WWF REPORT INT 2014

THIS REPORT HAS BEEN PRODUCED IN COLLABORATION WITH:

Global Footprint Network — Advancing the Science of Sustainability

Water Footprint Network

ZSL — Living Conservation

EMBARGOED until 30 Sept 2014 - 00:01 CET

Living Planet Report 2014

Species and spaces, people and places

WWF
WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

Zoological Society of London
Founded in 1826, the Zoological Society of London (ZSL) is an international scientific, conservation and educational organization. Its mission is to achieve and promote the worldwide conservation of animals and their habitats. ZSL runs ZSL London Zoo and ZSL Whipsnade Zoo; carries out scientific research in the Institute of Zoology; and is actively involved in field conservation worldwide. The ZSL manages the *Living Planet Index*® in a collaborative partnership with WWF.

Global Footprint Network
Global Footprint Network promotes the science of sustainability by advancing the Ecological Footprint, a resource accounting tool that makes sustainability measurable. Together with its partners, the Network works to further improve and implement this science by coordinating research, developing methodological standards, and providing decision-makers with robust resource accounts to help the human economy operate within the Earth's ecological limits.

Water Footprint Network
The Water Footprint Network (WFN) is a multi-stakeholder network committed to the transition to fair and smart use of the world's freshwater. WFN published the Global Water Footprint Assessment Standard in 2011 and advances the use of Water Footprint Assessment through sharing knowledge, demonstrating solutions and linking communities. WFN maintains the world's most comprehensive water footprint database, WaterStat, and the Water Footprint Assessment Tool.

WWF International
Avenue du Mont-Blanc
1196 Gland, Switzerland
www.panda.org

Institute of Zoology
Zoological Society of London
Regent's Park,London NW1 4RY, UK
www.zsl.org/indicators
www.livingplanetindex.org

Global Footprint Network
312 Clay Street, Suite 300
Oakland, California 94607, USA
www.footprintnetwork.org

Water Footprint Network
Drienerlolaan 5
7522 NB Enschede
The Netherlands
www.waterfootprint.org

Design by: millerdesign.co.uk

Cover photograph: © European Space Agency. *This Envisat radar image features a chain of volcanoes called the Virunga Mountains that stretch across Rwanda's northern border with Uganda and east into the Democratic Republic of Congo. This image was created by combining three Envisat radar acquisitions from 27 March 2003, 5 January 2006 and 12 August 2010 over the same area.*

ISBN 978-2-940443-87-1

FSC RECYCLED Paper made from recycled material FSC® C008152

This report has been printed
on FSC certified Revive Silk.

CONTENTS

Editor-In-Chief: Richard McLellan.
Lead Editors: Leena Iyengar, Barney Jeffries, Natasja Oerlemans.
Editorial Team: Monique Grooten, May Guerraoui, Paul Sunters.

External reviewers
Dr Jennie Moore, *Director, Sustainable Development and Environment Stewardship, BCIT School of Construction and the Environment, British Columbia Institute of Technology, British Columbia, Canada.*
Professor Topiltzin Contreras Macbeath, *Head Of The Conservation Biology Research Group, Centro De Investigaciones Biológicas, Universidad Autónoma del Estado de Morelos; and Minister for Sustainable Development, Government of the State of Morelos, Mexico.*

Contributors
Zoological Society of London: Louise McRae, Robin Freeman, Stefanie Deinet.

Global Footprint Network: Jason Ortego, Mathis Wackernagel, Steve Goldfinger, Golnar Zokai, Elias Lazarus, Michael Borucke, Scott Mattoon, Geoff Trotter.

Water Footprint Network: Ashok Chapagain.

WWF: Alison Harley (*Tigers Alive*), Joanne Shaw (*Rhino programme*), Cassandra Brooke (*climate*), Jon Hoekstra, (*land use and ecosystem services*); Rodney Taylor (*forests*); Paul Chatterton (*REDD+*); Jessica Battle (*marine*); Stuart Orr, Oliver Maennicke (*freshwater*); Ricardo Bosshard, Rodrigo Catalán, María Elisa Arroyo, Marygrace Balinos, Jaime Molina, Irina Montenegro, Cristina Torres, Francisco Viddi, Trevor Walter (*Chile case study*); David Greer (*mountain gorilla case study*); Aimee Gonzales, Amy Rosenthal, Valerie Burgener, Gregory Verutes (*Belize case study*); Luis Neves Silva, Sindiswa Nobula (*South Africa case study*); Sean Hoobin, Julie Chaise, Joshua Bishop, Doug Yuille (*Great Barrier Reef case study*); Hanne Jersild (*Denmark case study*); Carina Borgström-Hansson, Jeet Mistry, Annsofie Aronsson, Lina Dabbagh, Laura Tyrer, Mi Hwa Chae, Kiran Rajashekariah, Vanessa Perez-Cirera, Jinlei Feng, Liangchun Deng, (*cities*); Nasser Olwero, Shalynn Pack, Aurelie Shapiro (*GIS maps*).

Additional key contributions received from
Kate Arkema (Stanford University), **Albert Bleeker** (Energy Research Centre of the Netherlands), **Félix Pharand-Deschênes** (Globaïa), **Jan Willem Erisman** (Integrated Nitrogen Studies, VU University Amsterdam), **Louise Gallagher** (Luc Hoffmann Institute), **James Galloway** (University of Virginia), **Elaine Geyer-Allely** (WWF International), **David Harmon** (George Wright Society), **Eric Kissel** (WG2 TSU, IPCC), **Allison Leech** (University of Virginia), **Jonathan Loh** (ZSL), **Anna Behm Masozera** (IGCP), **Robert Meisner** (European Space Agency), **Mesfin Mekonnen** (University of Twente, the Netherlands), **Pauline Midgeley** (WG1 TSU, IPCC), **Kate Raworth** (Environment Change Institute, Oxford University), **Johan Rockström** (Stockholm Resilience Centre), **Arco Van Strien** (Statistics Netherlands), **Joshua Tewksbury** (Luc Hoffmann Institute), **Katherine Trebeck** (Oxfam GB).

Special thanks for review and support to
Rosamunde Almond (Cambridge Institute for Sustainability and Environment), **Mike Barrett** (WWF-UK), **Carlotta Bianchi** (WWF International), **Ellen Bogers** (Rabobank), **Gemma Cranston** (Natural Capital Leaders Platform, CISL), **Brent Corcoran** (Mondi Group), **Melanie Dass** (Mondi Group), **Jean-Philippe Denruyter** (WWF International), **Chris Enthoven** (WWF-Netherlands), **Ricardo Fuentes-Nieva** (Oxfam GB), **Peter Gardiner** (Mondi Group), **Johnson Gathia** (United Nations Publications), **Timothy Geer** (WWF International), **Chris Hails** (WWF International), **Kerryn Haselau** (Mondi Group), **Leo Hickman** (WWF-UK), **David Hirsch** (WWF International), **Gretchen Lyons** (WWF International), **Shaun Martin** (WWF-US), **Elisabeth Mclellan** (WWF International), **Mie Oehlenschläger** (WWF-Denmark), **Gemma Parkes** (WWF International), **Niki Parker** (WWF International), **Janos Pasztor** (WWF International), **Richard Perkins** (WWF-UK), **Julie Robinson** (The Nature Conservancy), **Anabela Rodrigues** (WWF-Mozambique), **Johannah Sargent** (WWF-UK), **Sophie Schlingemann** (IPCC Secretariat), **Sybil Seitzinger** (International Geosphere-Biosphere Programme, Sweden), **Sturle Hauge Simonsen** (Stockholm Resilience Centre), **Stephan Singer** (WWF International), **PJ Stephenson** (WWF International), **Thomas Ursem** (Rabobank), **Hanna Wetterstrand** (Stockholm Resilience Centre), **Mandy Woods** (WWF-GCEI), **Lucy Young** (WWF-UK), **Natascha Zwaal** (WWF-Netherlands).

Living Planet Report 2014

Species and spaces, people and places

FOREWORD

Message from WWF International Director General

This latest edition of the *Living Planet Report* is not for the faint-hearted. One key point that jumps out and captures the overall picture is that the *Living Planet Index* (LPI), which measures more than 10,000 representative populations of mammals, birds, reptiles, amphibians and fish, has declined by 52 per cent since 1970. Put another way, in less than two human generations, population sizes of vertebrate species have dropped by half. These are the living forms that constitute the fabric of the ecosystems which sustain life on Earth – and the barometer of what we are doing to our own planet, our only home. We ignore their decline at our peril.

© WWF-Canon / Matthew Lee

A range of indicators reflecting humanity's heavy demand upon the planet shows that we are using nature's gifts as if we had more than just one Earth at our disposal. By taking more from our ecosystems and natural processes than can be replenished, we are jeopardizing our future. Nature conservation and sustainable development go hand-in-hand. They are not only about preserving biodiversity and wild places, but just as much about safeguarding the future of humanity – our well-being, economy, food security and social stability – indeed, our very survival.

BY TAKING MORE FROM OUR ECOSYSTEMS AND NATURAL PROCESSES THAN CAN BE REPLENISHED, WE ARE JEOPARDIZING OUR FUTURE

This has to make us stop and think. What kind of future are we heading toward? And what kind of future do we want? Can we justify eroding our natural capital and allocating nature's resources so inequitably?

Natural capital is a key concept of the *Living Planet Report*. While it may be an economic metaphor, it encapsulates the idea that our economic prosperity and our well-being are reliant upon the resources provided by a healthy planet. In a world where so many people live in poverty, it may appear as though protecting nature is a luxury. But it is quite the opposite. For many of the world's poorest people, it is a lifeline. And we are all in this together. We all need food, fresh water and clean air – wherever in the world we live.

We cannot protect nature without also recognizing the needs and aspirations of people, and the right to development. But equally, we cannot have development or meet the needs and aspirations of people without protecting nature.

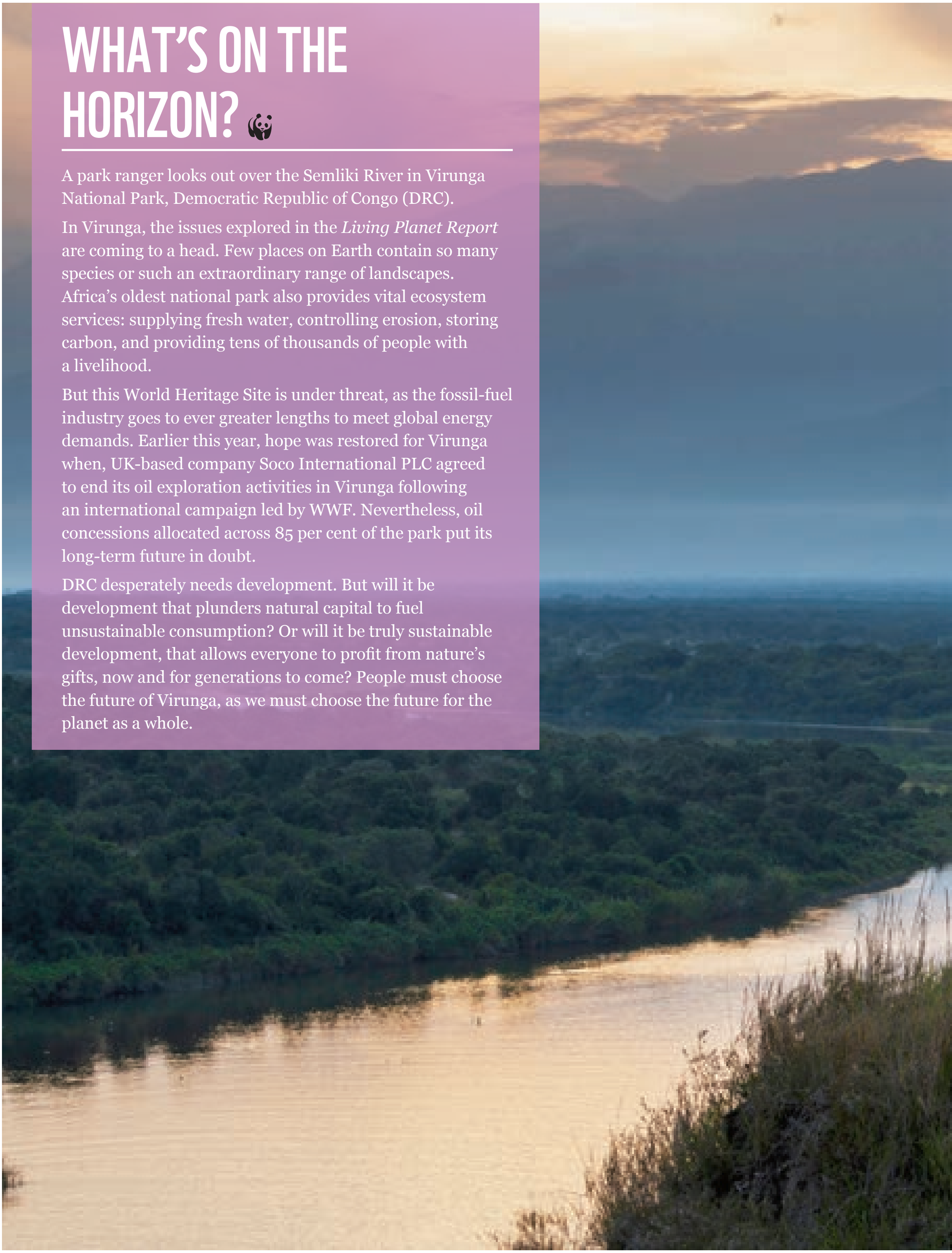
Things look so worrying that it may seem difficult to feel positive about the future. Difficult, certainly, but not impossible – because it is in ourselves, who have caused the problem, that we can find the solution. And it is by acknowledging the problem and understanding the drivers of decline that we can find the insights and, more importantly, the determination to put things right.

We need a few things to change. First, we need unity around a common cause. Public, private and civil society sectors need to pull together in a bold and coordinated effort. Second, we need leadership for change. Sitting on the bench waiting for someone else to make the first move doesn't work. Heads of state need to start thinking globally; businesses and consumers need to stop behaving as if we live in a limitless world.

Difficult but not impossible. And the key to making change lies in the subtitle of this edition of the *Living Planet Report* – "species and spaces, people and places". We really are all connected – and collectively we have the potential to find and adopt the solutions that will safeguard the future of this, our one and only planet. Now we must work to ensure that the upcoming generation can seize the opportunity that we have so far failed to grasp, to close this destructive chapter in our history, and build a future where people can live and prosper in harmony with nature.

Marco Lambertini
Director General
WWF International

IT IS BY ACKNOWLEDGING THE PROBLEM AND UNDERSTANDING THE DRIVERS OF DECLINE THAT WE CAN FIND THE INSIGHTS AND, MORE IMPORTANTLY, THE DETERMINATION TO PUT THINGS RIGHT



WHAT'S ON THE HORIZON?

A park ranger looks out over the Semliki River in Virunga National Park, Democratic Republic of Congo (DRC).

In Virunga, the issues explored in the *Living Planet Report* are coming to a head. Few places on Earth contain so many species or such an extraordinary range of landscapes. Africa's oldest national park also provides vital ecosystem services: supplying fresh water, controlling erosion, storing carbon, and providing tens of thousands of people with a livelihood.

But this World Heritage Site is under threat, as the fossil-fuel industry goes to ever greater lengths to meet global energy demands. Earlier this year, hope was restored for Virunga when, UK-based company Soco International PLC agreed to end its oil exploration activities in Virunga following an international campaign led by WWF. Nevertheless, oil concessions allocated across 85 per cent of the park put its long-term future in doubt.

DRC desperately needs development. But will it be development that plunders natural capital to fuel unsustainable consumption? Or will it be truly sustainable development, that allows everyone to profit from nature's gifts, now and for generations to come? People must choose the future of Virunga, as we must choose the future for the planet as a whole.

INTRODUCTION

Sustainable development has figured prominently on the international agenda for more than a quarter of a century. People talk earnestly of the environmental, social and economic dimensions of development. Yet we continue to build up the economic component, at considerable cost to the environmental one. We risk undermining social and economic gains by failing to appreciate our fundamental dependency on ecological systems. Social and economic sustainability are only possible with a healthy planet.

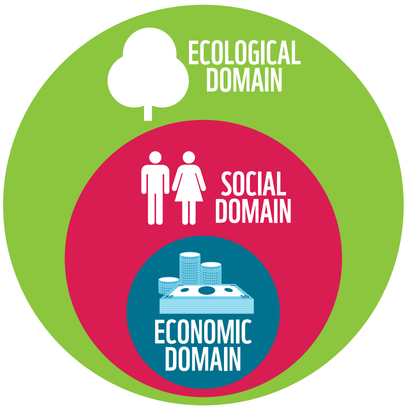


Figure 1: Ecosystems sustain societies that create economies

Ecosystems sustain societies that create economies. It does not work any other way round. But although human beings are a product of the natural world, we have become the dominant force that shapes ecological and biophysical systems. In doing so, we are not only threatening our health, prosperity and well-being, but our very future. This tenth edition of the *Living Planet Report*® reveals the effects of the pressures we are placing on the planet. It explores the implications for society. And it underlines the importance of the choices we make and the steps we take to ensure this living planet can continue to sustain us all, now and for generations to come.

Chapter 1 presents three established indicators of the state of the planet and our impact upon it: the *Living Planet Index*® (LPI), the Ecological Footprint and the water footprint.

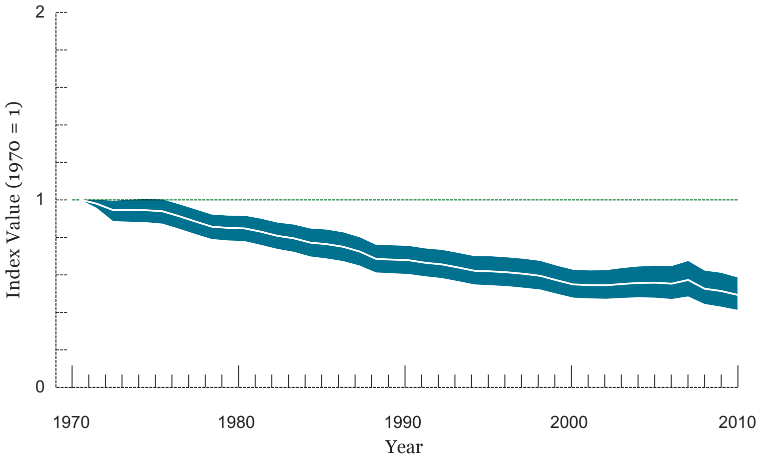
The LPI, which measures trends in thousands of vertebrate species populations, shows a decline of 52 per cent between 1970 and 2010 (Figure 2). In other words, vertebrate species populations across the globe are, on average, about half the size they were 40 years ago. This is a much bigger decrease than has been reported previously, as a result of the weighted adjustments made to the methodology,

Figure 2: Global Living Planet Index
The global LPI shows a decline of 52 per cent between 1970 and 2010. This suggests that, on average, vertebrate species populations are about half the size they were 40 years ago. This is based on trends in 10,380 populations of 3,038 mammal, bird, reptile, amphibian and fish species. The white line shows the index values and the shaded areas represent the 95 per cent confidence limits surrounding the trend (WWF, ZSL, 2014).

Key

Global Living Planet Index

Confidence limits



which aims to be more representative of global biodiversity (the methodology is explained further in Chapter 1 and in detail in Appendix).

The Ecological Footprint (Figure 3) shows that 1.5 Earths would be required to meet the demands humanity makes on nature each year. These demands include the renewable resources we consume for food, fuel and fibre, the land we build on, and the forests we need to absorb our carbon emissions. For more than 40 years, humanity's demand has exceeded the planet's biocapacity – the amount of biologically productive land and sea area that is available to regenerate these resources. This continuing overshoot is making it more and more difficult to meet the needs of a growing global human population, as well as to leave space for other species. Adding further complexity is that demand is not evenly distributed, with people in industrialized countries consuming resources and services at a much faster rate.

The water footprint helps us comprehend the massive volumes of water required to support our lifestyles – especially to grow food. As human population and consumption continue to grow, so too do our demands for water – but the volume of freshwater available does not. Today, more than a third of the world's population – about 2.7 billion people – live in river basins that experience severe water scarcity for at least one month each year.

Chapter 2 introduces a range of complementary information and indicators for assessing and understanding the state of the natural world and the human activities that affect it. We present and discuss the concept of planetary boundaries – the thresholds beyond which

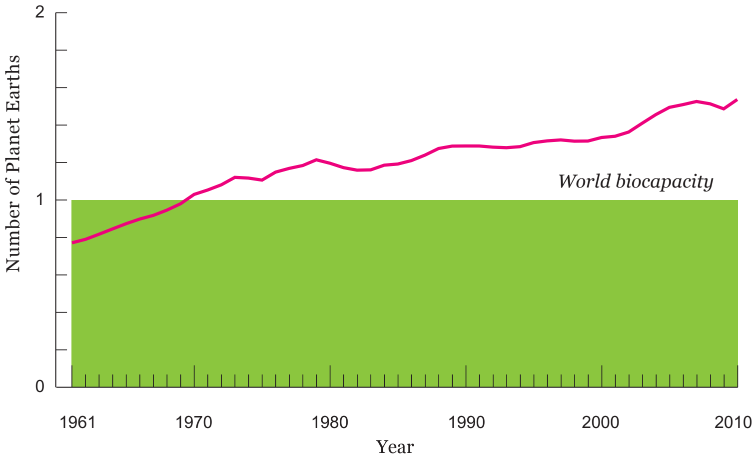


Figure 3: Humanity's Ecological Footprint
1.5 Earths would be required to meet the demands humanity currently makes on nature. For more than 40 years, humanity's demand has exceeded the planet's biocapacity – the amount of biologically productive land and sea area that is available to regenerate these resources (Global Footprint Network, 2014).

Key

Humanity's Ecological Footprint

World biocapacity

we risk potentially catastrophic changes to life as we know it. Three of these nine planetary boundaries appear to have already been crossed: biodiversity is declining far faster than any natural rate; the concentration of carbon dioxide in the atmosphere is already causing significant changes to our climate and ecosystems; and – while converting nitrogen from the air into fertilizer has helped feed the world – nitrogen pollution has become a significant, if underappreciated, environmental threat. We also look at other indicators that deepen our understanding of ecosystems and resource pressures in different contexts and at different levels, and see how this data can feed into practical tools and policy actions to tackle issues such as deforestation and water risk.

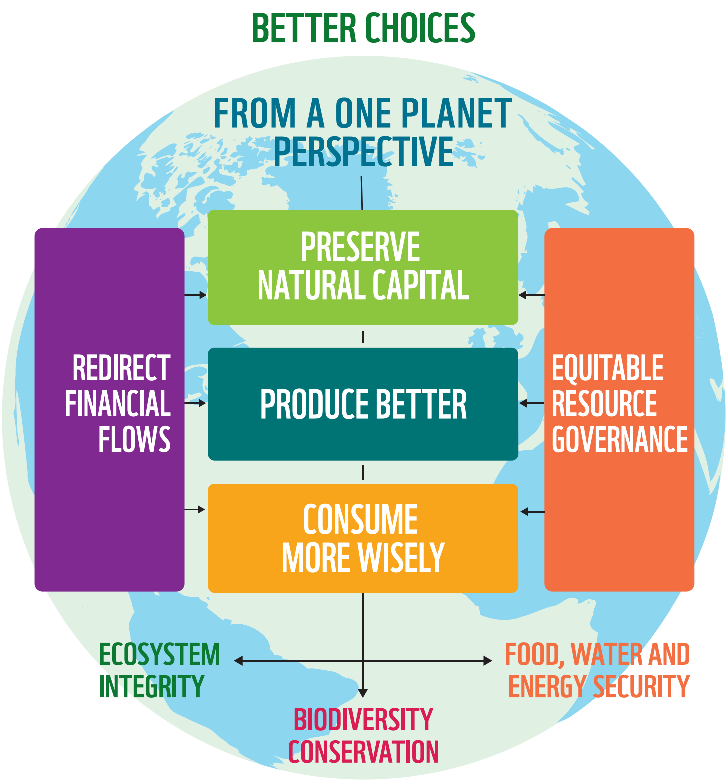
Why should we care about what the science and research tells us? Chapter 3 presents some possible answers to this question, by looking at how environmental changes affect our social and economic development, and how we might respond.

Better understanding of the services that ecosystems provide highlights just how much we depend upon the natural world. Forests, for example, provide shelter, livelihoods, water, fuel and food to 2 billion people directly, and help regulate the climate for everyone on the planet. Marine ecosystems support more than 660 million jobs globally and are a significant source of protein, particularly in developing countries. While it is impossible to put a price-tag on nature, ascribing an economic value to ecosystems and the services they provide is one way to convey what we stand to lose if we continue to squander our natural capital.

As the LPI declines and the Ecological Footprint increases, the planet's capacity to supply and replenish vital natural resources diminishes. Today, almost a billion people suffer from hunger, 768 million live without a safe, clean water supply and 1.4 billion lack access to a reliable electricity supply. Securing resilient, healthy communities where people can thrive will become an even greater challenge than it is today as population and consumption increase, and climate change and ecosystem degradation take their toll.

But the challenge is not an insurmountable one. As the final chapter demonstrates, people around the world are finding better ways to manage, use and share natural resources within the planet's capacity – with widespread environmental, social and economic benefits. Key to this is WWF's "One Planet Perspective" (Figure 4) – an understanding that the natural capital upon which our society and prosperity are built is finite, and that we need to use it more wisely, and share it more fairly. Only then can we truly begin to talk about sustainable development.

Figure 4: One Planet Perspective
(WWF, 2012).



AT A GLANCE

Chapter 1: The state of the planet

Biodiversity is declining sharply

- The global *Living Planet Index* (LPI) shows an overall decline of 52 per cent between 1970 and 2010. Due to changes in methodology to better reflect the relative sizes of species groups across biomes, this percentage has decreased considerably in comparison with previous publications.
- Falling by 76 per cent, populations of freshwater species declined more rapidly than marine (39 per cent) and terrestrial (39 per cent) populations.
- The most dramatic regional LPI decrease occurred in South America, followed closely by the Asia-Pacific region.
- In land-based protected areas, the LPI declined by 18 per cent, less than half the rate of decline of the overall terrestrial LPI.

Our demands on nature are unsustainable and increasing

- We need 1.5 Earths to meet the demands we currently make on nature. This means we are eating into our natural capital, making it more difficult to sustain the needs of future generations.
- The carbon Footprint accounts for over half of the total Ecological Footprint, and is the largest single component for approximately half of the countries tracked.
- Agriculture accounts for 92 per cent of the global water footprint. Humanity's growing water needs and climate change are exacerbating challenges of water scarcity.
- The dual effect of a growing human population and high per capita Footprint will multiply the pressure we place on our ecological resources.
- The Ecological Footprint per capita of high-income countries remains about five times more than that of low-income countries.
- By importing resources, high-income countries in particular, may effectively be outsourcing biodiversity loss. While high-income countries appear to show an increase (10 per cent) in biodiversity, middle-income countries show declines (18 per cent), and low-income countries show dramatic and marked declines (58 per cent).
- Countries with a high level of human development tend to have higher Ecological Footprints. The challenge is for countries to increase their human development while keeping their Footprint down to globally sustainable levels.

Chapter 2: Developing the picture

Additional indicators and ways of thinking give new perspectives on the state of the planet.

- The planetary boundaries concept defines nine regulating processes that keep the Earth in a stable state where life can thrive.
- Transgressing any of the nine boundaries could generate abrupt or irreversible environmental changes. Three appear to have been crossed already: biodiversity loss, climate change and nitrogen.
- Urgent and sustained global efforts could still keep temperature rises below 2°C – the level defined as "safe" – but our window of opportunity is fast closing.
- Nitrogen is essential to global food security, but nitrogen pollution has severe impacts on aquatic ecosystems, air quality, biodiversity, climate and human health.
- Local and thematic analysis helps identify the causes and effects of global challenges, and provides insights for devising practical solutions.

Chapter 3: Why we should care

Environmental changes affect us all

- Human well-being depends on natural resources such as water, arable land, fish and wood; and ecosystem services such as pollination, nutrient cycling and erosion control.
- Putting ecosystems at the centre of planning, and managing activities that depend on natural resources, brings economic and social benefits.
- While the world's poorest continue to be most vulnerable, the interconnected issues of food, water and energy security affect us all.
- For the first time in history, the majority of the world's population lives in cities, with urbanization growing fastest in the developing world.

Chapter 4: One planet solutions

Living within the planet's means is possible

- Individuals, communities, businesses, cities and governments are making better choices to protect natural capital and reduce their footprint, with environmental, social and economic benefits – as demonstrated in real-world case studies.
- Changing our course and finding alternative pathways will not be easy. But it can be done.

A LIVING PLANET

Only around 880 mountain gorillas remain in the wild – about 200 of them in Virunga National Park. Although they remain critically endangered, they are the only type of great ape whose numbers are increasing, thanks to intensive conservation efforts.

Mountain gorillas are among the 218 mammal species found in Virunga, along with 706 bird species, 109 reptile species, 78 amphibian species and more than 2,000 species of plants. But drilling for oil could lead to habitat degradation and see the park lose its protected status and World Heritage Site listing, leaving its wildlife increasingly vulnerable.

Globally, habitat loss and degradation, hunting and climate change are the main threats facing the world's biodiversity. They have contributed to a decline of 52 per cent in the *Living Planet Index* since 1970 – in other words, the number of mammals, birds, reptiles, amphibians and fish with which we share our planet has fallen by half.

CHAPTER 1: THE STATE OF THE PLANET

The Living Planet Index

The global LPI reveals a continual decline in vertebrate populations over the last 40 years. This global trend shows no sign of slowing down. For this tenth edition of the *Living Planet Report*, the LPI methodology has been updated and fine-tuned to give a better representation of the global distribution of vertebrate species (See Box 1 and Appendix for more details). The weighted LPI (LPI-D) shows that the size of populations (the number of individual animals) decreased by 52 per cent between 1970 and 2010 (Figure 5). This is a steeper decline than reported in previous years when the dominance of data from North America and Europe – areas where long-term trend information has been more readily available – had a strong influence on the global LPI.

The LPI is calculated using trends in 10,380 populations of over 3,038 vertebrate species (fishes, amphibians, reptiles, birds and mammals). These species groups have been comprehensively researched and monitored by scientists and the general public for many years, meaning that a lot of data is available to assess the state of specific populations and their trends over time.

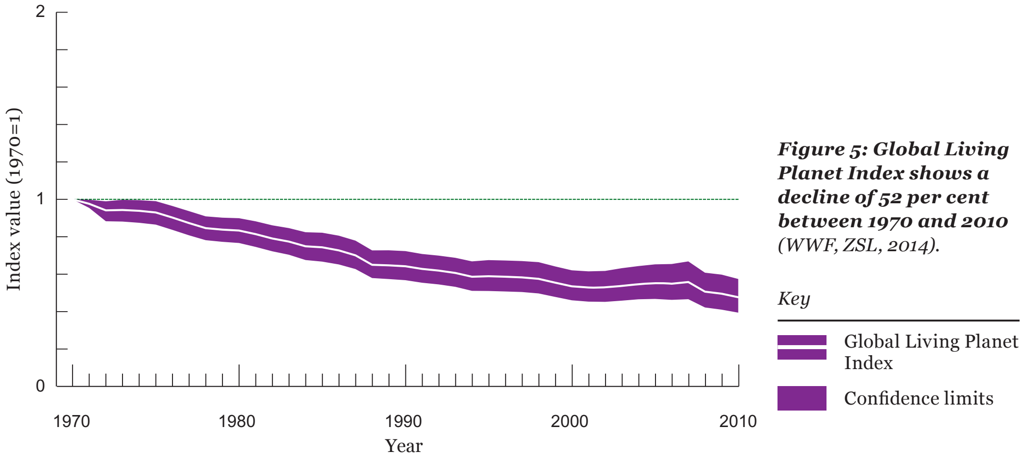
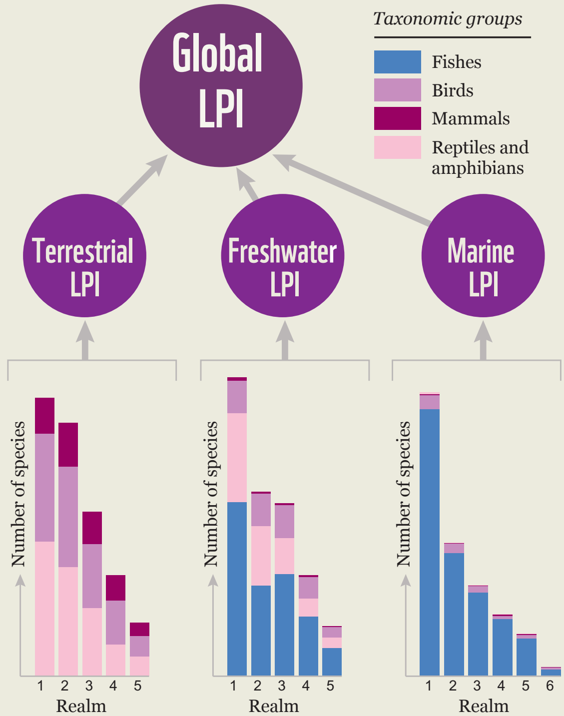


Figure 5: Global Living Planet Index shows a decline of 52 per cent between 1970 and 2010 *(WWF, ZSL, 2014).*

Box 1: Explaining the use of LPI-D, the weighted LPI

Figure 6: Illustration of how the global LPI is calculated using the LPI-D method
The bar charts show the relative number of species in each realm and by taxonomic group within each realm based on estimates taken from Wildfinder (WWF, 2006), the IUCN Red List (IUCN, 2013), Freshwater Species of the World (WWF/ TNC, 2013) and the Ocean Biogeographic Information System (OBIS, 2012). A weighted average method that places most weight on the largest (most species-rich) groups within a realm is used. Once the average trend for each realm has been calculated, a weighted average to calculate each system LPI is used, placing the most weight on the largest (most species-rich) realm within a system. The global LPI is the average of the terrestrial, freshwater and marine system LPIs (WWF, ZSL, 2014).



Terrestrial and Freshwater realms

1. Neotropical
2. Indo-Pacific
3. Afrotropical
4. Palearctic
5. Nearctic

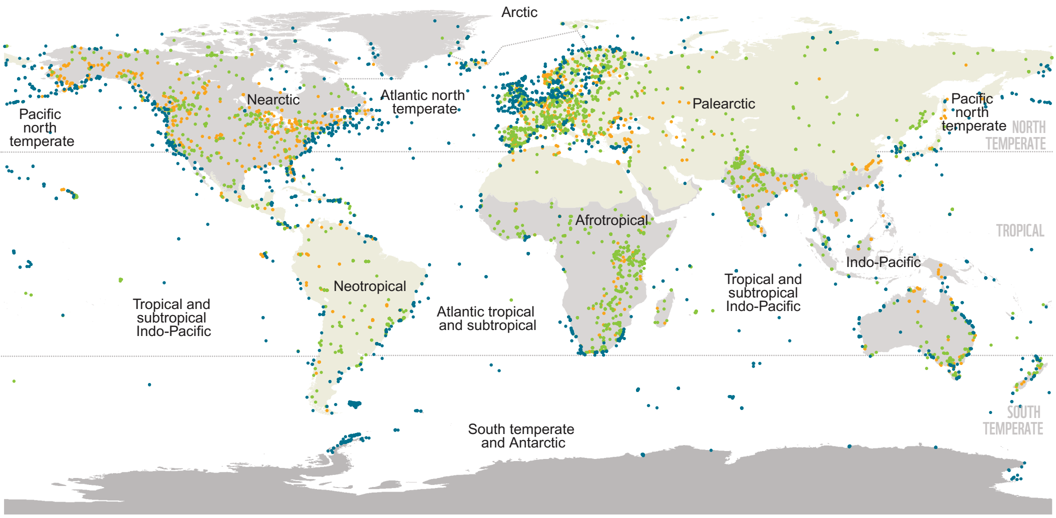
Marine realm

1. Tropical /subtropical Indo-Pacific
2. Atlantic tropical and sub-tropical
3. Atlantic north temperate
4. South temperate and Antarctic
5. Pacific north temperate
6. Arctic

The LPI-D is a variation of the LPI method that has been used in previous editions of the *Living Planet Report*. The LPI-D uses the estimated number of species in different taxonomic groups and biogeographic realms to apply weightings to the LPI data. (See Appendix for more detail on these weightings).

This is to account for the fact that the population trends for each taxonomic group and biogeographic realm in the LPI database are not a perfect representation of the number and distribution of vertebrate species that exist in the world. This means that, without weighting, the LPI over-represents trends in Europe and North America, and among birds; and under-represents trends in Africa, Asia and Latin America, and among reptiles, amphibians and fishes.

For the LPI-D method, ZSL has used estimates of the number of species in each taxonomic group in each biogeographic realm to apply a proportional amount of weighting to the data on those species in the LPI database, giving the most weight to the groups and realms with the most species, and the least weight to those groups and realms with the fewest.



Each population time-series in the LPI database is assigned to a region – a *biogeographic realm* or ocean – and classified according to whether the population lives predominantly in a terrestrial, freshwater or marine system (Figure 7). This makes it possible to look at how species are faring in different regions and biomes.

Figure 8 shows that the global LPI comprises a mixture of increasing, decreasing and stable populations across all species groups. Even though slightly more populations are increasing than declining, the magnitude of the population decline is much greater than that of the increase, resulting in an overall reduction since 1970.

Figure 7: The distribution of locations providing data for the Living Planet Index
Each point represents one population and is coded as to whether it is terrestrial, freshwater or marine. The map also shows the biogeographic realm divisions used for terrestrial/ freshwater systems and oceans for marine systems (WWF, ZSL, 2014).

Key

- Terrestrial
- Marine
- Freshwater

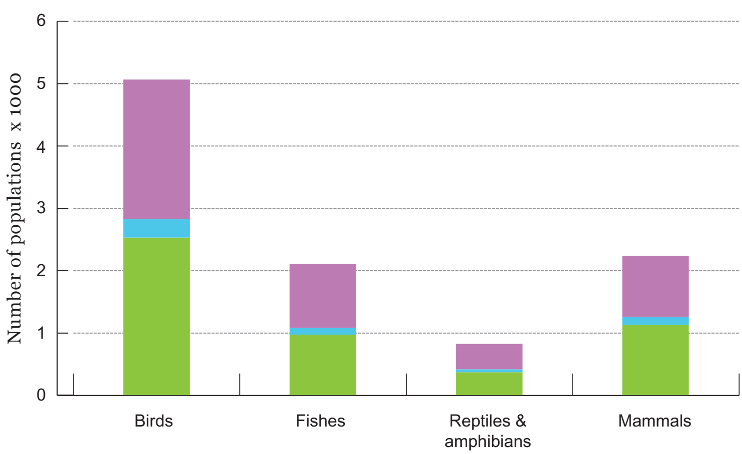


Figure 8: The number of declining, stable and increasing populations (1970 - 2010) in the global LPI
(WWF, ZSL, 2014).

Key

- Decline
- Stable
- Increase

The global LPI can be subdivided to show trends in temperate and tropical regions separately, based on whether the biogeographic realm in which the population is located is predominantly temperate or tropical.

The results indicate that vertebrates are declining in both temperate and tropical regions, but that the average decline is greater in the tropics. The 6,569 populations of 1,606 species in the temperate LPI declined by 36 per cent from 1970 to 2010 (Figure 9). The tropical LPI shows a 56 per cent reduction in 3,811 populations of 1,638 species over the same period (Figure 10).

Figure 9: The temperate LPI shows a decline of 36 per cent between 1970 and 2010
This is based on trends in 6,569 populations of 1,606 species (WWF, ZSL, 2014).

