Half Measures Scenario – gross deforestation rate declines by at least 50 per cent from the reference rate by 2020 and is maintained at that level indefinitely.

The Target Scenario was used to explore the costs and benefits of fast action to cut deforestation and degradation compared to the Do Nothing Scenario (Figure 56). Compared to the Target Scenario, doing nothing, delaying or taking half measures all result in more forest loss and associated GHG emissions, irreversible impacts on biodiversity, and declines in ecosystem services (for further analysis, see WWF, 2011a; b; c and for further information on the model see Strassburg *et al.*, 2012).

Figure 56: Comparison of gross deforestation under the Do Nothing Scenario, Target Scenario, Target Delayed Scenario and Half Measures Scenario
The figure shows cumulative deforestation between 2010 and 2050. Under the Do Nothing Scenario, the area deforested is greater than the current total forest area of the Democratic Republic of Congo, Peru and Papua New Guinea combined (WWF, 2011a).



Scenarios of biodiversity change: Modelling future habitat availability for tigers

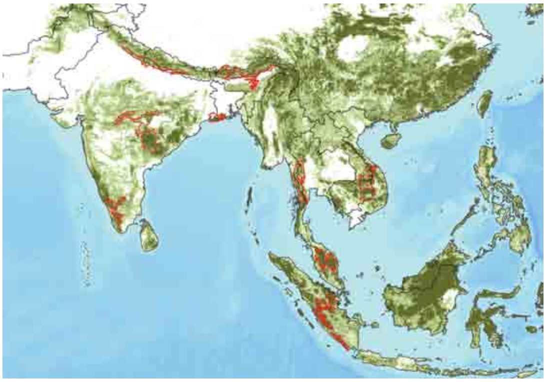
Asia's most iconic species, the tiger, and its forests are not strangers to change. Over the last century, tigers have decreased in the wild from 100,000 individuals to an estimated 3,200 to 3,500 (Global Tiger Initiative, 2011), while Asia's forests have decreased by more than 70 per cent in half of the countries in this region (Laurance, 2007). What's in store for Asia's forests and tigers?

Projections of forest change using the Living Forests Model Do Nothing Scenario suggest that 332,207 km^2 (roughly 42 per cent) of habitat within WWF Tiger Landscapes will experience a decline in forest cover, with 50,708 km^2 of habitat declining to a 0-10 per cent forest cover (Figure 57). Asia has the opportunity to address deforestation by taking actions to conserve the forests in which tigers live. This includes smart, planned development; accounting for the benefits provided by these forests in decision-making; and investment in forests and tigers by nations following through on their existing commitments to tiger conservation. At the rate forests and tigers are currently being lost, immediate action is crucial.

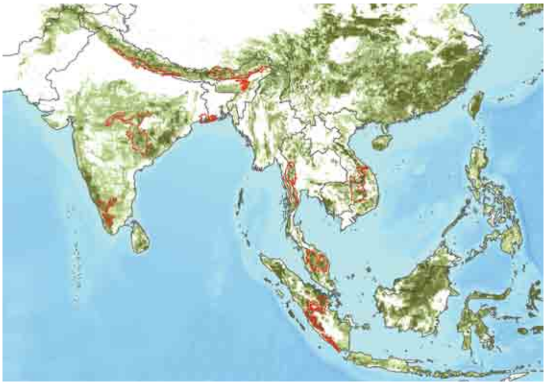
Figure 57: Forest cover in 2000 and projected forest cover in 2050
The Living Forests Model was used to model changes in forest cover within tiger range states between 2000 and 2050. The available habitat for tigers will shrink, according to projections based on past trends. This projection does not take in account national and local policies to protect forest resources (for more details about the model underlying these maps, see Strassburg et al., 2012).

Forest Cover %

- 1 - 10
- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100



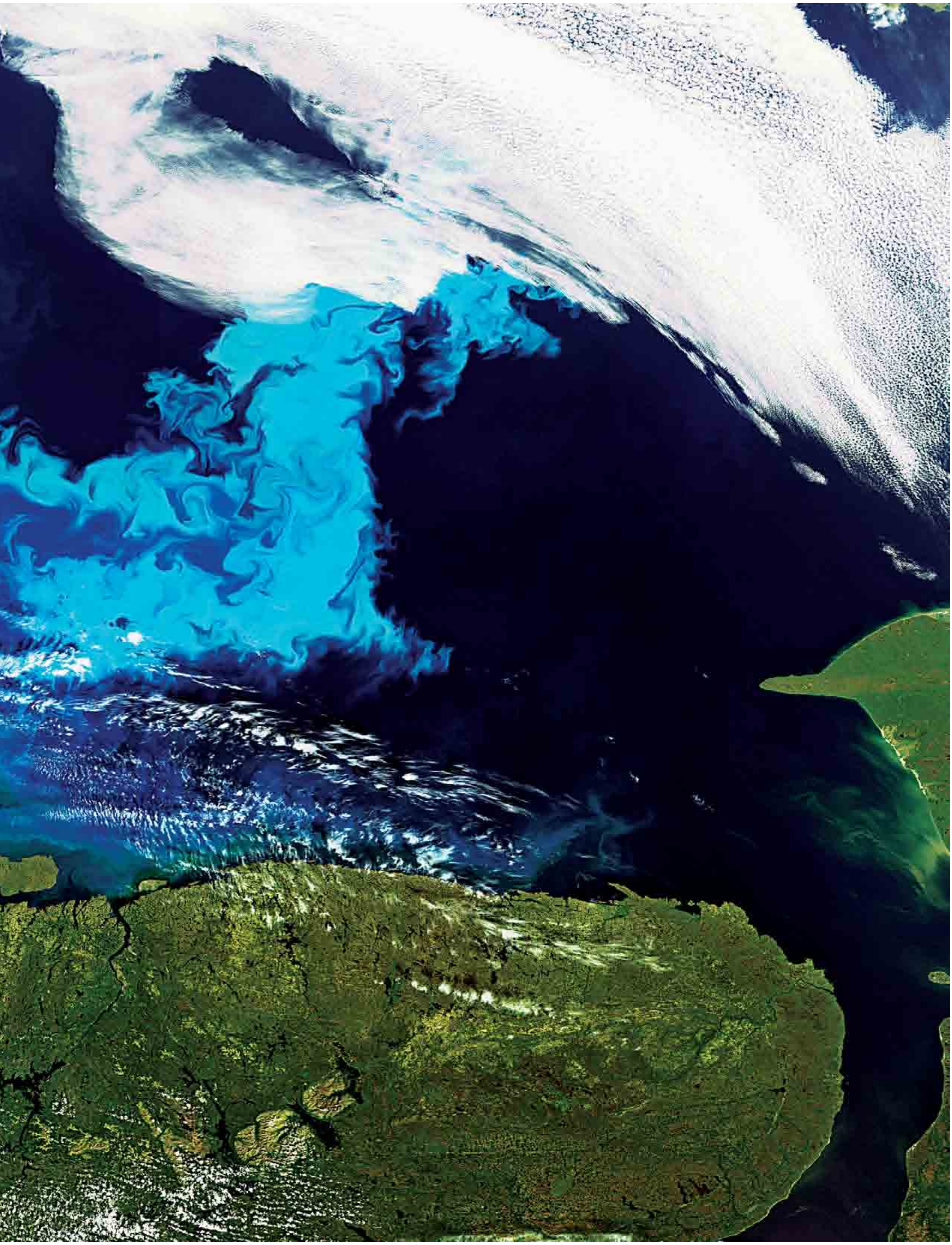
Forest Cover in 2000



Projected Forest Cover for 2050

CHAPTER 4: BETTER CHOICES FOR A LIVING PLANET

A satellite image of a phytoplankton bloom stretching across the Barents Sea off the coast of mainland Europe's most northern point, Cape Nordkinn. Free-floating phytoplankton highlight the whirls of ocean currents in spectacular shades of blue and green. These microscopic marine organisms that drift on or near the surface of oceans and seas have been called "the grass of the sea" because they are the foundation of the oceanic food chain. Phytoplankton are able to convert inorganic compounds such as water, nitrogen and carbon into complex organic materials. With their ability to "digest" these compounds, they are credited with removing as much carbon dioxide from the atmosphere as their plant "cousins" on land – therefore having a profound influence on climate. They are also sensitive to environmental changes, so it is important to monitor and model phytoplankton into calculations of future climate change.



ONE PLANET PERSPECTIVE

Most people essentially desire the same thing: A life where needs are met; to be safe and healthy; to be able to explore interests and realize potential; and to improve well-being. Along with these personal aspirations, they have the support of all 193 member states of the United Nations, which have committed under various international agreements to end poverty, ensure safe drinking water, protect biodiversity and reduce greenhouse gas emissions.

The trends and analyses outlined in this report suggest that under "business as usual", such expectations and commitments will become increasingly difficult to meet.

In order to reverse the declining Living Planet Index, bring the Ecological Footprint down to within planetary limits, avoid dangerous climate change and achieve sustainable development, a fundamental reality must be embedded as the basis of economies, business models and lifestyles: The Earth's natural capital – biodiversity, ecosystems and ecosystem services – is limited.

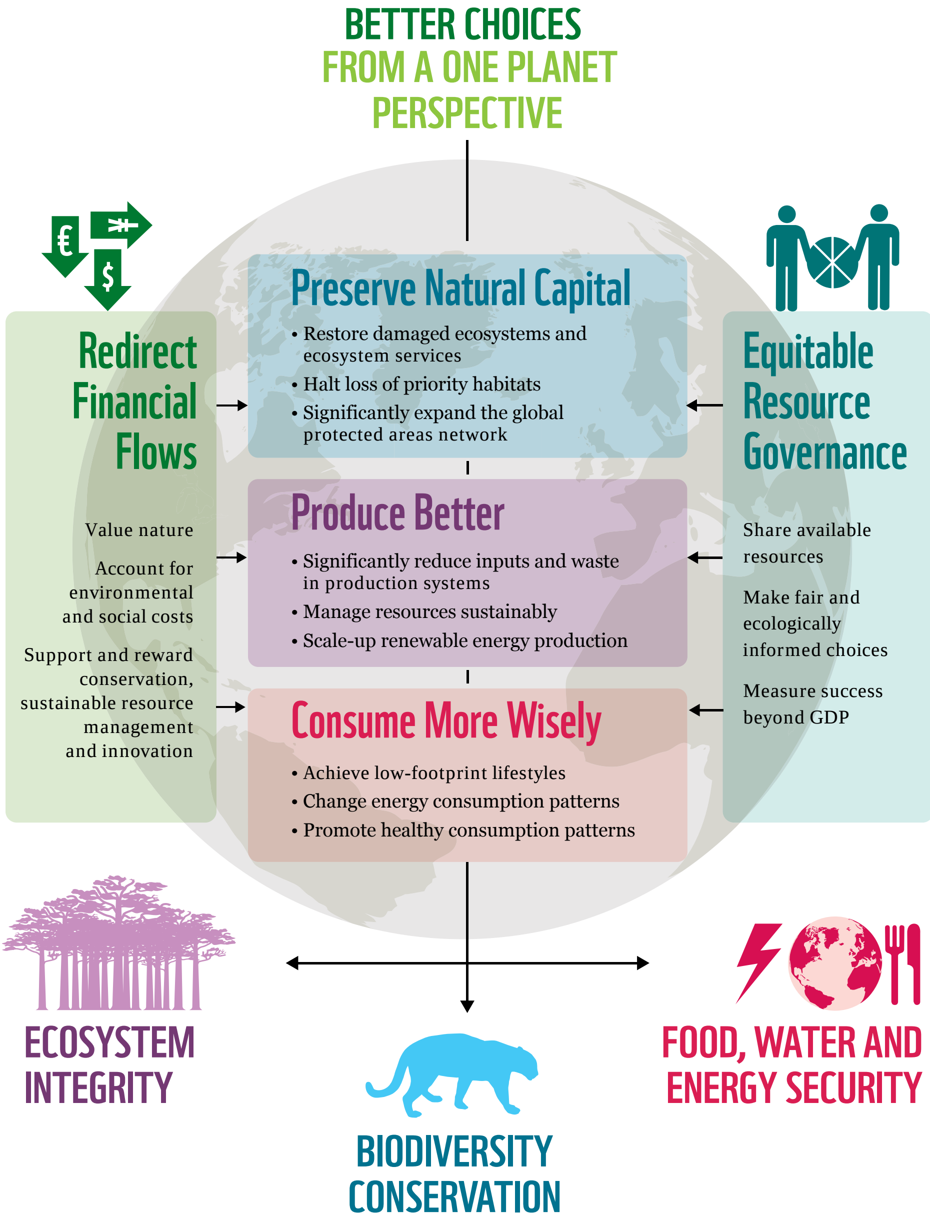
WWF's One Planet perspective explicitly proposes to manage, govern and share natural capital within the Earth's ecological boundaries. In addition to safeguarding and restoring this natural capital, WWF seeks better choices along the entire system of production and consumption, supported by redirected financial flows and more equitable resource governance. All of this, and more, is required to decouple human development from unsustainable consumption (moving away from material and energy-intensive commodities), to avoid greenhouse gas emissions, to maintain ecosystem integrity, and to promote pro-poor growth and development (Figure 58).