Key

Temperate Living Planet Index

Confidence limits

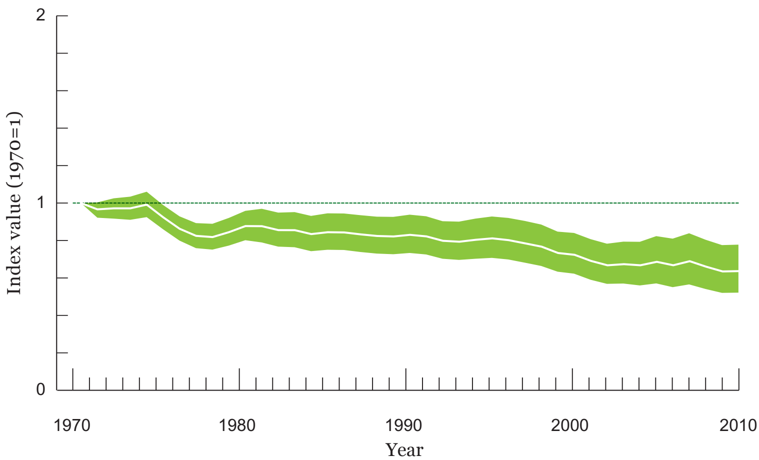
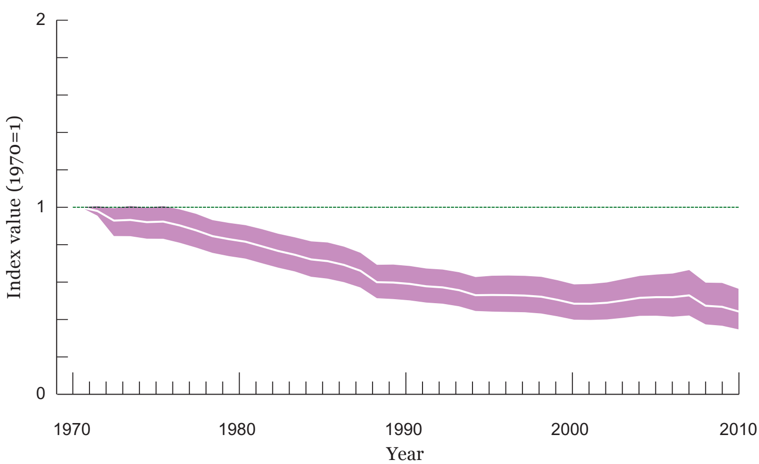


Figure 10: The tropical LPI shows a decline of 56 per cent between 1970 and 2010
This is based on trends in 3,811 populations of 1,638 species (WWF, ZSL, 2014).

Key

Tropical Living Planet Index

Confidence limits



Threats to species

The main threats to populations in the LPI are recorded based on information provided by each data source. Up to three main threats are recorded, relating to the population rather than the species as a whole. Habitat loss and degradation, and exploitation through hunting and fishing (intentionally for food or sport, or accidentally, for example as bycatch) are the primary causes of decline (Figure 11).

Climate change is the next most common primary threat in the LPI. Climate change has already been linked to the population decline and possible extinction of a number of amphibian species in the Neotropics (La Marca et al., 2005; Ron et al., 2003) and in Australia (Osborne et al., 1999; Mahoney, 1999). In the Arctic, the effects of a rapidly warming climate have been suggested as likely causes of decline in body condition and numbers in many polar bear (*Ursus maritimus*) and caribou (*Rangifer tarandus*) populations (Stirling et al., 1999; Vors and Boyce, 2009).

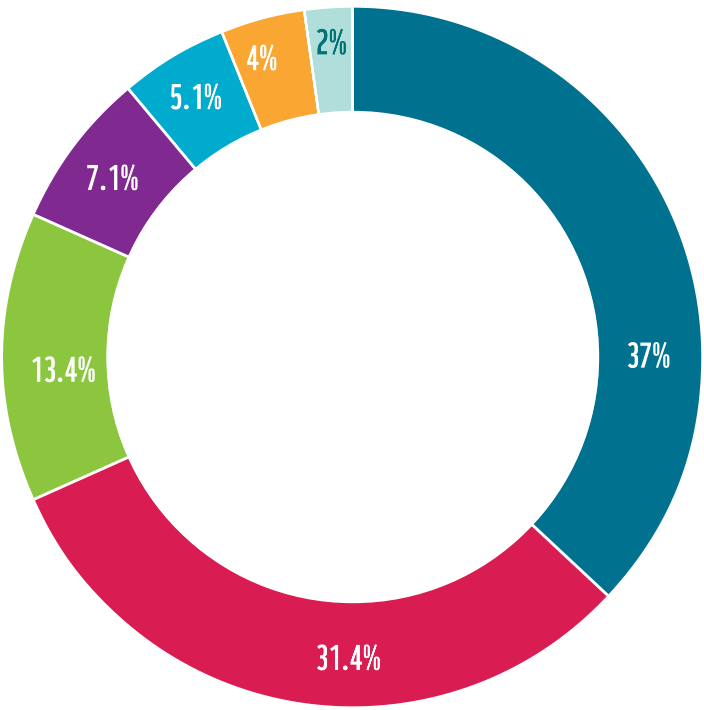


Figure 11: Primary threats to LPI populations
Information on threats has been identified for 3,430 populations in the LPI assigned to seven categories. Other populations are either not threatened or lack threat information (WWF, ZSL, 2014).

Key

- Exploitation
- Habitat degradation/change
- Habitat loss
- Climate change
- Invasive species/genes
- Pollution
- Disease

Terrestrial LPI

The terrestrial LPI contains population trends for 1,562 species of mammals, birds, reptiles and amphibians from a wide range of habitats. The index shows that terrestrial populations have been declining since 1970 (Figure 12) – a trend that currently shows no sign of slowing down or being reversed. On average, in 2010 – the year for which the most recent comprehensive dataset is available – terrestrial species had declined by 39 per cent. The loss of habitat to make way for human land use – particularly for agriculture, urban development and energy production – continues to be a major threat to the terrestrial environment.

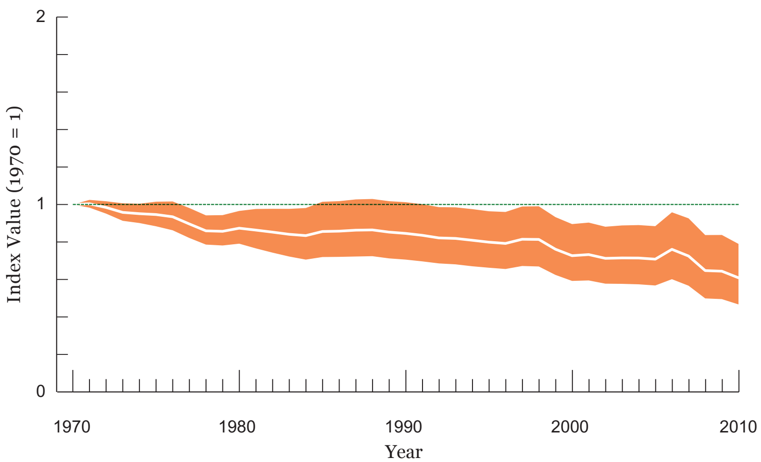
When habitat loss and degradation is compounded by the added pressure of wildlife hunting, the impact on species can be devastating. Take, for example, the forest elephant (*Loxodonta africana cyclotis*), a subspecies of the African elephant, which is distributed throughout fragmented forested areas in West and Central Africa. Due to a rapid loss of their traditional habitat, forest elephants had been restricted to a mere 6-7 per cent of their historic range (*circa* 1900) by 1984. Further recent analysis suggests that, across the forest elephant's range, the population size declined by more than 60 per cent between 2002 and 2011 – primarily due to increasing rates of poaching for ivory (Maisels et al., 2013).

Figure 12: The terrestrial LPI shows a decline of 39 per cent between 1970 and 2010
This is based on trends in 4,182 populations of 1,562 mammal, bird, reptile and amphibian species (WWF, ZSL, 2014).

Key

Terrestrial Living Planet Index

Confidence limits



Freshwater LPI

The freshwater index shows the greatest decline of any of the biome-based indices. The LPI for freshwater species shows an average decline of 76 per cent in the size of the monitored populations between 1970 and 2010 (Figure 13).

The indication that freshwater species are faring much worse than terrestrial species has been reinforced in other studies (Collen et al., 2014; Darwall et al., 2011; Cumberlidge et al., 2009). Further, freshwater protected areas have fallen far behind as effective conservation strategies – possibly because traditional terrestrial protected area models translate imperfectly to complex, interconnected freshwater ecosystems (Abell et al., 2007).

The main threats to freshwater species are habitat loss and fragmentation, pollution and invasive species (Collen et al., 2014). Direct impacts on water levels or on freshwater system connectivity have a major impact on freshwater habitats. For example, the Coorong, a coastal wetland of international significance in South Australia, has suffered from low water levels and rising salinity since 1985, primarily as a result of water extraction for irrigation (Gosbell and Grear, 2005). This has resulted in population declines in many resident and migratory species, including fish and shorebirds – such as the curlew sandpiper (*Calidris ferruginea*).

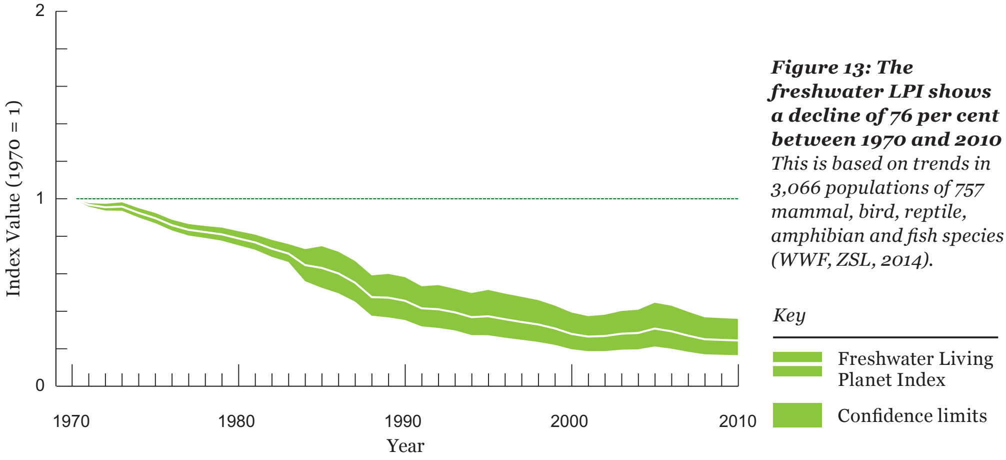
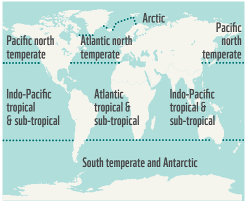


Figure 13: The freshwater LPI shows a decline of 76 per cent between 1970 and 2010
This is based on trends in 3,066 populations of 757 mammal, bird, reptile, amphibian and fish species (WWF, ZSL, 2014).

Marine LPI

Marine populations are assigned to marine realms. The marine LPI shows a decline of 39 per cent between 1970 and 2010 (Figure 14). This is based on trends in 3,132 populations of 910 mammal, bird, reptile and fish species. The index trend shows a fluctuating picture of decline and stability throughout the time period. The period from 1970 through to the mid-1980s experienced the steepest fall, after which there was some stability, until another period of decline in recent years.

Although the overall picture shows a declining trend, marine population trends differ across the globe. Some increases have been recorded among populations in the temperate oceans, particularly among mammal and fish species, which may indicate species populations recovering from long-term historical declines (Thurstan et al., 2010; Lotze et al., 2011).



The sharpest declines in marine populations have been observed in the tropics and the Southern Ocean. Species in decline in the tropics include marine turtles, particularly in the Indo-Pacific realm, and seabirds overall in the Atlantic, with bycatch from fishing being one of the main drivers behind these trends. Among the fish species showing declines are many shark species, which have suffered as a result of overfishing both in tropical Atlantic (Baum and Myers, 2004) and Pacific regions (Clarke et al., 2013b).

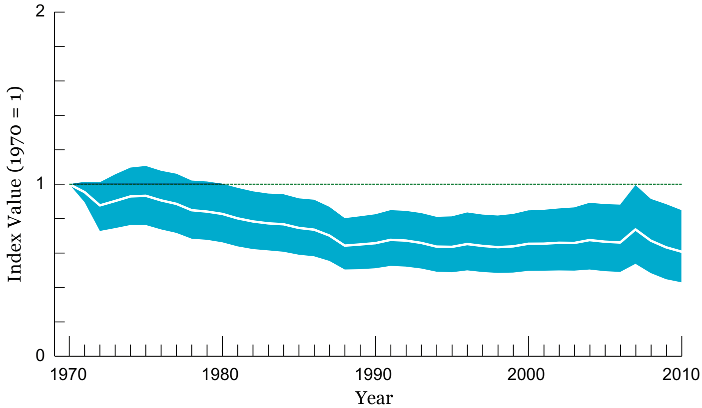
In the Southern Ocean, declines have been observed among many fish populations. This is likely due to growing fisheries activity in this area, including both reported and illegal or unregulated fishing (CCAMLR, 2014). Large migratory seabirds such as albatross and petrels have also been under threat from the rising presence of fishing vessels as they are frequently caught as bycatch. This is causing declines in population numbers and threatening some species, such as the iconic wandering albatross (*Diomedea exulans*) (BirdLife International, 2012).

Figure 14: The marine LPI – shows a decline of 39 per cent between 1970 and 2010
This is based on trends in 3,132 populations of 910 mammal, bird, reptile and fish species (WWF, ZSL, 2014).

Key

Marine Living Planet Index

Confidence limits

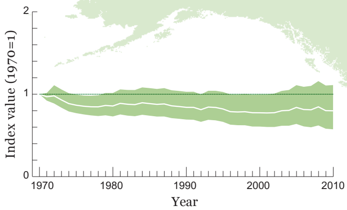


Biogeographic realms

All terrestrial and freshwater species populations can be assigned to one of five major biogeographic realms, which enables us to better understand how biodiversity is changing in different land regions of the world. Species population trends in all biogeographic realms show declines. But the situation is worst in the tropical realms, particularly in the Neotropics, where species declined by 83 per cent (Figure 15).

Nearctic

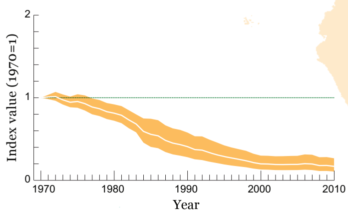
Fishes	83
Amphibians	73
Reptiles	48
Birds	461
Mammals	80



The Nearctic index reveals that, on average, populations declined by 20 per cent, although they appear relatively stable in more recent years. However, there is considerable variation, with some populations increasing while others decreased.

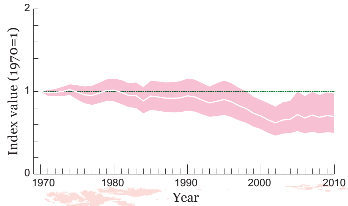
Neotropical

Fishes	86
Amphibians	61
Reptiles	25
Birds	310
Mammals	66

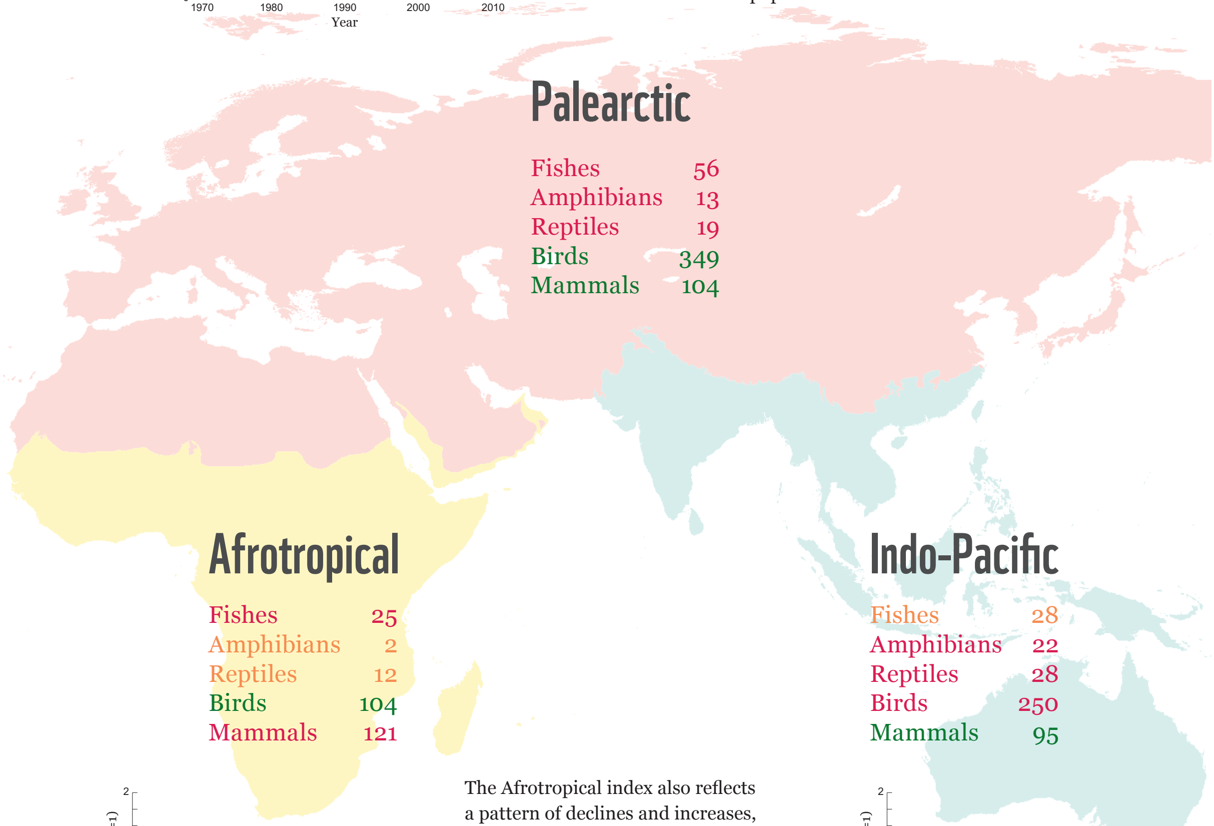


The Neotropical index shows a dramatic and continued decline in populations, with, on average, declines of 83 per cent. This is the most dramatic regional decrease and highlights the intense pressure felt by tropical species.

Figure 15: LPI by biogeographic realms
The tables show the number of species for each vertebrate group, with the colour denoting the average overall trend for each group (red – decline; orange – stable; green – increase) (WWF, ZSL, 2014).



The Palearctic index shows an overall average decline of 30 per cent, with mixed periods of loss and stability. There is considerable variation in this index, reflecting a mixture of increases and decreases in different populations.



Palearctic

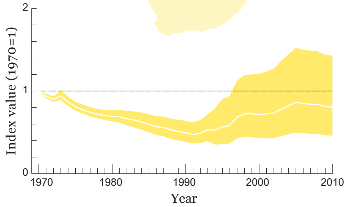
Fishes	56
Amphibians	13
Reptiles	19
Birds	349
Mammals	104

Afrotropical

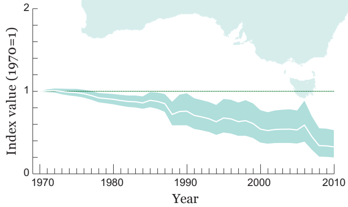
Fishes	25
Amphibians	2
Reptiles	12
Birds	104
Mammals	121

Indo-Pacific

Fishes	28
Amphibians	22
Reptiles	28
Birds	250
Mammals	95



The Afrotropical index also reflects a pattern of declines and increases, with more recent increases occurring with greater variability in population levels. This results in a lower confidence in the average index values during the second half of the time period. This change in trend halfway through the time series is due to varying trends in birds and fish, some of which are showing increases. Despite some evidence of recent increases, there is still a decline of 19 per cent recorded since 1970.



The Indo-Pacific index shows large and continuing declines in species populations. It has the second highest rate of decline (67 per cent) after the Neotropics.

Protected areas and protecting species

Protected areas are a way of conserving wild species and their habitats through better management of, access to, and use of, a given area of land or sea. To get an insight into whether protected areas are helping to conserve species, it is possible to focus on trends in populations from the terrestrial LPI that occur inside a protected area. The resulting index (Figure 16) is different from the terrestrial LPI overall: it remains more or less stable until the mid-1990s, after which there is a slight decline. Registering an overall reduction of 18 per cent since 1970, populations in protected areas are faring better than terrestrial populations as a whole, which have declined by 39 per cent. Protection may not be the only reason for this difference – other reasons that could contribute to this improved status include targeted conservation action, or the species for which data is available being less susceptible to threats. The LPI of protected areas does not distinguish between pressures being successfully controlled through protected area legislation and the area being situated away from such pressure hotspots. However, the relative trend is encouraging.

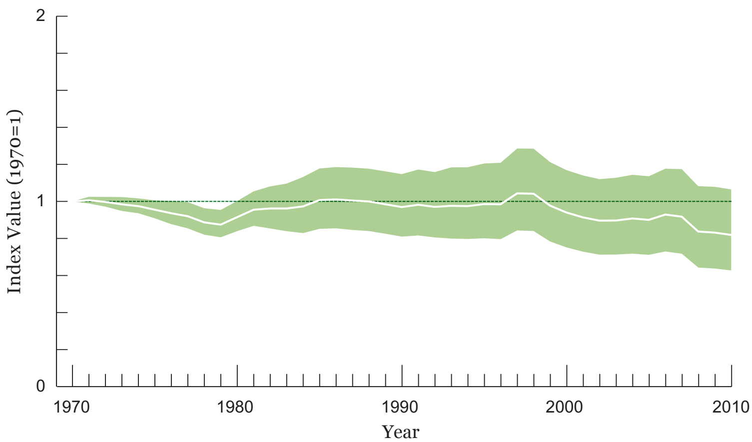


Figure 16: The terrestrial LPI of populations inside protected areas shows a decline of 18 per cent between 1970 and 2010
This is based on trends in 1,956 populations of 773 mammal, bird, reptile and amphibian species (WWF, ZSL, 2014).

Key

Terrestrial Living Planet Index inside protected areas

Confidence limits

Protected areas can offer refuge to threatened species that would otherwise be at greater risk of targeted exploitation. For example declines in tiger (*Panthera tigris*) populations, due to poaching, habitat loss and human-wildlife conflict, have been most pronounced outside protected areas (Walston et al., 2010). Conversely, Nepal's tiger population, located in five protected areas and three wildlife corridors, rose by 63 per cent between 2009 and 2013 (Figure 17). This conservation success has been attributed to the Nepalese government's anti-poaching efforts and improved site protection for wild tigers.

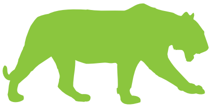
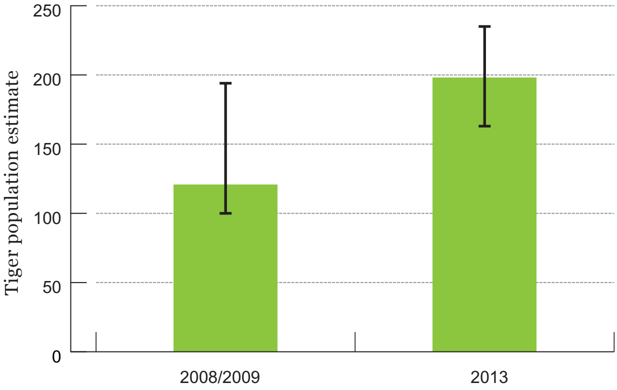


Figure 17: The increase in number of tigers in Nepal between 2008/9 and 2013
The error bars show the upper and lower limits of each population estimate (Government of Nepal, WWF-Nepal).



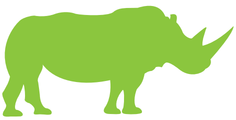


Figure 18: Current range of black and white rhino (Emslie, 2012a, 2012b) and individual population trends
The range is shown as whole countries due to the security issues of showing exact locations and includes countries where populations have been reintroduced or introduced to new areas. The dots show the approximate location of monitored populations and denotes whether the overall trend has been an increase or decrease. Dots outside the range are in countries where rhino are suspected to have gone extinct.

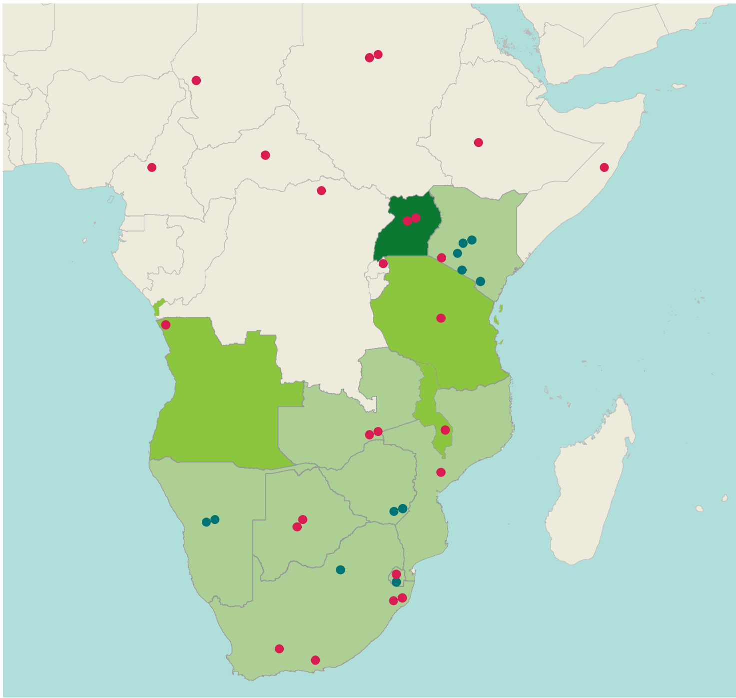
Species current range

Black and white rhino
Black rhino
White rhino

Monitored populations

Population increase
Population decrease

However, in some African protected areas, declines in large mammal species have been unabated (Craigie et al., 2010). This emphasizes the importance of maintaining the effectiveness of protected areas through strong management and law enforcement. This is vital for species that are targeted by poachers. For example, many rhino populations in Africa (Figure 18) have become regionally extinct or are in decline, despite largely occurring inside protected areas.



Africa has two species of rhino – black (*Diceros bicornis*) and white (*Ceratotherium simum*) – distributed across southern and eastern Africa, but the majority occur in just four countries: South Africa, Namibia, Zimbabwe and Kenya (Emslie, 2012a, 2012b). There are fewer than 5,000 black rhino and about 20,000 white rhino left in the wild (Emslie, 2012a; 2012b). Both species have experienced a loss in their range, and efforts have been made to reintroduce rhino to areas where they previously occurred, which has resulted in some increasing trends. However, the black rhino is considered to be at a very high risk of extinction (Critically Endangered) due to its low numbers and current threats (Emslie, 2012a). The white rhino is said to be "Near Threatened", which means that if threats persist and no action is taken, this species may soon also be at risk (Emslie, 2012b).

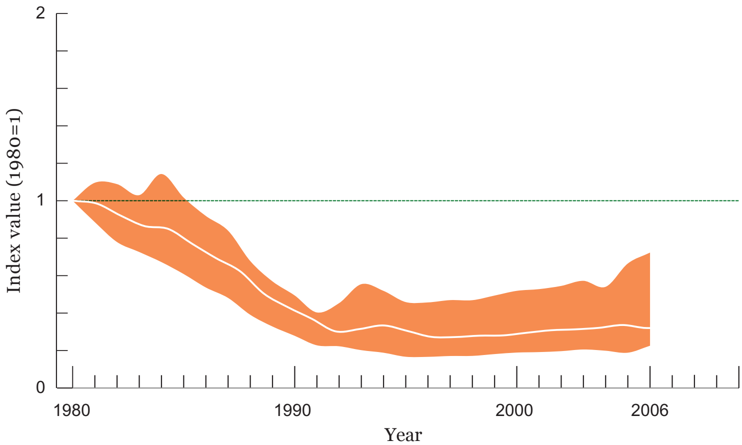


Figure 19: Index of population trends for black and white rhino (Diceros bicornis and Ceratotherium simum) from 1980 to 2006
The time series is shorter than other LPIs due to data availability. This index is based on 28 black and 10 white rhino populations from 20 countries (WWF, ZSL, 2014).

Key

Rhino LPI

Confidence limits

According to the available population data, both species declined by an average of 63 per cent between 1980 and 2006 (Figure 19). Most of this decline occurred during the 1980s and 1990s. Despite many efforts to bolster populations – such as by reintroducing rhinos – the trend, although improved, has not been fully reversed.

Illegal wildlife trade is by far the biggest threat currently facing both black and white rhino populations due to demand for their horns. A single horn can be sold for a very high price, making it an attractive prospect for poachers. The situation is exacerbated by a number of factors, including growing demand for rhino horn in Asia, particularly Viet Nam; weak governance and poor law enforcement in countries with wild rhinos; and the increase in corruption and emergence of crime syndicates attracted by the high profits from the rhino horn trade (Milliken, 2012).

In South Africa, where 80 per cent of all African rhinos are located, the rate of rhino poaching continues to accelerate. The number of animals poached for their horns rose from 13 in 2007 to more than 1,000 in 2013 (Figure 20). Despite growing awareness and improved protection, nearly 5 per cent of the country's overall rhino population was killed by poachers in 2013 alone, further increasing the pressure on existing populations.

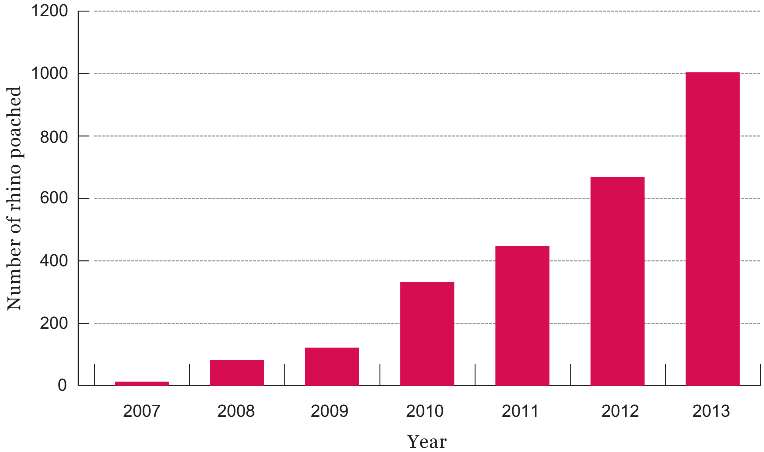


Figure 20: Increase in the number of rhino lost to poaching in South Africa from 2007 to 2013 *(Government of South Africa, WWF, 2014).*

Clearly threats to species are not mitigated by the designation of a protected area alone. A recent study of 87 marine protected areas shows that their success depends on five key factors: how much fishing is allowed, enforcement levels, how long protection has been in place, size of area, and degree of isolation (Edgar et al., 2014). Areas with no fishing, strong enforcement and at least 10 years of protection, with a large area (at least 100km^2) and isolated by sand or deep water, brought significant benefits. Compared to unprotected areas, they had twice as many large fish species and five times more large fish biomass, or 14 times more in the case of sharks. By contrast, protected areas with only one or two of these features were indistinguishable from fished sites.

While better design and management is needed to help protected areas to achieve their full potential, evidence suggests they have a significant role to play in halting declines in biodiversity.

The need for stronger protection will become increasingly important as human consumption places ever greater pressure on natural ecosystems. This is the subject of the next section.

HANDS AND FOOTPRINTS

This worker in Nigeria is helping to clean up one of the countless oil spills that's polluted the Niger Delta over the past five decades – a process that will take 30 years and cost US$1 billion, according to the UN. Soil and water have been contaminated, and people and wildlife have suffered. Similar spills in Virunga would be disastrous for the park's priceless biodiversity and the many people who rely on its natural resources.

But oil's impacts on the planet go far beyond local pollution. Fossil fuels have powered modern economic growth, but they're also one of the main reasons that humanity's Ecological Footprint is now larger than the planet can sustain. We simply don't have enough productive land and sea available to continue to meet our demands for food, forest products and living space, and to absorb our carbon dioxide emissions. As human populations and consumption grow, precious natural places like Virunga are coming under ever greater pressure.

EMBARGOED until 30 Sept 2014 - 00:01 CET

The Ecological Footprint

For more than 40 years, humanity's demand on nature has exceeded what our planet can replenish. Our Ecological Footprint – which measures the area (in hectares) required to supply the ecological goods and services we use – outstrips our biocapacity – the land actually available to provide these goods and services. Biocapacity acts as an ecological benchmark against which the Ecological Footprint can be compared. Both biocapacity and Ecological Footprint are expressed in a common unit called a global hectare (gha).

Humanity currently needs the regenerative capacity of 1.5 Earths to provide the ecological goods and services we use each year. This "overshoot" is possible because – for now – we can cut trees faster than they mature, harvest more fish than the oceans can replenish, or emit more carbon into the atmosphere than the forests and oceans can absorb. The sum of all human demands no longer fits within what nature can renew. The consequences are diminished resource stocks and waste accumulating faster than it can be absorbed or recycled, such as with the growing carbon concentration in the atmosphere.

Technological innovation, such as increasing efficiency in the use of resources and energy, or improving ecosystem yields, could reduce overshoot – but may also bring trade-offs. For example, enhancing agricultural biocapacity through fertilizers and mechanization has required greater use of fossil fuels, leading to a larger carbon Footprint.

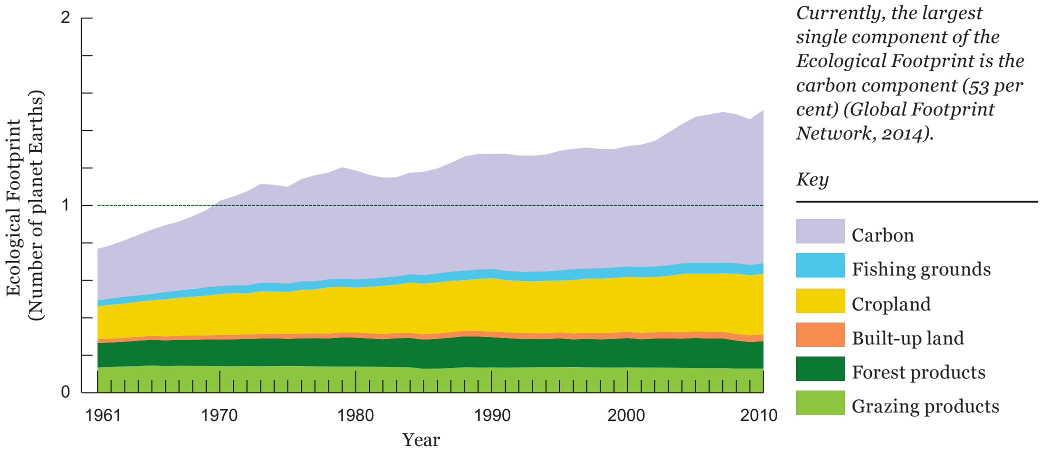


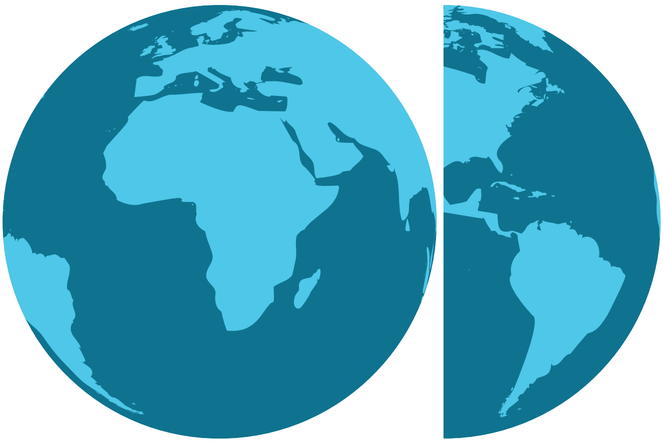
Figure 21: Global Ecological Footprint by component (1961-2010)
Currently, the largest single component of the Ecological Footprint is the carbon component (53 per cent) (Global Footprint Network, 2014).

IN 2010, GLOBAL ECOLOGICAL FOOTPRINT WAS 18.1 BILLION GHA, OR 2.6 GHA PER CAPITA. EARTH'S TOTAL BIOCAPACITY WAS 12 BILLION GHA, OR 1.7 GHA PER CAPITA

Globally, humanity's Ecological Footprint decreased by 3 per cent between 2008 and 2009, due mostly to a decline in demand for fossil fuels and hence a decreasing carbon Footprint. A small decline in demand for forest products was also apparent in 2008 and 2009. However, the latest figures for 2010 show the Footprint returning to an upward trend.

Carbon has been the dominant component of humanity's Ecological Footprint for more than half a century (Figure 21). And for most years, it has been on an upward trend. In 1961, carbon was 36 per cent of our total Footprint, but by 2010 (the year for which the most complete dataset is available), it comprised 53 per cent. The primary cause has been the burning of fossil fuels – coal, oil and natural gas.

OUR DEMAND FOR RENEWABLE ECOLOGICAL RESOURCES AND THE GOODS AND SERVICES THEY PROVIDE IS NOW EQUIVALENT TO MORE THAN 1.5 EARTHS



SINCE THE 1990s WE HAVE REACHED OVERSHOOT BY THE NINTH MONTH EVERY YEAR. WE DEMAND MORE RENEWABLE RESOURCES AND CO_2 SEQUESTRATION THAN THE PLANET CAN PROVIDE IN AN ENTIRE YEAR

Regional and national Ecological Footprints

A regional assessment of humanity's Ecological Footprint in 1961 and 2010 (Figure 22) shows that the global supply of and demand for renewable resources have changed over the past half-century – largely due to population growth.

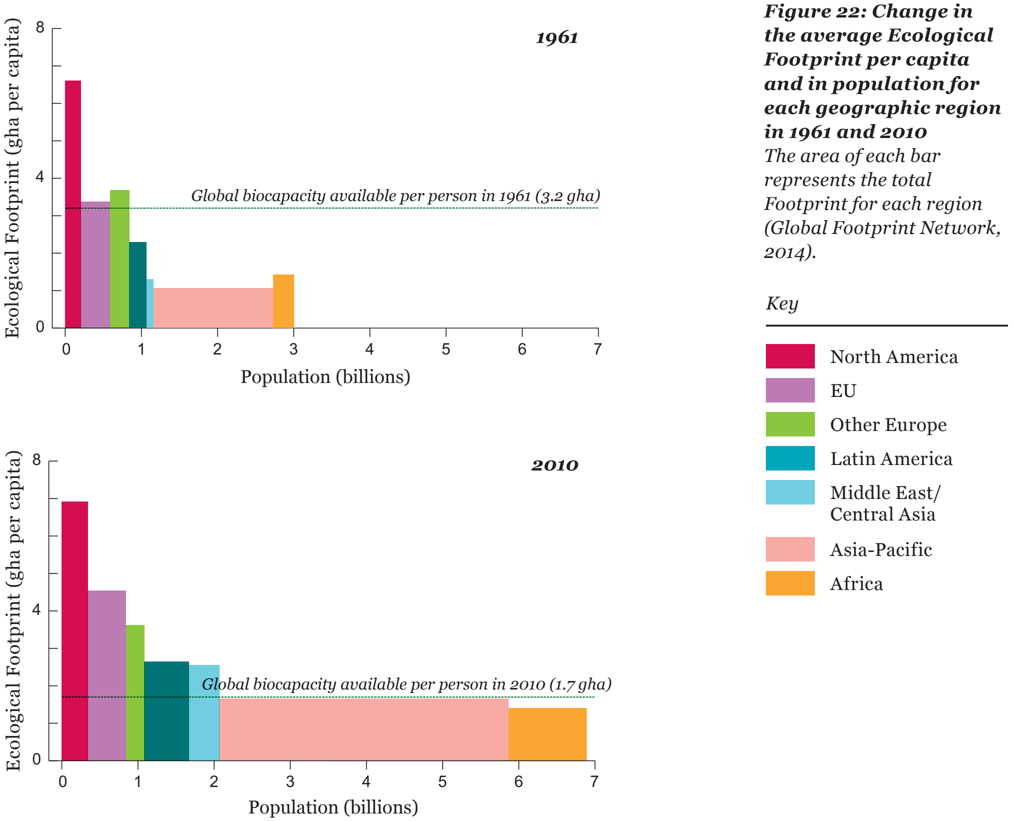


Figure 22: Change in the average Ecological Footprint per capita and in population for each geographic region in 1961 and 2010
The area of each bar represents the total Footprint for each region (Global Footprint Network, 2014).

In regions where population has grown at a faster rate than per capita consumption, population is the dominant force behind total Footprint gains. In Africa, Footprint growth is almost entirely driven by population gains: its population increased by 272 percent, but its per capita Footprint remained essentially unchanged. In North America, Latin America, the Middle East/Central Asia and Asia-Pacific, both population and per capita consumption changes are driving Footprint growth, but population increases are the main driver. In the EU, population growth and per capita growth contribute roughly equally. Only the non-EU European countries experienced a decline in total Footprint during this period, resulting predominately from a decline in population.

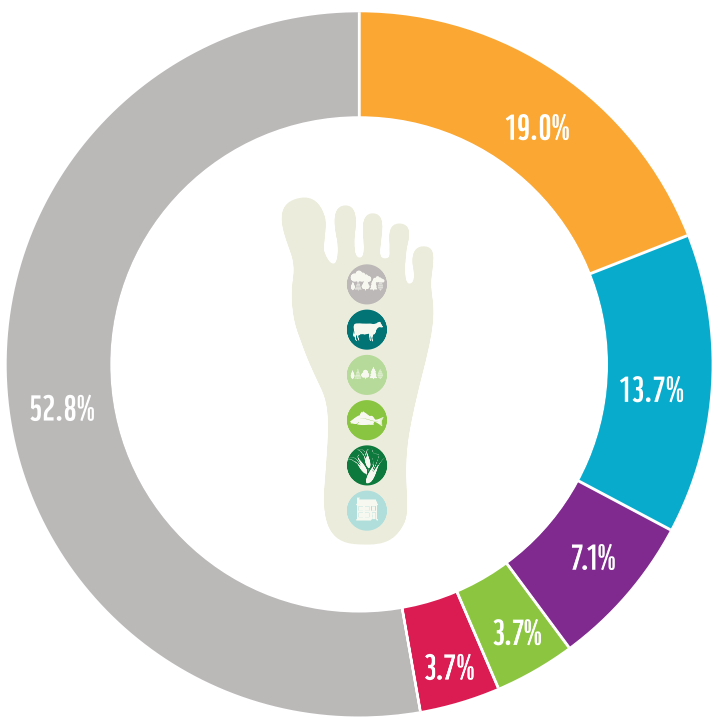
Ranking countries by total and per capita Ecological Footprint produces very different results.

The Ecological Footprint of the top five countries makes up about half the global total (Figure 24). Analysis of the 2014 National Footprint Accounts reveals that just two countries generated 31 per cent of the world's total carbon Footprint: China (16 per cent) and the USA (15 per cent). China is ranked 76th in its per capita Footprint (Figure 23), but with the world's biggest national population it has the planet's largest total Footprint. The population of the USA is around a quarter of that of China, but its total Footprint is almost as large because of its greater per capita consumption. Similarly, when multiplying population with per capita demand, India shifts from the 136th-largest Footprint per capita to the third largest in total, Brazil from 53rd to fourth, and Russia from 42nd to fifth.

Figure 24: Share of total Ecological Footprint among the top five countries with the highest demand and the rest of the world *(Global Footprint Network, 2014).*

Key

- China
- United States of America
- India
- Brazil
- Russia
- Rest of world



The size and composition of a nation's per capita Ecological Footprint reflects the goods and services used by an average person in that country, and the efficiency with which resources, including fossil fuels, are used in providing these goods and services. Not surprisingly, of the 25 countries with the largest per capita Ecological Footprint, most were high-income nations; for virtually all of these countries, carbon was the biggest Footprint component.

A nation's Footprint can exceed its own biocapacity – that is, it can operate with an ecological deficit – by harvesting ecosystems faster than they regenerate, drawing on resources that have accumulated over time; by importing products, and thus using the biocapacity of other nations; and/or by using the global commons, for instance by releasing carbon dioxide emissions from fossil fuel burning into the atmosphere.

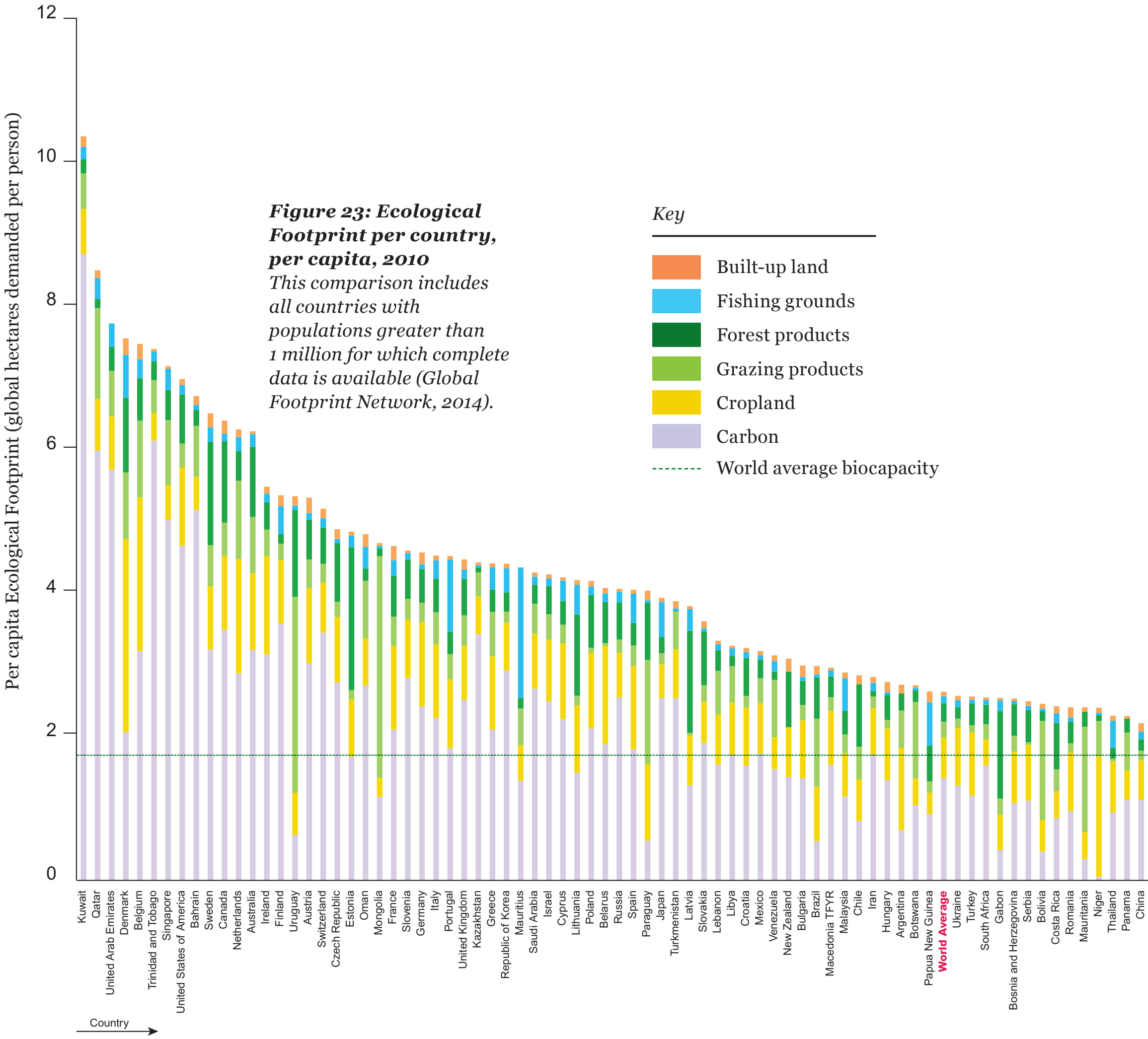
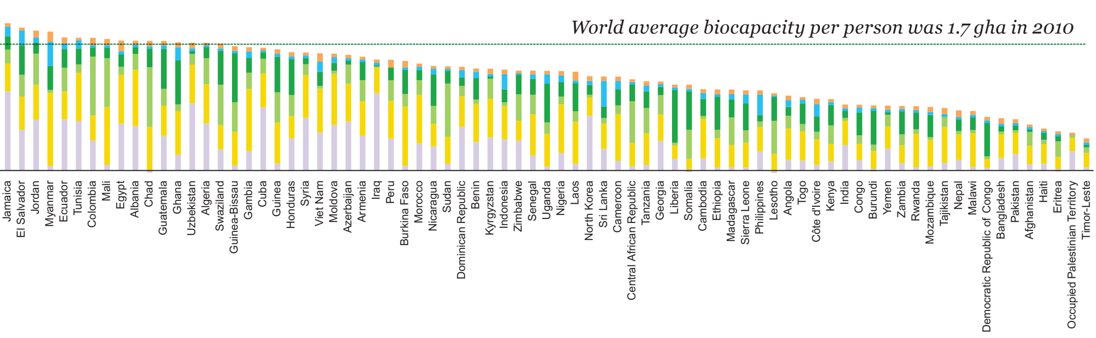


Figure 23: Ecological Footprint per country, per capita, 2010
This comparison includes all countries with populations greater than 1 million for which complete data is available (Global Footprint Network, 2014).

In 2010, the most recent year for which data is available, per capita Ecological Footprint exceeded global per capita biocapacity (1.7 gha) in 91 of the 152 countries (Figure 23). At a national level the carbon component represents more than half the Ecological Footprint for a quarter of all countries tracked. In fact the carbon Footprint is the largest single component for approximately half of all countries tracked.

Contributions to the global ecological overshoot vary across nations. For example, if all people on the planet had the Footprint of the average resident of Qatar, we would need 4.8 planets. If we lived the lifestyle of a typical resident of the USA, we would need 3.9 planets. The figure for a typical resident of Slovakia, or South Korea would be 2, or 2.5 planets respectively, while a typical resident of South Africa or Argentina would need 1.4 or 1.5 planets respectively.

AT A NATIONAL LEVEL THE CARBON FOOTPRINT REPRESENTS MORE THAN HALF THE ECOLOGICAL FOOTPRINT FOR A QUARTER OF ALL COUNTRIES TRACKED



Biocapacity

In 2010, Earth's biocapacity was approximately 12 billion global hectares (gha) – which amounts to about 1.7 gha for every person on the planet. This biologically productive land must also support the 10 million or more wild species with which we share the planet.

Human demands on nature vary considerably from country to country, and the biocapacity that provides for this demand is unevenly spread across the globe (Figure 25). A biocapacity-wealthy nation does not necessarily have a biocapacity "reserve". Even in nations with high biocapacity, local, national and international demand can exceed availability.

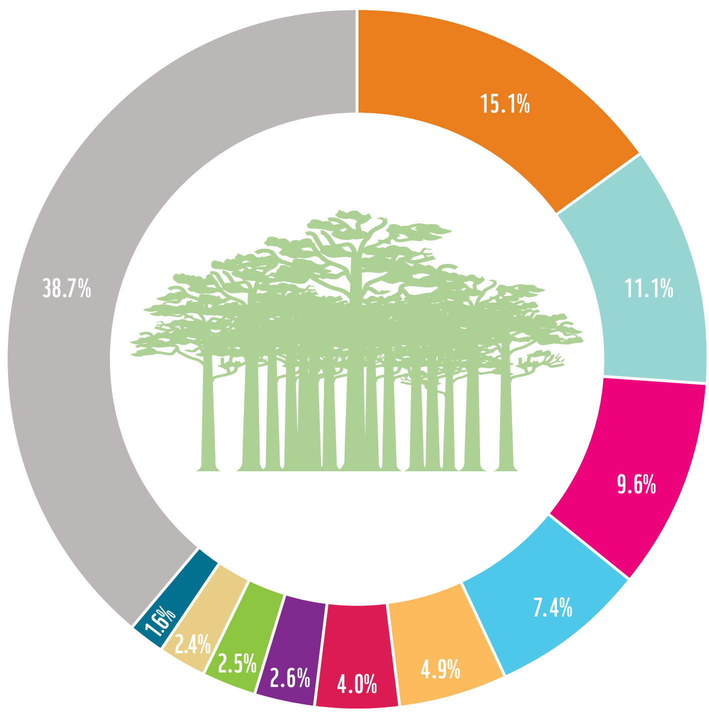
The number of nations whose Footprint exceeds their biocapacity has been steadily increasing with each passing year. Domestic demands continue to rise as a result of increasing populations and growth in per capita consumption. And for many nations, their biocapacity is subject to even greater pressure as more and more biocapacity is used to meet export demands.

THE NUMBER OF NATIONS WHOSE FOOTPRINT EXCEEDS THEIR BIOCAPACITY HAS BEEN STEADILY INCREASING WITH EACH PASSING YEAR. AS RESOURCES BECOME CONSTRAINED, COMPETITION IS GROWING – WHICH COULD HAVE INCREASINGLY SIGNIFICANT ECONOMIC, SOCIAL AND POLITICAL IMPLICATIONS

Almost 60 per cent of the world's total biocapacity is located in just 10 countries (Figure 26).

For most countries with a high biocapacity per capita, the forest land component represents the largest proportion of total biocapacity. Forests are particularly significant ecosystems because they provide services not only to local users, but also to others. As well as harbouring great biodiversity, they play a significant role in climate stability through storing and sequestering carbon, and in the water cycle – the subject of the next section.

Figure 26: Top 10 national biocapacities in 2010
Ten countries accounted for more than 60 per cent of the Earth's total biocapacity in 2010. They include five of the six BRIICS countries: Brazil, Russia, India, Indonesia and China (Global Footprint Network, 2014).



Key

- Brazil
- China
- United States of America
- Russia
- India
- Canada
- Indonesia
- Australia
- Argentina
- Democratic Republic of Congo
- Rest of world

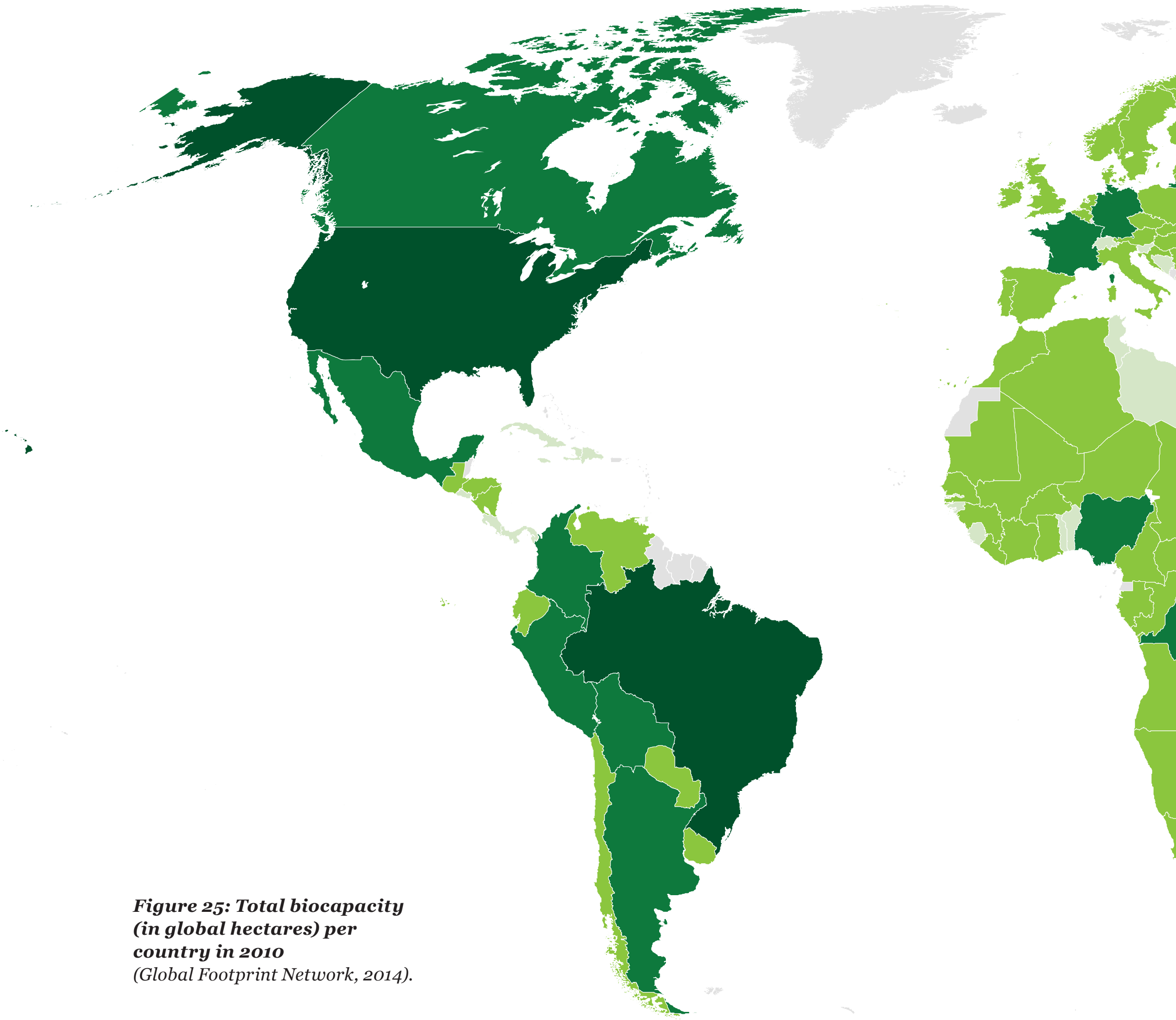


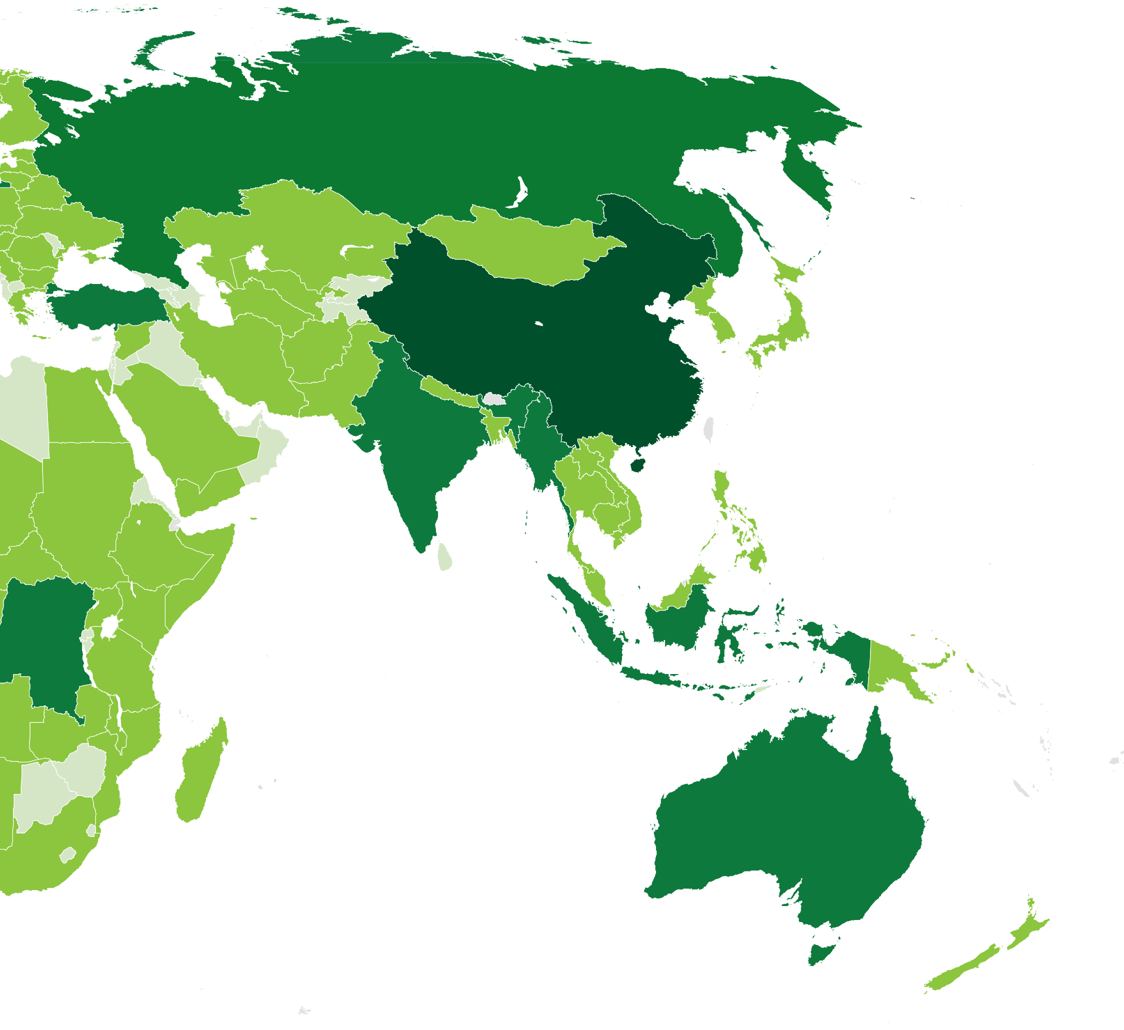
Figure 25: Total biocapacity (in global hectares) per country in 2010
(Global Footprint Network, 2014).

Key

Data are given in global hectares (gha)

- < 10 million
- 10 - 100 million
- 100 - 1,000 million
- > 1,000 million
- Insufficient data

EMBARGOED until 30 Sept 2014 - 00:01 CET



WATER FOOTPRINTS

In the fishing village of Vitshumbi on the southern shores of Lake Edward, people depend on fresh water from the lake. Lake Edward, part of a wetland of international importance, was the focus for Soco's oil exploration. A spill here could be devastating.

Fresh water is a precious resource. More than a third of the world's population lives in river basins that experience severe water shortages for at least one month each year (Hoekstra and Mekonnen, 2012). This number is likely to grow as human demands increase and climate change makes rainfall patterns more extreme and erratic.

EMBARGOED until 30 Sept 2014 - 00:01 CET

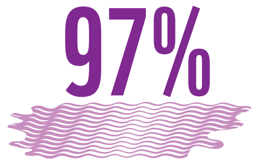
The water footprint

Water is the basis of life, yet there is a finite amount available. Some 97.5 per cent of our planet's water is salt water. Almost all of the remaining fresh water is locked up in glaciers and ice caps, or in aquifers deep under the surface (Postel et al., 1996). A fraction of 1 per cent of water is renewed each year by the hydrological cycle, and this amount is unevenly distributed. This means that some countries have an abundance of freshwater sources and others clearly do not.

The course of human development has been greatly influenced by the availability of water resources. The first significant human settlements were established alongside freshwater bodies, and great civilizations developed and spread along their waterways. The 20th century saw huge advances in technology and humans' ability to harness nature for productive purposes. Societies developed infrastructure projects, for instance building large dams to support irrigation, hydropower, and industrial and urban development. This development had huge impacts on the growth of nations and economies. However, much of this success has come at a cost, with rivers and aquifers in many parts of the world polluted, impaired or dried up.

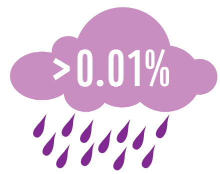
Communicating the importance of water in modern society has been challenging because of our disconnection from natural water sources. For many, water simply comes from a tap. Yet more than ever, the need to reconnect our societies and economies to water is urgent. Water is used in some form in almost all food production and manufacturing processes. Products may be viewed as containing the quantity of water used in their production – this is referred to as a "water footprint".

Water footprint is made up of three types of water use, known as blue, green and grey water footprints. The green water footprint is the volume of rainwater stored in soil that evaporates through crop growth. The blue water footprint is the volume of freshwater taken from surface (lakes, rivers, reservoirs) and ground water (aquifers) that is used and not returned to the system it was withdrawn from. The largest share of global blue water footprint occurs in crop fields as a result of evaporation of irrigation water. There is no green water footprint of household and domestic water uses, although they do show blue and grey water footprints. The grey water footprint is the volume of water polluted as a result of production processes (industrial and agricultural) and from waste water from household water use. It is the volume of water required to dilute pollutants to such an extent that the water quality reaches acceptable levels.



Some 97.5 percent of our planet's water is salt water

Almost all of the remaining fresh water is locked up in glaciers and ice caps, or in aquifers deep under the surface



A fraction of 1 percent of water is renewed each year by the hydrological cycle

The available fresh water is unevenly distributed

The water footprint has both temporal and spatial elements, according to when and where water is used. The “where” question leads us to the local context: the impact of the same water footprint will, of course, be very different in a region where fresh water is scarce, compared to one where it is abundant. Equally, countries with ample water resources at a national level may contain areas of scarcity. The “when” aspect helps us to understand the variability in the availability and consumption of water resources through the year in a given place. With climate change expected to make rainfall patterns more erratic and intense, the question of “when” will become even more important.

The concept of the water footprint helps governments, businesses and individuals to better understand how we use water in our lives and economies. It has exposed our often hidden dependence on this vital resource, and the vulnerability this implies. The water footprint provides an indicator of both direct and indirect use of freshwater. The water footprint of production includes all the water a country uses to produce goods and services, whether they are consumed locally or exported, expressed in cubic metres of water. The water footprint of production can help us understand and link supply chains and economic activities to areas of water stress or pollution.

Green water footprint
The volume of rainwater stored in soil that evaporates through crop growth.

Blue water footprint
The volume of freshwater taken from surface (lakes, rivers, reservoirs) and ground water (aquifers) that is used and not returned to the system it was withdrawn from.

Grey water footprint
The volume of water polluted as a result of production processes (industrial and agricultural) and from waste water from household water use. It is the volume of water required to dilute pollutants to the extent that the water quality reaches acceptable levels.

Water footprint of national production

Each country plans how it will use water to meet the needs of its people, economy and environment. In many ways, water shapes how economies develop, and determines which sectors are viable and which are not. The water footprint of production helps to reflect this, by accounting for all of the water used within a country for household, industrial and agricultural purposes, regardless of where the products are actually consumed.

Figure 27 shows the water footprint of production for the countries with the 20 largest water footprints in the world. The bars indicate the absolute amount of water use, separated into green and blue water footprints. The different coloured dots indicate the relative stress within these countries. These averages mask regional and river basin dynamics. More detailed analysis of river basin stress is needed to better understand local dynamics, issues and remedies (see the hydrograph in Figure 30 for one example).

National water footprint statistics are useful for identifying water hotspots on one level; the national water footprint of production bars in Figure 27 give a useful picture of overall impact. However, as mentioned above, national statistics can often mask basin-level realities: while most of the top 20 countries shown have an apparently healthy ratio of blue water footprint to blue water availability, they include many river basins that suffer severe water scarcity for at least part of the year. River basin information always tells a more relevant story, which is why the delineation in Figure 29 is an important improvement on our understanding of water footprint metrics.

NATIONAL WATER FOOTPRINT STATISTICS ARE USEFUL FOR IDENTIFYING WATER HOTSPOTS. HOWEVER, THEY CAN MASK BASIN-LEVEL REALITIES. MANY RIVER BASINS OF THESE TOP 20 COUNTRIES SUFFER SEVERE WATER SCARCITY FOR AT LEAST PART OF THE YEAR

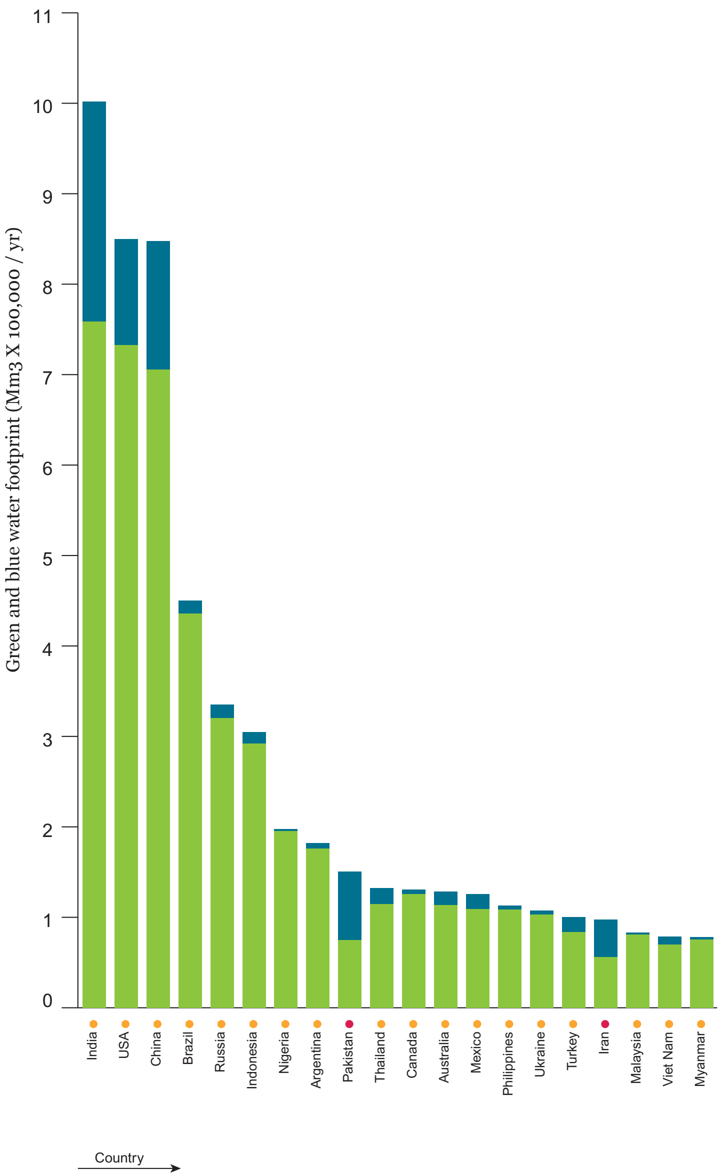


Figure 27: Water footprint of national production of top 20 countries with indication of overall risk of blue water scarcity
(Hoekstra and Mekonnen, 2012).

Key

Blue

Green

Stress on blue water resources
The different coloured dots represent total blue water footprint of production expressed as the ratio of blue water footprint to blue water availability.

0-20%

20-50%

Most of the world's food comes from rain-fed agriculture: seven times more green water than blue water is used in agricultural production (6,884 billion m³ compared to 945 billion m³). Agricultural production accounts for 92 per cent of the global water footprint, with 78 per cent of world crop production relying on rainfall. Industrial production takes up 4.4 per cent, while 3.6 per cent is used for domestic water supply. Approximately one-fifth of the global water footprint relates to production for export – 19 per cent in the agricultural sector and 41 per cent for industry (Hoekstra and Mekonnen, 2012).

Opportunities exist to significantly increase the productivity of both rain-fed and irrigated agriculture in many regions. At the same time, green water-based production will become increasingly vulnerable in some areas due to climate change affecting rainfall patterns. There will also be areas where rainfall will increase, presenting opportunities for new regions. Irrigation has increased agricultural productivity significantly, but in some cases has also increased water scarcity downstream. Irrigation is sometimes poorly monitored and managed, and groundwater may be pumped faster than it is recharged, calling into question its sustainability. Again, context is all-important: while some countries are discovering significant groundwater reserves, in other parts of the world – such as Australia, India and USA – these life-giving aquifers are

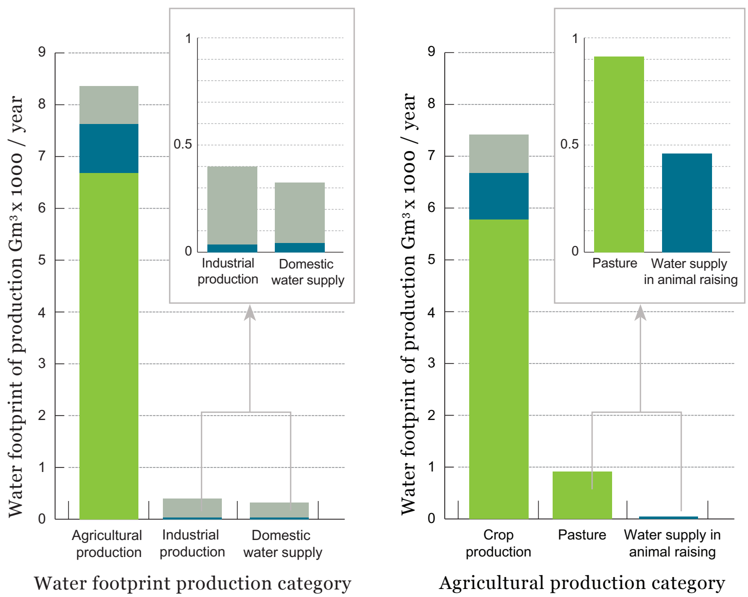


Figure 28: Breakdown of the global blue green and grey water footprint of production in billion m³/year, 1996-2005
A further breakdown shows that the agriculture sector has the largest water footprint, dominated by the green water component (Hoekstra and Mekonnen, 2012).

Key

- Green water
- Blue water
- Grey water

being severely depleted. Developing new underground freshwater resources can help increase food production, but best management practices and water stewardship principles need to be applied to avoid any negative impacts on people and nature in the long term.

While water needs to be monitored and managed at a river basin or catchment level, the water footprint assessment helps to provide an insight into global pressures and risks. It is not feasible to transport large quantities of actual water around the world, but a water-scarce country can import crops and products from other countries. Trade can help to alleviate local water shortages – but it can also exacerbate them.

Globally, the number of people affected by absolute or seasonal water shortages is projected to increase steeply – owing to climate change and increasing water demands (Schiermeier, 2013; Hoekstra and Mekonnen, 2012). In this context, understanding the impact that food and fibre production has on water resources is vital in order to secure adequate supplies for people and ecosystems.

Blue water scarcity

Stress on blue water resources is calculated on a monthly basis with more than 200 river basins, home to some 2.67 billion people, already experiencing severe water scarcity for at least one month every year (Hoekstra and Mekonnen, 2012).

In many cases, the blue water footprint leaves rivers incapable of maintaining natural environmental flows: "the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems" (Global Environmental Flows Network, 2007 and Hoekstra et al., 2012). The freshwater LPI reflects the impact of lower environmental flows on species, with a decline of 76 per cent since 1970 – a steeper fall than for marine and terrestrial ecosystems.

MORE THAN 200 RIVER BASINS, HOME TO SOME 2.67 BILLION PEOPLE, ALREADY EXPERIENCE SEVERE WATER SCARCITY FOR AT LEAST ONE MONTH EVERY YEAR

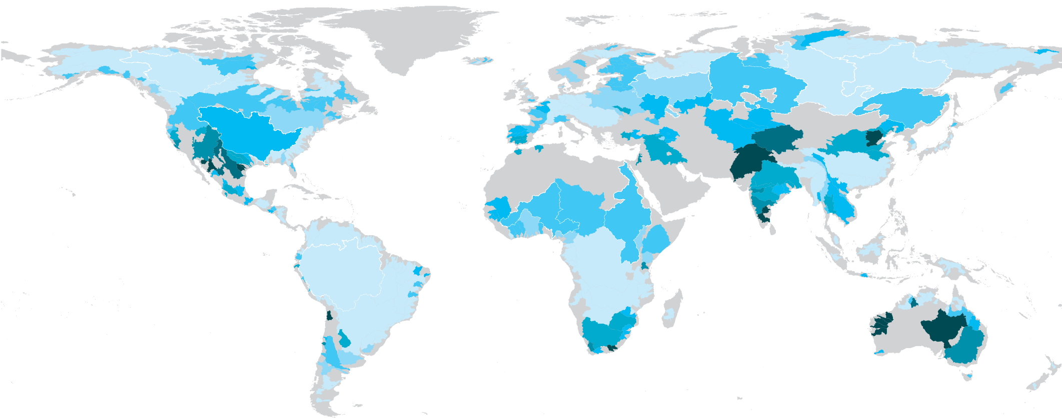
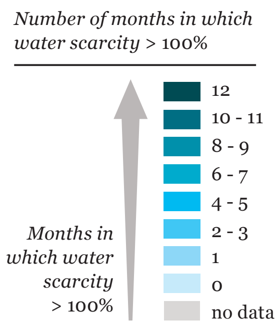


Figure 29: Blue water scarcity in 405 river basins between 1996 and 2005
The darkest blue shading indicates river basins where more than 20% of water available in the basin is being used throughout the year. Some of these areas are in the most arid areas in the world (such as inland Australia); however, 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).



The countries with the largest water footprint of production – China, India and the USA – also suffer moderate to severe water scarcity in different regions, at different times of the year. The USA is the largest exporter of cereal crops; however recent droughts have resulted in lower total crop yields with subsequent impacts on food prices. If, as projected, extreme weather events exacerbated by climate change become more frequent and unpredictable, it will impact global food trade – especially for importing countries that rely on water-intensive commodities for basic needs. Meanwhile, growing water demands and scarcity in China and India – countries that are largely self-sufficient in most foods – could lead to an increased dependence on imports, placing more pressure on global food trade. Considering that these two countries make up more than a third of global population, these trends could have significant consequences on food prices globally.

EXTREME WEATHER EVENTS DUE TO CLIMATE CHANGE COULD SEVERELY IMPACT GLOBAL FOOD TRADE – ESPECIALLY FOR IMPORTING COUNTRIES THAT RELY ON WATER-INTENSIVE COMMODITIES FOR BASIC NEEDS

The Mekong hydrograph

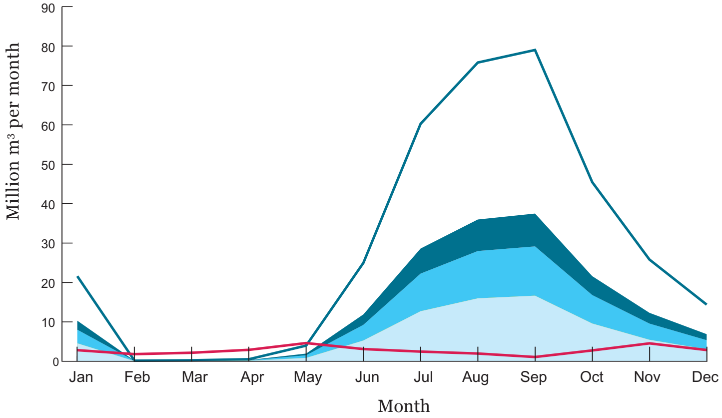


Figure 30: Mekong hydrograph: Water scarcity over the year for the Mekong basin (monthly average for the period 1996-2005) *The river run-off is divided into four zones of different shades of blue and white, based on presumptive environmental flow requirements. The actual blue water footprint is plotted over the hydrograph as a solid thick red line. If the line falls in the pale blue zone, 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, respectively, in that part of the year (Hoekstra et al., 2012).*

Key

- Natural run-off
- More than 40%
- 30 - 40%
- 20 - 30%
- 0 - 20%
- Blue water footprint

Figure 30 shows the hydrograph of the Mekong River. While seasonal flows vary from year to year, competition for water resources becomes critical during the dry season (February – April) when withdrawals exceed river flows. Water needs in the Mekong include irrigation, domestic and industrial uses, navigation of ships and adequate water delivery to the delta to minimize the risk of salt water intrusion, as well as to maintain minimum acceptable environmental flows (Mekong River Commission, 2005).

Dams are now being constructed on the main stem of the Mekong River. These developments are expected to affect flows and water demands, for example through increased irrigation for agriculture to replace lost fish protein. These increasing or modified demands are not yet well understood, especially in terms of the effect on seasonal supply. With the Mekong already experiencing water scarcity during the dry season, as the figure shows, the impact could be significant.

LOCAL NEEDS, GLOBAL PRESSURES

In the weekly market in Vitshumbi, people buy fresh vegetables and freshly caught fish from Lake Edward.

Few countries are richer in biocapacity and natural resources than DRC. Yet its inhabitants have one of the lowest Ecological Footprints on the planet, and the country sits rock bottom of the UN inequality-adjusted Human Development Index.

Oil extraction in Virunga, to help fuel the unsustainable lifestyles of higher-income countries, might bring short-term profits to a few. But it's unlikely to deliver real development: In the Niger Delta, poverty and inequality indicators have worsened since the discovery of oil. In the long term, the only way for the Congolese people to meet their needs and improve their prospects is through sustainable management and wise use of the country's natural capital.

People, consumption and development

It is impossible to fully understand the pressures being placed on the planet without considering the trends and implications of a growing global population. Human population demographics and dynamics have immense implications for virtually every environmental issue. Equally important, are consumption and rising wealth within these populations. This will affect where and how intensively resources are used, their quality and availability, and who is able to access them.

The world's total population today is already in excess of 7.2 billion, and growing at a faster rate than previously estimated. Revised estimates suggest that world population is likely to reach 9.6 billion by 2050 – 0.3 billion larger than under earlier UN projections (UNDESA, 2013a). Much of this growth is occurring in least developed countries (UNDESA, 2013b).

Population is unevenly distributed across the planet: 25 per cent of the world's 233 countries hold 90 per cent of the population (UNDESA, 2013b). Further, half of all future population growth is expected to occur in just eight countries: Nigeria, India, Tanzania, the Democratic Republic of Congo (DRC), Niger, Uganda, Ethiopia and the USA (UNDESA, 2013b). Of these countries, Nigeria will experience the most growth, and is expected to become the third most populous country in the world by 2050 (behind China and India). While the first seven countries have relatively low per capita Ecological Footprints, the USA has one of the world's highest.