The One Planet perspective reminds us that our choices are highly interdependent. Preserving natural capital, for example, will affect decisions and possible outcomes relating to the way we produce and consume. Financial flows and governance structures will similarly determine to a great extent whether production and consumption choices will actually contribute to biodiversity conservation, ecosystem integrity and, ultimately, food, water and energy for all.

This chapter outlines the top 16 priority actions required for living within the means of one planet. Implementing such a paradigm shift will be a tremendous challenge. We all face uncomfortable choices and trade-offs, but only by taking brave, informed decisions can healthy, sustainable and equitable human societies be ensured, now and into the future.

WWF'S ONE PLANET PERSPECTIVE PROPOSES TO MANAGE, GOVERN AND SHARE NATURAL CAPITAL WITHIN THE EARTH'S ECOLOGICAL BOUNDARIES

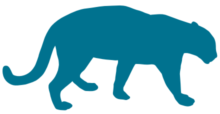
Figure 58: One Planet perspective
The centre panels reflect better choices for managing, using and sharing natural resources within One Planet limitations and ensuring food, water and energy security. Redirected financial flows and equitable resource governance are essential enabling factors.


BETTER CHOICES
FROM A ONE PLANET
PERSPECTIVE
Redirect Financial Flows
Value nature
Account for environmental and social costs
Support and reward conservation, sustainable resource management and innovation
Preserve Natural Capital
• Restore damaged ecosystems and ecosystem services
• Halt loss of priority habitats
• Significantly expand the global protected areas network
Produce Better
• Significantly reduce inputs and waste in production systems
• Manage resources sustainably
• Scale-up renewable energy production
Consume More Wisely
• Achieve low-footprint lifestyles
• Change energy consumption patterns
• Promote healthy consumption patterns
Equitable Resource Governance
Share available resources
Make fair and ecologically informed choices
Measure success beyond GDP
ECOSYSTEM INTEGRITY
BIODIVERSITY CONSERVATION
FOOD, WATER AND ENERGY SECURITY

SHARE AND SHARE ALIKE

A visitor to Margaret's farm will be given sweet, milky tea and a hearty helping of potatoes, beans and greens. Margaret will also share her time and her knowledge, and her warm laugh. Sharing enriches us. It feels good. While we understand this on a personal level, we tend to forget it when it comes time to make decisions about allocating resources. When we remember what counts, we will be able to count what matters.

PRESERVE NATURAL CAPITAL



Natural capital – biodiversity, ecosystems and ecosystem services – must be preserved and restored as the foundation of human societies and economies. Efforts must particularly focus on protecting and restoring key ecological processes necessary for food, water and energy security, as well as climate change resilience and adaptation. The Earth's diversity of species and habitats must also be preserved for their intrinsic value.

EFFORTS MUST FOCUS ON PROTECTING AND RESTORING KEY ECOLOGICAL PROCESSES NECESSARY FOR FOOD, WATER AND ENERGY SECURITY, AS WELL AS CLIMATE CHANGE RESILIENCE AND ADAPTATION

i. Significantly expand the global protected areas network

- Protect 20 per cent of representative land, freshwater and marine areas, including areas key for ecological processes necessary for biodiversity, food, water and energy security, and climate change resilience and adaptation.
- Implement adequate funding mechanisms for effective protected area management.

Halting forest degradation and deforestation

Achieving Zero Net Deforestation and Degradation (ZNDD) would not only stem the depletion of forest-based biodiversity and ecosystem services, but also eliminate the second-largest source of anthropogenic greenhouse gas emissions. WWF advocates ZNDD by 2020 to reflect the scale and urgency of these threats.

WWF defines ZNDD as: no net forest loss through deforestation and no net decline in forest quality through degradation; and stresses that: (a) most natural forest should be retained – the annual rate of loss of natural or semi-natural forests should be reduced to near zero; and (b) any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest restoration.

WWF's Living Forests Model projects that it is possible to achieve ZNDD by 2020, and warns that the longer it takes to achieve this goal the harder it will become to stem forest loss. But major changes in land and resource use will be needed; the implications and options for this are explored in WWF's *Living Forests Report* (WWF, 2011a; b; c).

ii. Halt loss of priority habitats

- Achieve Zero Net Deforestation and Degradation by 2020 and maintain thereafter.
- Halt fragmentation of freshwater systems.
- Increase the area of effectively managed marine protected areas from 5 per cent to at least 20 per cent.

iii. Restore damaged ecosystems and ecosystem services

- Prioritize restoration of ecosystems and ecosystem services necessary for food, water and energy security, and climate change resilience and adaptation.

Water reserves: Securing water resources for people and nature

The Mexican National Water Commission (CONAGUA), with support from WWF and the Fundacion Gonzalo Río Arronte, is working to manage freshwater ecosystems. In 2011, a national environmental flow standard was approved, and 189 basins were identified as potential "water reserves": watersheds with high biological richness and relatively high water availability. These basins are the main targets of the National Water Reserves Program (CONAGUA, 2011) that is creating conditions to safeguard the natural flow regimes that sustain critical ecosystems, secure the services they support and maintain buffering capacity against climate uncertainty and water scarcity risk.

PRODUCE BETTER

Efficient production systems would help lower humanity's Ecological Footprint to within ecological limits by significantly reducing human demand for water, land, energy and other natural resources. This is especially urgent in light of the growing human population and the need to meet the needs of the world's poor. Such systems must manage food, fibre, energy and water in an integrated manner, and ensure that sustainability is no longer a choice, but embedded into every commodity, product and process.

EFFICIENT PRODUCTION SYSTEMS WOULD HELP LOWER HUMANITY'S ECOLOGICAL FOOTPRINT TO WITHIN ECOLOGICAL LIMITS

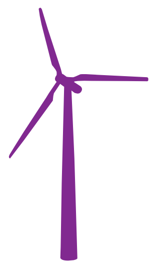
iv. Significantly reduce inputs and waste in production systems

- Increase total food supply-chain efficiency.
- Maximize energy, water and material efficiency.
- Maximize recycling and recovery.
- Minimize greenhouse gas emissions.

A new energy paradigm

In order for the world to stay below 2°C of warming – and so avoid dangerous climate change – global greenhouse gas emissions must be reduced to no more than 80 per cent of 1990 levels by 2050.

The energy sector is key to achieving this goal. WWF's *Energy Report* presents one of the possible pathways toward achieving a cost-effective energy system, based wholly on renewable energy (WWF, 2011d). The report raises a number of significant issues and challenges – political, economic, environmental and social – that will need to be addressed in order to realize this energy vision and minimize the impact of using more bioenergy.



Better cotton in Pakistan

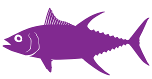
Pakistan is the world's third-largest producer of cotton, which contributes 55 per cent of its foreign earnings. 40,000 farmers in Pakistan are now growing cotton with help from the Better Cotton Initiative – a programme initiated by WWF and IKEA in 2006 to reduce the severe environmental impacts of conventional cotton production. In 2010, 170,000 hectares of cotton production utilized 40 per cent less chemical fertilizers, 47 per cent less pesticides and 37 per cent less water. Biodiversity was not the only beneficiary. While yields remained the same, farmers received a 15 per cent increase in income and their working conditions improved substantially. Support for the initiative came from Levi Strauss and Co, H&M, Adidas and Marks & Spencer (WWF, 2003).

v. Manage resources sustainably

- Eliminate overfishing by commercial fleets, including the indiscriminate capture of non-target organisms.
- Eliminate water over-abstraction.
- Implement policies to secure water quality.
- Minimize further habitat conversion through maximizing the sustainable use of productive land by improving genetic selection, adopting best practices, increasing efficiency, improving soil organic matter and rehabilitating degraded lands.

vi. Scale-up renewable energy production

- Increase the proportion of sustainable renewable energies in the global energy mix to at least 40 per cent by 2030 and 100 per cent by 2050.
- Increase the share of renewable energy in the overall energy mix, along with ambitious energy demand management, especially in sectors with limited renewable options that are likely to be dependent on bioenergy. (Aviation, shipping and high heat industrial applications are likely to be among these.)



Certification in Chile

Chile currently has one of the strongest economies in Latin America, with projections suggesting that it could meet OECD criteria for developed countries by 2020. It supplies 8 per cent of the global pulp and paper market. To avoid large environmental impacts and depletion of natural resources, fundamental choices are needed to transform the forestry sector and enable Chile to continue to supply pulp and paper in a more environmentally and socially sustainable way. The rising global demand for Forest Stewardship Council (FSC) certified paper is contributing to this transformation. WWF is therefore working closely with the forestry sector and the government of Chile to strengthen and broaden the scope of FSC certification.

Similar developments are underway in Chile's oceans and lakes. Chile is an important exporter of fish: It accounts for around 30 per cent of the global salmon market, 13 per cent of the global market for forage fish; and 3 per cent of the global market for whitefish. Marine Stewardship Council (MSC) certification is an important mechanism to tackle the current overexploitation of the Chilean fisheries and to achieve both environmentally sustainable and economically viable fisheries. The Chilean hake fishery has recently become the first to enter the MSC certification process. The Chilean salmon industry is working with WWF in developing Aquaculture Stewardship Council (ASC) standards for sustainable salmon farming.

CONSUME MORE WISELY

Living within the Earth's ecological limits also requires a global consumption pattern in balance with the Earth's biocapacity. The immediate focus must be on drastically shrinking the Ecological Footprint of high-income populations – particularly their carbon footprint. Changed dietary patterns among wealthy populations and reduced food waste are crucial, as is innovation for "low and fair" footprint solutions that allow developing nations and emerging economies to fulfil human needs and rights.

THE IMMEDIATE FOCUS MUST BE ON DRASTICALLY SHRINKING THE ECOLOGICAL FOOTPRINT OF HIGH-INCOME POPULATIONS

vii. Change energy consumption patterns

- Decrease energy demand by 15 per cent by 2050 compared to 2005.
- Increase the proportion of electricity produced using renewable energy to cover all global energy needs by 2050.
- Provide sustainable energy to everyone in "off-grid" areas.

The impact of food choices

The type and amount of food eaten by people living in higher-income countries already has global impacts on climate change, land and sea use, water availability and quality, biodiversity and equity issues. Future scenarios for achieving Zero Net Deforestation and Degradation and 100 per cent renewable energy are dependent on changed food consumption patterns. In particular, red meat and dairy consumption, and overall food loss and waste, must decrease in developed countries. Then everyone on the planet can enjoy healthy levels of protein in their diets, more space can be kept for nature, and bioenergy can expand without creating food shortages. Such a shift is also necessary to provide everyone on the planet with healthy levels of protein in their diet. Achieving such dietary changes will require cooperation from a broad set of stakeholders, including the food industry, governments, health institutions (such as the World Health Organization), consumer groups and individuals.

viii. Promote healthy consumption patterns

- Balance protein intake per capita as recommended by the World Health Organization (WHO).
- Minimize retailer and consumer food waste in high- and middle-income countries.