Population and natural resources

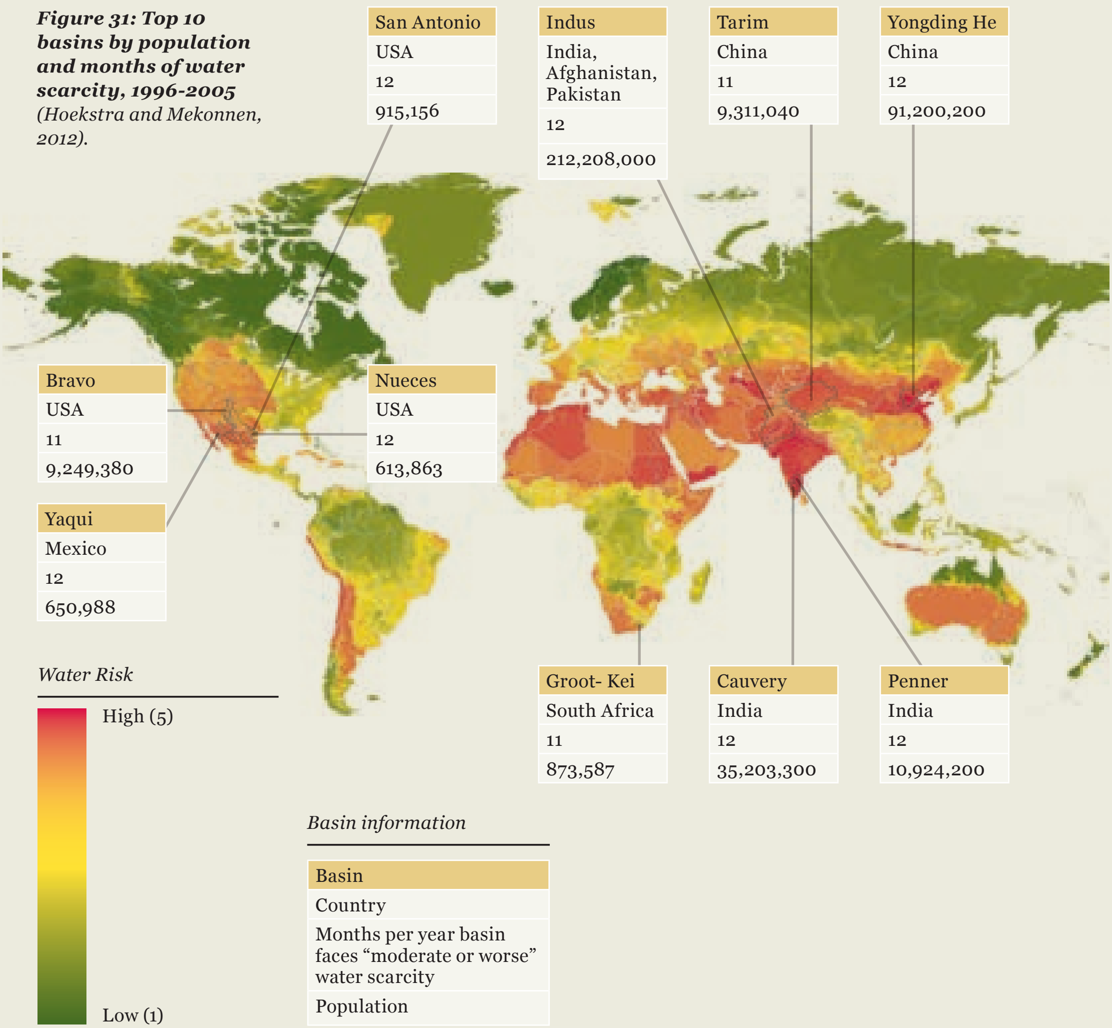
Just as population is not evenly distributed around the world, nor are natural resources or their use. This raises questions around the ability of individual countries to maintain the quality of their natural resources and meet the resource needs of their growing populations in the context of global consumption patterns.

Population and consumption trends will inevitably increase pressure on limited available natural resources, ecosystems, societies and economies – and lead to further disparity in resource availability with consequences that will be felt locally and globally.

Box 2: Water scarcity in river basins directly impacts people, agriculture and industries

India, China and the USA – the three countries with the highest water footprint of production – also contain 8 of the top 10 most populous basins experiencing almost year-round water scarcity (Figure 31). High levels of water scarcity – a dire situation for local populations – are likely to be compounded by climate change, further population growth and the rising water footprint that tends to accompany growing affluence. This has implications not just for the hundreds of millions of people directly affected, but also for the rest of the world.

Figure 31: Top 10 basins by population and months of water scarcity, 1996-2005 *(Hoekstra and Mekonnen, 2012).*



The Ecological Footprint shows that in the last 50 years, the planet's total biocapacity has increased from 9.9 to 12 billion gha (Figure 32). However, during the same period, the global human population increased from 3.1 billion to 6.9 billion, and per capita Ecological Footprint increased from 2.5 to 2.6 gha (Figure 33).

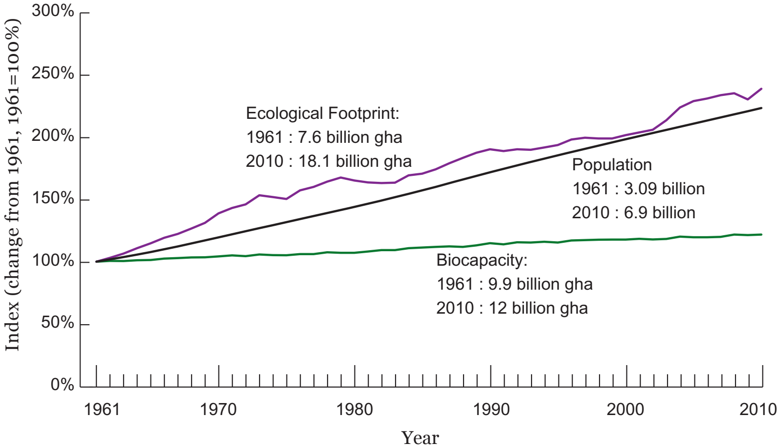


Figure 32: Trends in total biocapacity, Ecological Footprint and world population from 1961 to 2010 *(Global Footprint Network, 2014).*

Key

- Biocapacity
- Ecological Footprint
- Population

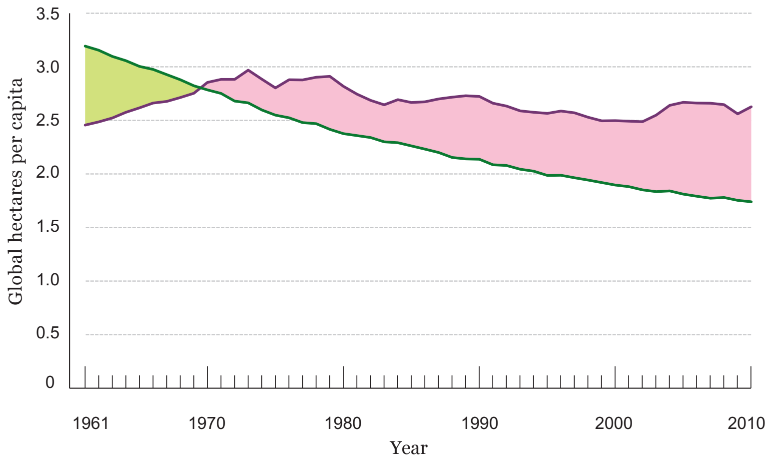
THE INCREASE IN THE EARTH'S PRODUCTIVITY HAS NOT BEEN ENOUGH TO COMPENSATE FOR THE DEMANDS OF THE GROWING GLOBAL POPULATION

Despite technological advances, agricultural inputs and irrigation that have boosted the average yields per hectare of productive area, especially for cropland, biocapacity per capita has reduced from 3.2 to 1.7 gha. This increased exploitation of ecological resources has, in many cases, come at the expense of the efficiency, quality and health of ecosystem functions. As a result, the world has fallen further behind in its quest for a sustainable future.

Figure 33: Trends in Ecological Footprint and biocapacity per capita between 1961 and 2010
(Global Footprint Network, 2014).

Key

Biocapacity reserve
Biocapacity deficit
Ecological Footprint per person
Biocapacity per person



THE DECLINE IN BIOCAPACITY PER CAPITA IS PRIMARILY DUE TO AN INCREASE IN GLOBAL POPULATION: MORE PEOPLE HAVE TO SHARE THE EARTH'S RESOURCES

LPI, Ecological Footprint and income

Living Planet Index

Comparing *Living Planet Index* trends in countries with different average levels of income shows stark differences (Figure 34). While high-income countries appear to show an increase (10 per cent) in biodiversity, middle-income countries show decline (18 per cent), and low-income countries show dramatic and marked decline (58 per cent). These differences may reflect the ability of higher-income countries to allocate resources to biodiversity conservation and restoration domestically. More importantly, they may also reflect the way these countries import resources – effectively outsourcing biodiversity loss and its impacts to lower-income countries (Lenzen et al., 2012).

Furthermore, the LPI database only dates back to 1970. If the baseline were extended to the beginning of the 20th century, or earlier, the LPI would likely reflect an overall decline for high-income countries. In Europe, North America and Australia, populations of many species were heavily impacted and exploited before 1970, and increases since then are most likely a result of recoveries from previously depleted levels.

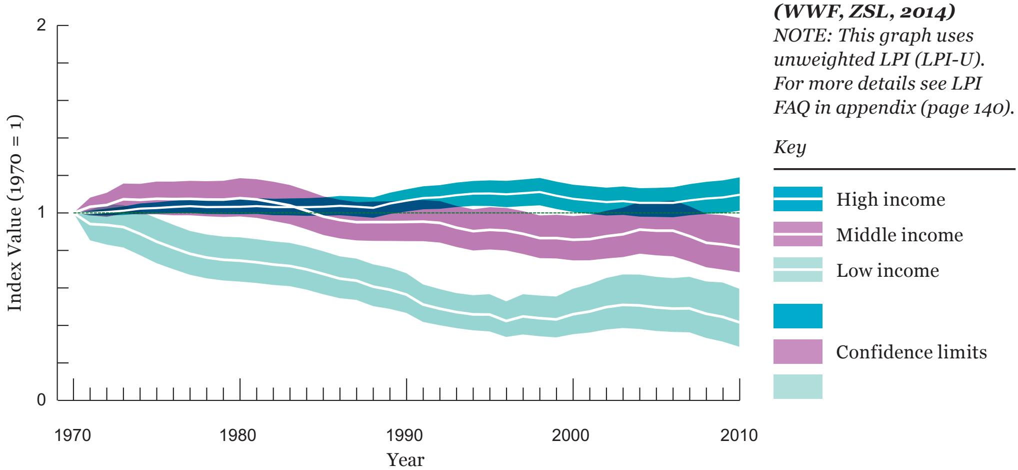


Figure 34: LPI and World Bank country income groups (2013) (WWF, ZSL, 2014)
NOTE: This graph uses unweighted LPI (LPI-U). For more details see LPI FAQ in appendix (page 140).

Ecological Footprint

Comparing the average per capita Ecological Footprints of groups of high-, medium- and low-income countries (Figure 35) shows that high-income countries have maintained high levels of consumption, but this trend fluctuates with the global economy. Events such as oil crises (in the 1970s) and recessions in the 1980s and 2000s shocked economies – and significantly reduced resource demands. However, with subsequent economic recovery came increasing consumption. Demands on resources – which increased during the hyper-growth period of the early 2000s – dropped when the world's economies started to contract in 2007.

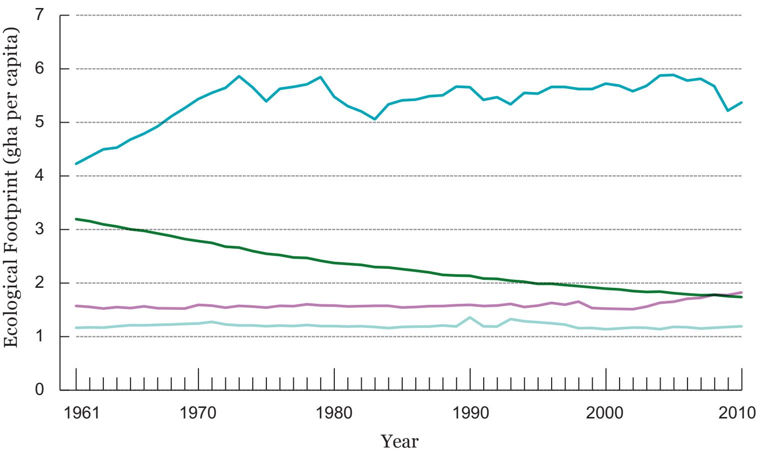


Figure 35: Ecological Footprint (gha) per capita in high-, middle- and low-income countries (World Bank classification and data) between 1961 and 2010
The green line represents world average biocapacity per capita (Global Footprint Network, 2014; World Bank, 2013).

Key

- High income
- Middle income
- Low income
- World biocapacity

High-income countries' use of ecological resources and services is still about five times more per capita than that of low-income countries. High-income countries often rely on the biocapacity of other nations or the global commons to meet their consumption demands. While importing biocapacity may be financially affordable for high-income countries today, prices could change, or ecological constraints could disrupt supply chains.

Middle- and low-income nations typically have smaller per capita Footprints. Nevertheless, nearly half of the middle- and low-income nations live on per capita Footprints lower than 1.7 gha – the maximum per capita Footprint that could be replicated worldwide without resulting in global overshoot. Even a Footprint of this size would mean that humanity claims the entire biocapacity of the planet, leaving no space for wild species.

The path to sustainable development

For a country's development to be replicable worldwide, it must have a per capita Ecological Footprint no larger than the per capita biocapacity available on the planet, while maintaining a decent standard of living. The latter can be defined as a score of 0.71 or above on the UNDP's inequality-adjusted Human Development Index (IHDI) (UNDP, 2013). Currently, no country meets both of these criteria (Figure 36).

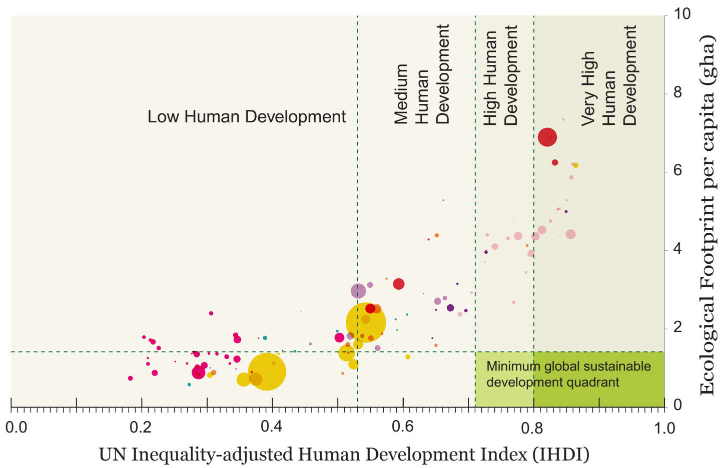


Figure 36: Correlating the Ecological Footprint with IHDI (latest data sets)
The dots representing each country are coloured according to their geographic region and scaled relative to their population (Global Footprint Network, 2014; UNDP, 2013).

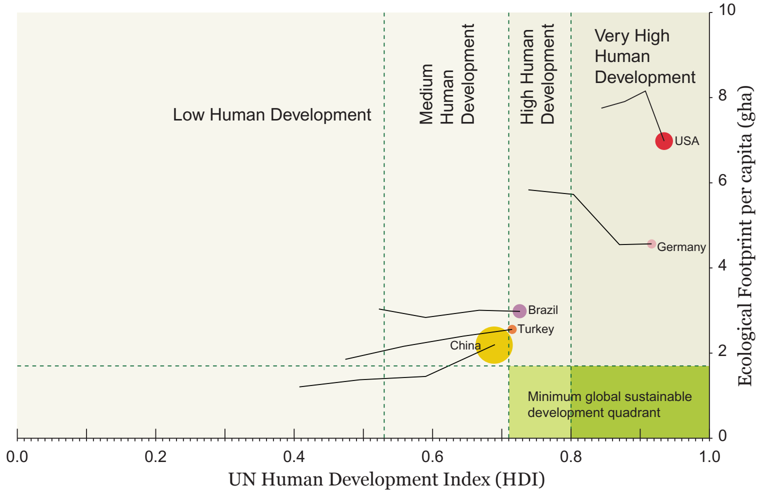
Key
- Africa
- Middle East/ Central Asia
- Asia -Pacific
- South America
- Central America/ Caribbean
- North America
- EU
- Other Europe

The path of progression to achieve sustainable development varies between countries. Development and improved living standards are, up to a point, linked to growing consumption of ecological services: the high human development in developed countries has been achieved at the expense of a high Ecological Footprint. Decoupling and reversing this relationship is a key global challenge. The challenge for countries in the bottom-left sector is to significantly increase their IHDI without significantly increasing their Ecological Footprint and for countries in the upper-right sector – with high IHDI – to reduce their Footprints.

With 10-year data intervals of HDI available (IHDI was not introduced until 2010), a plot of HDI versus Ecological Footprint is able to show countries' direction of progression (Figure 37). While not adjusted for inequality – which tends to be greater in countries with low HDI – trends of several selected countries show that they have improved their level of human development since 1980.

China and the USA show the most striking movement. The growth in China's HDI has been accompanied by accelerating resource use, particularly in the last decade. The USA's per capita Ecological Footprint trended upward between 1980 and 2000 until

Figure 37: The Ecological Footprint in relation to HDI.
Time trends (1980-2010) are shown for a small selection of countries. The dotted lines mark the HDI thresholds for low, medium, high and very high human development (Global Footprint Network, 2014; UNDP, 2013). NOTE: In this graph HDI is not inequality-adjusted.



it sharply declined during the onset of the recent global financial crisis. Brazil, whose Footprint and HDI values are slightly higher than China's, has achieved a decent standard of living as measured by the HDI (though its IHDI score is lower) while barely increasing its per capita Ecological Footprint over the last 50 years. Turkey's HDI has also increased significantly since 1980; it has nearly caught up with Brazil in terms of absolute HDI value, while maintaining a slightly lower Ecological Footprint per capita.

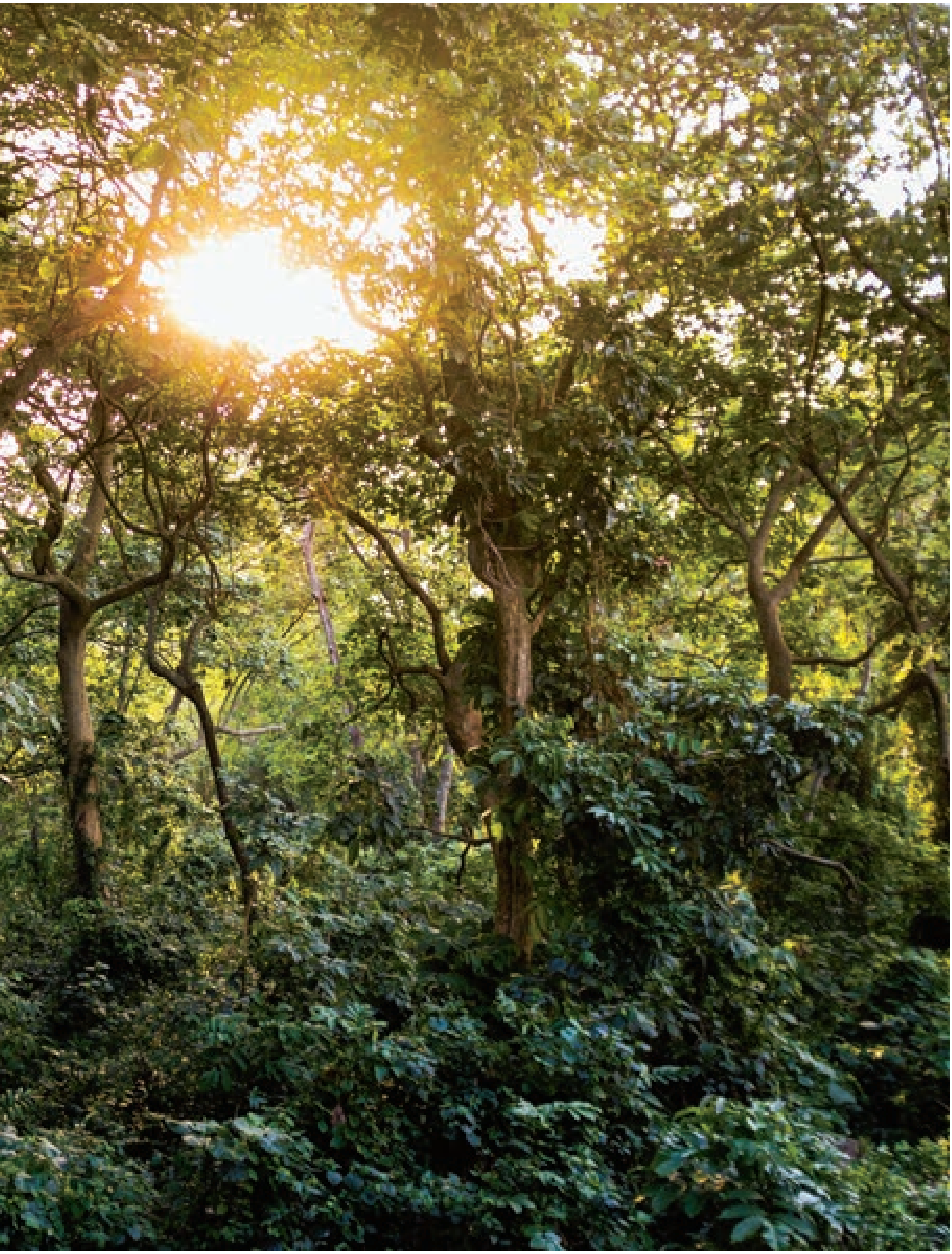
China, Brazil and Turkey are on track to reach the HDI level that Germany had in 1980 but with a relatively lower per capita Footprint. The 1990 reunification of East and West Germany was followed by slow population growth and a downward trending carbon Footprint, which contributed to Germany's total Footprint reduction over the next decade. Germany's per capita Footprint is still more than twice the per capita biocapacity available for the planet as a whole. However, it has continued to increase its HDI since 2000 while maintaining a relatively constant Footprint.

Each country may follow a different path toward sustainability; the challenge is determining how to reduce resource consumption by design while improving human development. Whatever a country's resource and economic wealth, each needs a national development strategy that addresses the reality of global biocapacity limits and the role biodiversity and ecosystems play in supporting human existence and enterprise. By recognizing nations' specific challenges and opportunities today, it is possible to work toward a future of secure natural resources that enables social improvement and prosperity globally.

SECRETS AND SERVICES

With its diverse landscapes and habitats, Virunga contains some of the richest biodiversity on the planet. As well as being a priceless part of our common heritage, it has huge educational and research value. Its hundreds of plant species contain secrets that could one day yield a medical breakthrough.

The forests of the Congo Basin help generate rainfall, and absorb and store carbon, to the benefit of all. With the carbon Footprint making up more than half of humanity's Ecological Footprint, and CO_2 levels in the atmosphere already at levels unprecedented in human history, protecting Virunga's forests is more important than ever.



CHAPTER 2: DEVELOPING THE PICTURE

The indicators presented in the previous chapter show some stark truths. The LPI reflects a steep decline among many populations of the species that help to sustain life on Earth. The Ecological Footprint shows that we are using ecological services at a faster rate than the planet can replenish. The water footprint demonstrates the effects of humanity's demands on increasingly scarce freshwater resources.

Other indicators, ways of thinking and areas of research reinforce these messages – complementing, deepening and extending the concepts discussed in chapter 1. A growing number of metrics and methodologies help us to understand more about the health of the planet, our impact upon it, and the possible implications. We can change our perspective and adjust our focus, panning out to look at global issues, or zooming in on specific regions, themes or species.

This chapter looks at a selection of these different perspectives. The Stockholm Resilience Centre outlines nine "planetary boundaries" beyond which we are in danger of crashing Earth's life-support systems. This leads into discussion of two areas where these boundaries appear to have already been crossed – climate change and the nitrogen cycle – as well as the implications for social equity. The section that follows gives examples of models and measures that can be scaled down from a global to a local or regional context for analysing changes to terrestrial, marine and freshwater ecosystems.

Indicators guide decisions: they do not just show us where we are, they also signal the direction in which we are going. They allow nations, businesses and institutions to measure progress toward achieving their social, economic and environmental goals and to account for associated trade-offs and risks. Their value is in the insights they offer that can be acted upon.

This planet is a complex place. No single metric can hope to capture all of the elements and dynamics of nature's complex, interconnected systems – nor how they relate to similarly complex and interconnected human activities. However, we can begin to capture this complexity by looking at a range of indicators, and correlating and linking them – as with plotting the HDI against the Ecological Footprint, seen in the previous chapter.

Tools and indicators like those presented in this report, among many others, offer clear assessments of risk, evidence

TOOLS AND INDICATORS HELP COMMUNICATE THE NEED FOR ACTION, AND GUIDE THE ACTION WE NEED TO TAKE

that we can act upon and ideas that prompt us to think differently, but cohesively. They help communicate the need for action, and guide the action we need to take.

Panning out: the planetary picture

Life on our planet depends on a number of interconnected environmental processes, operating on large temporal and spatial scales, known as Earth system services. Ocean currents bring nutrients from the deep to support productive marine ecosystems. Glaciers act as giant water-storage facilities, while glacial action creates fertile soils. Carbon dioxide in the atmosphere is dissolved and stored in the oceans, helping to keep the climate stable. Nitrogen and phosphorous cycles provide essential nutrients for plants to grow, chemical reactions in the atmosphere form protective ozone, and large polar ice sheets help regulate global temperature (Steffen et al., 2011).

Humans have profited hugely from the extraordinarily predictable and stable environmental conditions of the last 10,000 years – the geological period known as the Holocene. The favourable state of the planet during the Holocene made it possible for settled human communities to evolve and eventually develop into the modern societies of today, by profiting from the natural capital offered by a stable biosphere. However, advancements in Earth system science suggest that the world has entered a new period – the "Anthropocene" – in which human activities are the largest drivers of change at the planetary scale (Zalasiewicz et al., 2008). Given the pace and scale of change, we can no longer exclude the possibility of reaching critical tipping points that could abruptly and irreversibly change living conditions on Earth.

The planetary boundaries framework, developed by an international group of Earth systems scientists led by the Stockholm Resilience Centre, identifies the environmental processes that regulate the stability of the planet (Figure 38). For each it attempts to define, based on the best available science, safe boundaries. Beyond these boundaries, we enter a danger zone where abrupt negative changes are likely to occur. Defining planetary boundaries establishes a "safe operating space for humanity", in which we have the best chance of continuing to develop and thrive for many generations to come.

The nine identified boundaries are climate change, ocean acidification, biodiversity loss, interference with the global nitrogen and phosphorus cycles, ozone depletion, global fresh water use, land system change, atmospheric aerosol loading *(not yet quantified)*, and chemical pollution *(not yet quantified)*. All nine boundaries are based on the evidence of feedbacks, interactions and biophysical tipping points that can have dramatic impacts for humans. Since its publication in 2009, the planetary boundaries framework has stimulated scientific and wider debate, which has advanced scientific assessments of individual boundaries and influenced business and policy agendas.

Looking at large-scale processes from these outer limits provides a useful perspective on the ecosystem changes tracked in the LPI, as well as the pressures outlined in the Ecological Footprint. It also reveals other areas that require urgent attention. While exact tipping-points are impossible to determine with any degree of certainty, three planetary boundaries are assessed to have already been crossed: biodiversity loss – backing up the declines seen in the LPI – climate change, and changes to the nitrogen cycle, which are discussed in more detail below. Recent research suggests that we have also passed the sustainable level of phosphorus loading in freshwater systems.

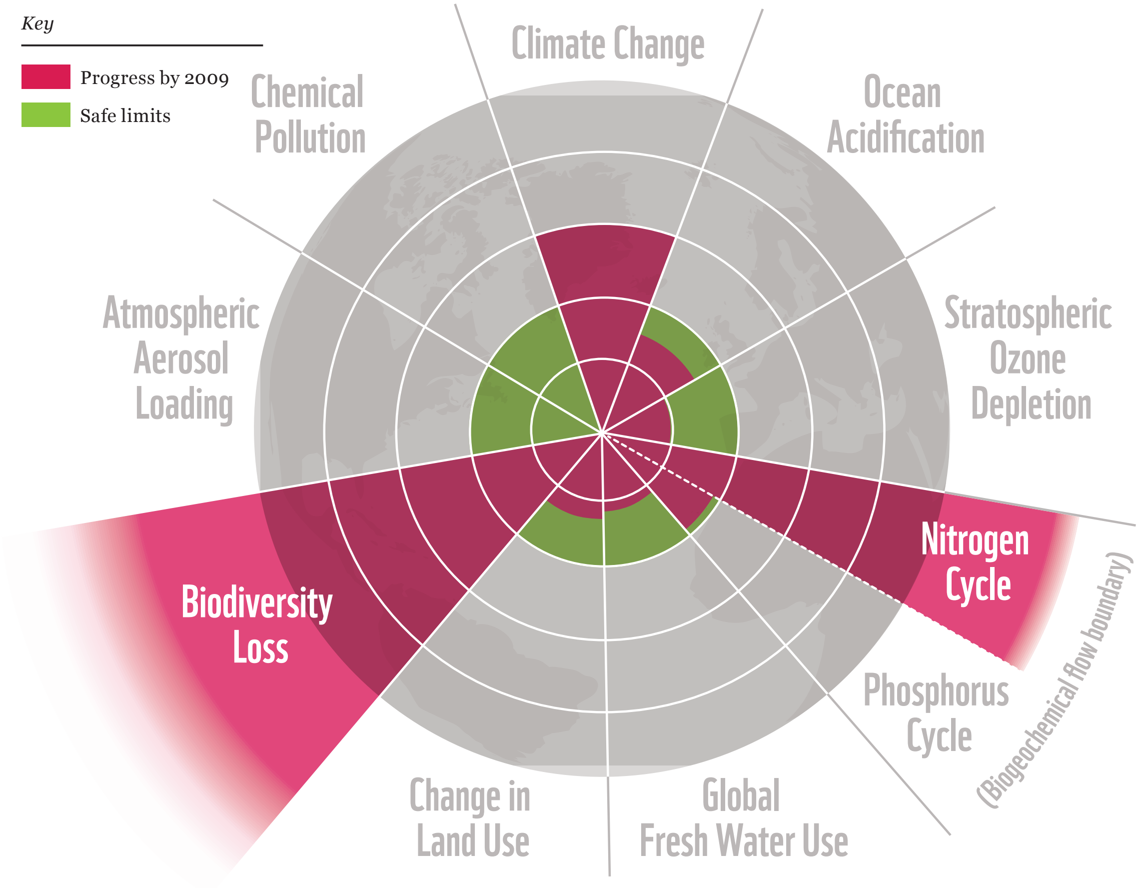
The planetary boundaries concept suggests that the existence of the world that we have known and profited from throughout the Holocene now depends on our actions as planetary stewards. It reinforces the need for a new development paradigm, within the means of one planet. Just as Chapter 1 highlighted the need to bring Ecological Footprints down to within Earth's biocapacity, planetary boundaries attempt to provide scientifically defined measures for realigning development policies, business models and lifestyle choices.

THE PLANETARY BOUNDARIES CONCEPT SUGGESTS THAT THE EXISTENCE OF THE WORLD THAT WE HAVE KNOWN AND PROFITED FROM THROUGHOUT THE HOLOCENE NOW DEPENDS ON OUR ACTIONS AS PLANETARY STEWARDS

Figure 38: Planetary boundaries
We have already overstepped three of the nine planetary boundaries (Stockholm Resilience Centre, 2009).

Key

Progress by 2009
Safe limits



THE PLANETARY BOUNDARIES FRAMEWORK HAS STIMULATED SCIENTIFIC AND WIDER DEBATE, ADVANCING SCIENTIFIC ASSESSMENTS OF INDIVIDUAL BOUNDARIES AND INFLUENCING BUSINESS AND POLICY AGENDAS

Box 3: Doughnut economics

Humanity is putting pressure on the planet to the extent that we are transgressing several planetary boundaries. However, the picture is more complex: while a small number of people are using the most resources, too many are excluded from lives in which they can flourish and live with dignity.

The "Oxfam Doughnut" (Figure 39) is a concept that brings these dynamics together visually: its value is in offering a single image tying two complex concepts together. It demonstrates that, just as beyond the environmental ceiling lies unacceptable environmental stress, below what we might describe as a "social foundation" lies unacceptable human deprivation in various manifestations (and those presented here are illustrative only).

The space between the planetary boundaries and the social foundation is the safe and just space for humanity to thrive in – the doughnut. It is safe in that it avoids crossing environmental tipping points that could make Earth inhospitable for humanity. And it is just in that it ensures that every person achieves certain standards of health, wealth, power and participation.

The doughnut illuminates the need for a new economic model that is both sustainable and inclusive – one which does not breach global planetary boundaries and which at the same time raises its citizens above a social floor.

This requires bold and transformational change in the purpose and nature of the world's economy. Rather than pursuing economic growth without regard for its quality or distribution, the Oxfam Doughnut shows how humanity needs an economy that redistributes power, wealth and resources to the poorest and focuses growth where it is most needed.

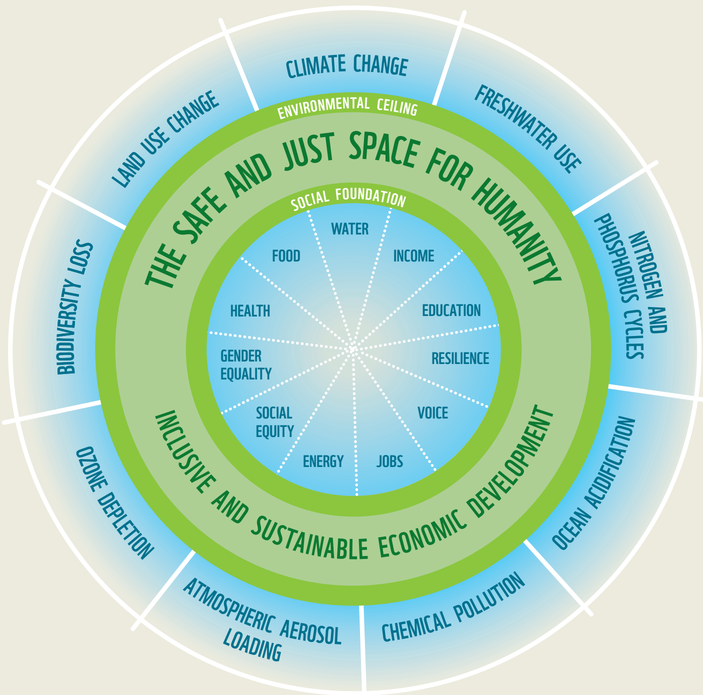
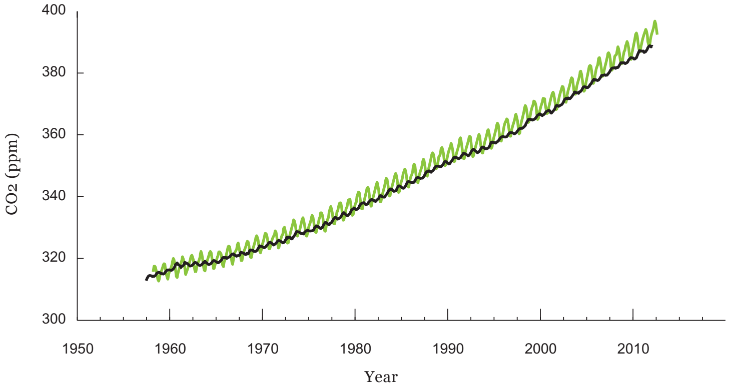


Figure 39: The Oxfam Doughnut – A safe and just operating space for humanity
Outside the Doughnut are dangerous environmental tipping points, while the space below the social foundation represents unacceptable human deprivation (Raworth, 2012).

Climate

On 9 May 2013, the concentration of carbon dioxide in the atmosphere above Mauna Loa, Hawaii – the site of the oldest continuous CO_2 measurement station in the world – reached 400 parts per million (ppm) for the first time since measurements began in 1958 (Figure 40). This is higher than they have been for more than a million years. Climate science shows major risks of unacceptable change at such concentrations.

Figure 40: Atmospheric concentration of carbon dioxide from Mauna Loa *(19°32'N, 155°34'W - green) and South Pole (89°59'S, 24°48'W – black) since 1958 (IPCC, 2013).*



EVERY PART OF THE NATURAL WORLD AND ITS INTERDEPENDENT SOCIAL AND ECONOMIC SYSTEMS IS BEING OR WILL BE AFFECTED BY CLIMATE CHANGE

Climate change is already impacting the planet's biodiversity and biocapacity, along with the well-being of humanity, particularly with regard to food and water security. The IPCC report released in March 2014 detailed the impacts of changing climatic regimes, suggesting that almost every part of the natural world and its interdependent social and economic systems is being, or will be, affected (Field et al., 2014).

Even if it were possible to hold atmospheric concentrations of greenhouse gases constant at current levels, temperatures would still continue to increase – by about 0.6°C over the course of the 21st century relative to the year 2000 (Collins et al., 2013). This warming will occur on top of the 0.85°C global mean temperature increase already experienced since 1880 (Stocker et al., 2013). To keep global temperature rises below 2°C – the stated goal of governments worldwide – requires urgent and sustained global efforts.

Even temperature increases well below this threshold represent significant risks to unique human and natural systems (Figure 41). The IPCC's 2014 Assessment Report notes that many terrestrial, freshwater and marine species have shifted their geographic ranges and activities in response to climate change. However, it is likely that some species will be unable to move fast enough to keep up with expected changes (Figure 42). Species extinctions are already at or above the highest rates found in

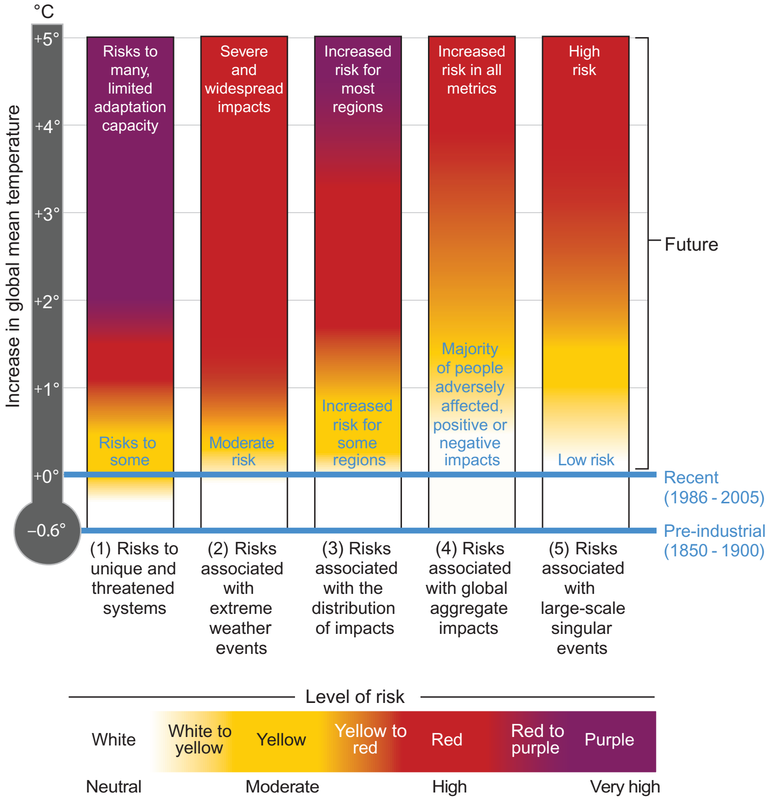


Figure 41: Risk levels associated with climate change *(Oppenheimer et al., 2014).*

the fossil record. Past climate changes were slower than those anticipated for the 21st century, but even these drove significant ecosystem shifts and extinctions (Williams et al., 2011).

Increasing CO_2 in the atmosphere is also the primary cause of ocean acidification. The current rate of acidification is unprecedented in the last 65 million years, and probably in the last 300 million (Pörtner et al., 2014). The spatial shifts of marine species that is already underway has profound implications for the global distribution of seafood catch potential and fisheries management. This has implications for global food security. Even under optimistic assumptions on the ability of coral reefs to rapidly adapt to thermal stress, one- to two-thirds of all the word's coral reefs are projected to experience long-term degradation (Frieler et al., 2013).