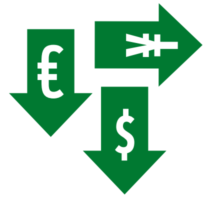
ix. Achieve low-footprint lifestyles

- Minimize resource consumption and waste by high-income individuals.
- Maximize market share of certified sustainable products.
- Transition urban areas to “smart” cities with low-footprint solutions for meeting urban housing, food, water, energy, and mobility needs.

ENOUGH FOR ALL

Not much goes to waste on Margaret's farm. But for a rapidly urbanizing population, growing their own food may not be an option. Instead, consumers can learn about where food comes from and how it is produced. By asking questions and demonstrating a commitment to sustainability, each of us can help push retailers to improve efficiency along their supply chains. A series of better choices can contribute to the fight against hunger and poverty, while conserving nature.

REDIRECT FINANCIAL FLOWS



In too many cases, the overexploitation of resources and damage or destruction of ecosystems are highly profitable for a few stakeholders in the short term; while the long-term benefits of protecting, maintaining and investing in natural capital are inadequately valued or not valued in an economic sense at all. As a result, the importance of biodiversity and ecosystem services is undervalued in economic and political trade-offs. Redirected financial flows that support conservation and sustainable ecosystem management are therefore an essential enabling condition for both preserving natural capital and for making better production and consumption choices – and ensuring that burdens are not passed on to future generations.

REDIRECTED FINANCIAL FLOWS SUPPORT CONSERVATION AND SUSTAINABLE ECOSYSTEM MANAGEMENT

x. Value nature

- Implement an inclusive and globally accepted system for measuring the economic and non-economic value of natural capital.
- Fully integrate this value into mainstream economic development policy and decision-making.

The sustainable finance sector

The International Finance Corporation (IFC), the private sector branch of the World Bank Group, reports an 11 per cent higher return from companies that demonstrate environmental and social standards. By attaching sustainability criteria to their lending and investment conditions, financial institutions can help raise standards in critical markets. Important incentives include cost savings from using resources efficiently, avoiding reputational risks and better access to markets. WWF engages with leading financial institutions such as IFC in developing new risk management tools and services. The IFC performance standards, which include credible standards such as MSC and FSC, are now adopted by 70 financial institutions worldwide. With guidance from WWF, Rabobank – the largest agricultural financer in the world – has attached similar sustainability conditions to its investments.

xi. Account for environmental and social costs

- Integrate social and environmental costs of production and consumption over long timeframes into standard national and corporate accounting and reporting methodologies.
- Ensure that social and environmental costs are reflected in the market price of all commodities and products, and in environmental impact assessments.

xii. Support and reward conservation, sustainable resource management and innovation

- Eliminate all subsidies that undermine sustainable resource use and conservation, particularly those underpinning fossil fuel use and unsustainable agriculture, forestry and fisheries.
- Develop/implement new financial mechanisms that redirect public and private investment to support sustainable practices and new technologies for sustainability, and provide new additional financing for conservation and restoration of natural capital.
- Improve policy for increased investments and large-scale deployment of innovations and new technologies that can enable sustainable development in both public and private spheres.

EQUITABLE RESOURCE GOVERNANCE

Equitable resource governance is the second essential enabling condition to shrink and share our resource use to stay within the regenerative capacity of one planet. In addition to efforts to reduce the footprint of high-income populations (see "Consume more wisely" section), we must also improve health and education standards, and create viable economic development plans. These must exist within legal and policy frameworks that provide equitable access to food, water and energy, and be supported by inclusive processes for sustainably managed land use. Equitable resource governance also requires a changed definition of well-being and success that includes personal, societal and environmental health.

EQUITABLE RESOURCE GOVERNANCE IS AN ESSENTIAL ENABLING CONDITION TO SHRINK AND SHARE OUR RESOURCE USE

Cities as solution hot spots for a One Planet economy

While political gridlock may stop rational action elsewhere, leading cities are already realizing the shared benefits of footprint reduction, social well-being and economic resilience. WWF's Earth Hour City Challenge invites cities to inspire the world with their plans for moving towards a 100% renewable economy and supporting One Planet Lifestyles. Whereas Earth Hour channels the public's impatient calls for global political action, the Earth Hour City Challenge helps local governments realize the social, economic and ecological benefits of developing One Planet solutions (for housing, energy, mobility, food, etc.) together with their citizens and businesses. City Challenge candidates are supported to report their performance, commitments and action plans. Public participation is promoted and best practice from finalist cities in all countries is documented and shared internationally. An international jury of experts awards the city undertaking the most inspiring, ambitious and credible actions "Earth Hour Capital of the year".
For more information: http://www.earthhour.org/

xiii. Share available resources

- Implement natural resource governance built on inclusive processes and broad participation by communities dependent on natural resources.
- Minimize the footprint of high-income populations and urban areas (see "Consume more wisely").
- Promote the transition toward sustainable, resource-efficient cities and reduce the direct impact of cities on water and land by limiting urban sprawl, promoting urban agriculture and sustainable waste (water) management.

xiv. Make fair and ecologically informed choices

- Implement policies and tools for analysing, resolving and managing competing land use and water use claims.

INVESTMENT IN ENERGY EFFICIENT URBAN INFRASTRUCTURE AND ECOSYSTEM SERVICES IS ESSENTIAL TO ENSURE FOOD, WATER AND ENERGY SECURITY FOR BILLIONS OF PEOPLE

xv. Measure success "beyond GDP"

- Include social and environmental indices in national indicators to measure and reward success.
- Implement economic policies with targets and indicators to monitor the impact of economic governance on natural capital and human well-being.

xvi. Sustainable population

- Explicitly integrate population dynamics (size, growth rate, composition, location and migration) and per capita consumption trends into national planning policies to support a better balance between population and available resources.
- Ensure universal access to gender-sensitive reproductive health services and information, reduce child mortality and support the empowerment of women and young girls through greater access to higher education and employment opportunities.

FINDING A NEW WAY

Once on a path, it can be difficult to see other routes. It can be tempting to think that the current way is the only way. But that's rarely the case. Margaret has farmed her land for decades and raised two children, thinking their lives would be much like hers. But through her willingness to change, she has opened new opportunities for the next generation. With her new income, she will send her son to study computers. Our adaptability and creativity can put humanity on a better path.

CLOSING WORDS: ACTIONS FROM INSPIRATIONAL LEADERS

IT ALWAYS SEEMS IMPOSSIBLE
UNTIL IT'S DONE

NELSON MANDELA

THE VULNERABLE NEED
SOLUTIONS FROM YOU; AND
FUTURE GENERATIONS NEED A
VISIONARY LEGACY FROM YOU

CHRISTIANA FIGUERES

I JUST HAVE SOMETHING
INSIDE ME THAT TELLS ME
THERE IS A PROBLEM AND
I MUST DO SOMETHING
ABOUT IT, SO I AM DOING
SOMETHING ABOUT IT

WANGARI MAATHAI

WE MUST BE THE CHANGE WE WISH TO SEE IN THE WORLD

MAHATMA GANDHI

SUSTAINABLE DEVELOPMENT IS A NOTION OF DISCIPLINE. IT MEANS HUMANITY MUST ENSURE THAT MEETING PRESENT NEEDS DOES NOT COMPROMISE THE ABILITY OF FUTURE GENERATIONS TO MEET THEIR NEEDS

GRO HARLEM BRUNDTLAND

YOU CANNOT SOLVE A PROBLEM FROM THE SAME CONSCIOUSNESS THAT CREATED IT. YOU MUST LEARN TO SEE THE WORLD ANEW

ALBERT EINSTEIN

ANNEX: TECHNICAL NOTES AND DATA TABLES

Photo: A hurricane as viewed from the International Space Station.

ANNEX 1: THE LIVING PLANET INDEX

What is the Living Planet Index?

The Living Planet Index (LPI) tracks trends in a large number of populations of species in much the same way that a stock market index tracks the value of a set of shares or a retail price index tracks the cost of a basket of consumer goods. The data used in constructing the index are time series of either population size, density, abundance or a proxy of abundance. For example, the number of nests or breeding pairs recorded may be used instead of a direct count of population. The Living Planet Index now contains populations between 1970 and 2008.

How many species and populations are there in the 20012 LPI?

The Living Planet Index is based on trends in **9,014 populations of 2,688 species of mammal, bird, reptile, amphibian and fish from around the globe**. This represents a substantial increase in data from previous years and means we have an ever clearer picture about the status the world's vertebrate species, which are themselves an indicator of the state of our natural capital.

What "cuts" of the LPI are included in the *Living Planet Report* (LPR) 2012?

LPR 2012 contains cuts of the LPI to reflect trends in:

1. **Tropical and temperate**
   The **tropical index** consists of terrestrial and freshwater species' populations found in the Afrotropical, Indo-Pacific and Neotropical realms, as well as marine species' populations from the zone between the Tropics of Cancer and Capricorn.
   The **temperate index** includes terrestrial and freshwater species' populations from the Palearctic and Nearctic realms, as well as marine species' populations found north or south of the tropics.
2. **Systems – freshwater, marine and terrestrial**
   This was assigned according to the system in which the population was monitored and in which it is normally found. Some species, such as Pacific salmon, can be found in both freshwater and marine environments, so it was possible for different populations of the same species to be included in different indices.

3. **Biogeographic realms – Afrotropical, Neotropical, Palearctic, Nearctic and Indo-Pacific**
   Biogeographic realms combine geographic regions with the historic and evolutionary distribution patterns of terrestrial plants and animals. They represent large areas of the Earth's surface separated by major barriers to plant and animal migration – such as oceans, broad deserts and high mountain ranges – where terrestrial species have evolved in relative isolation over long periods of time.

Trends in the LPI

What are the main trends in the latest LPI?

The global Living Planet Index has declined by 28 per cent between 1970 and 2008.

The index shows that the decline in biodiversity has been more much serious in tropical regions – where the index shows an average decline of 60 per cent – than in temperate regions, where there had already been significant biodiversity losses before 1970. Temperate regions show an average increase of 30 per cent in the index; however, this average does mask losses in individual species or regions whose conservation status has worsened. Moreover, the temperate index starts from a much lower baseline in 1970 than the tropical index, since most of the decline in temperate zones happened before 1970. The Living Planet Index is also calculated for systems and biogeographical realms, providing a clearer picture than ever before of the state of the world's biodiversity.

Between 1970 and 2008 temperate species showed an overall increase – particularly in comparison to tropical species. How can we explain this?

One explanation is that most habitat destruction since 1970 has taken place in the tropics. However, that is not to say that the state of biodiversity in temperate regions is better than in the tropics necessarily. The LPI shows only trends since 1970. Most habitat alteration and destruction in temperate regions occurred prior to 1970. If data were available, an LPI from 1900 to 1970 might show a decline in temperate regions equal to that in the tropics from 1970 to 2008. Other causes of population decline in wild species that may have had a greater impact in the tropics since 1970 are overexploitation of species and introduction of alien invasive species. Again, the important point to remember is that these drivers of biodiversity loss are not restricted to the tropics, but have occurred there mostly post-1970, whereas in temperate regions these processes have been at work for much longer.

		No. species on index	Percent Change 1970-2008	95% Confidence Limits Lower	Upper
Total	Global	2688	-28%	-38%	-18%
	Temperate	1518	31%	19%	44%
	Tropical	1354	-61%	-70%	-49%
Terrestrial	Global	1432	-25%	-34%	-13%
	Temperate	757	5%	-3%	15%
	Tropical	725	-44%	-55%	-30%
Freshwater	Global	737	-37%	-49%	-21%
	Temperate	436	36%	11%	67%
	Tropical	386	-70%	-80%	-57%
Marine	Global	675	-22%	-44%	6%
	Temperate	438	53%	27%	85%
	Tropical	287	-62%	-78%	-32%
Biogeographic realms	Afrotropical	250	-38%	-57%	-12%
	Indo-Pacific	384	-64%	-73%	-51%
	Neotropical	515	-50%	-69%	-21%
	Nearctic	684	-6%	-16%	6%
	Palearctic	535	6%	-7%	17%
By country income	High income	1732	7%	-1%	17%
	Middle income	1205	-31%	-42%	-19%
	Low income	204	-60%	-72%	-40%

Table 1: Trends in the Living Planet indices between 1970 and 2008, with 95% confidence limits
Income categories are based on the World Bank income classifications (2008). Positive number means increase, negative means decline.