Climate change will compound the impacts of other drivers of biodiversity loss such as habitat modification, over-exploitation, pollution and invasive species (Field et al., 2014). In the near term, secondary impacts through human adaptation are likely to affect many of the world's species and ecosystems. Rapid warming

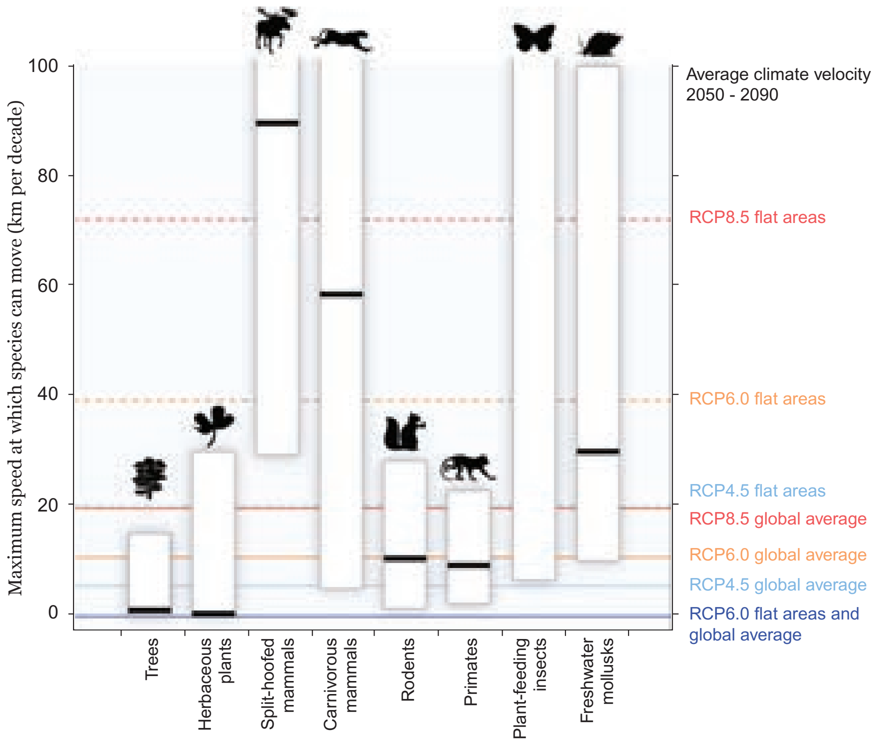
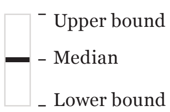


Figure 42: Species' ability to keep pace with climate change
Shown for different IPCC Representative Concentration Pathways (RCPs)
NOTE: The median has not been estimated for plant feeding insects (Field et al., 2014).



in the Arctic, for example, is already leading to increased human activities including shipping, commercial fishing, mining, and oil and gas development. This poses a serious threat to Arctic species attempting to adapt to a fast-changing climate. Management actions – like identifying and protecting habitat that is likely to experience least change, such as where long-term sea ice is expected to remain – are needed to ensure that wildlife will have a home in the future.

There are many plausible scenarios for how climate change and societal development will play out. Decisions we make now must not narrow our options for adapting to future conditions. While deep cuts in greenhouse-gas emissions are urgently needed to reduce the rate and magnitude of climate change, we must also take immediate action to increase resilience to improve human health, livelihoods, and social, environmental and economic well-being in the face of a rapidly changing climate. Both climate change mitigation and adaptation provide opportunities for transformation to the most ecologically and socially desirable of the potential futures that lie before us.

Nitrogen

Nitrogen, as one of the key nutrients necessary in the production of food, is essential for life. Although it makes up four-fifths of the air we breathe, unreactive nitrogen must be "fixed" by natural or synthetic processes to form the reactive nitrogen (N_r) that plants need to grow. Industrially produced fertilizers containing N_r have been one of the main drivers of dramatically improved agricultural yields over the last 60 years, and are fundamental to global food security.

But human activities now convert more nitrogen from the atmosphere into reactive forms than all of the planet's natural terrestrial processes combined (Folke, 2013). N_r loads to the atmosphere and terrestrial and aquatic systems have increased drastically. The main causes are production of nitrogen fertilizers, (inefficient) agricultural use and leaching, untreated wastewater from urban areas, and the burning of fossil fuels, which releases N_r to the atmosphere.

This has led to a cascade of environmental, human health and climate impacts. Excessive nitrogen in water – from fertilizer and manure run-off or sewage – can cause huge algal blooms, sucking oxygen out of the water and creating "dead zones". In the air, nitrous oxide (N_2O) is a potent greenhouse gas – 200 times more powerful than CO_2. While contributing to ozone depletion in the stratosphere, N_r, as NOx and as particulate matter, increases low-level ozone, which aggravates respiratory diseases (Galloway et al., 2003; Sutton et al., 2011; Erisman et al., 2013). Increased nitrogen in the soil can upset the balance of ecosystems and reduce biodiversity (Fields, 2004).

At the planetary scale, the additional amount of nitrogen activated by humans is now so large that it significantly upsets the global cycle of this important element. The planetary boundary for human modification of the nitrogen cycle appears to have been passed by a distance: worldwide, human activities release 121Mt/year of N_r into the biosphere, against a proposed boundary of 35Mt/year (Röckstrom et al., 2009). Some have questioned this tipping point: for example, de Vries et al. (2013) suggest a threshold of 60-100 Mt/year.

With large regional differences in both the use and impacts of nitrogen, determining a global limit is challenging. Indeed, some regions – including many parts of Africa – suffer from low availability of N_r; the challenge lies in increasing the supply of N_r in such a way that it is harmless for the soil and the environment and allows nutrients to remain in the system.

Within this global picture, indicators are being developed to better understand the use and impacts of nitrogen at regional,

$N \rightarrow N_r$

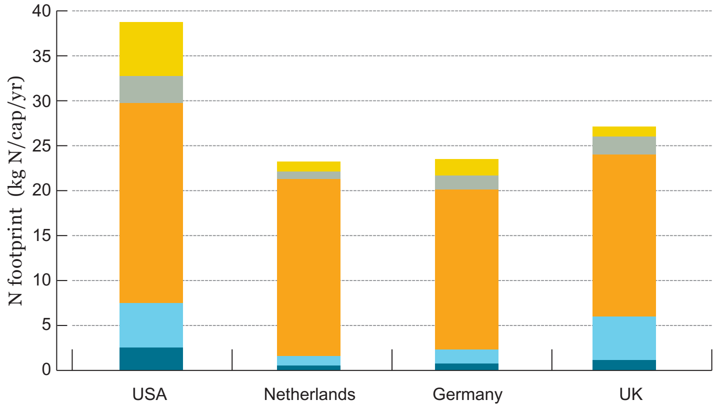
HUMAN ACTIVITIES NOW CONVERT MORE NITROGEN FROM THE ATMOSPHERE INTO REACTIVE FORMS THAN ALL OF THE PLANET'S NATURAL TERRESTRIAL PROCESSES COMBINED

national and individual levels. The nitrogen footprint calculates the total N_r released to the environment as a result of a person's resource consumption, focusing on food, housing, transportation, and goods and services (Leach et al., 2012). Nitrogen footprint calculators have been completed for the USA, Netherlands, UK and Germany (Figure 43), and are in progress for Tanzania, Japan, China and Austria. European footprints are smaller than those of the USA, because of less meat consumption per capita, less energy use for transport, greater fuel efficiency and better sewage treatment.

Figure 43: Personal nitrogen footprint of USA, UK, Germany and the Netherlands
N-footprints are shown by sector. Nitrogen footprint of food consumption is the nitrogen directly consumed, whereas that of food production is the virtual loss to the environment (Leach et al, 2012).

Key

- Food production
- Housing
- Transport
- Goods & services
- Food consumption



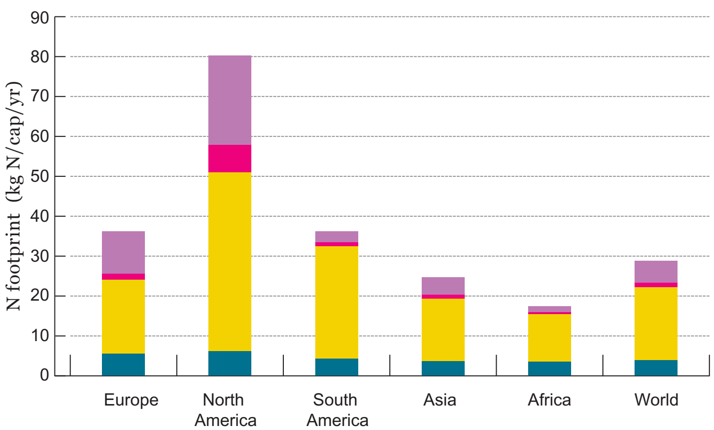
The Nitrogen Loss Indicator (Figure 44), developed for the Convention on Biological Diversity, represents the potential nitrogen pollution from all sources within a country or region as a result of the production and consumption of food and the use of energy. The N_r loss is largest in North America (81kg/capita/yr) – more than twice the world average (29 kg/capita/yr).

The N_r loss is region or country bound, whereas the N-footprint includes all sources, including those outside the country in question.

Figure 44: Nitrogen Loss Indicator: Average loss of reactive nitrogen per inhabitant in 2008
National calculations, upon which these regional figures are based, are also available (www.initrogen.org). The Nitrogen Loss Indicator measures potential reactive nitrogen pollution; the actual pollution depends on environmental factors and the extent to which the waste nitrogen can be reused (Bleeker et al, 2013).

Key

- Energy use
- Food processing
- Food production
- Food consumption



Zooming in

If we focus only on global or national trends, we risk missing the local realities and thematic contexts – how trends play out in various landscapes, catchment areas and ecosystems that do not necessarily adhere to geopolitical boundaries, or the risks they raise for specific sectors, livelihoods or communities. Local and thematic analysis is essential, not only to identify the causes and effects of global challenges, but also to provide insights for devising practical solutions. Other assessments and indicators complement the LPI, Ecological Footprint and water footprint by offering further insights on the pressures our demands place on terrestrial, marine and freshwater systems, and the impacts of these pressures.

LOCAL INDICATORS IDENTIFY LOCAL CONTEXTS OF GLOBAL ISSUES AND PROVIDE INSIGHTS FOR DEVELOPING PRACTICAL SOLUTIONS

Box 4: A national LPI-based assessment

Complementing the global LPI, the Dutch Central Bureau of Statistics recently completed a *Living Planet Index* study for its native species at a national level. Along with vertebrate populations, the study also included data on invertebrate species (dragonflies, butterflies) and higher plants. The Dutch study varied from the standard LPI methodology, to include distribution data and non-standardized, opportunistic citizen science data (Van Strien et al., 2013). The resulting index showed an overall increase since 1990, which is consistent with trends in other parts of Europe. However, butterfly populations showed a marked decline (Figure 45) – potentially suggesting that the absence of invertebrate species from the global LPI could mask even greater losses in biodiversity. Local studies such as these can add depth to global metrics, while helping to set the context for local action.

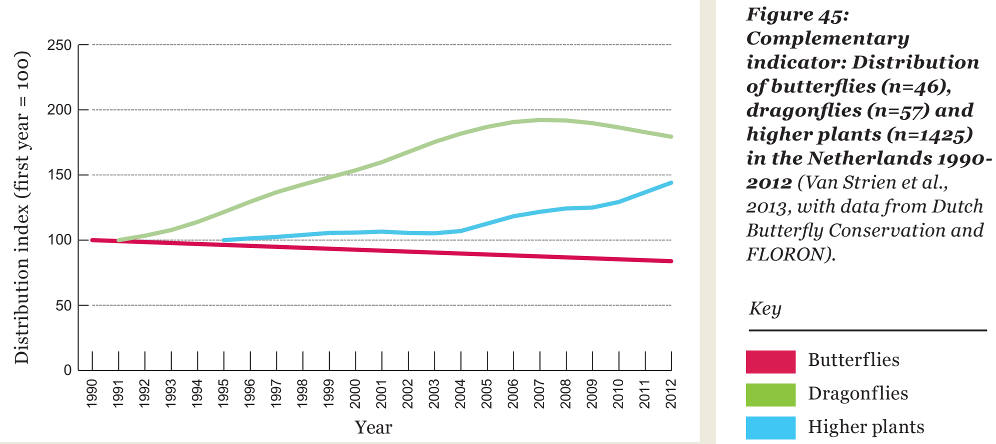


Figure 45: Complementary indicator: Distribution of butterflies (n=46), dragonflies (n=57) and higher plants (n=1425) in the Netherlands 1990-2012 *(Van Strien et al., 2013, with data from Dutch Butterfly Conservation and FLORON).*

Terrestrial: protected areas, forests and land-use change

Habitat loss and degradation is the main cause of biodiversity loss identified in the LPI. As discussed in Chapter 1, avoiding this loss and degradation through establishing and maintaining protected areas can help to preserve biodiversity and natural capital. A key element of habitat protection is identifying the most important areas, and monitoring their physical status, spatially and temporally.

The UNEP-WCMC World Database of Protected Areas is the authoritative source for protected area coverage worldwide. The global protected area system has grown to include more than 100,000 protected areas, covering more than 14 per cent of all land area. However, that coverage is uneven (Figure 46). A disproportionate amount of protected areas are located in high-elevation, high-latitude and low-productivity lands. Temperate grasslands, Mediterranean habitats and tropical dry forests are significantly under-represented in the global protected area network, leaving the unique biodiversity found in these areas particularly vulnerable (Hoekstra et al., 2010).

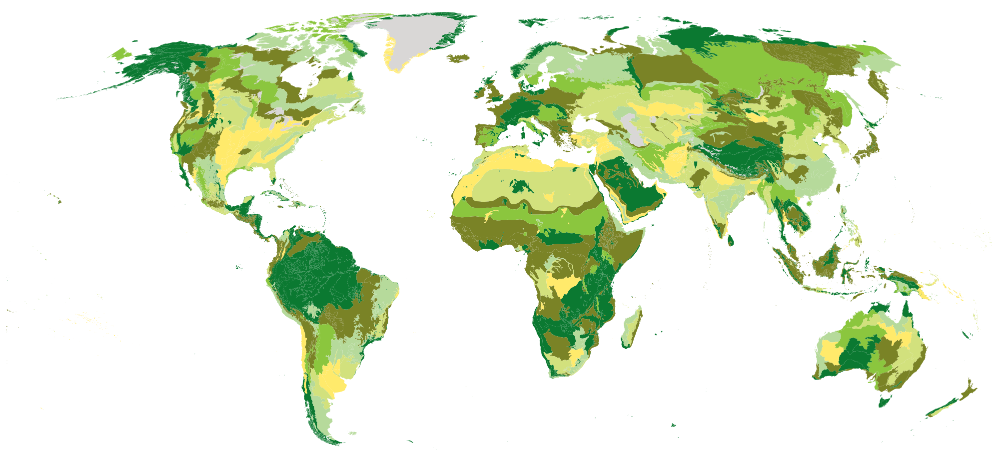
Meanwhile, many currently protected habitats in biodiverse regions are at risk from protected area downgrading, downsizing and degazettement (PADDD). These roll-backs are documented by PADDDtracker.org (WWF, 2014b).

Knowing where, how much and how quickly landscapes are changing is critical for identifying the leading edges of loss of habitat and natural capital. Satellite imagery makes it possible to monitor changes in land use and land cover around the world at different spatial resolutions. Understanding the cause of these changes –

Figure 46: Percentage of land area formally protected, by terrestrial ecoregion *(Hoekstra et al., 2010; IUCN and UNEP, 2014).*

Key

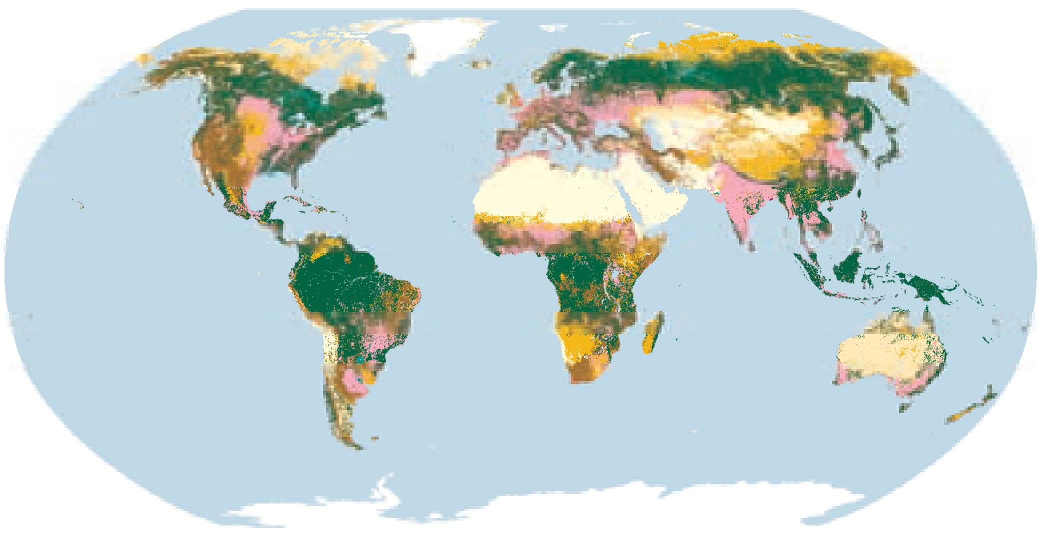
- 21% – 100%
- 11% – 20%
- 9% – 10%
- 6% – 8%
- 3% – 5%
- 0% – 2%
- Not Applicable



such as deforestation, expansion of agriculture or fragmentation by roads – can help to inform effective conservation strategies. Land-use data can also be analysed to help us understand the trade-offs and consequences of our choices.

One example is Global Land Cover (GLC)-SHARE, a new FAO database for assessing the Earth's land and water resources. Data for GLC-SHARE is a combination of best available high-resolution sources from national, regional or sub-national land-cover databases (FAO, 2013). It is expected to inform agro-ecological zoning and assessments of yield productivity, bioenergy, land and water resources, ecosystem services and biodiversity, and climate impacts, among others (Latham et al., 2014) (Figure 47).

Figure 47: Global dominant land cover classes, 2014
(Latham et al., 2014).



WWF and the International Institute for Applied Systems Analysis (IIASA) looked at land-use data to examine the pressures on forests. Overall the planet's forests are declining in area and in quality. This has severe impacts on biodiversity – since the majority of terrestrial species live in forests – and the already overstretched capacity for forests to absorb our carbon footprint, as well as affecting ecosystem services such as water provision and flood prevention. In response, WWF has set a global goal of achieving zero net deforestation and forest degradation (ZNDD) by 2020.

The WWF/IIASA Living Forests Model draws on historical trends and projected demands to show possible land-use change under various future scenarios (Figure 48). Current deforestation trends point toward catastrophic and irreversible losses of biodiversity and runaway climate change. Even achieving ZNDD by 2030, as opposed to 2020, would mean losing an extra 69 million hectares of forest worldwide – an area the size of Texas – and 23Gt of additional CO_2 emissions (WWF, 2011b).

The model suggests that, with better governance and smarter land use, it would be possible to meet global demand for food and forest products without any further loss of forests between now and 2030. After this time, though, if consumption continues to grow, maintaining ZNDD could result in significant losses of other important ecosystems, such as grasslands, and big rises in food prices. In addition, projected increases in demand for wood, particularly for bioenergy by 2050 would mean a 25 per cent increase in the area of natural forest managed for commercial harvesting, along with an extra 250 million hectares of new tree plantations (WWF, 2011b). These forecasts raise important questions around how to manage trade-offs, and help point toward possible solutions – such as better, more effective and less resources intensive agricultural practices, reducing land-intensive meat consumption in high-income countries, improving energy and manufacturing efficiency, and increasing reuse and recycling of wood and paper.

Figure 48: Forest area in 2000 and projected forest area in 2050
In selected countries as calculated by the WWF/ IIASA Living Forests Model under a "Do Nothing" scenario, in which demand for land increases to supply a growing global population with food, fibre and fuel, and historical patterns of poorly planned and governed exploitation of forest resources continue (WWF, 2011b).

Per cent forest

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

Forested area in 2000.

Projected forested area in 2050 under a "Do Nothing" scenario.

BOX 5: Sustaining Biocultural Diversity: the most important conservation takes place on the ground, as part of a living culture (Loh and Harmon, 2014).

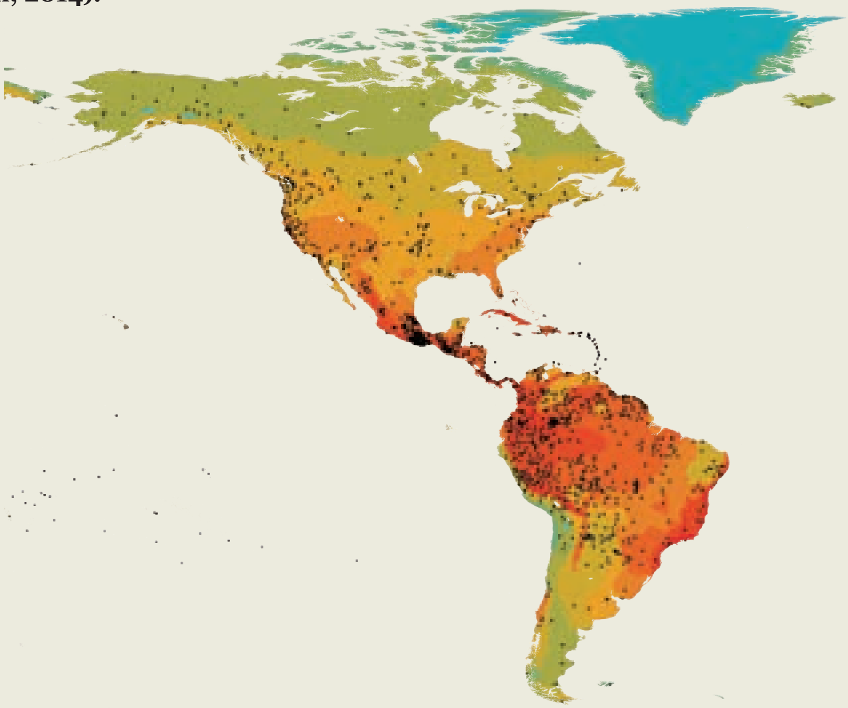
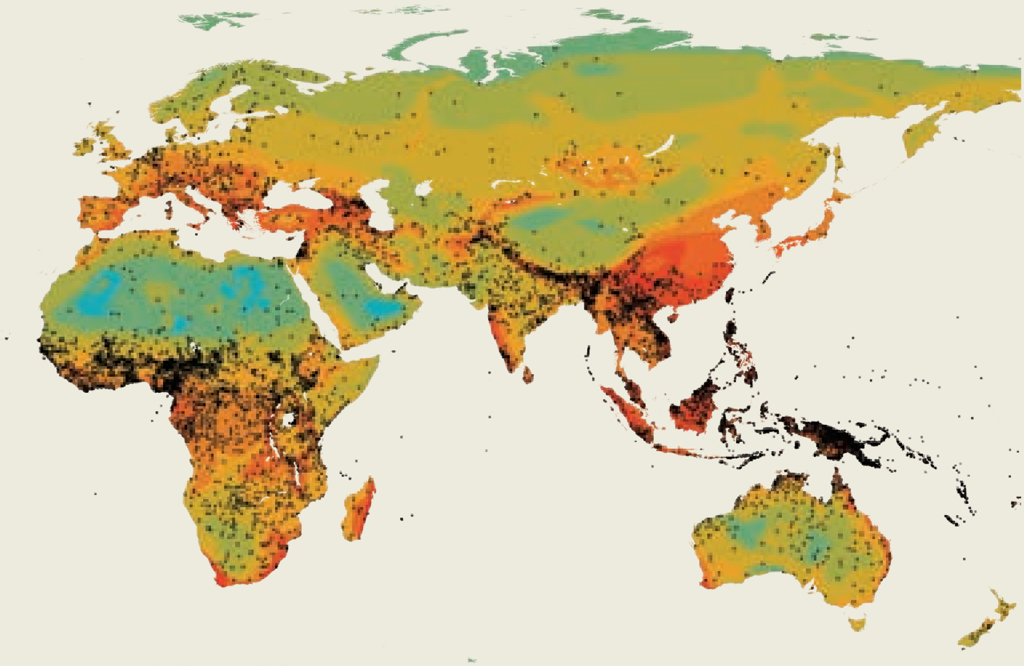


Figure 49: The diversity of languages (black dots) strongly correlates with areas of high plant diversity (Globaïa, 2014).

Languages and species have evolved in remarkably similar ways, and striking parallels can be drawn between the two (Harmon, 2002). Figure 49 shows a strong correlation between areas of high biodiversity and of high linguistic diversity.

The decline in global biodiversity is mirrored by a fall in humanity's linguistic diversity, according to recent research by Jonathan Loh and David Harmon. Using the IUCN Red List criteria, it found that a minimum of 25 per cent of the world's languages are threatened, and 6 per cent have gone extinct since 1970 (Loh and Harmon, 2014).

The authors also used the LPI methodology to create an index called the Index of Linguistic Diversity (ILD) (Harmon and Loh, 2010). The results indicate that while both biodiversity and linguistic diversity are threatened globally, they are declining at different rates in different regions. By far the most rapid losses in linguistic diversity have occurred in the Americas. The ILD plummeted by more than 75 per cent between 1970 and 2009 in both the Nearctic and Neotropical realms.



Number of vascular plant species (10,000 km²) (Barthlott et al., 2005).

- <20
- 20-200
- 200-500
- 500-1,000
- 1,000-1,500
- 1,500-2,000
- 2,000-3,000
- 3,000-4,000
- 4,000-5,000
- >5,000

Language data (SIL International)

- Language

As the world's most widely spoken languages have expanded, small languages have dwindled away. Some linguists predict that 90 per cent of the world's languages will die out this century (Nettle, 1999; Nettle and Romaine, 2000).

Most of the languages threatened with extinction are evolutionarily quite distinct from the few dominant world languages, and so they represent very different cultures. Along with the languages, the traditional knowledge of these indigenous cultures, accumulated over tens of thousands of years, is being forgotten. This includes important knowledge related to the uses of natural species, such as medicinal plants and fishing methods, as well as a vast array of spiritual and religious beliefs.

Exploring the parallels between nature and culture, and understanding the processes that underlie their evolution, ecology and extinction, is a step toward ensuring that we can continue to inhabit a world of incredible diversity.

Marine: fishing and coastal development

The marine LPI, which looks at the 3,132 populations of 910 mammal, bird, reptile and fish species, has declined by 39 percent since 1970. The biennial FAO State of the World's Fisheries and Aquaculture (SOFIA) report has also chronicled a downward trend in marine fisheries since the 1970s.

The latest report (FAO, 2014) found that the proportion of assessed stocks fished within or at biologically sustainable limits had declined from 90 per cent in 1974 to 71.2 per cent in 2011. Some 28.8 per cent of fish stocks were overfished, and a further 61.3 per cent were fully exploited, thus any further fishing on these is overfishing. This leaves just 9.9 per cent of fish stocks worldwide being fished below sustainable levels.

Figure 50 shows that, as the proportion of overfished stocks has increased, the proportion of underfished stocks – those with potential for expansion – has fallen. This is the result of fisheries moving to less fished resources as others become overfished and depleted. A recent trend has been for open-ocean fishers to move into deeper waters and further from shore as near-shore stocks decline. If this trend is not halted, there could be a decline in global catches as new fishing grounds also become exhausted (FAO, 2014), further exacerbating social and economic impacts.

However, these statistics look at fish stocks in isolation, without taking into account the wider role of fish in the ecosystem. Ocean ecosystems present a complex challenge for comprehensive understanding – as they are still well behind the terrestrial world in terms of robust, long-term data. Inter-linkages in the ocean system

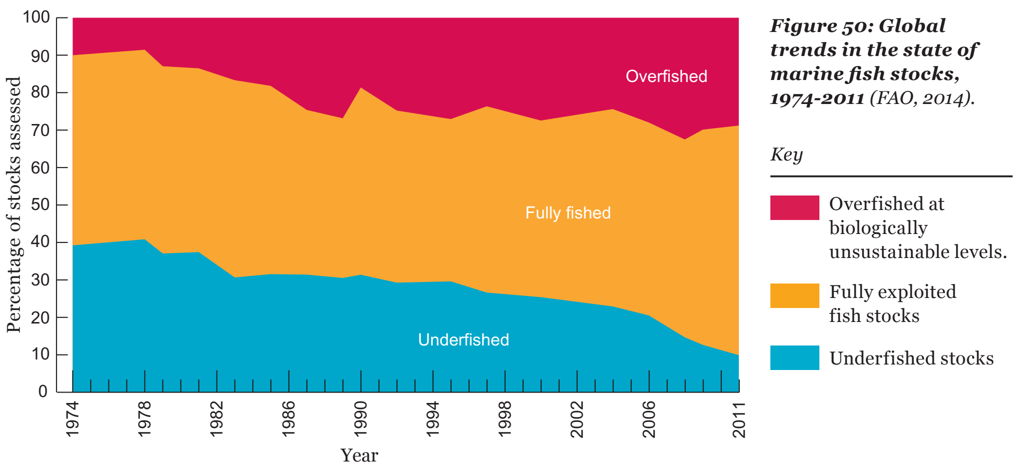


Figure 50: Global trends in the state of marine fish stocks, 1974-2011 *(FAO, 2014).*

are strong – fully exploited, overfished or depleted fish stocks can have cascading effects in the ecosystem. For example, the loss of large predatory fish such as sharks alters the entire composition of species and changes the way the ecosystem functions.

The decline in quantity and quality of fish stocks is not solely related to overfishing and destructive fishing. Marine ecosystems and fish stocks are subject to multiple pressures (Figure 51), including pollution; coastal infrastructure development for housing, industry or recreation; shipping; mining; agricultural run-off; introduction of exotic species; and, not least, climate change and ocean acidification (Caddy and Griffiths, 1995). The combined impact of these pressures has significant implications for food security and livelihoods of coastal communities.

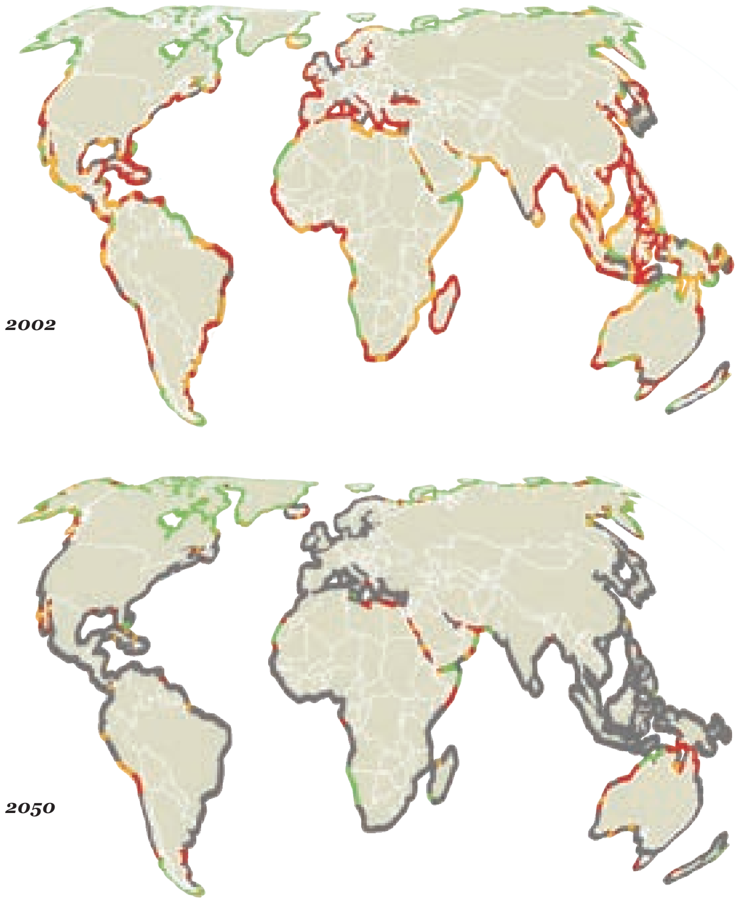


Figure 51: Infrastructure development, intensive agricultural expansion, urbanization and coastal development are increasing pressure on marine ecosystems. *The situation is most severe around Europe, the east coast of the United States, east China and Southeast Asia. These are also primary fishing grounds. Coastal zones are identified as approximately 75km from the coastline, and this map identifies the most common impact class in this zone (Ahlenius, UNEP/GRID-Arendal, 2008).*

Key

- Very high - high
- High - medium
- Medium - low
- Low

Freshwater: the Water Risk Filter

Meeting the needs of all water users depends on good governance at the river-basin level. A better understanding of water risks at the river-basin level provides guidance for action that ultimately benefits freshwater ecosystems. The water footprint (discussed earlier in Chapter 1) helps countries, governments, businesses and individuals understand the volume of water involved in production and consumption. But the volume of water alone doesn't provide a complete picture – context is crucial. Water risk is derived from the cumulative use of water in a river basin by all water users. Even though users may be highly water efficient or even use a relatively small amount of water, if they are in a water-stressed catchment where the rules and allocations are non-existent, they will be exposed to some level of risk. Complementary tools and measures are therefore needed to better assess specific risks and potential impacts at the river basin level.

WWF's Water Risk Filter (www.waterriskfilter.org) considers basin-related risks such as the availability of water, aggregated demand, water quality and ecosystem status, governance and regulation issues, and, particularly for businesses, potential reputational risks.

Company-specific risks (presented in Figure 52) encompass the reliance of the company on water use volumes, pollution potential of the processes, supply chain risks, foreseen changes in water regulation or specific licences, and the company's involvement in local stakeholder engagement. In total, the risks are evaluated against almost 100 indicators.

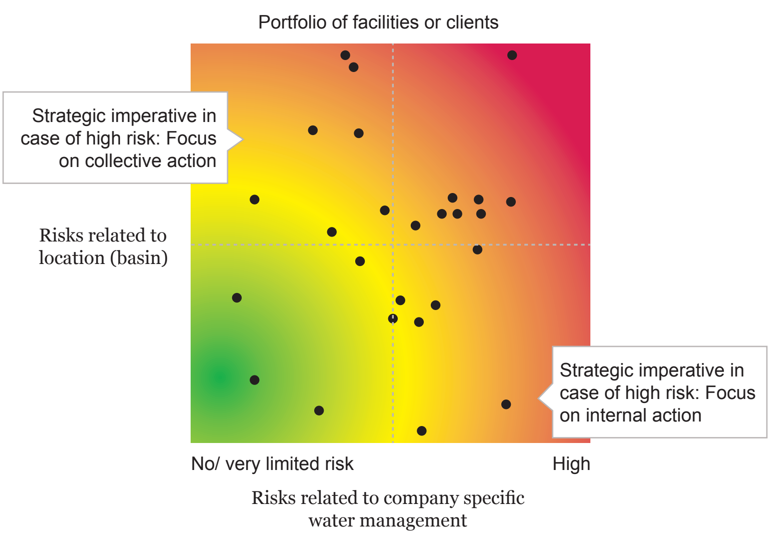


Figure 52: Water Risk Filter: plotting risks helps companies understand where to take action
(WWF, 2014a).

Key

- High risk
- Medium risk
- Low or very limited risk
- Indicator plots of risk

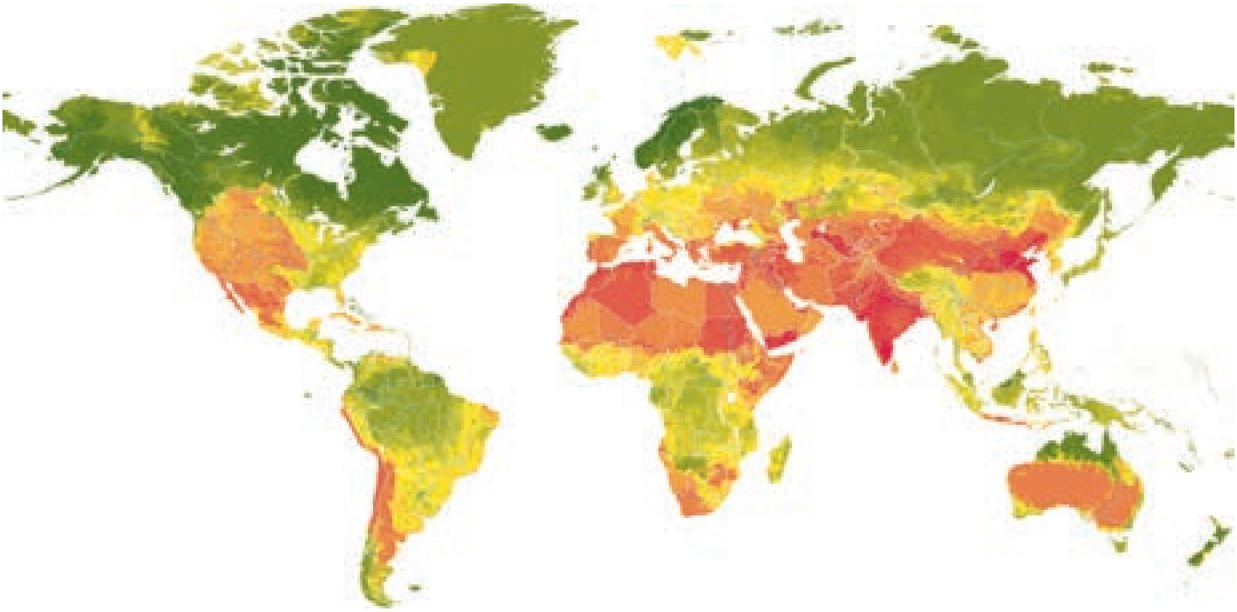


Figure 53: Overall water risk map *(WWF, 2014a).*

Water Risk

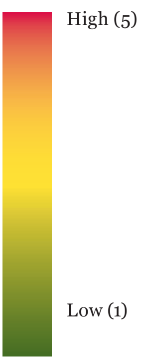


Figure 53 summarizes the basin risk score (that is, risk due to conditions in that river basin) at a sub-catchment level. As users can see where risks lie for specific facilities, they can make informed decisions about where to act. This free tool also includes a mitigation toolbox, which guides institutions toward strategic approaches and tested responses.

The Water Risk Filter provides an example of how, using robust data from a range of indicators, global problems like water scarcity can be broken down to achieve better-informed, more meaningful decisions, strategies, actions and outcomes.

The urgent need to act upon the evidence and data we have seen so far will be discussed further in the next chapter.

LEAPING INTO THE FUTURE

DRC has one of the youngest and fastest-growing populations in the world. But what sort of future is in store for these children from the fishing village of Vitshumbi on the southern shores of Lake Edward?

Virunga National Park is their inheritance – and it offers huge potential. A recent study commissioned by WWF suggests that, in a stable situation where the park is properly protected, its economic value could be more than US$1 billion a year. Responsible development of industries like tourism within the park could provide jobs for 45,000 people (WWF/Dalberg, 2013).

EMBARGOED until 30 Sept 2014 - 00:01 CET

CHAPTER 3: WHY WE SHOULD CARE

Planet Earth and the staggering web of life to which we all belong are worth protecting for their own sake. This is reflected by the sense of wonder and profound respect for nature that run deep in many cultures and religions. People instinctively relate to the well-known proverb: *We do not inherit the Earth from our ancestors; we borrow it from our children.*

Yet, as the last two chapters clearly illustrate, we are not proving good stewards of our only planet. We are making excessive demands on the natural world, and Earth's ecosystems are suffering as a result. The way we meet our needs today is compromising the ability of future generations to meet theirs – the very opposite of sustainable development.

Humanity's well-being and prosperity – indeed, our very existence – depends on healthy ecosystems and the services they supply, from clean water and a liveable climate, to food, fuel, fibre and fertile soils. Progress has been made in recent years in quantifying the financial value of this natural capital and the dividends that flow from it. A recent estimate valued global ecosystem services at US$125 trillion to US$145 trillion a year (Costanza et al., 2014). Such valuations make an economic case for conserving nature and living sustainably – but valuation is not the same as commodification or privatization, and many ecosystem services are best considered public goods (Costanza et al., 2014). After all, any valuation of ecosystem services is a "gross underestimate of infinity", since without them there can be no life on Earth (McNeely et al., 2009).

With another 2.4 billion people to be added to the human population by 2050, the challenge of providing everyone with the food, water and energy they need is already a daunting prospect. Unless we take significant steps to reduce the pressures we are placing on the planet's climate and natural processes, it could prove impossible. Protecting nature and using its resources responsibly are prerequisites for human development and well-being, and building resilient, healthy communities. This is equally relevant for the poorest rural communities – who often rely directly on nature for their livelihoods – as for the world's great cities, which are increasingly vulnerable to threats such as flooding and pollution as a result of environmental degradation.

To date, concern and commitments have yet to be matched by adequate action. But when humanity responds to warning signs and acts collectively, we can achieve great things. For example, the Montreal Protocol provides an excellent model of a science-based, precautionary response to an environmental threat – the depletion of the ozone layer. The first ever universally ratified treaty, it committed every country to stringent conditions for phasing out CFCs and other ozone-depleting substances. All parties have complied, resulting in a successful reversal of the threat to the ozone layer. Similarly, the Millennium Development Goals galvanized efforts to tackle global poverty. Now we need an even greater, all-inclusive effort to safeguard the health of our environment and the welfare of our society, for us today and for our children into the future.