Why is the total number of species in the marine, freshwater and terrestrial LPIs more than that of the global index?

The system the population is assigned depends on where the population is located, rather than where the species lives in general. This means that some species, like Pacific salmon, can have both marine populations and freshwater populations, depending on where they are in their migration cycle. This effectively "double counts" the species numbers (but not the population numbers) as they appear in both the marine and freshwater LPI cut, but only appear once in the global species counts.

Cases like this are minimized by asking a series of questions before assigning the population a system:

1. In which system does the species spend the majority of its time?
2. Which system does the species primarily rely on to sustain itself?
3. In which system does the species breed?
4. In which system is the species most threatened?

Borderline cases are the hardest to assign. For example, how do you assign a system to a seabird that spends most of its time at sea (where it is at risk from longline fishing), but breeds on land (where it is being impacted by rats preying on its eggs)? These are dealt with on a case-by-case basis and result in some species being included in more than one system, giving rise to the differences in totals seen in Table 1.

Are extinct species included in the LPI?

Possibly, although thankfully very few. For example, the baiji – or Yangtze River dolphin – is now considered to be extinct (according to a survey in 2006 that failed to find any individuals in the Yangtze River in China). Accidental mortality caused by the fishing gear widely used in the Yangtze ecosystem is thought to be the main cause. In any case, absence of evidence is not evidence of absence, and biologists normally consider an absence of 50 years as evidence for extinction.

What role has climate change played in the overall decline of species, particularly in recent trends?

It is likely that climate change has caused a decline in populations of some species, particularly those in vulnerable ecosystems such as coral reefs, mountains and the Arctic, but the LPI measures only average trends in species' populations. We have not analysed the causes of trends in species' populations. Over the last 30 years, the principal cause of population decline in wild species has been habitat loss or alteration. Over the next 30 years, however, it is likely that climate change will be a more important factor affecting population trends, as well as itself being a driver of habitat loss and alteration.

Calculating the LPI

Where do the data used in the LPI come from?

All data used in constructing the index are time series of either population size, density, abundance or a proxy of abundance. The species' population data used to calculate the index are gathered from a variety of sources. We collate time-series information for vertebrate species from published scientific literature, online databases (e.g., NERC Centre for Population Biology [Global Population Dynamics Database], Pan-European Common Bird Monitoring Scheme) and grey literature. Data are only included if a measure of population size is available for at least two years, and information available on how the data were collected, what the units of measurement were and the geographic location of the population. The data must be collected using the same method on the same population throughout the time series and the data source referenced and traceable.

The period covered by the index is from 1970 to 2008.
The year 2008 is chosen as the "cut-off" year for the index because there is not yet enough data to calculate a robust index for 2009-2011. Datasets are currently being added to the database to allow the calculation of the index for those years.

How is the Living Planet Index calculated?

The LPI is based on population trends in over 2,600 vertebrate species worldwide. Data on species' populations from two or more years since 1970 are collected from a wide variety of published sources and entered into the LPI database. In some cases, we have data on more than one population of a single species. For each population, the rate of change from one year to the next is calculated. If we have data from only a few, non-consecutive years, we assume there was a constant annual rate of change in the population between each data year. Where we have data from many years (consecutive or not) we fit a curve through the data points using a statistical method called generalized additive modelling. Where we have more than one population trend for a single species, the average rate of change across all of the populations is calculated for each year. Then we calculate the average rate of change across all species from year to year. The index is set equal to 1 in 1970, and the average annual rate of population change is used to calculate the index value in each successive year.

Technical details of the calculations

Annual data points were interpolated for time series with six or more data points using generalized additive modelling, or by assuming a constant annual rate of change for time series with less than six data points. First, the average rate of change in each year is calculated across all populations of a species, then across all species. The average annual rates of change in successive years were chained together to make an index, with the index value in 1970 set to 1.

Details of each of the methodologies used for each of the cuts of the LPI are outlined below:

a. **System LPIs**
   Each species is classified as being terrestrial, freshwater or marine, according to the system on which it is most dependent for survival and reproduction. The indices for terrestrial, freshwater and marine systems were aggregated by giving equal weight to temperate and tropical species within each system, i.e., a tropical index and a temperate index were first calculated for each system and the two were then aggregated to create the system index.

b. **Realm LPIs**
   Each species' population in the LPI database was assigned to a realm according to its geographic location. Realm indices were calculated by giving equal weight to each species, with the exception of the Palearctic realm, in which families were aggregated with equal weight. This was done because the volume of time series data for birds available from this realm far outweighs all other species put together. The data from Indo-Malaya, Australasia and Oceania were insufficient to calculate indices for these realms, so they were combined into a super-realm, Indo-Pacific.

How has the Living Planet Index changed since LPR 2010?

On the whole, the results are very similar to the LPIs in LPR 2010. As we continue to add data, we are consistently seeing the same patterns of population trend at the global level. The following section details changes to the data set since LPR 2010.

Increases in the LPI Database

The size of the dataset has increased by 13 per cent since LPR 2010 (see Figure 59). As populations in the LPI are continually added, so the average trend for each index changes. As a result, the 2012 dataset may show differences in the detail of some of the indices produced in 2010, but the overall trajectory of the trend remains roughly the same.

Compared to 2010 there are:

- 6 per cent more species and 13 per cent more populations in the global LPI;
- 7 per cent more terrestrial species and 19 per cent more terrestrial populations;
- 6 per cent more marine species and 18 per cent more marine populations;
- 3 per cent more freshwater species and 4 per cent more freshwater populations.

These changes have improved the spread of the data among different regions and different taxa also. There is a better balance between tropical and temperate species; for example, tropical species now account for 47 per cent of the species in the index compared to 41 per cent in 2010. Each of the taxa is better represented; for example, reptile species have increased by the greatest proportion at 39 per cent. Increasing the dataset in this way generally improves the robustness of the indices and usually produces smoother trends.

Methodology changes

The method used to calculate the LPI has remained unchanged since 2008 (see Collen *et al.*, 2009 for more details).

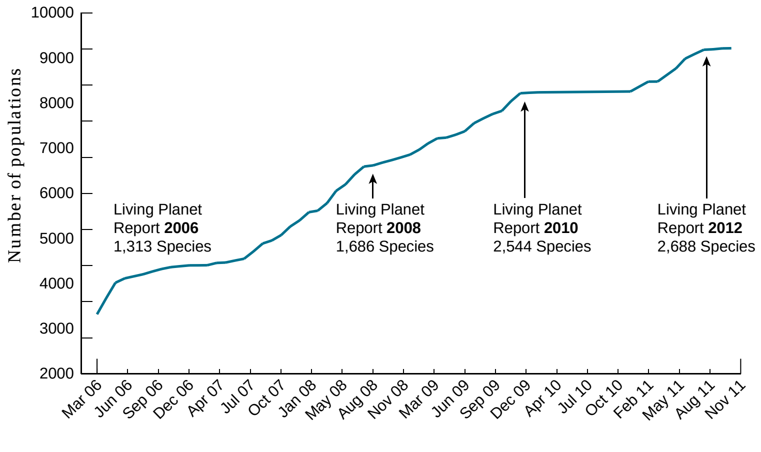


Figure 59: The cumulative number of population time series in the LPI database

ANNEX 2: ECOLOGICAL FOOTPRINT: FREQUENTLY ASKED QUESTIONS

How is the Ecological Footprint calculated?

The Ecological Footprint measures the amount of biologically productive land and water area required to produce the resources an individual, population or activity consumes and to absorb the waste it generates, given prevailing technology and resource management. This area is expressed in global hectares (hectares with world-average biological productivity). Footprint calculations use yield factors to normalize countries' biological productivity to world averages (e.g., comparing tonnes of wheat per UK hectare versus per world average hectare) and equivalence factors to take into account differences in world average productivity among land types (e.g., world average forest versus world average cropland).

Footprint and biocapacity results for countries are calculated annually by the Global Footprint Network. Collaborations with national governments are invited, and serve to improve the data and methodology used for the National Footprint Accounts. To date, Switzerland has completed a review, and Belgium, Ecuador, Finland, Germany, Ireland, Japan and the UAE have partially reviewed or are reviewing their accounts. The continuing methodological development of the National Footprint Accounts is overseen by a formal review committee. A detailed methods paper and copies of sample calculation sheets can be obtained from www.footprintnetwork.org

Footprint analyses can be conducted at any scale. There is growing recognition of the need to standardize sub-national Footprint applications in order to increase comparability across studies and longitudinally. Methods and approaches for calculating the Footprint of municipalities, organizations and products are currently being aligned through a global Ecological Footprint standards initiative. For more information on Ecological Footprint standards see www.footprintstandards.org

What is included in the Ecological Footprint? What is excluded?

To avoid exaggerating human demand on nature, the Ecological Footprint includes only those aspects of resource consumption and waste production for which the Earth has regenerative capacity, and where data exists that allow this demand to be expressed in terms of productive area. For example, toxic releases are not accounted for in Ecological Footprint accounts. Nor are freshwater withdrawals, although the energy used to pump or treat water is included.

Ecological Footprint accounts provide snapshots of past resource demand and availability. They do not predict the future. Thus, while the Footprint does not estimate future losses caused by current degradation of ecosystems, if this degradation persists it may be reflected in future accounts as a reduction in biocapacity.

Footprint accounts also do not indicate the intensity with which a biologically productive area is being used. Being a biophysical measure, it also does not evaluate the essential social and economic dimensions of sustainability.

How is international trade taken into account?

The National Footprint Accounts calculate the Ecological Footprint associated with each country's total consumption by summing the Footprint of its imports and its production, and subtracting the Footprint of its exports. This means that the resource use and emissions associated with producing a car that is manufactured in Japan, but sold and used in India, will contribute to India's rather than Japan's consumption Footprint.

National consumption Footprints can be distorted when the resources used and waste generated in making products for export are not fully documented for every country. Inaccuracies in reported trade can significantly affect the Footprint estimates for countries where trade flows are large relative to total consumption. However, this does not affect the total global Footprint.

How does the Ecological Footprint account for the use of fossil fuels?

Fossil fuels such as coal, oil and natural gas are extracted from the Earth's crust and are not renewable in ecological time spans. When these fuels burn, carbon dioxide (CO_2) is emitted into the atmosphere. There are two ways in which this CO_2 can be stored: human technological sequestration of these emissions, such as deep-well injection, or natural sequestration. Natural sequestration occurs when ecosystems absorb CO_2 and store it either in standing biomass, such as trees, or in soil.

The Carbon footprint is calculated by estimating how much natural sequestration would be necessary to maintain a constant concentration of CO_2 in the atmosphere. After subtracting the amount of CO_2 absorbed by the oceans, Ecological Footprint accounts calculate the area required to absorb and retain the remaining carbon based on the average sequestration rate of the world's forests. CO_2 sequestered by artificial means would also be subtracted from the Ecological Footprint total, but at present this quantity is negligible. In 2008, 1 global hectare could absorb the CO_2 released by burning approximately 1,450 litres of gasoline.

Expressing CO_2 emissions in terms of an equivalent bioproductive area does not imply that carbon sequestration in biomass is the key to resolving global climate change. On the contrary, it shows that the biosphere has insufficient capacity to offset current rates of anthropogenic CO_2 emissions. The contribution of CO_2 emissions to the total Ecological Footprint is based on an estimate of world average forest yields. This sequestration capacity may change over time. As forests mature, their CO_2 sequestration rates tend to decline. If these forests are degraded or cleared, they may become net emitters of CO_2.

Carbon emissions from some sources other than fossil fuel combustion are incorporated in the National Footprint Accounts at the global level. These include fugitive emissions from the flaring of gas in oil and natural gas production, carbon released by chemical reactions in cement production and emissions from tropical forest fires.

How does the Ecological Footprint account for carbon emissions absorbed by the oceans versus uptake by forests?

The National Footprint Accounts calculate the Carbon Footprint by considering sequestration from the world's oceans and forests. Annual ocean uptake values are taken from Khatiwala *et al.*, 2009 (ref: Khatiwala, S. *et al.*, 2009. Reconstruction of the history of anthropogenic CO_2 concentrations in the ocean. *Nature* 462, 346-350) and used with the anthropogenic carbon emissions taken from CDIAC (CDIAC, 2011). There is a relatively constant percentage uptake for oceans, varying between 28 per cent and 35 per cent over the period 1961-2008. The remaining CO_2 requires land based sequestration. Due to the limited availability of large-scale datasets, the calculation currently assumes the world average sequestration rate for uptake of carbon dioxide into forests. Therefore the Carbon Footprint is a measure of the area of world average forest land that is necessary to sequester the carbon dioxide emissions that are not absorbed into the world's oceans.

Does the Ecological Footprint take into account other species?

The Ecological Footprint compares human demand on biodiversity with the natural world's capacity to meet this demand. It thus serves as an indicator of human pressure on local and global ecosystems. In 2008, humanity's demand exceeded the biosphere's regeneration rate by more than 50 per cent. This overshoot may result in depletion of ecosystems and fill-up of waste sinks. This ecosystem stress may negatively impact biodiversity. However, the Footprint does not measure this latter impact directly, nor does it specify how much overshoot must be reduced if negative impacts are to be avoided.

Does the Ecological Footprint say what is a "fair" or "equitable" use of resources?

The Footprint documents what has happened in the past. It can quantitatively describe the ecological resources used by an individual or a population, but it does not prescribe what they should be using. Resource allocation is a policy issue, based on societal beliefs about what is or is not equitable. While Footprint accounting can determine the average biocapacity that is available per person, it does not stipulate how this biocapacity should be allocated among individuals or countries. However, it does provide a context for such discussions.

How relevant is the Ecological Footprint if the supply of renewable resources can be increased and advances in technology can slow the depletion of non-renewable resources?

The Ecological Footprint measures the current state of resource use and waste generation. It asks: In a given year, did human demands on ecosystems exceed the ability of ecosystems to meet these demands? Footprint analysis reflects both increases in the productivity of renewable resources and technological innovation (for example, if the paper industry doubles the overall efficiency of paper production, the footprint per tonne of paper will halve). Ecological Footprint Accounts capture these changes once they occur and can determine the extent to which these innovations have succeeded in bringing human demand within the capacity of the planet's ecosystems. If there is a sufficient increase in ecological supply and a reduction in human demand due to technological advances or other factors, Footprint Accounts will show this as the elimination of global overshoot.

For additional information about current Ecological Footprint methodology, data sources, assumptions and results, please visit: www.footprintnetwork.org/atlas

For more information on the Ecological Footprint at a global level, please see: (Butchart *et al.*, 2010; Global Footprint Network, 2010; GTZ, 2010; Kitzes *et al.*, 2009; Kitzes *et al.*, 2008) at a regional and national level, please see (Ewing *et al.*, 2009; Global Footprint Network, 2008; WWF, 2007; 2008a) and for further information on the methodology used to calculate the Ecological Footprint, please see (Ewing B. *et al.*, 2009; Galli *et al.*, 2007).

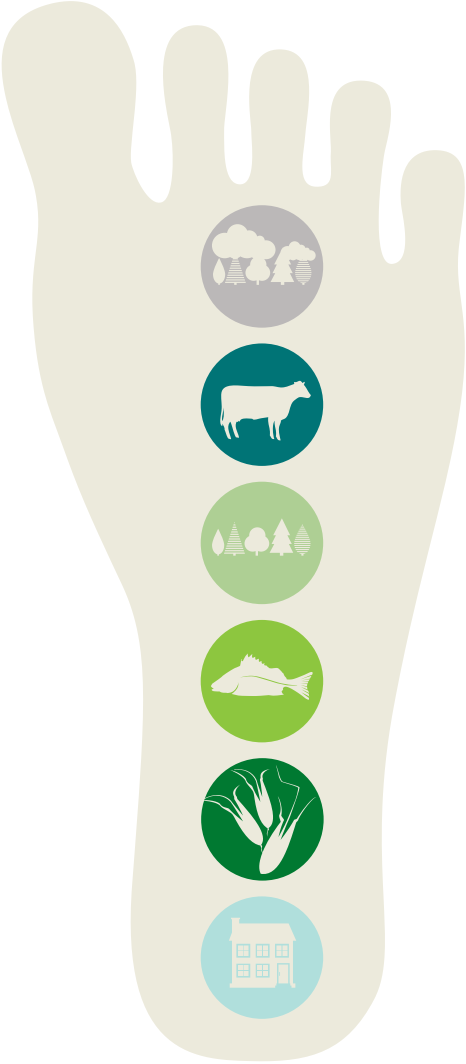


Table 2: Ecological Footprint data tables. Please note: World population is inclusive of countries not included in the Table. Table includes Footprint data for countries with populations greater than 1 million.

Country/region	Population (millions)	Cropland	Grazing land	Forest land	Fishing ground	Carbon	Built up land	Total Ecological Footprint	Cropland	Grazing land	Forest land	Fishing ground	Built up land	Total biocapacity
		Ecological Footprint 2008 (global hectares per person)							Biocapacity 2008 (global hectares per person)					
World	6,739.6	0.59	0.21	0.26	0.10	1.47	0.06	2.70	0.57	0.23	0.76	0.16	0.06	1.78
High-income countries	1,037.0	1.03	0.31	0.58	0.19	3.38	0.11	5.60	0.98	0.28	1.17	0.51	0.11	3.05
Middle-income countries	4,394.1	0.53	0.17	0.19	0.10	0.85	0.07	1.92	0.49	0.21	0.78	0.16	0.07	1.72
Low-income countries	1,297.5	0.47	0.12	0.23	0.06	0.18	0.07	1.14	0.46	0.21	0.31	0.09	0.07	1.14
Africa	975.5	0.51	0.23	0.29	0.07	0.29	0.06	1.45	0.46	0.41	0.48	0.11	0.06	1.52
Algeria	34.4	0.51	0.35	0.13	0.02	0.62	0.02	1.65	0.19	0.31	0.02	0.01	0.02	0.56
Angola	18.0	0.36	0.14	0.13	0.11	0.09	0.06	0.89	0.29	1.66	0.72	0.25	0.06	2.98
Benin	8.4	0.55	0.06	0.31	0.10	0.30	0.04	1.36	0.46	0.04	0.41	0.03	0.04	0.98
Botswana	2.0	0.42	1.22	0.18	0.01	0.93	0.07	2.84	0.17	2.58	0.65	0.28	0.07	3.76
Burkina Faso	15.5	0.84	0.19	0.35	0.01	0.06	0.08	1.53	0.83	0.18	0.27	0.00	0.08	1.37
Burundi	7.9	0.26	0.07	0.45	0.01	0.02	0.04	0.85	0.24	0.15	0.01	0.01	0.04	0.45
Cameroon	18.8	0.48	0.12	0.27	0.06	0.11	0.05	1.09	0.52	0.11	1.08	0.11	0.05	1.87
Central African Republic	4.2	0.37	0.62	0.30	0.01	0.03	0.04	1.36	0.32	0.62	7.38	0.00	0.04	8.35
Chad	10.7	0.64	0.87	0.29	0.01	0.01	0.08	1.89	0.60	1.36	1.05	0.09	0.08	3.17
Congo	3.8	0.26	0.11	0.48	0.07	0.12	0.03	1.08	0.14	3.51	8.07	0.44	0.03	12.20
Congo, Democratic Republic of	62.5	0.15	0.02	0.50	0.01	0.03	0.05	0.76	0.13	0.28	2.60	0.05	0.05	3.10
Egypt	78.3	0.66	0.07	0.16	0.03	0.96	0.18	2.06	0.45	0.00	0.00	0.02	0.18	0.65
Eritrea	4.9	0.16	0.23	0.20	0.01	0.03	0.03	0.66	0.09	0.23	0.10	1.01	0.03	1.47
Ethiopia	79.4	0.41	0.13	0.50	0.00	0.04	0.06	1.13	0.36	0.13	0.05	0.05	0.06	0.65
Gabon	1.5	0.48	0.22	0.96	0.12	0.00	0.03	1.81	0.24	4.11	20.94	3.41	0.03	28.72
Gambia	1.6	0.72	0.15	0.21	0.09	0.20	0.05	1.41	0.43	0.07	0.21	0.39	0.05	1.15
Ghana	23.3	0.58	0.10	0.61	0.17	0.21	0.07	1.74	0.70	0.28	0.17	0.06	0.07	1.28
Guinea	9.6	0.65	0.33	0.51	0.04	0.10	0.08	1.72	0.65	0.91	0.76	0.52	0.08	2.93
Guinea-Bissau	1.5	0.35	0.42	0.19	0.03	0.07	0.05	1.10	0.47	0.41	0.39	2.08	0.05	3.40

Country/region	Population (millions)	Cropland	Grazing land	Forest land	Fishing ground	Carbon	Built up land	Total Ecological Footprint	Cropland	Grazing land	Forest land	Fishing ground	Built up land	Total biocapacity
		Ecological Footprint 2008 (global hectares per person)							Biocapacity 2008 (global hectares per person)					
Kenya	38.5	0.20	0.27	0.28	0.06	0.11	0.03	0.95	0.19	0.27	0.02	0.02	0.03	0.53
Lesotho	2.1	0.19	0.49	0.37	0.00	0.01	0.01	1.07	0.08	0.72	0.00	0.00	0.01	0.81
Liberia	3.7	0.31	0.03	0.75	0.02	0.12	0.05	1.28	0.21	0.71	1.66	0.33	0.05	2.95
Libyan Arab Jamahiriya	6.2	0.65	0.54	0.12	0.04	1.82	0.02	3.19	0.15	0.23	0.02	0.24	0.02	0.66
Madagascar	19.5	0.30	0.39	0.27	0.08	0.06	0.06	1.16	0.27	1.50	0.89	0.19	0.06	2.92
Malawi	14.0	0.46	0.04	0.17	0.01	0.05	0.05	0.78	0.44	0.09	0.03	0.06	0.05	0.67
Mali	14.5	0.74	0.75	0.16	0.03	0.10	0.10	1.86	0.76	0.73	0.64	0.05	0.10	2.29
Mauritania	3.3	0.43	1.79	0.20	0.10	0.30	0.05	2.86	0.12	3.40	0.06	1.60	0.05	5.21
Mauritius	1.3	0.60	0.54	0.12	1.88	1.41	0.00	4.55	0.17	0.00	0.01	0.38	0.00	0.56
Morocco	31.3	0.60	0.21	0.06	0.05	0.37	0.03	1.32	0.30	0.18	0.09	0.10	0.03	0.70
Mozambique	22.3	0.26	0.04	0.32	0.03	0.08	0.05	0.78	0.22	1.09	0.68	0.16	0.05	2.21
Namibia	2.2	0.43	1.05	0.14	0.00	0.38	0.03	2.03	0.21	1.67	0.37	4.90	0.03	7.18
Nigeria	150.7	0.81	0.10	0.21	0.10	0.15	0.07	1.44	0.84	0.17	0.02	0.02	0.07	1.12
Rwanda	10.0	0.40	0.06	0.15	0.01	0.05	0.04	0.71	0.40	0.06	0.01	0.01	0.04	0.52
Senegal	11.8	0.69	0.27	0.23	0.08	0.21	0.04	1.53	0.43	0.21	0.53	0.19	0.04	1.40
Sierra Leone	5.6	0.32	0.15	0.39	0.13	0.06	0.09	1.13	0.86	0.38	0.19	0.19	0.09	1.71
Somalia	8.9	0.18	0.66	0.50	0.02	0.04	0.04	1.44	0.08	0.65	0.26	0.33	0.04	1.36
South Africa	49.3	0.42	0.19	0.31	0.08	1.57	0.03	2.59	0.32	0.62	0.02	0.22	0.03	1.21
Sudan	41.4	0.47	0.82	0.21	0.00	0.09	0.03	1.63	0.42	0.81	0.94	0.14	0.03	2.34
Swaziland	1.2	0.40	0.53	0.11	0.00	0.33	0.07	1.45	0.29	0.55	0.05	0.01	0.07	0.97
Tanzania, United Republic of	42.3	0.36	0.36	0.24	0.09	0.08	0.06	1.19	0.37	0.39	0.13	0.07	0.06	1.02
Togo	5.8	0.41	0.11	0.31	0.05	0.13	0.03	1.03	0.44	0.14	0.04	0.02	0.03	0.67
Tunisia	10.2	0.65	0.12	0.21	0.10	0.66	0.03	1.76	0.53	0.09	0.05	0.25	0.03	0.96
Uganda	31.3	0.53	0.15	0.54	0.23	0.06	0.05	1.57	0.52	0.17	0.02	0.05	0.05	0.81
Zambia	12.4	0.18	0.18	0.35	0.01	0.10	0.02	0.84	0.07	1.08	1.11	0.03	0.02	2.31
Zimbabwe	12.5	0.24	0.35	0.30	0.00	0.25	0.02	1.17	0.18	0.35	0.14	0.01	0.02	0.72
Middle East/ Central Asia	383.7	0.60	0.20	0.12	0.04	1.44	0.06	2.47	0.39	0.22	0.12	0.13	0.06	0.92
Afghanistan	29.8	0.24	0.20	0.06	0.00	0.01	0.02	0.54	0.16	0.20	0.02	0.00	0.02	0.40
Armenia	3.1	0.58	0.39	0.08	0.01	0.61	0.06	1.73	0.31	0.27	0.07	0.02	0.06	0.72
Azerbaijan	8.9	0.59	0.26	0.10	0.01	0.96	0.04	1.97	0.34	0.21	0.10	0.02	0.04	0.72