"SUSTAINABLE DEVELOPMENT IS DEVELOPMENT THAT MEETS THE NEEDS OF THE PRESENT WITHOUT COMPROMISING THE ABILITY OF FUTURE GENERATIONS TO MEET THEIR OWN NEEDS." (WCED, 1987)

Ecosystem services and their value

Human well-being depends on natural resources such as water, arable land, fish and wood, and the services that ecosystems provide, such as pollination, nutrient cycling and erosion control. These ecosystem services, in turn, depend on the planet's natural capital – its forests, grasslands, rivers, lakes, oceans, topsoil and biodiversity. All of these benefits are provided freely, and usually taken for granted. But their social and economic value is vast.

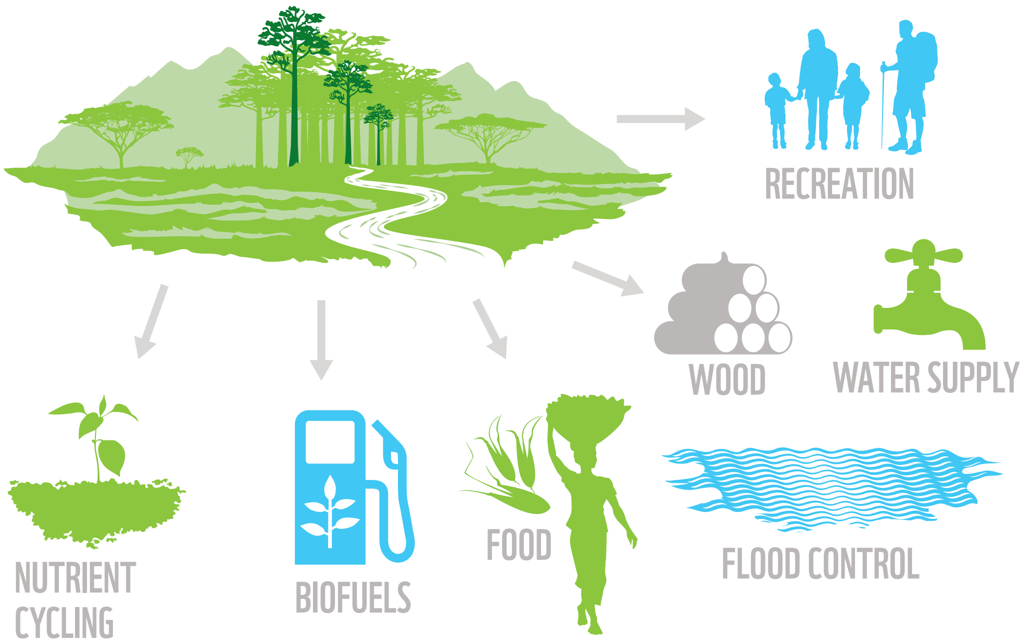
More than 60 per cent of the vital services provided by nature are in global decline because of overexploitation (MEA, 2005). Forest ecosystems provide shelter, livelihoods, water, fuel and food for more than 2 billion people, including 350 million of the world's poorest people who rely directly on forests for their subsistence and survival (FAO, 2012a). Forest loss and degradation is estimated to cost the world economy US$2-4.5 trillion annually (Sukhdev, 2010).

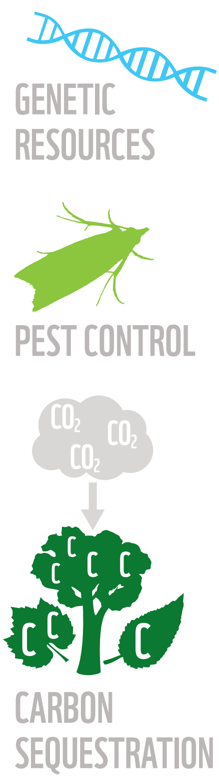
Marine ecosystems power the economies of many coastal and island states, with fisheries alone supporting more than 660 million jobs globally (FAO, 2012b). Fisheries supply 15 per cent of the animal protein in our diets (FAO, 2012b), rising to more than 50 per cent in many of the least developed countries in Africa and Asia (FAO, 2008). If threats to oceans are not abated, the economic losses could reach US$428 billion by 2050 (SEI, 2012).

Impacts on nature are glossed over in conventional economics as "environmental externalities". For example, while the amount a business pays for the water it uses will show up in its accounts, the impact of over-abstraction or pollution on freshwater ecosystems and communities downstream will not. According to a UN-backed study, the top 3,000 businesses have estimated annual externalities of almost US$2.1 trillion; in 2008, environmental damage cost US$6.6 trillion, or 11 per cent of global GDP, and the annual cost of pollution, greenhouse gas emissions, waste and depleted resources could reach US$28.6 trillion by 2050 (UNEP FI, 2011).

Economic activities are often managed independently of each other with little consideration for the ecosystems on which they depend, which can create conflicts, unforeseen consequences and long-term costs. Ecosystem-based approaches, by contrast, provide an integrated way of planning, managing and balancing human activities while maintaining these essential natural resources and systems. The Baltic Sea, for example, has suffered from pollution, overfishing and unsustainable coastal development – but recent analysis suggests that using an ecosystem-based approach to guide tourism, agriculture and fishing development could bring 550,000 jobs and an additional €32 billion (US$44 billion) a year to the region by 2030 (Boston Consulting Group, 2013).

Figure 54: Ecosystem services





Assessing the economic value of ecosystems and biodiversity is important for a number of reasons – not least the persuasiveness of economic language to decision-makers in the public and private sectors (Atkinson et al., 2012). The Economics of Ecosystems and Biodiversity (TEEB – teebweb.org) project helps governments and businesses to understand and incorporate environmental externalities into their decision-making. TEEB has conducted studies on whole biomes such as oceans and coasts, and water and wetlands, as well as sectors such as agriculture and food, and cities. The Natural Capital Project (www.naturalcapitalproject.org) has pioneered technologies that help predict how land-use change, infrastructure development and resource use will affect the supply and value of resources – such as water, timber and fish – and services such as flood and erosion control. The World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES – wavespartnership.org) programme is helping countries establish national accounts so that natural capital can be integrated within development planning.

Such initiatives can help to improve planning, resolve conflicts, and explore trade-offs and synergies. They should not be seen as an attempt to reduce nature to a monetary value: rather, they expose the flaws of conventional economic thinking, and provide an alternative means to plan, manage and measure genuinely sustainable development.

Box 6: Payments for ecosystem services and REDD+ in Acre

Payments for ecosystem services (PES) – in which beneficiaries of an environmental service pay those who maintain the ecosystem that provides it – are one way of using economics to support conservation. For example, PES schemes might involve industrial water users paying communities upstream to safeguard forests in water catchments. REDD+, the UN initiative for reducing emissions from deforestation and forest degradation, provides a global example. The idea involves industrialized countries paying developing countries to conserve their forests, which provide the universal benefit of carbon storage. Over 50 developing countries are now benefiting from incentives to reduce emissions from forested lands and invest instead in low-carbon development. REDD+ has the potential to bring more money into forest conservation activities than all other initiatives combined. This is opening up unprecedented opportunities not only for biodiversity conservation, but also to address poverty, land rights, land use, sustainable development and governance.

The PES/REDD+ programme in the state of Acre in the Brazilian Amazon is a leading example. Acre has an impressive record of protecting the rainforest while supporting local livelihoods. The 15 million-hectare state more than halved the rate of deforestation between 2006 and 2010, avoiding almost half a billion tonnes of carbon emissions. This was achieved while also increasing agricultural production and reducing poverty. More than 2,000 farming families have received annual payments in exchange for verified performance in protecting forests, as well as technical and marketing support to develop sustainable livelihoods based on agricultural products. The state has attracted more than US$50 million in external funding to expand its efforts, including payments from the German development bank, KfW, equivalent to reducing 4 million tonnes of CO_2 emissions at a rate of US$5 per tonne (WWF-Brazil, 2013).

Food, water and energy

Food, water and energy – and the biodiversity and ecosystems upon which they depend – are closely intertwined, and are fundamental to human existence. Today, almost a billion people suffer from hunger (Water, Energy and Food Security Nexus, 2011); 768 million people are living without a safe, clean water supply (WHO/UNICEF, 2013); 1.4 billion lack access to a reliable electricity supply, and 2.7 billion depend on traditional sources of bioenergy such as wood as their main fuel for cooking and heating (WWF, 2011a). These needs will become ever harder to fulfil as the world's population soars and consumption rises among the growing middle classes. Climate change and the depletion of ecosystems and natural resources will further exacerbate the situation. While the world's poorest continue to be most vulnerable, food, water and energy security issues affect us all.

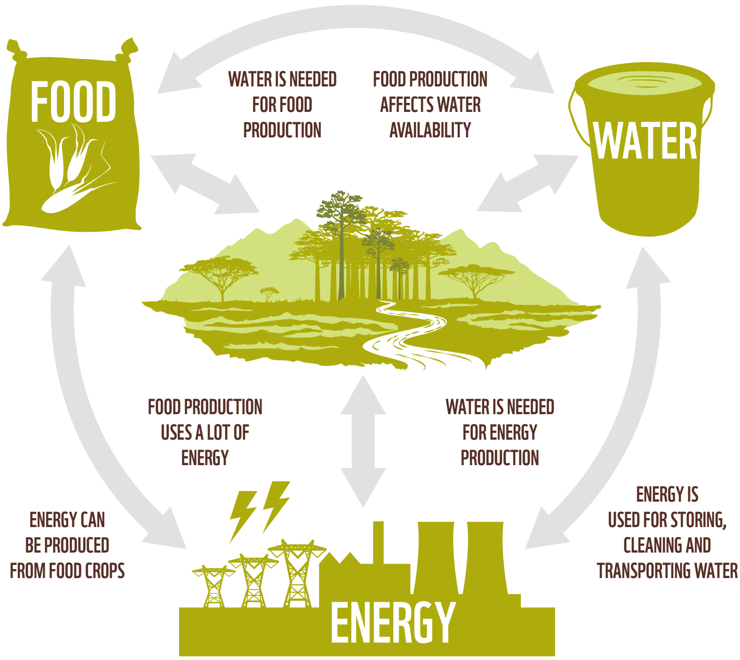


Figure 55: The inter-relationships and interdependencies between the biosphere and food, water and energy security
How we produce food, use water or generate energy impacts on the biosphere that supports these needs.

As seen in Chapter 1, the world's water footprint is already contributing to increasing water scarcity in numerous major river basins. Global freshwater demand is projected to exceed current supply by more than 40 per cent by 2030 (WRG, 2009); by 2030, almost half of the world's population will be living in areas of high water stress (OECD, 2008).

Water scarcity is having, and will continue to have, a profound impact on both food and energy security, since water is needed to produce both.

Awareness is growing of the interdependency of food, water and energy security, and healthy ecosystems. On average, every calorie we eat requires a litre of water to produce (Water, Energy and Food Security Nexus, 2011). Food production also makes up around 30 per cent of global energy consumption (FAO, 2012), and rising energy costs drive rising food prices. Energy generation uses approximately 8 per cent of the global water withdrawals, a figure which rises to 45 per cent in industrialized countries – for cooling power plants, for extracting and processing fossil fuels, through evaporation from reservoirs, or for growing biofuels (Water, Energy and Food Security Nexus, 2011). Meanwhile, purifying and pumping water requires vast amounts of energy.

This interdependence means that efforts to secure one aspect can easily destabilize others – underlining the importance of better understanding and managing these trade-offs. Attempts to boost agricultural productivity, for example, may lead to increased demand for water and energy inputs. Irrigation has raised food production in India – but 20 per cent of all electrical power is now used to pump water for irrigation from diminishing groundwater reserves (Water, Energy and Food Security Nexus, 2011). In many countries, increased fertilizer use has polluted water supplies – increasing the need for energy-intensive purification treatments.

Climate change – largely caused by the energy we use – will have a severe impact on the natural world, and on food and water security. However, alternatives to fossil fuels also pose a risk if they are badly managed. Biofuels, for example, will compete even further with food crops for limited land and water resources. Similar trade-offs and risks surround large-scale hydropower projects such as the 12 mainstream dams planned for the Lower Mekong – see Box 7.

Today, the world produces more than enough food to feed everybody – global per capita food supply today is around 2,800kcal per day. (Nutritional experts recommend an average daily intake of 2,500kcal for men or 2,000kcal for women – FAO, 2013). However, much of this food is unevenly distributed and up to a third is wasted (FAO, 2011). Similarly, consumption of animal products – which have a high water, energy and land footprint – is much greater in high-income countries.

Continually attempting to increase food production by using more water, more land and more energy is unsustainable; an alternative solution would be to move toward a more equitable food supply that uses resources more efficiently. Ensuring all of these depends on healthy, resilient ecosystems.

We cannot conjure perpetual growth out of a closed system – but we can make the system work better.

Box 7: Hydropower, fresh water and fisheries in the Mekong

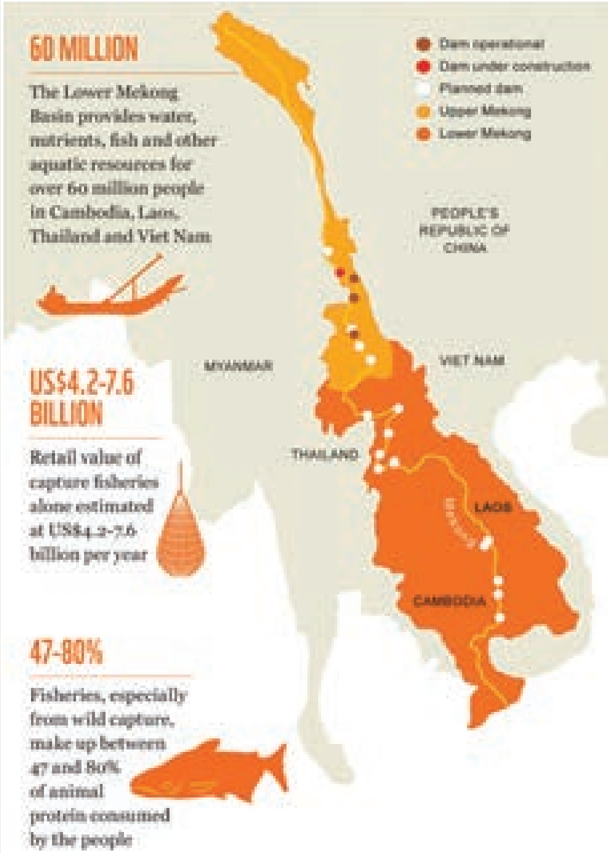


Figure 56: Life along the Mekong

The Mekong River connects six countries over a distance of 4,800km, from China's Tibetan-Qinghai plateau, through Cambodia, Laos, Myanmar and Thailand to Viet Nam – where its vast delta empties into the South China Sea. The river contains more than 1,100 species of fish – three times as many per unit area as the Amazon – including four of the world's ten largest freshwater fish. The Mekong basin is the world's most important inland fishery, providing a quarter of the global freshwater catch and the primary source of protein for 60 million people (Orr et al., 2012).

But the Mekong is under pressure from rapid economic development. With electricity demand expected to grow at a rate of 6-7 per cent annually in Cambodia, Laos, Thailand and Viet Nam up to 2025 (ICEM, 2010), hydropower is seen as an important part of the future energy supply.

However, dams could devastate fish populations by damaging the ecosystem's integrity. Dams on tributaries alone are expected to reduce fish stocks by 10-26 per cent by 2030, while mainstream dams could mean a further 60-70 per cent loss (Orr et al., 2012). Replacing fish as a protein source with livestock would require up to 63 per cent more pasture lands and 17 per cent more water (Orr et al., 2012) – in a basin that already experiences severe water scarcity for three months of the year (Hoekstra and Mekonnen, 2012). Increased food prices associated with higher costs of livestock production would exacerbate poverty. Dams would also restrict the flow of nutrients and sediment to the Mekong Delta – one of the world's most important rice-growing regions – and reduce resilience to the impacts of climate change.

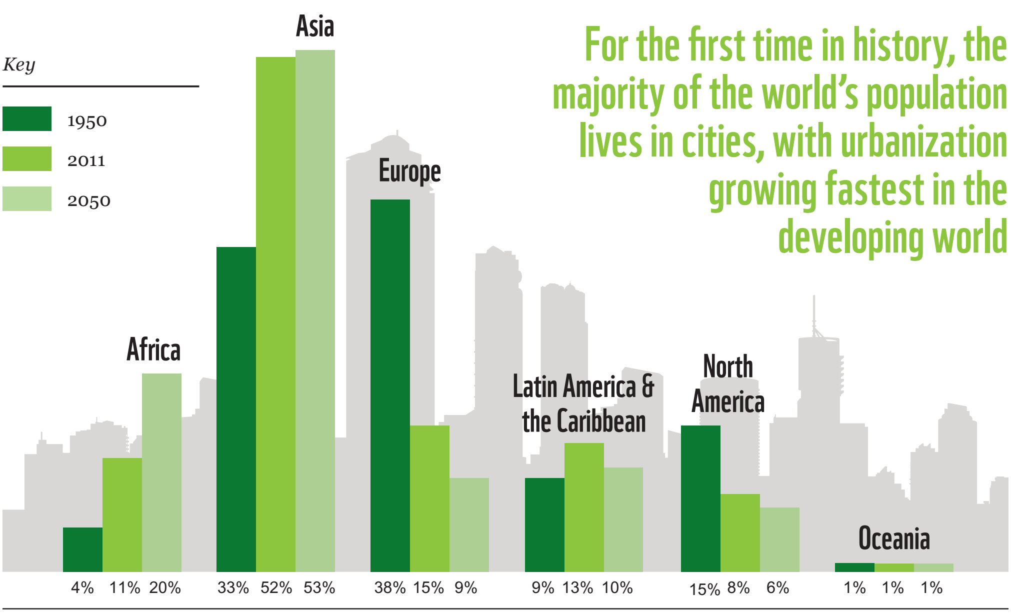
Healthy communities

The health of human communities is determined by resource security and environmental resilience. Without these, our development is built on shaky foundations. We will struggle to reduce poverty and meet basic needs for food, water and energy, which are increasingly likely to become sources of conflict. We leave ourselves vulnerable to the growing intensity of natural hazards and the impacts of climate change.

Healthy communities are the basis of our physical, mental and social well-being. And the basis of healthy communities is a healthy environment. For hundreds of millions of people whose livelihoods depend directly on the resources and services that nature provides, the link is obvious. For the ever-growing number of people who live in cities, increasingly detached from the natural world, the importance of healthy ecosystems may not be so immediately apparent – and yet the effects of environmental problems can be just as striking, from air and water pollution to extreme weather events.

The global population landscape has changed in the past decade. For the first time in history, the majority of the world's population lives in cities, with urbanization growing fastest in the developing world. Statistically, this is the result of natural growth, rural-urban migration and reclassification of rural to urban land (Buhaug and Urdal, 2013). Looking a little deeper, however, the

Figure 57: Distribution of the world urban population by region *(UNDESA, 2012)*.



For the first time in history, the majority of the world's population lives in cities, with urbanization growing fastest in the developing world

trend has a lot to do with environmental security: resource scarcity (farming and grazing lands, forests, and water), environmental degradation, frustration with reliance on increasingly unpredictable natural systems, and natural hazards all pushing people to leave behind their rural settings in search of greater livelihood and lifestyle security. This in turn has significant consequences for the health of the cities that absorb them.

Population in urban areas is projected to increase from 3.6 billion in 2011 to 6.3 billion in 2050 (UNDESA, 2012). The vast majority of the projected population increase that is expected to occur between now and 2050 will take place in the cities of the developing world (UNDESA, 2012; Sachs, 2008).

Megacities (cities of more than 10 million people) are on the rise. In 1970, the world had only two megacities – Tokyo and New York – but today there are 23 (UNDESA, 2012), and this number is increasing.

In many circumstances, city infrastructures are unable to keep pace with such rapid increases in population – nor the growth of their inhabitants' demands. This has implications for the quality of life of city dwellers and their access to basic amenities. A billion people already live in city slums (UNFPA, 2007): their number will greatly increase, and social problems proliferate, without massive investment in infrastructure and services, and efforts to tackle urban poverty.

Rapidly growing urban populations and consumption also put increasing strain on the natural services upon which cities rely. Healthy cities need to invest in preserving and restoring these. For example, around a third of the world's biggest cities depend on nature reserves for their drinking water (Dudley and Stolten, 2003). Megacities such as New York, Rio de Janeiro and Mexico City now run schemes to conserve forests and wetlands, and improve land management within their water catchments.

Urban settlement patterns in the region were originally influenced by availability of land and accessibility to deep-sea ports (ADB, 2013). High concentrations of people, infrastructure and economic activity mean that urban centres are highly exposed to natural hazards and climate change risks.

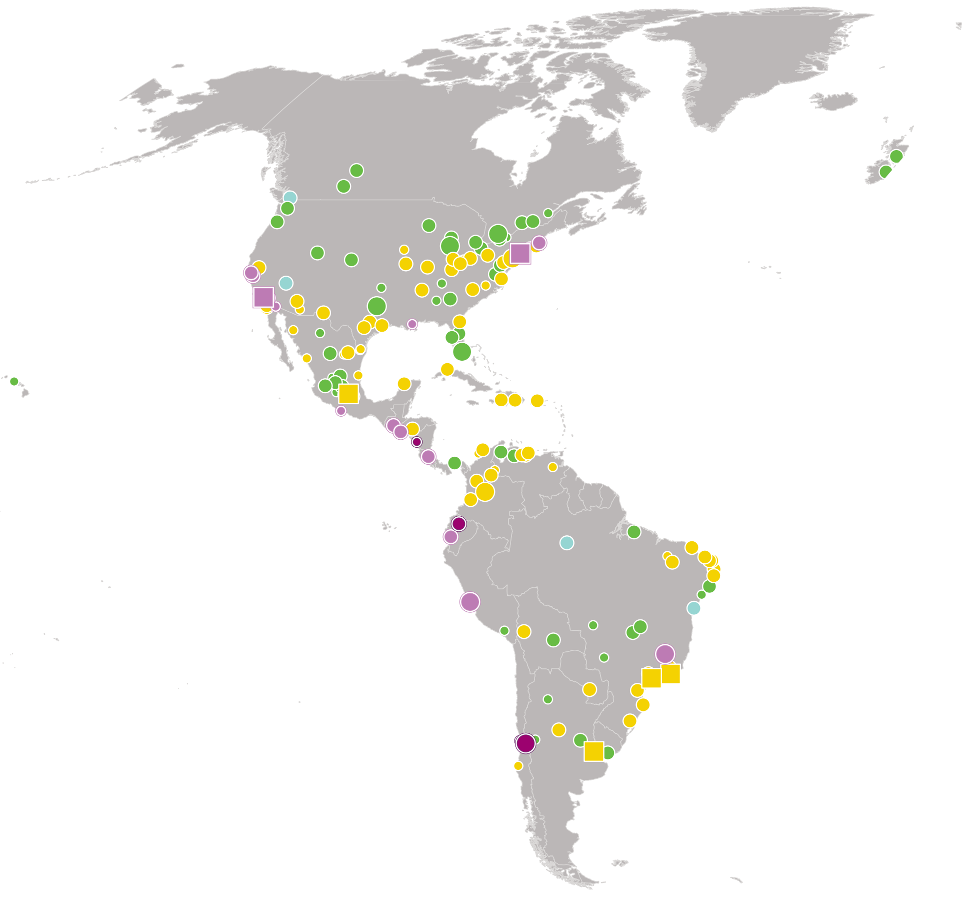


Figure 58: Distribution of cities by population size in 2011 and risk of natural hazards (UNDESA, 2012).

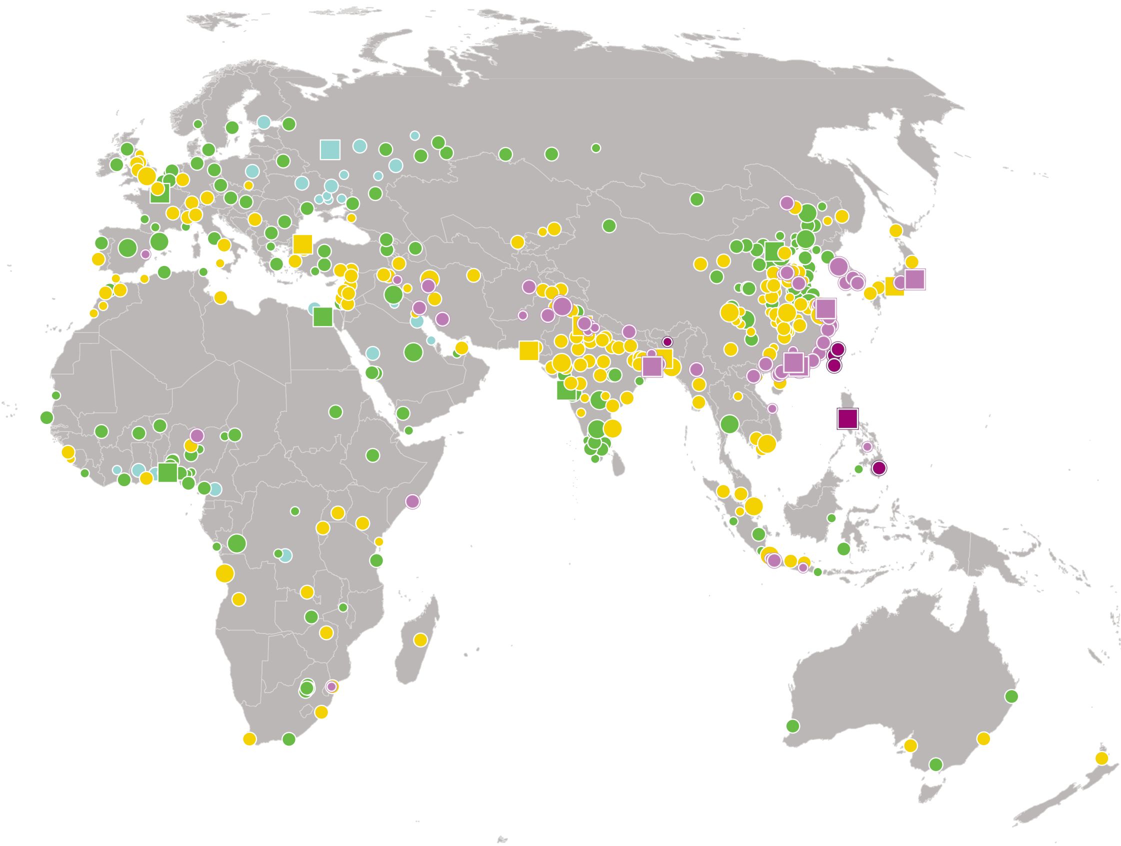
Hazards exposed to

- No Hazard
- Hazard not in top 3 deciles
- 1 Hazard in top 3 deciles
- 2 Hazards in top 3 deciles
- 3+ Hazards in top 3 deciles

Note: In terms of frequency of occurrence and scale of natural hazards, cities in the top three deciles are said to be at relatively high risk.

Among the 63 most populated urban areas (with 5 million or more inhabitants in 2011), 39 are located in regions exposed to a high risk of at least one natural hazard; 72 per cent are located on or near the coast; two-thirds are in Asia (figure 58). Among the six natural hazards analysed, the greatest and most common hazard is flooding, potentially affecting areas where 30 of the 63 cities are located. Other hazards include cyclones (10 cities), droughts (9) and earthquakes (6) (UNDESA, 2012).

The degradation of ecosystems and the loss of the services they provide, such as protection from floods and storm surges, increase our vulnerability to natural hazards and the cost of mitigating these impacts (Costanza et al., 2014) – even as these are predicted to become more frequent and more intense as a result of climate change. But while the state of communities is partly shaped by external forces, it is also determined by individual actions. From village to metropolis, communities have ways and means of



City population

- 750-1000 thousand
- 1-5 million
- 5-10 million
- 10 million or more

improving their security and resilience, and implementing solutions from the bottom up.

Community-based natural resource management – which gives communities control over decisions regarding ecosystems and natural resources such as water, forests, communal lands, protected areas and fisheries – is one successful model for improving rural livelihoods and security. Many cities are developing innovative approaches to protecting natural capital and improving their citizens' well-being in a sustainable way. Since cities have high concentrations of people, as well as skills, money, technology and creativity needed to develop solutions, this presents an opportunity to secure healthy communities and more sustainable lifestyles for a large proportion of humanity.

The next chapter looks in more detail at some of these possible solutions.

© Brent Stirton / Reportage by Getty Images / WWF-Canon

BRIGHT SPARKS

Generating energy doesn't always have to be damaging to the environment. This welder is at work on a community hydropower project in Mutwanga, DRC, which relies on water from Virunga National Park. The project, set up by the Congolese Wildlife Authority, will provide electricity to 25,000 people. It will also power schools, a hospital and an orphanage, as well as creating jobs and business opportunities. At the same time, nearby residents have a greater incentive to look after the park's forests and wetlands, which ensure the water supply. Unlike many misplaced and poorly planned hydropower developments around the world, this project will have minimal impacts on ecosystems while generating sustainable energy.

Around the world, projects like this one are showing that development and conservation can go hand in hand, and that protecting natural capital can lead to genuine social and economic progress.

CHAPTER 4: ONE PLANET SOLUTIONS

As we have seen in the preceding chapters, we urgently need to halt the depletion of natural resources, restore damaged ecosystems, conserve biodiversity and maintain essential ecosystem services. At the same time, we need to provide equitable access to natural resources and provide food, water and energy for a growing global population. The big question is: how are we going to do it?

The Earth's natural capital, on which our social and economic prosperity is built, is finite. This basic fact should be embedded in every economic forecast and development strategy, in business plans and investment decisions, in our livelihoods and lifestyle choices.

The One Planet Perspective (Figure 59) outlines better choices for managing, using and sharing natural resources within the planet's capacity. It requires that we:

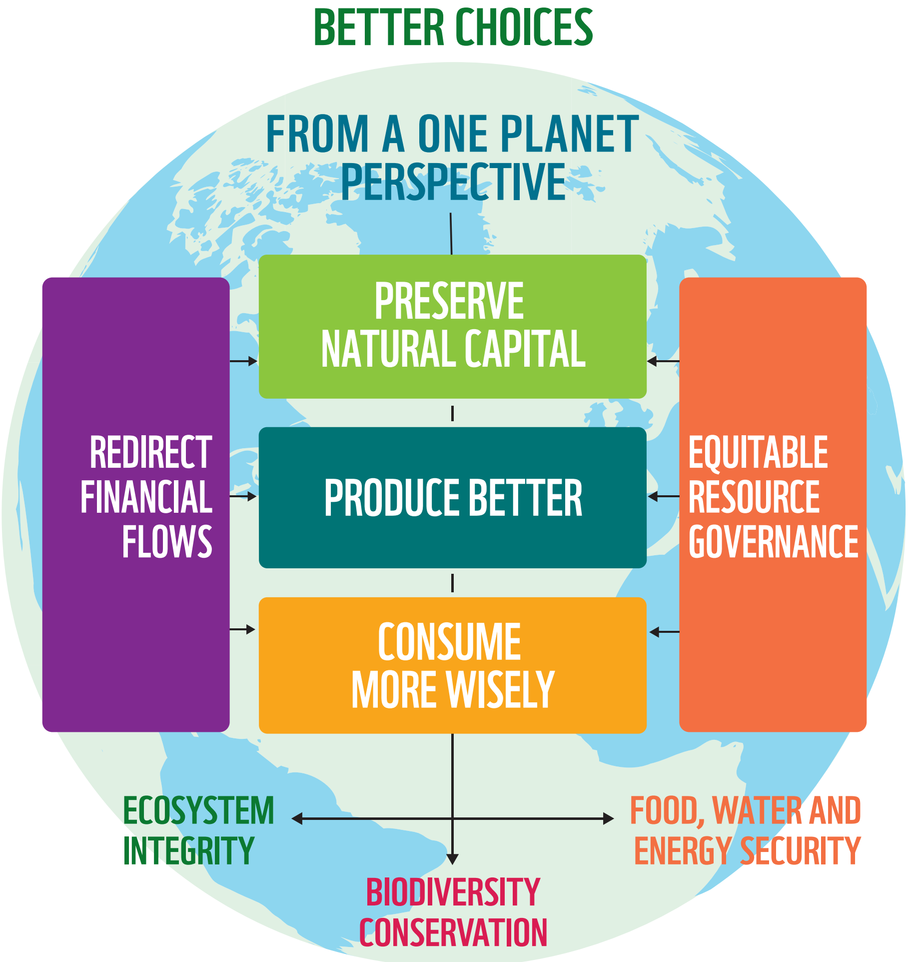
- Preserve natural capital: restore damaged ecosystems, halt the loss of priority habitats, significantly expand protected areas.
- Produce better: reduce inputs and waste, manage resources sustainably, scale-up renewable energy production.
- Consume more wisely: through low-footprint lifestyles, sustainable energy use and healthier food consumption patterns.

It also suggests two essential enabling conditions:

- Redirect financial flows: value nature, account for environmental and social costs, support and reward conservation, sustainable resource management and innovation.
- Equitable resource governance: share available resources, make fair and ecologically informed choices, measure success beyond GDP.

While the global indices and trends presented in earlier chapters leave us in no doubt about the scale of the challenges that we face, there is room for hope. Numerous examples, from all around the world, demonstrate the One Planet Perspective in practice – with significant environmental, social and economic benefits. In this chapter, we discuss some of the solutions being developed, and present seven case studies. More are available on the *Living Planet Report 2014* website (wwf.panda.org/lpr), and many other examples exist.

Figure 59: One Planet Perspective
(WWF, 2012).



1 Southern Chile

PROTECTION, PRODUCTION AND PEOPLE

A model for marine conservation integrates blue whales, salmon production and social equity

© WWF Chile / Jorge Oyarce

"We are privileged to live in this environment, in absolute harmony between the marine ecosystems and our indigenous world view. Our ocean, land and air are sacred spaces and provide everything for our survival. They give us many things, like being able to go down to the beach and harvest nutritious fresh shellfish, without contamination. We have also started offering ecotourism activities, which shows others that caring for nature can generate income for the family."
Sandra Antipani, indigenous leader from Chiloé Island, Southern Chile

The fjords and channels of Patagonia in southern Chile – known as the Chiloense Marine Ecoregion – are a unique environment of immense conservation importance. The region is home to many species of marine mammals and birds, cold-water corals and highly productive fisheries. It also hosts one of the most important feeding areas for the largest animal ever to have existed: the blue whale. Almost wiped out by whaling, its survival depends on such critical areas being protected.

The Chiloense Marine Ecoregion provides its human population with myriad services: food and income for local fishermen, stunning scenery and wildlife that attract tourists, and spiritual and cultural values. It also supports fish production on a globally important scale, sheltering the larvae of several commercially important species, and providing 30 per cent of the world's salmon production, 3 per cent of whitefish and 12 per cent of forage fish (FAO, 2014). But the overexploitation of these marine resources has reached dangerous levels; important habitats have already been lost, and the ecosystem and its services are under stress.

For more than a decade, WWF has worked with local communities and authorities on an integrated conservation strategy for the marine ecoregion. The approach is based on sound science, rigorous landscape and seascape planning, and close engagement with many stakeholders – including local and indigenous communities, government, producers, and the finance and retail sectors.

One goal is to establish a network of marine protected areas – extending along the coast and beyond Chile's waters into the high seas. In early 2014, the coordinated efforts of WWF-Chile, the Blue Whale Centre, Austral University of Chile and the Melimoyu Foundation, led to the Chilean government to create the Tic Toc Marine Park – which includes crucial blue whale feeding and nursing grounds – and two other marine protected areas. Together, they cover more than 120,000 hectares. As well as offering protection to whales and dolphins, and giving fish stocks the chance to recover, these protected areas should increase the marine ecosystem's resilience to climate change.

Outside protected areas, efforts are being made to reduce the impact of fisheries and aquaculture, particularly salmon production. Producers, buyers, scientists, environmental and social NGOs and others have worked together, in Chile and internationally, to develop the Aquaculture Stewardship Council (ASC) standard for responsible salmon farming. The ASC standard – the result of almost 10 years of dialogue – aims to minimize or eliminate negative environmental and social impacts of salmon farming. Conditions include strict controls on water quality, fish escapes, use of chemicals and antibiotics, and how best to manage natural predators such as seals and seabirds.

In 2013, companies representing 70 per cent of the world's farmed salmon production – including seven Chilean companies – pledged to certify all of their farms to the ASC standard by 2020.

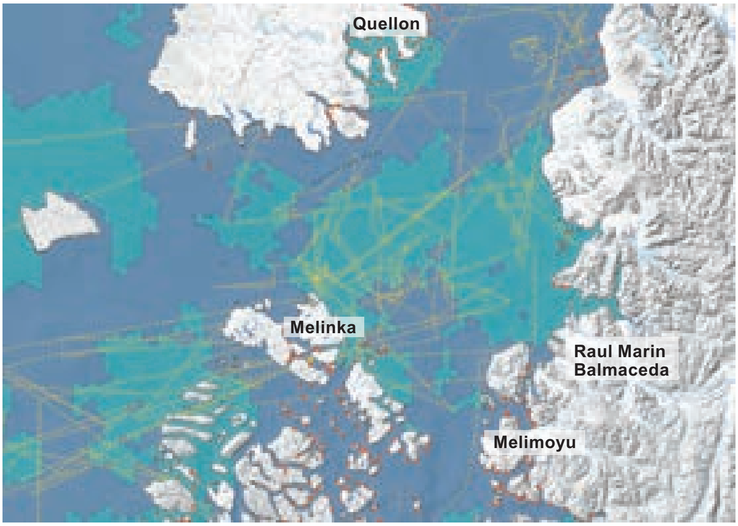
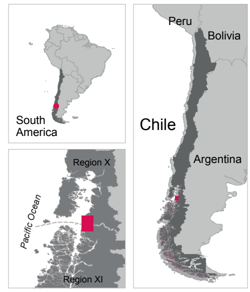


Figure 60: Satellite tracking data helps to map blue whale routes within the Chiloense Marine Ecoregion *(WWF-Chile, 2014).*

location map



Key

- Whale sightings
- Whale Routes
- Salmon farms
- Marine Protected Areas
- Protected Areas
- Marine Priority Conservation Areas

* Multiple use Marine Protected Area

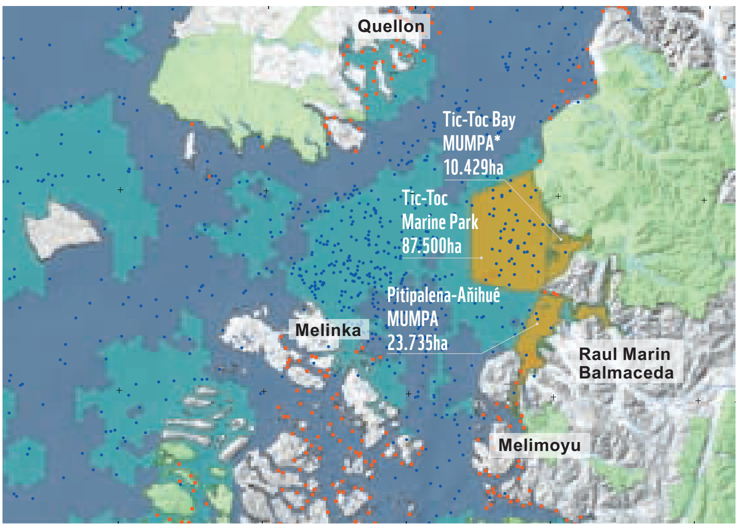


Figure 61: Recently declared marine protected areas *protecting important habitats for blue whales (WWF- Chile, 2014).*

This presents a real opportunity, but much work needs to be done to accelerate the uptake of better practices to achieve ASC certification.

Long-term conservation success depends on equitable and sustainable development for the region's inhabitants, including indigenous people. With the new marine protected areas expected to generate increased ecotourism, WWF is working with communities to enable them to take advantage of emerging opportunities. This should improve people's livelihoods, and increase the incentive to protect their natural and cultural heritage.

ASC certification will also require producers to operate in a socially responsible way, both as employers and neighbours.

"I believe that the salmon industry first needs to get to know the community where they operate – consider the perception of the people, their culture, the history and above all respect the ecosystem, the plants and animals that live there," says Sandra Antipani, an indigenous leader from Chiloé island. "The idea of conservation of marine ecosystems and blue whales is in our indigenous consciousness."

Preserve natural capital: WWF and partners are working to establish a network of marine protected areas covering at least 10 per cent of Chile's coastal waters.

Produce better: Meeting the ASC standard will greatly reduce the impact of salmon aquaculture on marine ecosystems. A pilot project is assessing the impacts of ASC, based on 42 social, economic and environmental indicators.

Consume more wisely: Demand from consumers and retailers for more responsibly farmed salmon has helped encourage producers to commit to ASC certification.

Redirect financial flows: WWF encourages financial institutions to support sustainable commodity production, including certifications like ASC. In Chile, the Dutch bank Rabobank is working with WWF and Chilean salmon producers to improve sustainability performance. This will enable the producers to be more competitive and less vulnerable to environmental and social risks. This will also have a positive impact on the banking relationship and credit decisions.

Equitable resource governance: Local and indigenous communities in the area have become important allies for marine conservation and better social and environmental practices in the salmon industry.

COMMUNITIES AND CONSERVATION

Mountain gorilla populations are increasing, and the people who live alongside them are benefiting

Augustin Akantambira of Kabaga village near Bwindi Impenetrable National Park in Uganda shows his gorilla carvings for sale to tourists

"Before there was no connection between the park and communities. Now it is totally different. They understand that the park is important for them because they are benefitting directly from the money we are getting from tourism. They respect the gorillas."
Patience Dusabimana, community leader and guide, Volcanoes National Park, Rwanda

With fewer than a thousand mountain gorillas left in the wild, the odds appear stacked against them. Just two populations remain in small islands of forest, surrounded by a rising tide of humanity. Some of the darkest episodes in recent history took place in this region – the Rwandan genocide and the wars that have devastated the Democratic Republic of Congo (DRC). The consequences can still be felt, as tens of thousands of people attempt to rebuild their livelihoods, based largely on the natural resources around them.

Yet mountain gorilla numbers have increased by almost 30 per cent in recent years (IGCP, 2012) – the only species of great ape whose numbers are rising. A spiral toward extinction has been transformed into a virtuous circle as people and gorillas thrive together.

Mountain gorillas survive in two isolated populations, among the Virunga volcanoes on the borders of DRC, Rwanda and Uganda; and the Bwindi Impenetrable National Park in Uganda. Since 1991, mountain gorilla conservation has been led by the International Gorilla Conservation Programme (IGCP) – a coalition involving WWF and Fauna and Flora International.

The IGCP works with local people and government agencies to manage a cross-border network of protected areas, and to develop responsible mountain gorilla tourism. This creates jobs as tour guides, porters or park rangers. Tourists come from all over the world to see gorillas in their natural habitat, and the revenues help fund gorilla conservation and community projects. Ultimately, local people gain more from preserving their natural resources than from exploiting them in the short term.

Gorilla tourism has transformed communities in the region – like Nkuringo, an isolated mountain town in Uganda. The town is home to the Clouds Mountain Gorilla Lodge, a community-owned boutique hotel that welcomes 1,200 guests a year. It directly employs more than 40 people, but the benefits extend to more than 30,000 others living in nearby villages.

Restaurants, bars and other accommodation are opening up, while craft shops sell carved wooden gorillas, t-shirts and baskets made by local artisans, many of whom are women. Income from the hotel and gorilla-tracking permits goes into a community foundation, which has funded a range of enterprises, including vegetable growing and tea plantations. The foundation funds a sponsorship scheme that pays for the poorest children to go to school. It’s also meeting the costs of training nurses and building a health centre.

In Rwanda, gorilla tourism is the engine powering a tourist industry worth US$200 million a year in foreign exchange earnings (Nielsen and Spenceley, 2010) – although tourist numbers are limited to avoid negative impacts on the gorillas, local people and the local environment. Communities around the national parks share 5 per cent of the money generated by park permits – which has helped to build schools and hospitals, set up sustainable businesses, and fund environmental projects such as tree planting and erosion control.

Furthermore, the IGCP's "gorilla water" initiative has brought improved water and sanitation to many communities and households, by helping construct rainwater storage facilities. With most villages in the area lacking a safe water supply, women and children used to collect water from streams within the national parks. Not only was this an arduous and potentially dangerous chore, but the presence of large numbers of people posed a threat to the gorillas and other wildlife. Now, many women and children have more time to spend on education and improving their livelihoods, and fewer people need to enter the gorillas' habitat. The communal effort of building water tanks, and their shared ownership, has helped to strengthen the sense of community – a particularly important outcome in an area with large numbers of displaced people, where the scars of conflict are still raw – and establish a positive connection with the parks and the gorillas.

As Anna Behm Masozera, head of the IGCP, puts it: "When done mindfully and respectfully, conservation has the power and potential to bring people together for a common cause, both across park boundaries where park and people intersect, and across international borders as well."

Preserve natural capital: The value of Uganda's gorillas as a tourist attraction has been estimated at between US$7.8 million and US$34.3 million (IGCP, 2014).

Redirect financial flows: A proportion of park revenues (which varies by country) is distributed to neighbouring communities, supporting community-led health, education, infrastructure and livelihood projects.

Equitable resource governance: As people benefit directly from the gorillas and understand their value, they have an added incentive to look after the forest.

Consume more wisely: Tourists are directly benefiting communities and conservation through their spending.

With mountain gorillas as the star attraction, ecotourism in DRC's Virunga National Park – following the successful models demonstrated in Rwanda and Uganda – could create thousands of jobs and bring in an estimated US$235 million per year.

3 Belize

VALUING NATURAL CAPITAL

Belize's new coastal development plan takes full account of the huge value of natural ecosystems

© naturepl.com / Roberto Rinaldi / WWF-Canon

The Mesoamerican Reef off the coast of Belize supports species like hawksbill turtles and attracts tourists from around the world.

"The coastal zone of Belize is undeniably one of the country's greatest assets. It is treasured by the Belizean people for its economic and socio-cultural values, and wide range of ecosystem benefits. Belize's first ever national integrated coastal zone management plan will help Belizeans to better understand the incredible value of our treasured coastal zone, and provide a sound science-based blueprint for long-term, sustainable management of our coastal and marine resources."
Chantelle Clark-Samuels, Director, Coastal Zone Management Authority and Institute

The beauty and diversity of Belize's coastal ecosystems are world renowned, drawing tourists from around the globe. More than 40 per cent of the country's population live and work along the coast and depend on these ecosystems for their livelihoods.

Fishing is a way of life and a vital source of food for many Belizeans. Commercial fisheries that depend on reefs and mangroves are worth an estimated US$14-16 million a year. Tourism associated with coastal ecosystems contributed an estimated US$150-196 million to the national economy in 2007 (12-15 per cent of GDP). Reefs and mangroves protect coastal properties from erosion and storm surges, saving an estimated US$231-347 million through avoided damages each year. By comparison, Belize's GDP in 2007 was US$1.3 billion (Cooper et al., 2009).

But too often, the benefits of natural ecosystems are overlooked in coastal investment and policy decisions. Unchecked development, overfishing and pressures from tourism threaten the country's reefs, even as the threats of warming seas, fiercer storms and other climate-related changes loom larger.

Fish populations will decrease if they lose the mangroves that provide critical nursery habitats. As reefs and mangroves decline, Belize's low-lying cayes and coastal properties will become

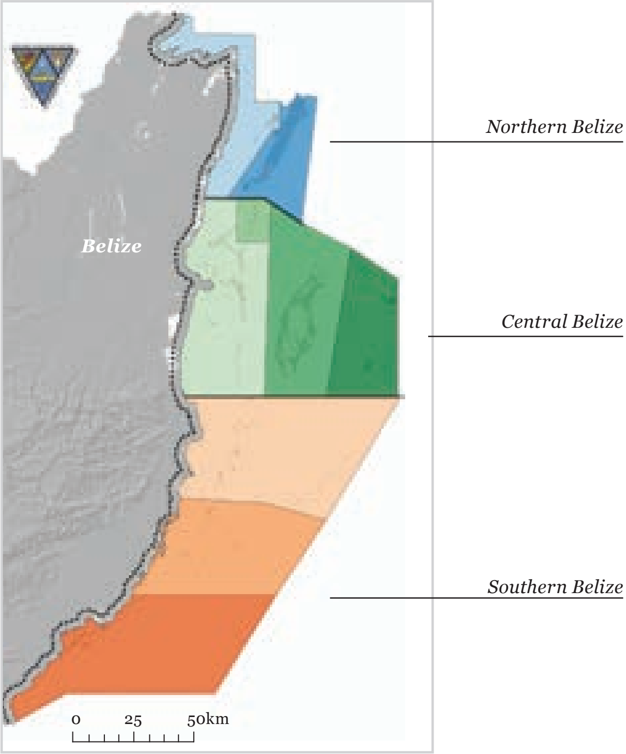
Figure 62: Nine coastal planning regions of Belize *(Natural Capital Project, 2013).*

Key

Northern Belize
- Northern Region
- Ambergris Caye

Central Belize
- Central region
- Caye Cauker
- Turneffe Atoll
- Lighthouse Reef Atoll

Southern Belize
- South northern region
- South central region
- Southern region



2010 — *Current*

2025

Conservation
Presents a vision of long-term ecosystem health through sustainable use and investment in conservation

Informed Management
Blends strong conservation goals with current and future needs for coastal development and marine uses

Development
Prioritizes immediate development needs over long-term sustainable use and future benefits from nature

Figure 63: Three 2025 scenario storylines from the Integrated Coastal Zone Management Plan of Belize *(Natural Capital Project, 2013).*

increasingly vulnerable to storms and erosion, and tourism will suffer (Cooper et al., 2009).

In 2010, Belize's Coastal Zone Management Authority and Institute (CZMAI) began to develop the country's first national Integrated Coastal Zone Management Plan in partnership with WWF and the Natural Capital Project (NatCap). The plan replaces *ad hoc* development decisions with informed, long-term management. It provides science-based evidence to help resolve conflicts between competing interests and minimize the risks to natural habitats from human activities.

Research was conducted into the benefits that coastal and marine ecosystem services provide for people, and the impacts that human activities have on them. Project staff consulted closely with the public at national and local levels, and coastal advisory committees – representing industries such as tourism and fishing, local and national government, and community development and environmental organizations – were formed in nine coastal regions. Through meetings, interviews and field trips, these committees provided local knowledge and data, shared their goals and values, and regularly reviewed the plan as it took shape.

To understand the implications of different development scenarios, the team used NatCap's tool InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) (Sharp et al., 2014). InVEST is designed to help policymakers and stakeholders incorporate the value of various ecosystem services into their decision-making, and better understand the trade-offs involved. For instance, by looking at how the level of coastal development in a

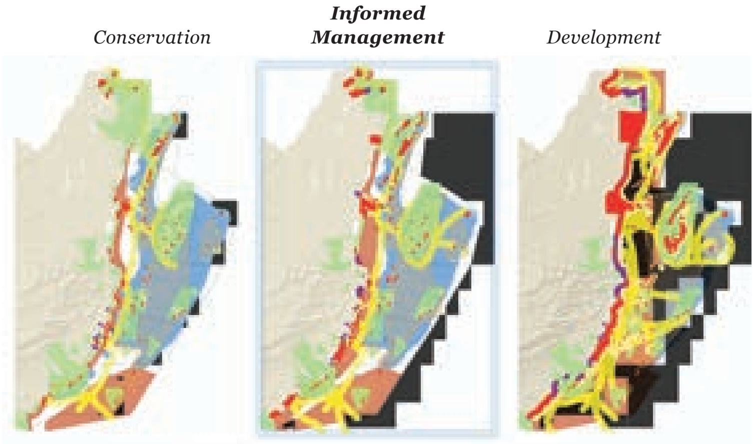


Figure 64: Three future zoning schemes designed and discussed with stakeholders in Belize *(Natural Capital Project, 2013).*

Key

- Coastal development
- Aquaculture
- Dredging
- Conservation
- Agricultural runoff
- Oil exploration
- Fishing
- Marine transport
- Marine recreation

particular area will affect ecosystems like mangroves, seagrass beds and coral reefs, it is possible to compare the expected gains in tourist revenue against the potential loss in income for lobster fishers and the increased vulnerability to storms. The tool also shows the potential economic return on investment in protecting and restoring critical ecosystems.

By balancing conservation with current and future development needs, the plan could boost revenue from lobster fishing by US$2.5 million; increase the functional area of coral reefs, mangroves and seagrass by up to 25 per cent; and double the value of these ecosystems for protecting the coast by 2025 (Cooper et al., 2009). In short, it will help the people of Belize to plot a wiser course for managing the incredibly valuable resources that their ocean and coast provide.

Preserve natural capital: Belize's coastal and ocean ecosystems provide services worth up to US$559 million per year – equivalent to 43 per cent of GDP (Cooper et al., 2009).

Redirect financial flows: The Integrated Coastal Zone Management Plan encourages investment that recognizes the true value of ecosystem services.

Equitable resource governance: The Integrated Coastal Zone Management Plan has been developed with local stakeholders, to balance competing demands and allow informed decisions on the use of natural resources.

4 South Africa

PLANTATIONS AND WETLANDS

Smart land-use planning has restored a vital wetland, and laid the foundation for successful partnerships

© Brett Florens

"Forestry is a big part of our livelihood and it is important we have a good relationship with SQF. The community graze their cattle in the plantations, collect firewood and honey, and many are forestry workers and contractors."
Induna Alson Mpangela, smallholder, Mankwathini, KwaZulu Natal

Water is one of South Africa's scarcest natural resources, and the country's wetlands are hugely important for people and nature. The wetlands purify and store water, control erosion, reduce the severity of droughts and floods by regulating stream flow, and recharge aquifers. They are vital for biodiversity, tourism, agriculture and grazing, and as a source of food and plant materials for rural communities. Some 6 million people without regular access to safe drinking water draw what they need directly from streams, rivers, lake and marshes.

More than half of South Africa's wetlands have been significantly damaged by poorly managed agriculture and other development. Two-thirds of wetland types are threatened, and almost half are critically endangered (WWF-South Africa,2013). In the past, the commercial forestry sector has been part of the problem, with plantations being established in wetland areas, and non-native species consuming large amounts of water. However, the sector is also a vital part of the South African economy, contributing 1.8 per cent of GDP and employing 110,000 people (Nyoka, 2003).

To strike a better balance between production and conservation, pulp and packaging company Mondi has taken a lead in mapping, protecting and rehabilitating wetlands.

Box 8: New Generation Plantations

Set up by WWF in 2007, the New Generation Plantation (NGP) platform brings together companies and government forest agencies from around the world to explore, share and promote better ways of planning and managing plantations. Around 250 million hectares of new plantations could be needed between now and 2050 to meet a projected tripling in wood consumption while conserving natural forests (WWF, 2011b).

NGP promotes plantations that:

- Maintain ecosystem integrity;
- Protect and enhance high conservation values;
- Are developed through effective stakeholder involvement processes;
- Contribute to economic growth and employment.

The Mondi Group participates in the NGP platform, which advocates new models of plantation forestry that contribute to the welfare of local communities and work in harmony with natural ecosystems.

www.newgenerationplantations.org

The impressive results can be seen in iSimangaliso Wetland Park, the country's last remaining coastal wilderness and a popular tourist destination. In 1999 iSimangaliso was designated a World Heritage Site for its rich biodiversity, unique ecosystems and natural beauty. At its heart is Lake St. Lucia, a long, narrow estuary separated from the Indian Ocean by towering sand dunes. The lake is rich in wildlife, and hundreds of hippos and crocodiles can be seen basking in the shallow waters.

On the western shores of the lake are extensive commercial pine plantations. Mondi took these over in 2004, when South Africa privatized its state forests. To manage them, it formed SiyaQhubeka Forests (SQF), in partnership with local economic empowerment organizations, communities and the government.

But SQF had inherited a problem. Over the years, there had been bitter disputes involving the forestry industry, environmentalists and local people. Some poorly sited plantations were having a negative impact on the lake and its wildlife by reducing freshwater flows. Water levels were too low and salinity levels too high, especially in the dry season.

Mondi-SQF worked with the government, environmental NGOs and the park authority to determine which areas were suitable for commercial plantations, and which should be returned to their natural state. They mapped out a 120-km long "eco-boundary" dividing wetland areas and other important ecosystem components from the dry mineral soils best suited to plantations, where negative impacts would be minimal.

As a result, 9,000 hectares of plantations with significant potential conservation value were transferred to the iSimangaliso Wetland Park. The plantation trees were removed, and the land restored to wetlands and savannah. A further 14,200 hectares of SQF's land – including plantations as well as areas of natural forest and wetlands – was later officially incorporated into the park.

The project has restored trust and restored ecosystems. Today, both SQF and the park are thriving enterprises. Regular freshwater flows into Lake St. Lucia have been secured and rehabilitated wetlands and grasslands already support a wide range of biodiversity.

As well as benefiting Lake St. Lucia's many birds and freshwater species, the project has extended the habitat of the park's large animals. Tourists come to see elephants, rhinos, giraffes and cheetahs in areas which, just a few years ago, were dense pine forest. Herds of buffalo, zebras and antelopes graze in the fire breaks and corridors between the trees. The plantations also provide an important buffer, protecting the wilderness area from encroaching development and reducing the threat of poaching.

Involving local people in the plantation model has raised the levels of skills, education and viable small businesses in the area. Mondi-SQF supports local forestry-related businesses, and awards most contracts to community-based enterprises. On neighbouring tribal areas, around 3,000 residents grow eucalyptus woodlots of a couple of hectares on land unsuitable for other crops, with Mondi-SQF paying a premium for the wood they supply.

Nationally, Mondi's wetland rehabilitation work has involved the loss of around 5 per cent of its productive forestry land, while its community investments also carry a significant cost. Ultimately, however, Mondi considers it a worthwhile investment to secure its social licence to operate – and long-term ecological, social and economic viability.

Preserve natural capital: Rehabilitating wetlands around Lake St. Lucia has restored ecosystem services and attracted tourism revenue.

Produce better: By keeping plantations away from wetland areas, forestry companies are reducing the impact of timber production on freshwater resources.

Consume more wisely: By choosing Forest Stewardship Council (FSC)-certified wood and paper products, consumers can encourage responsible forest management, including protecting and enhancing areas of high conservation value. In South Africa, the FSC standard now includes conditions for keeping plantations out of wetlands and buffer zones around them.

Redirect financial flows: Rehabilitating wetlands brings environmental, social and long-term economic value that far outweighs the loss of plantation area and the short-term costs.

Equitable resource governance: Communities are shareholders in SQF, and areas of land are being returned to community ownership.

5 Great Barrier Reef

LAND, RIVERS AND SEA

Investing in water stewardship boosts agriculture, fishing and tourism, and helps to conserve one of the world's iconic environmental assets

"If stuff that runs off our farm is affecting the Reef we need to do what we can to reduce it. And that's the idea of this, to get proactive and show what can be done. Hopefully that will lead to change within the industry."
Gerry Deguara, sugarcane grower, Queensland

Catchment run-off is one of the biggest threats to the health of many marine areas around the world.

This is particularly true for the Great Barrier Reef, one of the world's natural wonders and a World Heritage Site. Water running off catchments collects farm fertilizer, pesticides and soil, and flushes these pollutants out onto the Reef. The impact on corals and seagrass, and the species that rely on them for food and shelter, is immense.

A recent study found that reef coral cover has halved since 1985 (De'ath et al., 2012). More than 40 per cent of this loss was due to outbreaks of the coral-eating crown of thorns starfish, which are fuelled by fertilizer run-off from farms. With the decline in the Reef's health – exacerbated by outdated fishing practices, and threats such as port expansion, the dumping of dredge spoil and climate change – the World Heritage Committee is considering adding the Great Barrier Reef to its "In Danger" list.

WWF is working with farmers, governments and companies to cut pollution so coral can recover, and to enable the Great Barrier Reef to build resilience to the increasing impacts of climate change. The work promotes more sustainable commodity production, and better water stewardship, water security and freshwater habitat protection.

One key initiative is Project Catalyst, which brings together sugarcane growers, The Coca-Cola Foundation, government agencies and WWF to test and implement new practices that reduce pollution and improve farm productivity. Nearly 100 Queensland farmers are involved in the project.

To get the cuts to pollution necessary for the Great Barrier Reef's survival, this good work needs to be scaled-up across all of the catchments that run into the Reef – encompassing millions of hectares and thousands of farms. This will require a significant boost in private and public investment. Australian national and state governments have so far committed AUS$750 million (US$670 million) over 10 years to support the health of the Reef. Some of this funding will help farmers invest in better practices and technology that will increase productivity while reducing pollution, erosion and water use.

While much more needs to be done, the initial results are impressive. In the last five years, some 2,000 farmers have adopted improved management practices across more than 3 million hectares. Early indications show that total pesticide pollution has been cut by 15 per cent and fertilizer pollution by 13 per cent – although some participating farmers have achieved even greater reductions. Farmers benefit too, seeing improved productivity and spending less on chemical inputs.

Market forces can also play a significant role in improving production practices. WWF is working with large buyers of sugar and supply chain businesses to promote Bonsucro, an international standard for more sustainable sugar production, and to help farmers improve their practices in order to achieve certification. Work is also being carried out to develop similar standards and better management practices with the cattle industry, the other major user of land in the Great Barrier Reef catchment area. Consumers are encouraged to reduce their impact on the Reef by choosing products that are verified as sustainable.

The economic case for much greater investment is clear. According to the Australian government, the Great Barrier Reef World Heritage Area adds AUS$5.68 billion (US$5.10 billion) a year to the Australian economy and generates almost 69,000 full-time equivalent jobs (Deloitte Access Economics, 2013). Investing in its health not only preserves one of the world's environmental wonders, but also boosts the fishing and tourism industries and the communities that rely on them.

Similar pollution reduction models can be applied across many catchments globally, helping communities to benefit from more productive agriculture, fishing and tourism industries, and protecting the natural assets upon which they depend.

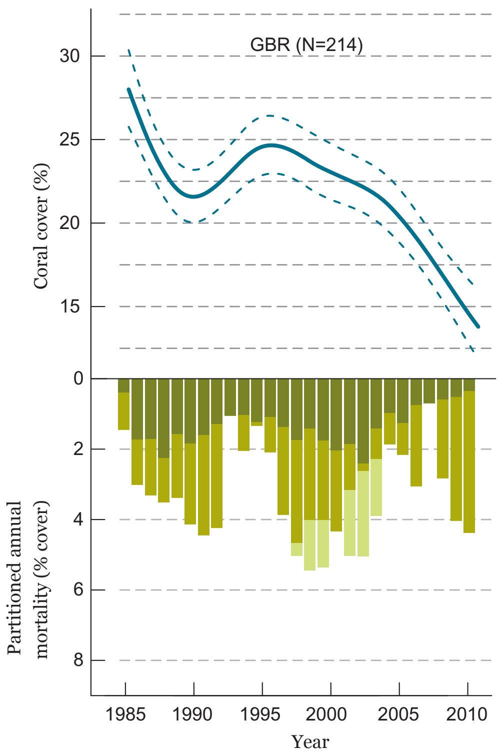


Figure 65: The 27-year decline of the coral cover on the Great Barrier Reef
Tropical cyclones, coral predation by crown of thorns starfish (COTS) and coral bleaching accounted for 48, 42 and 10 per cent of the estimated loss respectively (De'ath et al., 2012).

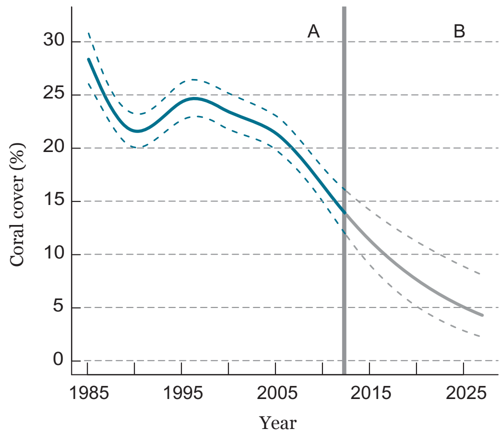
Key

- COTS
- Cyclones
- Bleaching
- N Number of reefs

Figure 66: A projection study (B) based on De'ath et al., 2012 (A), shows that if the declining trend continued, coral cover would be half of 2012 levels by 2022 *(AIMS, 2012).*

Key

- Trend line
- Confidence limits
- Trend line
- Confidence limits



Preserve natural capital: The Great Barrier Reef is the world's largest coral reef ecosystem and a World Heritage Site. It is recognized as one of the most significant sites for biodiversity, supporting tens of thousands of species, many of which are of global conservation significance.

Produce better: Sugarcane growers implementing better practices have reduced pesticide pollution by 15 per cent and fertilizer pollution by 13 per cent – keeping chemicals on farm where they are needed, and off the Reef.

Consume more wisely: Consumers can help protect the environment by supporting producers and production schemes that are striving to reduce impacts on the environment, such as, for example, Bonsucro certified sugar and MSC-certified seafood.

Redirect financial flows: Improving farming practices on land provides a huge return on investment, since the Reef is worth AUS$5.68 billion (US$5.10 billion) a year to the Australian economy and supports almost 69,000 jobs.

INVESTING IN THE REEF'S HEALTH NOT ONLY PRESERVES ONE OF THE WONDERS OF THE NATURAL WORLD BUT ALSO BOOSTS FISHING AND TOURISM INDUSTRIES AND THE COMMUNITIES THAT RELY ON THEM

WINDS OF CHANGE

Denmark has been producing electricity from wind since the 19th century, and continues to be a wind power world leader

Danish wind power pioneer Christian Riisager, photographed in 2003. Photo courtesy of The Danish Film Institute / Stills & Posters Archive.

"On a windy day, my wife said: If you want to try to connect your wind turbine to the grid, now is the time! Everything went fine, the electric meter started to run backwards, and no fuses blew. I never dreamt of making a living out of my wind turbine interest. But people started to pass by to look at my turbine in the garden, and then I thought I may just as well take the chance."
Christian Riisager (1930-2008) *(Excerpt of interview with the Danish Wind Industry Association, 2000).*

An old Chinese proverb says: "When the winds of change blow, some people build walls, others build windmills." The Danish wind energy story is an example of the latter. The country has a long tradition of using wind to produce renewable electricity, and continues to be a world leader in harnessing and providing wind power.

December 2013 marked a significant milestone, when wind power provided an equivalent of 57.4 per cent of Denmark's electricity consumption – the first time ever that wind power supplied more than half of a country's electricity needs for a whole month. December 21 set another record, with wind turbines generating the equivalent of 102 per cent of Danish electricity consumption.

The Danish wind power story started in 1891, when the first electricity-generating wind turbine was built by Poul la Cour, a meteorologist and school principal. La Cour made many experiments with production and storage of wind power and was called "the wizard from Askov making light and power out of rain and wind". He also began to educate wind electricians.

In 1956, one of his former students, Johannes Juul, built the so-called mother of modern wind turbine design – a 200kW three-bladed turbine, which was subsequently connected to the nation's power grid. Juul's wind turbine was constructed as part of a wind programme conducted by the association of Danish power stations, but this was shut down in 1962.

In the 1970s, inspired by the oil crisis and a strong Danish anti-nuclear movement, individual pioneers led a wind power revival. Christian Riisager, a carpenter, made his own wind turbine and connected it to the electricity grid in secret, by plugging it into the wall outlet for his washing machine. Riisager began serial production of 22kW wind turbines, and several other Danish manufacturers including Vestas and Bonus Energy (Siemens Wind Power since 2004) did the same over the next few years.

Thanks to these early trailblazers, Denmark became a world-leading wind power manufacturer. In 2013 Danish companies supplied 25 per cent of the world's wind turbines. Danish expertise plays a major role in wind energy technology in the world. The wind industry makes an important contribution to the Danish economy, employing some 27,500 people, with exports amounting to about 50 billion Danish kroner (US$9.2 billion) in 2013 (Danish Wind Industry Association, 2014).

Strong interaction between public research institutions, regulators, industry and citizens has enabled Denmark to become not only an early innovator but also a world champion in wind energy. Various economic incentives have encouraged investment by private households, energy companies and other investors. Equally importantly, the national research centre Risoe (today part of Technical University Denmark) established safety and quality standards for wind turbines as early as 1979.

Wind power development in Denmark has been led by civil society, with individuals and families taking up financial incentives to buy wind turbines or shares in cooperatives to invest in wind power in their communities. While most new investment today is from professional investors, cooperatives and local participation continue to play a role. Some 40,000 Danes are part-owners or individual owners of turbines; since 2009, 20 per cent of the capacity of each new onshore wind farm must be available for citizens of the local community to buy. Opinion polls show that about 90 per cent of Danes are in favour of wind power.

Continued support for wind power throughout changing governments has helped to stimulate demand, technological innovation and cost reductions. The results today are significant. In 2013, wind power provided an equivalent of a third of Danish electricity consumption – and the Danish parliament has committed to meeting half of the country's electricity needs with wind power by 2020. The Danish government's goal is to achieve 100 per cent renewable energy in the energy and transport sectors by 2050.

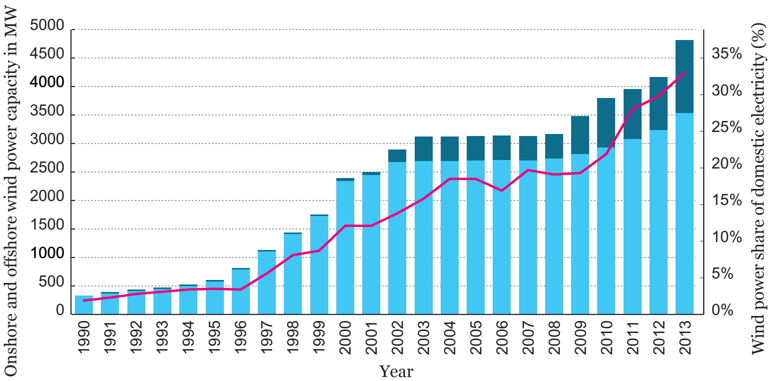
In Denmark, it's clear which way the winds of change are blowing.

Produce better: Wind power in Denmark displaces power production from fossil fuels, reducing carbon emissions.

Redirect financial flows: Danish wind power development has been characterized by long-term planning and political will to promote wind power investments through economic incentives for investors.

Equitable resource governance: Some 40,000 Danes are part-owners or individual owners of wind turbines. The Danish community-ownership model has been replicated in other countries, including Germany.

Figure 67: As of December 2013, there were 5,200 wind turbines in Denmark with an installed wind capacity of 4,800MW, offshore wind power accounting for 1,271MW
(Danish Energy Agency, 2014).



Key

- Wind power offshore capacity, MW
- Wind power onshore capacity, MW
- Wind power's share of domestic electricity

CONTINUED SUPPORT FOR WIND POWER THROUGHOUT CHANGING GOVERNMENTS HAS HELPED TO STIMULATE DEMAND, TECHNOLOGICAL INNOVATION AND COST REDUCTIONS. THE RESULTS TODAY ARE SIGNIFICANT. IN 2013, WIND POWER PROVIDED AN EQUIVALENT OF A THIRD OF DANISH ELECTRICITY CONSUMPTION. THE DANISH PARLIAMENT HAS COMMITTED TO MEETING HALF OF THE COUNTRY'S ELECTRICITY NEEDS WITH WIND POWER BY 2020

WE LOVE CITIES

A growing numbers of cities are demonstrating their willingness to lead in the transition to a sustainable future.

© Jonah M. Kessel / WWF

Earth Hour City Challenge 2014 Winner: Cape Town

This decade is the first in history in which more people live in towns and cities than in rural areas. And, as the world's population grows, the proportion living in cities is set to increase further, especially in the global South. This presents both a challenge and an opportunity.

Increasing consumption, resource use and waste in cities is driving the world's growing Ecological Footprint. However, with good planning and governance, cities can meet people's needs much more efficiently than less densely populated areas. Over the next three decades, tremendous investment will take place in urban areas.

This provides a window of opportunity to redirect financial flows toward creating healthy, sustainable cities. Smart choices made at all levels now could improve the quality of life for hundreds of millions of people, and massively reduce the footprint of our lifestyles.

While cities are responsible for more than 70 per cent of our planet's energy-related carbon emissions (UN HABITAT, 2011), they also have the potential to become centres of renewable energy production and energy efficiency. In Cape Town, where heating water accounts for 40 per cent of household energy, a scheme aims to help residents install 60,000-150,000 solar water heaters in five years. The 2014 Global Earth Hour Capital has also initiated projects such as retrofitting more than 43,000 streetlights, replacing 1,328 traffic lights with low-energy LEDs, and introducing smart meters.

Many other major cities offer incentives for residents and businesses to install rooftop solar power. Shanghai, WWF-China's Low Carbon Pilot City, is launching a local incentive for residents and businesses to install distributed solar power: on top of the national incentive of 0.42 yuan per kWh the city will provide an

"CAPE TOWN'S PARTICIPATION IN THE EARTH HOUR CITY CHALLENGE ALLOWED US TO LEARN FROM OTHER CITIES, PUSHING US TO THINK MORE CREATIVELY. WITH THE HELP OF OUR RESIDENTS, THE BUSINESS COMMUNITY AND OTHER CIVIC ORGANISATIONS, OUR CITY WILL CONTINUE TO FIND LOW FOOTPRINT SOLUTIONS THAT IMPROVE QUALITY OF LIFE AND BUILD A THRIVING, DYNAMIC ECONOMY AT THE SAME TIME." COUNCILLOR GARRETH BLOOR, CITY OF CAPE TOWN MAYORAL COMMITTEE MEMBER

Box 9: WWF's urban initiatives

Conservation outcomes are closely linked to production and consumption patterns, which are largely driven by the demands of urban societies. WWF's work for sustainable cities (wwf.panda.org/sustainablecities) is an integral part of its efforts to build a future in which we all live well in harmony with nature and within the capacity of one planet – a "one planet future".

- WWF's **Earth Hour City Challenge** aims to mobilize action and support from cities in a global transition toward a 100 per cent renewable and sustainable future, and to stimulate the development and dissemination of best practices for sustainable urban development.
- **We Love Cities** is a social media platform on which citizens are invited to express support for the climate actions of finalist cities in the Earth Hour City Challenge and to post suggestions for how their cities can become more sustainable. Within only two months in 2014, it collected more than 300,000 expressions of support and suggestions.
- **Urban Solutions** is a global inventory of learning cases, providing 100+ real examples of how cities are approaching the need to minimize their Ecological Footprints and protect ecosystem services and biodiversity.
- **Low Carbon Cities** is exploring low carbon development models in China in order to learn from and replicate successful experiences.

additional subsidy of 0.4 yuan (US$0.07) per kWh for household installations and 0.25 yuan for business installations (Shanghai DRC, 2014). Chicago is aiming to become a leader in residential and commercial rooftop solar development, as part of its goal to reduce carbon emissions by 25 per cent below 1990 levels by 2020.

The transport sector is responsible for more than 25 per cent of world energy related carbon emissions (Baumert, 2005), and traffic pollution is a huge problem in many cities. But areas of high population density lend themselves to sustainable transport solutions.

In Stockholm, more than three-quarters of citizens use public transport, supported by initiatives such as a congestion tax, walking school buses, cycling education, and city planning for biking and "walkability". Up to half of Copenhagen's residents cycle to their place of work or study – cycling is considered a distinct traffic category with its own separate road area. Vancouver has reversed transport trends by banning new highways and investing heavily in public transport. One in three drivers in Seoul – 820,000 people – has joined the city's No Driving Day programme, contributing to better air quality, less traffic congestion and greenhouse-gas emissions cuts. Participants who register to leave their cars at home for one day each week are rewarded with reduced tolls and parking charges and other incentives.

Cities are also increasingly taking responsibility for water management. Some are actively protecting forests, wetlands and catchment areas vital to local water supply. Mexico City's reforestation programme is planting 2 million trees per year to help secure its water supply, and protected natural areas now make up almost 60 per cent of the federal district. Others are improving water security through collecting rainwater and recycling: water-scarce Singapore, for example, receives more than half of its water supply from rainwater collection (20 per cent), recycled water (30 per cent) and desalination (10 per cent).

Globally, urban farming supplies nearly 15 per cent of all food: many cities have introduced policies to support local food production – which can help reduce transport and greenhouse-gas emissions; provide employment; improve the urban environment; and reduce pressure on natural ecosystems. In Shanghai, for example, municipal government policy has led the city to produce more than 55 per cent of its vegetables and 90 per cent of its green-leaf vegetables locally. Belo Horizonte in Brazil has radically increased local and organic food production, improving poor residents' access to nutritious produce, reducing childhood malnutrition and increasing income for local farmers (World Future Council, 2013).

Urban farming is also an example of the increased "greening" of cities. Measures like planting trees and flowers, enhancing green spaces, and restoring waterways and wetlands are bringing

>25%

TRANSPORT ACCOUNTS FOR MORE THAN 25 PERCENT OF WORLD ENERGY RELATED CARBON EMISSIONS, AND TRAFFIC POLLUTION IS A HUGE PROBLEM IN MANY CITIES. BUT AREAS OF HIGH POPULATION DENSITY LEND THEMSELVES TO SUSTAINABLE TRANSPORT SOLUTIONS

social, economic and environmental benefits. Mexico City aims to create 10,000m^2 of new green roofs annually, to improve air quality, regulate humidity, reduce temperatures and provide new biodiversity resources. In many places, urban habitats are becoming important havens for native plants, insects, birds and animals: 20 per cent of all bird species live in cities (Conniff, 2014).

Cities can also take a lead in protecting biodiversity and the natural environment far beyond their own boundaries by addressing consumption. Sendai in Japan has been a front-runner in developing green purchasing regulations: its municipal institutions make more than 90 per cent of their purchases from a recommended list of green products, and the city has helped set up a Green Procurement Network involving around 3,000 public, private and voluntary sector organizations, including all of the largest cities. Ghent in Belgium promotes a meat-free day each week to help reduce agriculture's carbon emissions and environmental impact, and to encourage improved human health and animal welfare – an idea that has been adopted by cities such as Helsinki, Cape Town, San Francisco and Sao Paolo.

All of these examples show that we have a choice. Urbanization does not have to mean ever-increasing pollution, sprawl, high-impact lifestyles and overstretched services. Wise investment, planning and governance in cities today could secure healthy, sustainable communities and lifestyles for more than half of humanity.

Preserve natural capital: Natural spaces in and around cities provide vital ecosystem services, including clean air and water, flood protection, biodiversity habitat and recreational values.

Produce better: Nearly 15 per cent of the world's food is supplied by urban farming. Cities are also increasingly generating their own renewable energy.

Consume more wisely: Cities are centres of consumption – but smart urban development and better consumption choices can also help people live more sustainable lives.

Redirect financial flows: US$350 trillion will be spent on urban infrastructure between 2005 and 2035 (WWF, 2010). This provides a window of opportunity to turn cities from being threats to becoming solutions for global footprint reduction and biodiversity protection.

Equitable resource governance: Well-governed, forward-thinking and well-designed cities are more sustainable along every dimension. Good governance rewards itself.

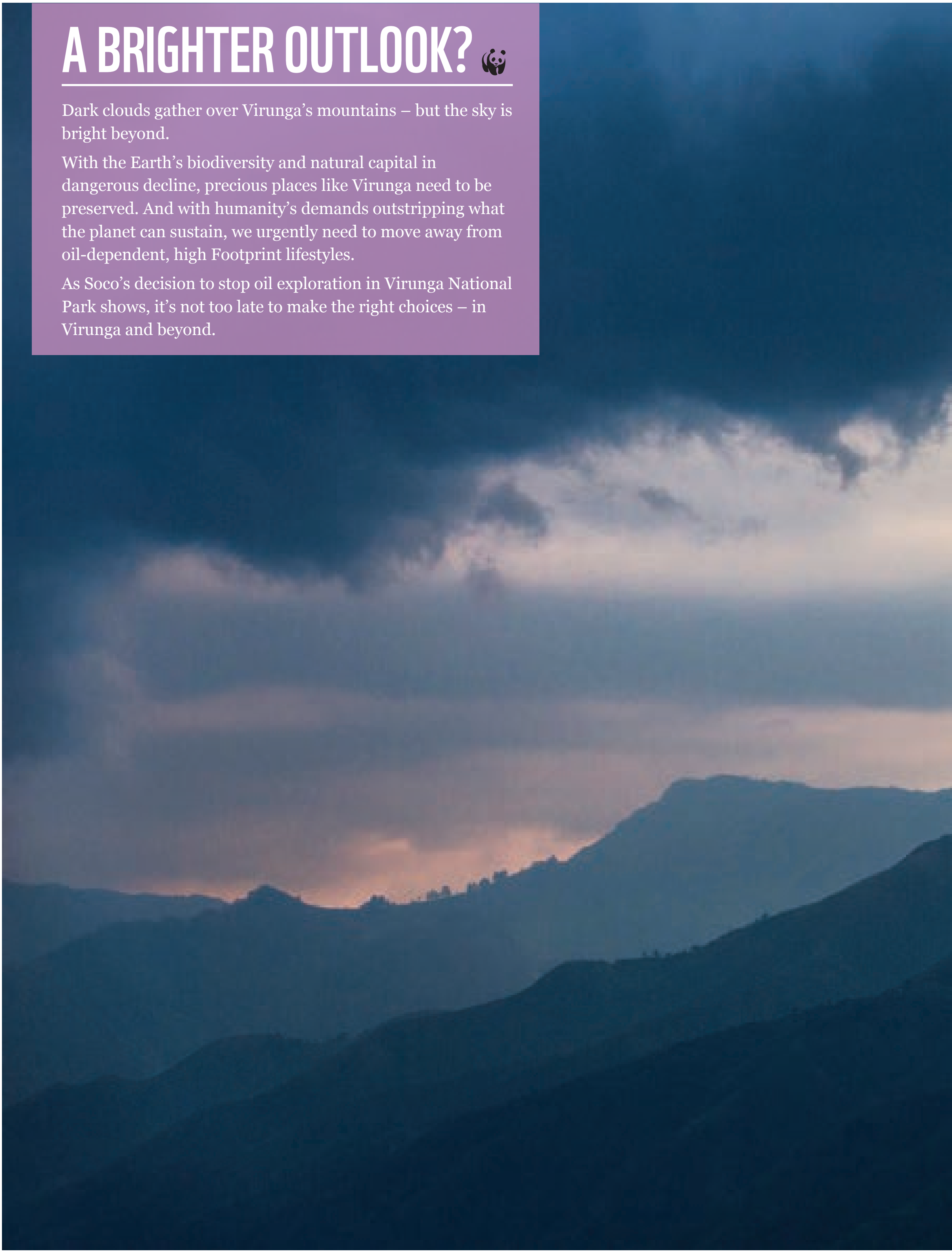
For references and further details, see wwf.panda.org/urbansolutions

A BRIGHTER OUTLOOK?