Country/region	Population (millions)	Cropland	Grazing land	Forest land	Fishing ground	Carbon	Built up land	Total Ecological Footprint	Cropland	Grazing land	Forest land	Fishing ground	Built up land	Total biocapacity
		Ecological Footprint 2008 (global hectares per person)							Biocapacity 2008 (global hectares per person)					
Georgia	4.4	0.44	0.30	0.11	0.07	0.48	0.04	1.43	0.15	0.36	0.57	0.05	0.04	1.17
Iran, Islamic Republic of	72.3	0.55	0.13	0.05	0.10	1.77	0.06	2.66	0.36	0.08	0.07	0.28	0.06	0.84
Iraq	29.8	0.33	0.09	0.01	0.00	0.96	0.02	1.42	0.14	0.02	0.05	0.01	0.02	0.24
Israel	7.1	0.86	0.36	0.33	0.01	2.33	0.06	3.96	0.17	0.01	0.03	0.01	0.06	0.29
Jordan	5.8	0.66	0.41	0.18	0.05	0.74	0.09	2.13	0.09	0.02	0.03	0.00	0.09	0.24
Kazakhstan	15.7	0.76	0.25	0.12	0.02	2.95	0.04	4.14	1.13	2.01	0.24	0.06	0.04	3.48
Kuwait	2.5	0.80	0.64	0.23	0.29	7.70	0.07	9.72	0.01	0.01	0.00	0.32	0.07	0.43
Kyrgyzstan	5.2	0.55	0.16	0.08	0.01	0.41	0.07	1.29	0.43	0.68	0.09	0.06	0.07	1.33
Lebanon	4.2	0.66	0.48	0.28	0.05	1.33	0.05	2.85	0.22	0.05	0.06	0.01	0.05	0.39
Occupied Palestinian Territory	3.8	0.33	0.05	0.00	0.00	0.09	0.00	0.46	0.11	0.02	0.00	0.00	0.00	0.13
Oman	2.6	0.74	1.04	0.16	0.37	3.27	0.11	5.69	0.09	0.07	0.00	1.92	0.11	2.20
Qatar	1.4	0.91	1.12	0.17	0.46	8.91	0.11	11.68	0.03	0.00	0.00	1.91	0.11	2.05
Saudi Arabia	26.2	0.80	0.36	0.26	0.06	2.44	0.07	3.99	0.18	0.13	0.07	0.21	0.07	0.65
Syrian Arab Republic	19.7	0.48	0.16	0.05	0.01	0.71	0.04	1.45	0.37	0.11	0.04	0.00	0.04	0.57
Tajikistan	6.7	0.42	0.17	0.02	0.00	0.21	0.08	0.90	0.29	0.17	0.01	0.01	0.08	0.56
Turkey	70.9	0.92	0.08	0.28	0.03	1.17	0.07	2.55	0.74	0.13	0.32	0.05	0.07	1.31
Turkmenistan	4.9	0.93	0.54	0.01	0.01	2.37	0.13	3.98	0.89	2.01	0.02	0.14	0.13	3.19
United Arab Emirates	8.1	0.77	1.06	0.37	0.25	5.97	0.03	8.44	0.05	0.00	0.07	0.49	0.03	0.64
Uzbekistan	26.8	0.54	0.09	0.03	0.00	1.09	0.07	1.82	0.53	0.21	0.06	0.03	0.07	0.91
Yemen	22.6	0.29	0.18	0.03	0.00	0.32	0.05	0.87	0.13	0.13	0.04	0.25	0.05	0.60
Asia-Pacific	3,729.6	0.46	0.07	0.15	0.11	0.76	0.07	1.63	0.40	0.09	0.18	0.12	0.07	0.86
Australia	21.5	1.61	1.11	1.16	0.10	2.68	0.03	6.68	2.14	6.16	2.55	3.69	0.03	14.57
Bangladesh	145.5	0.33	0.01	0.08	0.02	0.15	0.07	0.66	0.28	0.00	0.00	0.06	0.07	0.42
Cambodia	13.8	0.52	0.04	0.25	0.07	0.27	0.05	1.19	0.51	0.11	0.21	0.13	0.05	1.01
China	1,358.8	0.52	0.13	0.14	0.10	1.15	0.09	2.13	0.38	0.11	0.22	0.07	0.09	0.87
India	1,190.9	0.37	0.00	0.12	0.02	0.31	0.05	0.87	0.38	0.00	0.02	0.03	0.05	0.48
Indonesia	235.0	0.44	0.04	0.16	0.20	0.23	0.07	1.13	0.47	0.06	0.32	0.41	0.07	1.32
Japan	126.5	0.50	0.15	0.24	0.39	2.83	0.06	4.17	0.11	0.00	0.34	0.07	0.06	0.59
Korea, Democratic People's Republic of	24.1	0.33	0.01	0.14	0.02	0.75	0.06	1.31	0.27	0.00	0.23	0.07	0.06	0.62

Country/region	Population (millions)	Cropland	Grazing land	Forest land	Fishing ground	Carbon	Built up land	Total Ecological Footprint	Cropland	Grazing land	Forest land	Fishing ground	Built up land	Total biocapacity
		Ecological Footprint 2008 (global hectares per person)							Biocapacity 2008 (global hectares per person)					
Korea, Republic of	47.7	0.73	0.18	0.23	0.47	2.93	0.07	4.62	0.18	0.00	0.09	0.38	0.07	0.72
Lao People's Democratic Republic	6.0	0.56	0.14	0.39	0.01	0.08	0.13	1.30	0.57	0.18	0.73	0.04	0.13	1.65
Malaysia	27.5	0.61	0.26	0.47	0.46	2.02	0.08	3.90	0.85	0.01	0.70	0.86	0.08	2.50
Mongolia	2.7	0.28	3.97	0.13	0.00	1.13	0.01	5.53	0.08	8.93	6.16	0.15	0.01	15.33
Myanmar	47.3	1.09	0.01	0.34	0.28	0.08	0.14	1.94	1.11	0.01	0.64	0.32	0.14	2.22
Nepal	28.9	0.36	0.05	0.20	0.00	0.07	0.09	0.76	0.34	0.04	0.06	0.00	0.09	0.53
New Zealand	4.3	0.72	0.00	1.21	0.75	1.56	0.06	4.31	0.22	2.91	4.91	2.09	0.06	10.19
Pakistan	167.4	0.35	0.01	0.09	0.01	0.24	0.05	0.75	0.30	0.00	0.01	0.04	0.05	0.40
Papua New Guinea	6.5	0.31	0.18	0.38	0.81	0.84	0.16	2.68	0.43	0.04	2.45	0.59	0.16	3.67
Philippines	90.2	0.45	0.07	0.09	0.32	0.00	0.06	0.98	0.37	0.02	0.10	0.07	0.06	0.62
Singapore	4.8	0.52	0.92	0.31	0.15	4.20	0.00	6.10	0.00	0.00	0.00	0.02	0.00	0.02
Sri Lanka	20.5	0.36	0.07	0.15	0.28	0.29	0.06	1.21	0.30	0.02	0.04	0.05	0.06	0.46
Thailand	68.3	0.57	0.05	0.16	0.67	0.89	0.07	2.41	0.73	0.01	0.22	0.14	0.07	1.17
Timor-Leste	1.1	0.24	0.07	0.05	0.02	0.05	0.04	0.47	0.20	0.06	0.56	0.00	0.04	0.86
Vietnam	86.0	0.52	0.02	0.18	0.12	0.43	0.12	1.39	0.59	0.01	0.16	0.22	0.12	1.09
Latin America	576.8	0.64	0.67	0.39	0.12	0.80	0.08	2.70	0.80	0.80	3.60	0.31	0.08	5.60
Argentina	39.7	0.80	0.62	0.28	0.13	0.77	0.12	2.71	2.88	1.72	0.71	1.69	0.12	7.12
Bolivia	9.6	0.44	1.58	0.17	0.01	0.35	0.06	2.61	0.59	2.41	15.26	0.06	0.06	18.39
Brazil	191.5	0.80	0.95	0.55	0.05	0.48	0.10	2.93	1.09	1.03	7.25	0.16	0.10	9.63
Chile	16.8	0.55	0.33	0.91	0.62	0.73	0.09	3.24	0.32	0.47	2.12	0.73	0.09	3.74
Colombia	45.0	0.38	0.72	0.14	0.03	0.43	0.11	1.80	0.29	1.22	2.23	0.04	0.11	3.89
Costa Rica	4.5	0.37	0.24	0.81	0.05	0.93	0.11	2.52	0.43	0.33	0.62	0.10	0.11	1.60
Cuba	11.3	0.71	0.22	0.11	0.06	0.79	0.02	1.90	0.26	0.08	0.21	0.14	0.02	0.71
Dominican Republic	9.7	0.39	0.14	0.12	0.08	0.65	0.04	1.42	0.20	0.12	0.17	0.01	0.04	0.54
Ecuador	14.1	0.36	0.34	0.23	0.75	0.62	0.07	2.37	0.39	0.33	1.21	0.17	0.07	2.18
El Salvador	6.1	0.53	0.31	0.41	0.14	0.57	0.04	1.99	0.31	0.11	0.05	0.11	0.04	0.62
Guatemala	13.7	0.42	0.23	0.56	0.04	0.47	0.06	1.78	0.39	0.19	0.38	0.04	0.06	1.07
Haiti	9.7	0.29	0.06	0.10	0.02	0.09	0.03	0.60	0.22	0.03	0.01	0.01	0.03	0.31
Honduras	7.3	0.29	0.33	0.55	0.03	0.48	0.06	1.73	0.37	0.29	1.03	0.23	0.06	1.97

Country/region	Population (millions)	Cropland	Grazing land	Forest land	Fishing ground	Carbon	Built up land	Total Ecological Footprint	Cropland	Grazing land	Forest land	Fishing ground	Built up land	Total biocapacity
		Ecological Footprint 2008 (global hectares per person)							Biocapacity 2008 (global hectares per person)					
Jamaica	2.7	0.41	0.30	0.22	0.12	0.63	0.04	1.72	0.14	0.00	0.10	0.05	0.04	0.33
Mexico	110.6	0.74	0.40	0.32	0.09	1.69	0.06	3.30	0.49	0.25	0.49	0.14	0.06	1.42
Nicaragua	5.6	0.36	0.33	0.43	0.07	0.33	0.04	1.56	0.41	0.58	0.80	0.50	0.04	2.33
Panama	3.4	0.45	0.54	0.21	0.78	0.96	0.04	2.97	0.21	0.49	1.33	0.61	0.04	2.67
Paraguay	6.2	0.50	1.06	0.84	0.01	0.48	0.11	2.99	2.05	2.35	6.36	0.06	0.11	10.92
Peru	28.5	0.50	0.50	0.20	0.45	0.30	0.08	2.03	0.35	0.50	2.65	0.24	0.08	3.82
Uruguay	3.3	0.84	2.98	0.37	0.11	0.67	0.11	5.08	1.31	5.25	1.12	2.24	0.11	10.03
Venezuela, Bolivarian Republic of	28.1	0.48	0.88	0.17	0.12	1.32	0.05	3.02	0.20	0.61	1.84	0.30	0.05	3.00
North America	338.4	1.13	0.22	0.85	0.10	4.75	0.07	7.12	1.66	0.26	2.22	0.75	0.07	4.95
Canada	33.3	1.49	0.42	0.74	0.10	3.63	0.05	6.43	2.81	0.23	8.27	3.55	0.05	14.92
United States of America	305.0	1.09	0.19	0.86	0.09	4.87	0.07	7.19	1.53	0.26	1.56	0.44	0.07	3.86
EU	497.1	1.13	0.34	0.53	0.14	2.42	0.16	4.72	0.91	0.13	0.77	0.27	0.16	2.24
Austria	8.3	1.08	0.22	0.62	0.03	3.05	0.28	5.29	0.87	0.15	2.04	0.00	0.28	3.34
Belgium	10.6	1.82	0.95	0.47	0.17	3.26	0.45	7.11	0.46	0.11	0.28	0.05	0.45	1.33
Bulgaria	7.6	0.95	0.21	0.51	0.03	1.68	0.17	3.56	1.19	0.18	1.01	0.09	0.17	2.65
Czech Republic	10.4	1.17	0.19	0.83	0.02	2.89	0.17	5.27	1.17	0.12	1.21	0.00	0.17	2.68
Denmark	5.5	2.77	0.70	1.21	0.78	2.54	0.26	8.25	2.40	0.03	0.27	1.85	0.26	4.81
Estonia	1.3	0.83	0.07	1.60	0.15	1.93	0.15	4.73	0.79	0.36	3.32	4.11	0.15	8.73
Finland	5.3	1.11	0.19	0.40	0.27	4.15	0.10	6.21	0.95	0.00	8.64	2.50	0.10	12.19
France	62.1	1.25	0.39	0.60	0.18	2.24	0.25	4.91	1.47	0.24	0.87	0.16	0.25	2.99
Germany	82.5	1.18	0.26	0.43	0.01	2.49	0.20	4.57	0.95	0.09	0.64	0.08	0.20	1.95
Greece	11.3	1.26	0.53	0.38	0.13	2.53	0.11	4.92	1.03	0.09	0.14	0.22	0.11	1.59
Hungary	10.0	1.29	0.03	0.44	0.01	1.63	0.18	3.59	1.82	0.10	0.58	0.01	0.18	2.68
Ireland	4.4	1.26	0.47	0.53	0.04	3.75	0.16	6.22	0.59	0.79	0.24	1.64	0.16	3.41
Italy	59.9	1.03	0.40	0.46	0.14	2.39	0.10	4.52	0.62	0.06	0.30	0.06	0.10	1.15
Latvia	2.3	0.79	0.10	1.25	0.26	1.48	0.07	3.95	0.98	0.66	3.03	1.88	0.07	6.63
Lithuania	3.4	1.05	0.13	1.02	0.39	1.59	0.20	4.38	1.43	0.75	1.67	0.27	0.20	4.32
Netherlands	16.5	1.30	1.09	0.54	0.10	3.14	0.16	6.34	0.30	0.06	0.08	0.44	0.16	1.03

Country/region	Population (millions)	Cropland	Grazing land	Forest land	Fishing ground	Carbon	Built up land	Total Ecological Footprint	Cropland	Grazing land	Forest land	Fishing ground	Built up land	Total biocapacity
		Ecological Footprint 2008 (global hectares per person)							Biocapacity 2008 (global hectares per person)					
Poland	38.2	0.98	0.04	0.75	0.07	2.01	0.08	3.94	0.99	0.12	0.71	0.10	0.08	2.00
Portugal	10.6	0.96	0.00	0.14	0.95	2.01	0.05	4.12	0.29	0.24	0.64	0.07	0.05	1.29
Romania	21.6	0.92	0.13	0.35	0.04	1.23	0.16	2.84	0.93	0.16	1.00	0.09	0.16	2.33
Slovakia	5.4	1.07	0.25	0.86	0.02	2.28	0.18	4.66	1.00	0.08	1.60	0.00	0.18	2.86
Slovenia	2.0	0.94	0.25	0.61	0.04	3.22	0.15	5.21	0.37	0.23	1.84	0.00	0.15	2.59
Spain	45.1	1.26	0.31	0.35	0.38	2.39	0.06	4.74	0.98	0.11	0.25	0.06	0.06	1.46
Sweden	9.2	0.97	0.47	0.99	0.17	3.00	0.10	5.71	0.64	0.04	6.36	2.38	0.10	9.51
United Kingdom	61.5	0.88	0.45	0.53	0.06	2.65	0.15	4.71	0.49	0.10	0.11	0.50	0.15	1.34
Other Europe	239.3	1.05	0.16	0.40	0.17	2.23	0.05	4.05	1.01	0.27	2.82	0.73	0.05	4.88
Albania	3.2	0.71	0.21	0.09	0.02	0.71	0.06	1.81	0.41	0.13	0.20	0.08	0.06	0.88
Belarus	9.7	1.41	0.02	0.42	0.07	1.98	0.08	3.99	1.38	0.31	1.61	0.02	0.08	3.40
Bosnia and Herzegovina	3.8	0.78	0.22	0.48	0.04	1.16	0.05	2.74	0.41	0.26	0.91	0.00	0.05	1.64
Croatia	4.4	1.02	0.13	0.66	0.07	1.89	0.43	4.19	0.87	0.17	1.14	0.32	0.43	2.92
Macedonia TFYR	2.1	0.79	0.21	0.33	0.07	3.87	0.09	5.36	0.53	0.22	0.70	0.01	0.09	1.55
Moldova	3.6	1.01	0.09	0.11	0.06	0.77	0.06	2.10	1.11	0.07	0.09	0.01	0.06	1.33
Norway	4.8	1.05	0.13	0.66	1.27	1.58	0.08	4.77	0.36	0.02	3.18	1.75	0.08	5.40
Russian Federation	143.2	1.05	0.20	0.47	0.09	2.55	0.04	4.40	0.94	0.34	4.22	1.08	0.04	6.62
Serbia	9.8	0.87	0.06	0.34	0.05	1.25	0.00	2.57	0.95	0.07	0.39	0.00	0.00	1.41
Switzerland	7.6	0.76	0.28	0.55	0.06	3.26	0.10	5.01	0.21	0.15	0.73	0.01	0.10	1.20
Ukraine	46.0	1.14	0.03	0.17	0.11	1.68	0.07	3.19	1.49	0.13	0.41	0.13	0.07	2.23

ANNEX 3: GLOSSARY OF TERMS AND ABBREVIATIONS USED IN THE REPORT

Biocapacity	The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. Biocapacity is measured in global hectares (Global Footprint Network, 2012).
Biocapacity deficit	The difference between the *biocapacity* and *Ecological Footprint* of a region or country. A biocapacity deficit occurs when the Footprint of a population exceeds the biocapacity of the area available to that population. Conversely, a biocapacity remainder exists when the biocapacity of a region exceeds its population's Footprint. If there is a regional or national biocapacity deficit, it means that the region is importing biocapacity through trade or liquidating regional ecological assets. In contrast, the global biocapacity deficit cannot be compensated through trade, and is therefore equal to *overshoot*.
Biocapacity per person	This is calculated by dividing the number of productive global hectares available by the number of people living on the planet in that year.
Biodiversity	Shorthand for biological diversity. Variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD and UNEP).
Biome	A major portion of the living environment of a particular region characterized by its distinctive vegetation and maintained by local climatic conditions.
Carbon budget	The average global temperature must not rise more than 2 degrees Celsius over pre-industrial levels if we are to avoid dangerous climate change (many Parties to the Convention have accepted this objective, as first asserted in 1995. A review of the objective to look at whether a 1.5ºC limit is in fact needed is scheduled for 2013-15). The 2°C objective can be further expressed as a global carbon budget. To have a reasonable chance (better than 50 per cent) of forestalling such a rise, cumulative global carbon emissions must be limited to 870 gigatons of CO2 equivalent between 2009 and 2100 (Höhne and Moltmann, 2009).
Carbon Footprint	The demand on biocapacity required to sequester (through photosynthesis) the carbon dioxide (CO2) emissions from fossil fuel combustion. Although fossil fuels are extracted from the Earth's crust and are not regenerated in human time scales, their use demands ecological services if the resultant CO2 is not to accumulate in the atmosphere. The Ecological Footprint therefore includes the biocapacity, typically that of unharvested forests, needed to absorb that fraction of

	fossil CO_2 that is not absorbed by the ocean (Global Footprint Network, 2012). There are several calculators that use the phrase "Carbon Footprint", but many just calculate tonnes of carbon, or tonnes of carbon per Euro, rather than demand on bioproductive area.
The CLUM model – Consumption Land Use Matrix	The CLUM presented in Chapter 1 represents the Ecological Footprint of consumption and contains three main components. The first component is short-lived consumption paid by individuals (also known as "household" or "HH"). This component contains food, housing maintenance and operations, personal transportation, goods and services. The second component is consumption paid for by government (called "government") and it contains short-lived consumption expenditure such as public services, public schools, policing and governance, and defence. The third component is consumption for long-lived assets (called "gross fixed capital formation"), which may be paid by households (e.g., new housing), firms (e.g., new factories and machinery) or governments (e.g., transport infrastructure). These three components summed are equivalent to the total Ecological Footprint per nation.
Country income categories	Countries were assigned to high, middle or low income categories based on World Bank income thresholds. The World Bank classifies economies according to 2007 Gross National Income (GNI) per person per year. This is calculated by dividing the gross national income of each country (converted to US dollars using the World Bank Atlas method), by the mid-year population (for more information see The World Bank, 2012). **The categories are: Low income:** ≤US$935 GNI per person. **Middle income:** US$936-11,455 GNI per person (combines World Bank categories of lower middle and upper middle income). **High income:** ≥US$11,456 GNI per person.
Ecological Footprint	A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes, and to absorb the waste it generates, using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country's Footprint includes land or sea from all over the world. Ecological Footprint is often referred to in short form as Footprint (Global Footprint Network, 2012).
Ecological Footprint: Future scenarios *(continues over)*	This "business as usual" scenario has the following assumptions: (a) Global population of 9.3 billion by 2050 (UN, 2010 Medium variant); (b) Total energy demand doubles from 2005 levels (IEA Business as Usual from IEA, 2008); (c) Increasing dependency on coal for power generation from 45% in 2005 to 60% by 2050 (IEA Business as Usual); (d) 12% increase in caloric intake per person, with an increase in the amount from meat, milk, and dairy; decrease in amount from cereals and fish (FAO Agriculture Towards 2030/2050 FAO, 2006); (e) Constant crop and forest yields based on 2005 figures; (f) Increase in crops fed to animals (FAO Agriculture Towards 2030/2050, FAO, 2006); (g) Increases in atmospheric CO_2 and methane concentrations associated

Ecological Footprint: Future scenarios *(continued)*

with the scenarios in food and energy were combined with the estimates of the IPCC (IPCC, 2007b) and a land suitability model (Global Agro-Ecological Zones – GAEZ) to predict changes in the area and suitability of land for growing crops (Fischer et al., 2008).

Ecosystem

A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Ecosystem services

The Millennium Ecosystem Assessment distinguished supporting, provisioning, regulating and cultural services that contribute to human well-being (Millennium Ecosystem Assessment, 2005a; b). These services are defined in the four panels below:

Provisioning services

Goods obtained directly from ecosystems (e.g., food, medicine, timber, fibre and bioenergy).

Regulating services

Benefits obtained from the regulation of natural processes (e.g., water filtration, waste decomposition, climate regulation, crop pollination and regulation of some human diseases).

Supporting services

Regulation of basic ecological functions and processes that are necessary for the provision of all other ecosystem services (e.g. nutrient cycling, photosynthesis and soil formation).

Cultural services

Psychological and emotional benefits gained from human relations with ecosystems (e.g., enriching recreational, aesthetic and spiritual experiences).

Global hectare (gha)

A productivity weighted area used to report both the biocapacity of the Earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of biologically productive land and water in a given year. Because different land types have different productivity, a global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world bioproductivity varies slightly from year to year, the value of a gha may change slightly from year to year (Global Footprint Network, 2012).

Human development

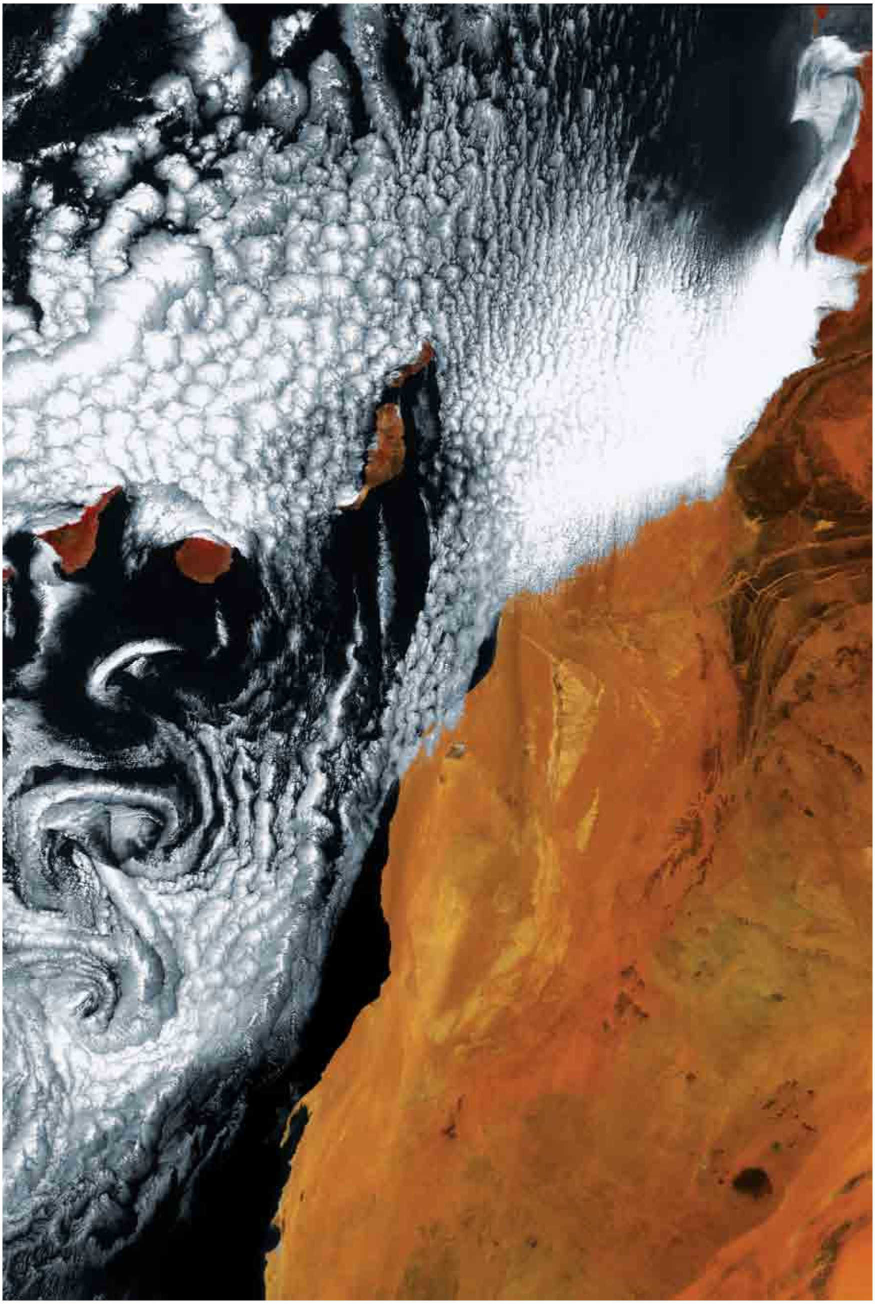
Human development is a process of "enlarging" people's choices. Enlarging people's choices is achieved by expanding human capabilities and functioning. At all levels of development the three essential capabilities for human development are for people to lead long and healthy lives; to be knowledgeable; and to have a decent standard of living. If these basic capabilities are not achieved, many choices are simply not available and many opportunities remain inaccessible. But Human development is a process of "enlarging" people's choices. Enlarging people's choices is achieved by expanding human capabilities and functioning. At all levels of development the three essential capabilities for human development are for people to lead long and healthy lives; to be knowledgeable; and to have a decent standard of living. If these basic capabilities are not achieved, many choices are

	simply not available and many opportunities remain inaccessible. But the realm of human development goes further: Essential areas of choice, highly valued by people, range from political, economic and social opportunities for being creative and productive; to enjoying self-respect, empowerment and a sense of belonging to a community. The concept of human development is a holistic one, putting people at the centre of all aspects of the development process. (Source: Human Development Report webpage).
HDI	The HDI – Human Development Index – is a summary composite index that measures a country's average achievements in three basic aspects of human development: health, knowledge and a decent standard of living. The HDI contains three components: **1.** Health: Life expectancy at birth (number of years a newborn infant would live if prevailing patterns of mortality at the time of birth were to stay the same throughout the child's life). **2.** Knowledge: A combination of the adult literacy rate and the combined primary, secondary and tertiary gross enrolment ratio. **3.** Standard of living: GDP per capita (PPP US$). (Source: Human Development Report webpage).
Inequality-adjusted Human Development Index (IHDI)	The IHDI is a measure of the level of human development of people in a society that accounts for inequality. Under perfect equality, the IHDI is equal to the HDI; but it falls below the HDI when inequality rises. In this sense, the IHDI is the actual level of human development while the HDI can be viewed as an index of the potential human development that could be achieved if there is no inequality. The IHDI accounts for inequality in HDI dimensions by "discounting" each dimension's average value according to its level of inequality. The average loss in the HDI due to inequality is about 23 per cent – that is, adjusted for inequality, the global HDI of 0.682 in 2011 would fall to 0.525. Countries with less human development tend to have greater inequality in more dimensions – and thus larger losses in human development. This new version of the HDI was developed for the 2011 Human Development Report (UNDP, 2011) and at the time of publication, the adjustment has been applied to 134 countries. For this definition and more information, see the IHDI homepage.
Living Planet Index (LPI)	The LPI reflects changes in the health of the planet's ecosystems by tracking trends in over 9,000 populations of vertebrate species. Much as a stock market index tracks the value of a set of shares over time as the sum of its daily change, the LPI first calculates the annual rate of change for each species' population in the dataset (example populations are shown in Figures 4-6). The index then calculates the average change across all populations for each year from 1970, when data collection began, to 2008, the latest date for which data is available (Collen *et al.*, 2009 and see Annex 1 for more details).

National Accounts Review Committee	Global Footprint Network's scientific advisors who develop and endorse recommendations for methodological changes to the Ecological Footprint Accounts (Global Footprint Network, 2012).
National Footprint Accounts	The central data set that calculates the footprints and biocapacities of the world, and roughly 150 nations from 1961 to the present (generally with a three-year lag due to data availability). The ongoing development, maintenance and upgrades of the National Footprint Accounts are coordinated by Global Footprint Network and its 70+ partners (Global Footprint Network, 2012).
Natural capital	Natural capital can be defined as all of the raw materials and natural cycles on Earth. Footprint analysis considers one key component: life-supporting natural capital, or ecological capital for short. This capital is defined as the stock of living ecological assets that yield goods and services on a continuous basis. Main functions include resource production (such as fish, timber or cereals), waste assimilation (such as CO2 absorption or sewage decomposition) and life support services (such as UV protection, biodiversity, water cleansing or climate stability).
Overshoot	Global overshoot occurs when humanity's demand on the natural world exceeds the biosphere's supply, or regenerative capacity. Such overshoot leads to a depletion of Earth's life-supporting natural capital and a build-up of waste. At the global level, biocapacity deficit and overshoot are the same, since there is no net-import of resources to the planet. Local overshoot occurs when a local ecosystem is exploited more rapidly than it can renew itself (Global Footprint Network, 2012).
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Virtual water	The "virtual water content" of a product is the same as its "Water Footprint". The Water Footprint of a product (a commodity, good or service) is the volume of freshwater used to produce the product, measured at the place where the product was actually produced. It refers to the sum of the water used in the various steps of the production chain.
Water Footprint	The Water Footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community, or produced by the business. The Water Footprint of a nation is defined as the total amount of water that is used to produce the goods and services consumed by the inhabitants of the nation.
ZNDD	WWF defines ZNDD as: no net forest loss through deforestation and no net decline in forest quality through degradation; and stresses that: (a) most natural forest should be retained – the annual rate of loss of natural or semi-natural forests should be reduced to near zero; and (b) any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest restoration.

LIST OF ABBREVIATIONS

ASC	Aquaculture Stewardship Council
BRIICS	Brazil, Russia, India, Indonesia, China, South Africa
CBD	Convention on Biological Diversity
CLUM	Country Land Use Matrix
CONAGUA	Mexican National Water Commission (Comisión Nacional del Agua)
EF	Ecological Footprint
EFR	Ecological Footprint Report
ESA	European Space Agency
ESRI	Environmental Systems Research Institute
FAO	United Nations Food and Agricultural Organization
FSC	Forest Stewardship Council
GAM	General Additive Modeling
GAEZ	Global Agro Ecological Zones
GDP	Gross Domestic Product
Gha	Global Hectares
GHG	Greenhouse Gas
GNI	Gross National Income
HDI	Human Development Index
ICCAT	International Commission for the Conservation of Atlantic Tunas
IEA	International Energy Agency
IFC	International Finance Corporation
IHDI	Inequality-adjusted Human Development Index
IIASA	International Institute for Applied Systems Analysis
IPCC	International Panel on Climate Change
IUCN	International Union for the Conservation of Nature
MEA	Millennium Ecosystem Assessment
MSC	Marine Stewardship Council
LPI	Living Planet Index
LPR	Living Planet Report
OECD	Organization for Economic Cooperation and Development
REDD	Reducing Emissions from Deforestation and Forest Degradation
TEEB	The Economics of Ecosystems and Biodiversity
TOE	Tons of Oil Equivalent
UNDP	United Nations Development Programme
UNFCCC	United Nations Convention on Climate Change
UNFPA	United Nations Population Fund
WBCSD	World Business Council for Sustainable Development
WF	Water Footprint
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wide Fund for Nature
ZNDD	Zero Net Deforestation and Forest Degradation
ZSL	Zoological Society London



A satellite image of the Canary Islands with unique cloud formations, created by "Von Karman vortices", off the coast of Africa (right) in the Atlantic Ocean. These vortices, named after aeronautical engineer Theodore von Karman, form as air flows around an object in its path, causing it to separate and create eddies in its wake. The clockwise and counter-clockwise spirals in this image were created as wind blowing from the north over the Atlantic was disturbed by the archipelago. The islands are (left to right): El Hierro, La Palma, La Gomera, Tenerife, Gran Canaria, Fuerteventura and Lanzarote.

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As at: May 2012

Publication details

Published in May 2012 by WWF – World Wide Fund for Nature (formerly World Wildlife Fund), Gland, Switzerland. Any reproduction in full or in part of this publication must mention the title and credit the above-mentioned publisher as the copyright owner.

Recommended citation:
WWF. 2012. *Living Planet Report* 2012. WWF International, Gland, Switzerland.