Dark clouds gather over Virunga's mountains – but the sky is bright beyond.

With the Earth's biodiversity and natural capital in dangerous decline, precious places like Virunga need to be preserved. And with humanity's demands outstripping what the planet can sustain, we urgently need to move away from oil-dependent, high Footprint lifestyles.

As Soco's decision to stop oil exploration in Virunga National Park shows, it's not too late to make the right choices – in Virunga and beyond.



EMBARGOED until 30 Sept 2014 - 00:01 CET

THE PATH AHEAD

Much of this edition of the *Living Planet Report* makes for troubling reading. Yet the same indicators that show where we have gone wrong can help to point us onto a better path.

There is nothing inevitable about the continuing decline in the LPI, or ongoing ecological overshoot. They are the sum of millions of decisions, often made with little or no consideration of the importance of our natural world. Poor governance at local, national and international levels. Policies with a myopic focus on economic growth and narrow interests. Business models that focus on short-term profits and fail to account for externalities and long-term costs. Inefficient, outmoded and unnecessarily destructive ways of generating and using energy, catching fish, raising food, and transporting goods and people. Desperate strategies for earning a livelihood. Excessive consumption that makes few happier or healthier. This all adds up to immense costs to the planet, and its inhabitants.

In each case, there is a better choice. Changing our course and finding alternative pathways will not be easy. But it can be done.

CHANGING OUR COURSE AND FINDING ALTERNATIVE PATHWAYS WILL NOT BE EASY. BUT IT CAN BE DONE

At the Rio+20 conference in 2012, the world's governments affirmed their commitment to an "economically, socially and environmentally sustainable future for our planet and for present and future generations" (UN, 2012). This is "Our Common Vision", the place we need to aim for. Its coordinates are mapped out in the preceding pages. It can be seen in the global sustainable development quadrant outlined in Chapter 1 (Figure 36) – the currently unoccupied territory where everyone is able to enjoy a high level of human development with an Ecological Footprint that is within global biocapacity. This is essentially the same space envisioned in the Oxfam Doughnut – the "safe, just operating space" that stays within planetary boundaries while ensuring that everyone achieves an acceptable level of health, well-being and opportunity (Figure 39).

WWF's One Planet Perspective (Figure 59) gives an idea of how we might reach it, through a series of practical decisions. We need to divert investment away from the causes of environmental problems and toward the solutions; make fair, far-sighted and ecologically informed choices about how we manage the resources we share; preserve our remaining natural capital, protecting and restoring important ecosystems and habitats; produce better and consume more wisely.

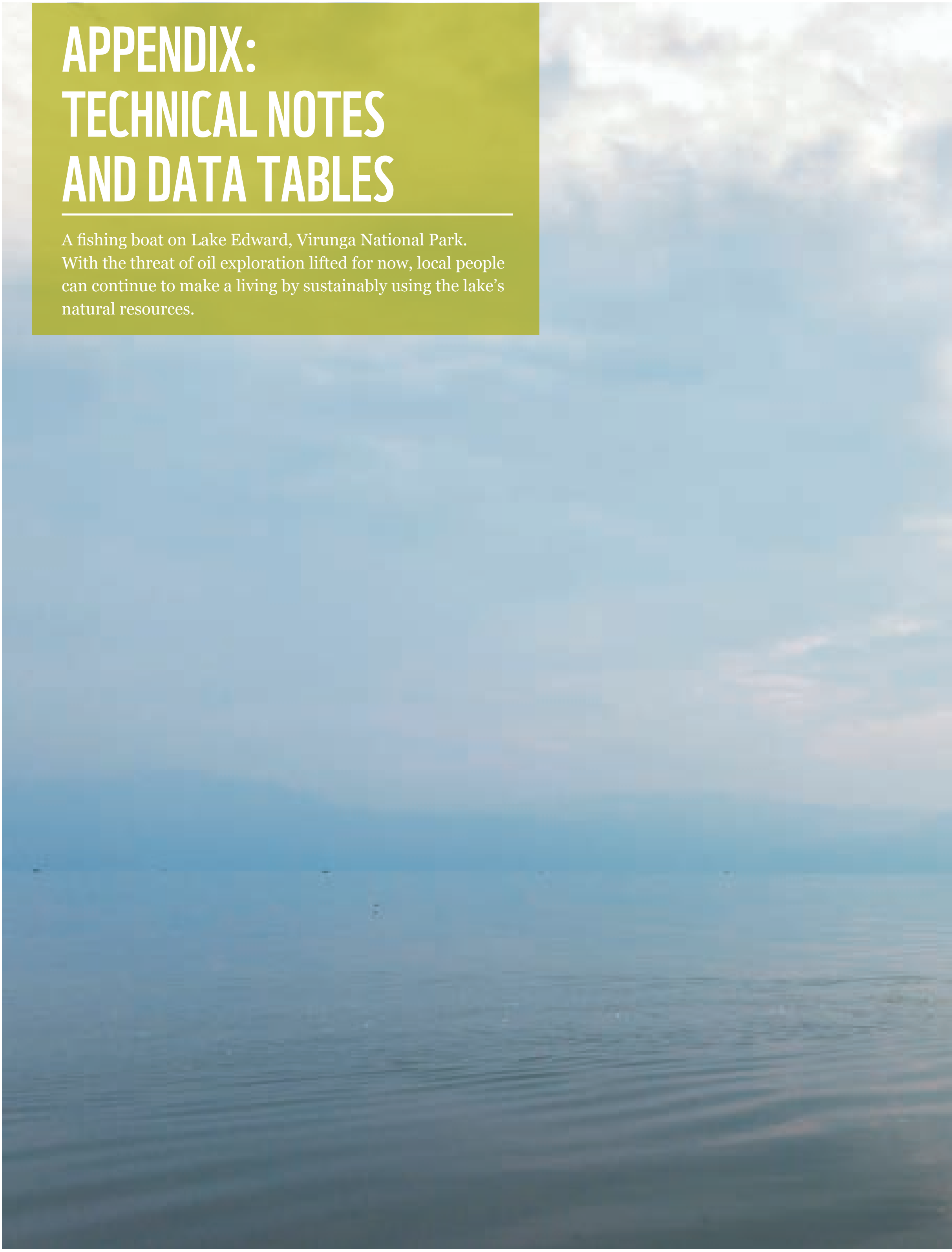
For all the dispiriting data, signs of progress can be seen. From different directions, there are countries plotting a course toward the global sustainable development quadrant – emerging economies that have raised standards of living for their populations with much lower resource intensity than industrialized countries, and industrialized countries that have significantly reduced their Footprints without compromising their citizens' well-being.

In 2015, world leaders will agree two potentially critical global agreements. The post-2015 development framework – which will include Sustainable Development Goals to be achieved by all countries by 2030 – is an opportunity to unite countries around a common agenda to promote sustainable economic development, reduce inequalities, and protect and enhance the natural resources and systems that support human well-being. An effective framework would guide policy and investment at a scale that would make a real difference in reversing the trends outlined in this report. Similarly, parties to the UN Framework Convention on Climate Change have set an objective of reaching a new global agreement in Paris in 2015. After years of gridlocked climate talks, this is a critical opportunity to reach a deal that applies to all countries and lays the basis for keeping climate change within safe limits, adapting to its impacts, and providing the means of support to do so.

There is much in this report to inform these world leaders and their nations as they make decisions on the future of the world's people and places, species and spaces, over the next two years and beyond. There are hard facts to be acknowledged about the state of the planet, and yet much room for optimism. The case studies presented in Chapter 4 are just a handful of the myriad examples of how individuals, communities, businesses and governments are finding ways to meet people's needs within the means of one planet. They demonstrate that sustainable development that allows all people to live a good life on a healthy planet, in harmony with nature, is possible. They give us hope for a better future.

WE KNOW WHERE WE WANT TO BE
WE KNOW HOW TO GET THERE
NOW WE NEED TO GET MOVING

APPENDIX: TECHNICAL NOTES AND DATA TABLES



A fishing boat on Lake Edward, Virunga National Park. With the threat of oil exploration lifted for now, local people can continue to make a living by sustainably using the lake's natural resources.

EMBARGOED until 30 Sept 2014 - 00:01 CET

APPENDIX

Living Planet Index FAQ

1. 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 which span any number of years between 1970 and 2010.

The LPI 2014 reflects 40 years of trend data – from 1970 to 2010. After 2010, the amount of available data decreases due to the time taken for data to be collected, published and then entered into the LPI database, making the 2010 database the most comprehensive and reliable for use at this time.

2. How many species and populations are there in the LPI?

The LPI is based on trends in 10,380 populations of 3,038 species of mammal, bird, reptile, amphibian and fish from around the globe. This represents a substantial increase in data from previous years and provides an ever clearer picture about the status of the world's vertebrate species, one indicator of the state of our natural capital.

3. What "cuts" of the LPI are included in the *Living Planet Report* 2014?

The 2014 report contains cuts of the LPI to reflect trends in:

A. **Tropical and temperate regions**
   All populations are classified as either tropical or temperate, according to whether the realm in which the population is monitored is largely temperate (Nearctic, Palearctic, Atlantic north temperate, Pacific north temperate, Arctic, South temperate and Antarctic) or largely tropical (Neotropical, Afrotropical, Indo-Pacific, Atlantic tropical and subtropical, Tropical and sub-tropical Indo-Pacific.)
B. **Systems – freshwater, marine and terrestrial**
   Each population is assigned to the system in which it is monitored and is normally found. Some species, such as Pacific salmon, can be found in both freshwater and marine environments, so it is possible for different populations of the same species to be included in different indices.

C. **Biogeographic realms (terrestrial and freshwater) – 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. Indo-Pacific represents three realms combined (Indo-Malaya, Australasia and Oceania) as individually these do not have enough data to analyse separately.

D. **Populations in terrestrial protected areas**
This is calculated based on trends in 1,956 populations of 773 mammal, bird, reptile and amphibian species that occur inside protected areas on land. Information on the population's location comes from the original data source, and is checked against the Protected Planet database (www.protectedplanet.net).

E. **Income groups – high, middle and low**
This is based on whether the monitored population occurs in a high-, middle- or low-income country, according to World Bank income classifications (2010).

Trends in the LPI

4. What are the main trends shown by the LPI?

The global LPI declined by 52 per cent between 1970 and 2010, using the new diversity-weighted LPI methodology (LPI-D – see question 10 below).

The results show that species are faring much worse in freshwater systems than in terrestrial or marine systems. All biogeographic realms (terrestrial and freshwater species) show a decline but the temperate realms have not declined as much as the tropical realms since 1970.

		Number of species	Per cent change 1970 - 2010	95% confidence limits	
				Lower	Upper
Global	Global	3,038	-52%	-61%	-43%
	Temperate	1,606	-36%	-48%	-22%
	Tropical	1,638	-56%	-65%	-44%
Systems	Terrestrial	1,562	-39%	-53%	-20%
	Freshwater	757	-76%	-83%	-64%
	Marine	910	-39%	-57%	-15%
Biogeographic realms (terrestrial and freshwater species)	Nearctic	745	-20%	-43%	11%
	Neotropical	548	-83%	-89%	-73%
	Palearctic	541	-30%	-50%	-3%
	Afrotropical	264	-19%	-53%	42%
	Indo-Pacific	423	-67%	-80%	-47%
Country income group	High	1,979	10%	1%	19%
	Middle	1,357	-18%	-32%	-3%
	Low	181	-58%	-71%	-40%
Populations in protected areas	Terrestrial	773	-18%	-37%	6%
Species sample	African rhinos	2	-63%	-77%	-28%

Table 1: Trends in the Living Planet indices between 1970 and 2010, with 95 per cent confidence limits
Income categories are based on the World Bank income classifications (2010). Positive number means increase, negative means decline (WWF, ZSL, 2014).

5. Between 1970 and 2010 temperate realms (Nearctic and Palearctic) show less of a decline than tropical realms (Neotropical, Afrotropical and Indo-Pacific). How can we explain this?

One explanation is that most habitat destruction since 1970 has taken place in the tropics. However, that is not necessarily to say that the state of biodiversity in temperate regions is better than in the tropics. The LPI shows trends since 1970 only. Most habitat alteration and destruction in temperate regions occurred prior to this. If data were available, an LPI from 1900 to 1970 might show a decline in temperate realms similar to that in the tropics from 1970 to 2010. 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.

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

The system to which 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, but only appear once in the global species count.

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

- In which system does the species spend the majority of its time?
- Which system does the species primarily rely on to sustain itself?
- In which system does the species breed?
- 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 rats prey 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.

7. Are extinct species included in the LPI?

Yes, although there are very few. For example, the Baiji – or Yangtze river dolphin (*Lipotes vexillifer*) – 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 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.

8. 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. Looking at the main threats affecting species populations for this report found that over the last 40 years, the principal causes of population decline in wild species have been habitat loss or alteration, and exploitation. Climate change is ranked next in importance. Over the next 40 years, however, climate change is likely to become a more prevalent factor affecting population trends, as well as itself being a driver of habitat loss and alteration. Our data suggest that the potential impact of climate change is growing as it has been listed as the main threat in an increasing proportion of populations in the LPI from 2005 to 2010.

Calculating the LPI

9. 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. Time series information for vertebrate species is collated from published scientific literature, online databases and grey literature, totalling 2,337 individual data sources. Data are only included if a measure of population size were 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 2010. The year 2010 is chosen as the cut-off point for the index because there is not yet enough data to calculate a robust index up to the present day. Datasets are continually being added to the database.

10. Technical details of the calculations

For each population, the rate of change from one year to the next is calculated. If the data available are from only a few, non-consecutive years, a constant annual rate of change in the population is assumed between each data year. Where data are available from many years (consecutive or not) a curve is plotted through the data points using a statistical method called generalized additive modelling. In the case where more than one population trend for a single species is available, the average rate of change across all of the populations is calculated for each year.

The unweighted LPI (LPI-U) methodology presented in previous editions of the *Living Planet Report* makes calculations based on 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 (For more details: Collen, B., Loh, J., McRae, L., Whitmee, S., Amin, R. & J. Baillie. 2009. Monitoring change in vertebrate abundance: the Living Planet Index. *Conservation Biology* 23: 317-327.)

The LPI-D is an adapted version of this method. It has not been used in previous editions of the *Living Planet Report*. The LPI-D attempts to make the indicator more representative of vertebrate biodiversity by accounting for the estimated diversity of species globally. Because the LPI dataset is not uniformly distributed across regions and species (Figure 7), this new approach is being employed to calculate indices to reflect the number and distribution of vertebrate species in the world. The LPI-D method involves a system of weighting that reflects the actual proportions of species found in each taxonomic group and realm. These proportions allow the index to be weighted accordingly. Table 2 shows the proportion by realm of the total number of species found in each taxonomic group. The greater the number for a given group, the more weight given to the population trends of those species. For example, fish species represent the largest proportion of vertebrate species in all biogeographic realms except for Indo-Pacific (where reptiles and amphibians are the largest group), so they carry most weight in the realm LPIs.

This provides a means of reducing bias in groups such as temperate birds, which have previously dominated some of the global and regional LPIs.

Because of their low representation in the total numbers of species and populations, reptiles and amphibians are combined into a herpetofaunal group; and data from Indo-Malaya, Australasia and Oceania is grouped into an Indo-Pacific realm. In addition, the individual classes of fish have been aggregated into one group encompassing all fish species.

Table 2: The proportion of species by group and realm for (a) terrestrial and freshwater species and (b) marine species
The values also represent the weighting applied to the data for each species group when calculating the realm and system LPIs (WWF, ZSL, 2014).

a. Terrestrial and freshwater weightings applied to data:

	Afrotropical	Nearctic	Neotropical	Palearctic	Indo-Pacific
Fishes	0.32589	0.289108	0.328142	0.315503	0.218028
Birds	0.260032	0.264985	0.260027	0.295608	0.308086
Mammals	0.132963	0.175804	0.085695	0.170045	0.133595
Reptiles and amphibians	0.281115	0.270102	0.326136	0.218844	0.340291

b. Marine weightings applied to data:

	Arctic	Atlantic North Temperate	Atlantic Tropical and Sub-tropical	Pacific North Temperate	Tropical and Sub-tropical Indo-Pacific	South Temperate and Antarctic
Reptiles	0	0.001303	0.001630	0.000935	0.005505	0.000957
Birds	0.172867	0.068635	0.069353	0.080916	0.048714	0.054261
Mammals	0.035011	0.009774	0.006224	0.025257	0.004878	0.022342
Fishes	0.792123	0.920286	0.922791	0.892890	0.940901	0.922438

The LPI-D method has been used for all the LPIs in this report, except for the income group graphs. Due to insufficient data, the LPI-D approach could not be used, so the LPI-U is used instead.

11. How are different LPIs calculated?

Realm LPIs are calculated using the LPI-D method described above. Terrestrial and freshwater populations are combined to produce LPIs for the Afrotropical, Nearctic, Neotropical, Palearctic and Indo-Pacific realms using the weighting values for each species group in Table 3a. Marine realm LPIs are also calculated using proportional weighting of the species groups in Table 3b. In the table below, the Arctic, Atlantic north temperate and Pacific north temperate were combined and the two tropical realms were combined to show results for three marine areas – North temperate and Arctic, Tropical and subtropical, and South temperate and Antarctic.

System LPIs are calculated by first producing realm indices using the LPI-D method (terrestrial and freshwater populations are separated for this purpose). The system LPIs are then calculated using a weighted average of the realm LPIs for that system. The values for the weighting are equivalent to the proportion of vertebrate species each realm contains compared to the estimated total number of vertebrate species for that system (Table 3). For example, the Neotropics carry the most weight and the Nearctic the least in the terrestrial and freshwater LPIs; the Tropical and subtropical Indo-Pacific is the realm given the most weight in the marine LPI. The LPI for populations in terrestrial protected areas is calculated in the same way as the terrestrial LPI.

Table 3: The proportion of species by realm for (a) terrestrial and freshwater species and (b) marine species
The values also represent the weighting applied to the data for each realm when calculating the system LPIs (WWF, ZSL, 2014).

a. Terrestrial and freshwater realm weightings applied to data:

	Afrotropical	Nearctic	Neotropical	Palearctic	Indo-Pacific
Terrestrial LPI	0.189738	0.061683	0.321132	0.116431	0.292168
Freshwater LPI	0.211701	0.060853	0.365550	0.123314	0.225576

***b. Marine realm weightings applied to data*:**

	Arctic	Atlantic North Temperate	Atlantic Tropical and Sub-tropical	Pacific North Temperate	Tropical and Sub-tropical Indo Pacific	South Temperate and Antarctic
Marine LPI	0.014541	0.146489	0.214706	0.068026	0.456553	0.099685

The global LPI is an average of the terrestrial, freshwater and marine LPIs, giving an equal weight to each. Similarly, the system LPIs are averaged to obtain the temperate and tropical LPIs.

The income group LPIs (figure 34) are calculated using the LPI-U method: each LPI is an average of the species trends, with no additional weighting (see table 4, page 146-47).

12. How has the *Living Planet Index* changed since 2012?
The global and system LPIs show a declining trend as also seen in the 2012 edition of the *Living Planet Report*. However, the magnitude of the trend is greater than in previous years for many LPIs. There are two reasons for this. One is that the dataset is always changing as new data continue to be added (see point 13 below). A different composition of species and populations means that new trends are continuously being added, resulting in the indices produced being slightly different.

Secondly, the use of the LPI-D method means that the results give different trend values than in previous reports. Each species was previously given equal weight; now, a level of weighting that is proportional to the size of each taxonomic group (birds, mammals, amphibians, reptiles, fishes) and realm is given. The effect this has on the results varies between LPIs.

As an example, the Palearctic LPI contains 541 species, of which 64 per cent are birds, 19 per cent are mammals, 11 per cent are fishes, and 6 per cent are reptiles and amphibians. The LPI-U method would have weighted each group in these proportions. The LPI-D method reflects the proportion of species that should be found in each group. This gives 32 per cent of the weight to fish species, 30 per cent to birds, 22 per cent to reptiles and amphibians and 17 per cent to mammals. In other words, the LPI-D method gives fish, reptiles and amphibians more weight and birds and mammals less weight than in the previous Palearctic LPI, to better reflect the actual diversity of species.

The revision to the method creates a number of different results. By adjusting the contribution of each species group to reflect the number of species it contains, the aim is to provide a better representation of what is happening to trends in vertebrate species across the world. A detailed comparison of the results compared to the 2012 report is shown in Table 4.

13. Increases in the size of the LPI dataset

The size of the dataset has increased by 15 per cent since the 2012 edition of the *Living Planet Report*. As populations are continually added to the LPI, so the average trend for each index changes. As a result, the 2014 dataset may show differences in the detail, in addition to the new version of the method.

Compared to 2012 there are:

- 13 per cent more species and 15 per cent more populations in the global LPI;
- 9 per cent more terrestrial species and 11 per cent more terrestrial populations;
- 35 per cent more marine species and 31 per cent more marine populations;
- 3 per cent more freshwater species and 8 per cent more freshwater populations.

These changes have also improved the spread of the data among different regions and different taxa. There is a better balance between tropical and temperate species. For the first time there are more tropical than temperate species in the LPI – tropical species now account for 51 per cent of the species in the index compared to 47 per cent in 2012. Each of the taxa is also better represented: for example, reptile species have increased by the greatest proportion at 46 per cent, followed by an increase in fish species of 33 per cent. Increasing the dataset in this way generally improves the robustness of the indices and usually produces smoother trends.

Developing the LPI method

14. Why was the LPI method revised?

The method was revised in order to give a better representation of the world's vertebrate species.

The LPI contains data for 3,038 out of an estimated 62,839 vertebrate species that have been described globally. There is no "perfect LPI" which has data for all species from all over the world. The challenge therefore is to represent all 62,839 species using those for which data are available. There are two ways of doing this. One is to collect more data and add to the number of species that are in the LPI, particularly from some less well represented groups like reptiles and fish. This is the approach taken until now. Great strides have been made in improving the taxonomic and geographic coverage of the data over the years with the intention of further, ongoing improvement (see point 13 above).

The second approach is to use the LPI-D method – a weighting system that allows the adjustment of the calculation of the LPI to provide a better representation of the results we would expect if a complete dataset was available – containing all vertebrate species.

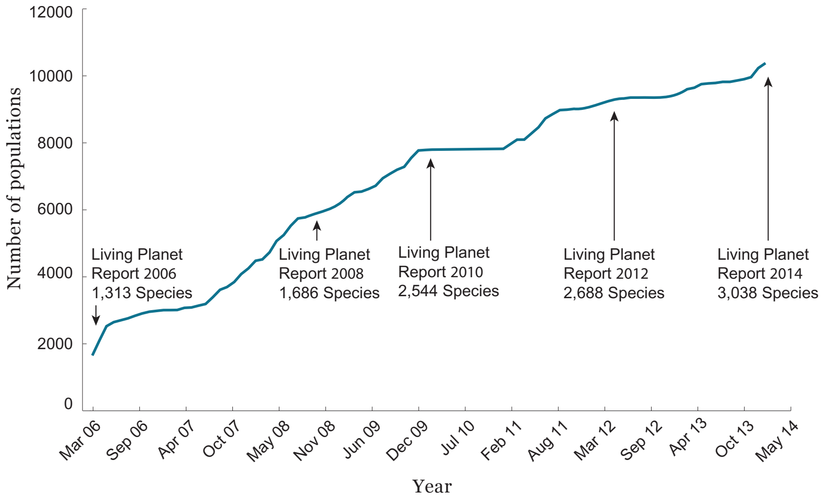


Figure 68: The cumulative number of population time series in the LPI database and number of species in each Living Planet Report since 2006 *(WWF, ZSL, 2014).*

In previous editions of the *Living Planet Report*, a weighting system has been used that gives equal importance to tropical species as to temperate. That approach is now being extended to include a proportional weighting according to the number of species each species group contains; instead of using a tropical/temperate split, biogeographic realms are being used to divide and weight the data.

The dataset behind the LPI is now large enough to use these subdivisions. Some of the subdivisions are still quite small, such as Afrotropical amphibians and reptiles, but efforts will be made to keep filling in these data gaps in order to continually improve the LPI.

15. What implication does this have on the previous results?

The previous results were calculated using a valid peer-reviewed method. Now that the dataset is larger, it is possible to use a revision to this method producing different results that are considered to provide a better representation of trends in vertebrate species than previously. These new results do not discredit previous LPIs; rather, they are the latest outputs from what is a continually evolving process. Efforts will be made to continue to add more data in the future, and to continue to refine the method as necessary to obtain the most representative results possible from the data available.

Table 4: LPI results: Comparison between LPR 2012 and LPR 2014

		2014		2012	
		Number of species	Per cent change 1970 - 2010	Number of species	Per cent change 1970 - 2008
Global	Global	3,038	-52%	2,688	-28%
	Temperate	1,606	-36%	1,518	31%
	Tropical	1,638	-56%	1,354	-61%
Systems	Terrestrial	1,562	-39%	1,432	-25%
	Freshwater	757	-76%	737	-37%
	Marine	910	-39%	675	-22%
Biogeographic realms (terrestrial and freshwater species)	Nearctic	745	-20%	684	-6%
	Neotropical	548	-83%	515	-50%
	Palearctic	541	-30%	535	6%
	Afrotropical	264	-19%	250	-38%
	Indo-Pacific	423	-67%	384	-64%
LPI and country income groups					
Country income group	High	1,979	10%	1,732	7%
	Middle	1,357	-18%	1,205	-31%
	Low	181	-58%	204	-60%

	Explanation
	The global LPI shows a greater decline than in 2012 because of larger declines in the terrestrial, freshwater and marine indices but particularly in the freshwater index. Because the global LPI is an average of these three, the per cent change is greater. When using the LPI-U method the bird and mammal data outweigh everything else and so the index increases. Using the LPI-D method means that reptiles, amphibians and fish species, which are largely declining, are given appropriate weight in the index calculation. This results in a larger overall decline.
	The temperate LPI in 2014 shows a decline, whereas in 2012 it was increasing. This is because bird and mammal species dominate this dataset and are increasing on average. When using the LPI-U method the bird and mammal data outweigh everything else and so the index increases. Using the LPI-D method means that reptiles, amphibians and fish species, which are largely declining, are given more weight in the index calculation. This results in an overall decline.
	The tropical LPI shows a similar level of decline in 2012 to 2014. The use of the LPI-D method does mean that the index is calculated in a different way but the effect on the result is small as declines are widespread across all taxonomic groups. There is less of a dominance of one or two taxonomic groups compared to the temperate LPI.
	In 2012 the combined tropical realms were given equal weight to the combined temperate realms. Using the LPI-D method the temperate realms carry about 18 per cent of the weight in the terrestrial and freshwater LPIs and about 33 per cent in the marine LPI, to better reflect the greater biodiversity in the tropics. The increase in weight of tropical realms, which have greater declines than temperate realms, results in the greater declines we see in the system LPIs for 2014. The freshwater LPI has changed the most; this is due largely to the catastrophic declines among Neotropical amphibians and fishes.
	The reason for the greater decline in 2014 is the same reason for the change in the temperate LPI: more weight given to fish, amphibian and reptile populations, which are declining on average, and less to bird and mammal populations.
	The greater decline in the Neotropics in 2014 is due to the declines in fish, amphibian and reptile populations which together have 66 per cent of the weight in this LPI. The LPI-U method which was used in 2012 resulted in these groups having less of an influence on the overall trend.
	The reason for the change from an increase to a decline in 2014 is the same reason for the change in the temperate LPI: more weight given to fish, amphibian and reptile populations, which are declining on average, and less to bird and mammal populations.
	This LPI still shows a decline but it is smaller compared to the result in 2012. The LPI in 2012 was dominated by mammal species that are declining. Now the weighting has changed so that mammals represent only 11 per cent. Because the trends in birds, amphibians and reptiles are more stable or sometimes increasing, this has produced a shallower decline in the LPI for 2014.
	The results are very similar to 2012. This is because all taxonomic groups (except for mammals) are showing a decline so changing the weighting has little effect for this realm.
	The LPI-D method was not applied to these indices; it is not easily applicable at the country level as it would need species estimates for each country and this is not readily available for all groups. The use of a different method here does not compromise the consistency of these results, as the purpose of these indices is to provide a comparison between income groups, not to other LPIs. The results of the high-income and low-income LPIs are about the same in 2012 and 2014. A difference has been noted in the LPI for middle-income countries. The exact reason for this is hard to pinpoint but it is likely to be a combination of a change in data and a change in categories. World Bank categories have been used for this exercise. Each year the countries assigned to each category change and so the data behind each LPI changes. For example, seven countries have moved from the low- to the middle-income category since the last LPR (Ghana, Laos, Mauritania, Senegal, Uzbekistan, Viet Nam, Zambia). Also the number of species changed in this index from 1,205 in 2012 to 1,357 in this report, either as new data or as a result of a change in the countries in this category.

Ecological Footprint FAQ

1. How is the Ecological Footprint calculated?
The Ecological Footprint measures the amount of biologically productive land and water area (biocapacity) required to produce the resources an individual, population or activity consumes, and to absorb carbon dioxide emissions they generate, 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 or world average cropland, against world average productivity of all land types).

Global Footprint Network calculates the Footprint and biocapacity results for countries annually. It invites collaborations with national governments, which 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, the Philippines, Russia and the UAE have partially reviewed or are reviewing their accounts.

National reviews allow contextual understanding of the Footprint and provide further resolution of Footprint results at the local level. UAE National Footprint Accounts have been reviewed with local partners since 2007. The UAE Footprint of 7.75 gha per capita reported in Figure 23 is the result of replacing partial, incomplete or missing international data with verified national figures, specifically for population, local CO_2 emissions and international trade. The UAE per capita Footprint before this would have been 10.2 gha.

The continuing methodological development of the National Footprint Accounts is overseen by a formal review committee.

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 longitudinally and across studies. Methods and approaches for calculating the Footprint of municipalities, organizations and products are being improved through a global Ecological Footprint standards initiative.

2. What does a global hectare represent?
A global hectare (gha) is a way of expressing productive capacity in a common unit. It is defined as a hectare with the world-average

productivity of all biologically productive land and water in a given year (Kitzes et al., 2007). Ecological Footprint accounting normalizes different types of areas to account for differences in land and sea productivity. Actual areas, in hectares, are converted into global hectares using equivalence factors, which account for productivity differences between land types (e.g., cropland versus forest product), and yield factors, which account for differences within land types between countries (e.g., a hectare of cropland in Italy versus a hectare of cropland in Paraguay).

Beginning with the 2012 edition of the National Footprint Accounts, all Footprint and biocapacity results are expressed in *constant global hectares*, i.e., global hectares which for all previous years have been normalized based on the average yields of productive area in the most recent year being reported.

3. 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 Earth has regenerative capacity, and where data exists that allows 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. When values for a "water footprint" are reported, they most commonly refer to the total volume of water consumed, the area of catchments or recharge zones needed to supply a given quantity of water, or the Ecological Footprint required for a utility to provide a given supply of water.

Ecological Footprint accounts provide snapshots of past resource demand and availability calculated from annual production and consumption data. 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 do not indicate how intensively a biologically productive area is being used. As a biophysical measure, it does not evaluate the essential social and economic dimensions of sustainability.

4. How does Footprint accounting aggregate distinct environmental problems?

Footprint accounting focuses solely on one environmental problem: competition for available biocapacity. Aggregation of these demands on biocapacity is based on the percentage of global biocapacity each type of demand—for food, fibre, timber or carbon sequestration—occupies. At its most basic level, each of these demands requires surface area on the planet where plants can grow to provide resources that are useful to society; these resources can then either be harvested or left standing in order to absorb carbon emissions. Because there is limited area available on the planet to grow these resources, Footprint accounting asks whether this area is sufficient to keep up with all the competition on it, and if not, how much additional area of the same kind is needed to provide for this excess demand.

5. 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. For example, 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.

Like any measure, Ecological Footprint accounting is subject to misinterpretation. Therefore, it is important to point out that this metric does not measure everything related with trade or sustainability, nor does it impose goals or suggest what might be the ideal Footprint levels for countries or cities. There are no "shoulds" in Ecological Footprint accounting; it documents only "what is" and helps to identify the consequences of choices.

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

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

The carbon footprint is calculated by estimating how much natural sequestration would be necessary to maintain a constant concentration of carbon dioxide in the atmosphere. After subtracting the amount of carbon dioxide 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. Carbon dioxide sequestered by artificial means would also be subtracted from the Ecological Footprint total, but at present this quantity is negligible.

Expressing carbon dioxide 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 carbon dioxide emissions. The contribution of carbon dioxide 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 carbon dioxide sequestration rates tend to decline. If these forests are degraded or cleared, they may become net emitters of carbon dioxide. 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.

7. 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 sequestration values are calculated with data from Khatiwala et al. (2009) and carbon emissions taken from the Carbon Dioxide Information Analysis Center (CDIAC, 2011). There is a relatively constant percentage uptake rate for oceans, varying between 28 per cent and 35 per cent annually over the period from 1961 to 2010. The remaining carbon dioxide requires land-based sequestration. Due to the limited availability of large-scale datasets, the NFA methodology 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.

However, this does not imply that global ecological overshoot (Footprint of consumption in excess of biocapacity) results from carbon dioxide emissions alone. The total Footprint is made up of the sum of all demands for all land types. For example, if humanity demanded less food and timber, more land could be dedicated to carbon sequestration.

Previous NFA calculation of the role of the oceans in sequestering anthropogenic carbon used a constant quantity of ocean uptake rather than constant percentage. This assumption caused an underestimation of the carbon footprint component in the early decades tracked by the NFAs, which has since been adjusted (Borucke et al., 2013). This methodology improvement has resulted in a change in humanity's Footprint value between 1961 and the late 1990s and a shift in the global overshoot date.

8. Does the Ecological Footprint take into account other species?

The Ecological Footprint compares human demand on biocapacity 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 2010, 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, and the resulting stress on the ecosystem may negatively impact biodiversity. However, the Footprint does not measure this latter impact directly, nor does it specify how much overshoot must be reduced to avoid negative impacts.

9. Does the Footprint measure sustainability?

Robust and accurate Ecological Footprint accounts can help us make decisions toward sustainability, and can quantitatively show the positive impacts of groups, businesses, and people making decisions that are helping to bring human demand within the means of the planet. However, no single metric is a complete measure of sustainability. The Ecological Footprint measures one key dimension of sustainability: the extent to which Earth's productive ecosystems have sufficient regenerative capacity to keep up with humanity's consumptive demands. Other sustainability-relevant indicators include the United Nations' Human Development Index and measures of biodiversity.

The Ecological Footprint will not show directly if a country's rates of consumption are sustainable, but it will show whether the country's demand for ecological resources is greater than its bioproductive ability to regenerate those resources in a given year, in which case the excess demand has been met through the importing of biocapacity from other countries. This information is significant for any sustainability assessment.

10. 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. Although Footprint accounting can determine the average biocapacity available per capita, it does not stipulate how this biocapacity should be allocated among individuals or countries. However, it does provide a context for such discussions.

11. 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 global ecological supply and a reduction in human demand due to technological advances or other factors, Footprint accounts will show these effects as the elimination of global overshoot.

12. How does the Ecological Footprint support public policy development?

Biocapacity and Ecological Footprint accounting inform public policy decisions in the same way that savings and expense accounting informs financial decisions. Global Footprint Network focuses on the national level in part because many important policy decisions are established and enforced at the national level, such as carbon emission and ozone depletion regulations on the environmental side, and taxation and budgeting on the financial side.

Ecological Footprint and biocapacity can be calculated for nations, regions, cities, and even smaller population groups. The science behind the Ecological Footprint reveals the reality of resource limitations and thus empowers entities at any level to make policy decisions from a realistic and informed standpoint. It empowers decision-makers to compare the outcomes of those decisions to each other within the context of resource constraints.

13. What NFA calculation improvements have been made between LPR 2012 and LPR 2014?

In addition to changes in the way global hectares are represented (see question 2) and ocean-sequestered anthropogenic carbon is calculated (see question 7), there have been several improvements made to the National Footprint Accounts since LPR 2012. Embodied energy values have been updated for 20 elements (e.g., nickel and manganese), which has reduced the carbon Footprint for some countries and increased it for others. Bunker fuel, which was previously allocated based on production tonnage, is now based on country imports. Hydropower units have been corrected from TWh/year to GWh/year, resulting in an increase in consumption Footprint and biocapacity in the built-land component. Fish catch and trophic level formulae have been corrected, and four fish commodities have been added; these changes had the biggest impact on Footprints of countries that export large quantities of fish (e.g., Ecuador). Finally, Croatia, Iceland, Liechtenstein, Macedonia, Switzerland, Serbia and Montenegro were newly included in CORINE area data.

NOTE: CORINE (Coordination of Information on the Environment) land-cover data, provided by the European Environment Agency is one of the sources used for calculating land area values in the NFAs. The CORINE database has 44 different land-use classifications which are reclassified into the NFA's five biocapacity components. CORINE land-area data is used whenever possible because the results are considered more robust than those from national reporting or estimates which are the basis of the Resourcestat values.

For Ecological Footprint detailed method paper, copies of sample calculation sheets, data sources and results, please visit: www.footprintnetwork.org

Table 5: Ecological Footprint and biocapacity data tables

PLEASE NOTE: (1) Table includes Footprint data (in percentage values), for countries with populations greater than 1 million. (2) Population data is from UN FAO.

Region/country	Population (2010)	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Global Footprint per capita ranking	Cropland	Grazing land	Forest land	Fishing grounds	Built-up land	Global biocapacity per capita ranking
		2010 Footprint composition (as percentage of total Footprint)							2010 biocapacity composition (as percentage of total biocapacity)					
Africa														
Algeria	35,468,000	31	20	9	1	2	37	90	37	53	4	2	5	131
Angola	19,082,000	42	17	12	9	6	14	131	12	54	23	8	2	38
Benin	8,850,000	37	4	21	6	3	28	109	52	4	37	3	4	99
Botswana	2,007,000	14	39	7	1	1	39	60	2	71	18	8	1	25
Burkina Faso	16,469,000	54	11	23	2	6	4	104	63	13	18	0	6	78
Burundi	8,383,000	27	10	55	1	4	3	137	55	33	2	2	9	141
Cote d'Ivoire	19,738,000	36	10	21	17	7	8	133	49	18	28	0	4	64
Cameroon	19,599,000	50	9	17	9	5	10	119	35	5	51	6	3	59
Central African Republic	4,401,000	25	46	20	1	3	5	120	4	7	88	0	0	14
Chad	11,227,000	33	46	16	0	4	0	86	19	43	33	3	2	32
Congo	4,043,000	25	13	35	8	4	16	136	1	29	66	4	0	7
Democratic Republic of Congo	65,966,000	19	2	65	2	6	5	145	4	11	82	2	2	33
Egypt	81,121,000	37	6	9	3	8	36	84	69	0	0	4	28	135
Eritrea	5,254,000	31	40	17	2	6	4	150	8	15	7	67	2	75
Ethiopia	82,950,000	36	11	44	0	6	4	126	58	18	7	7	10	113
Gabon	1,505,000	19	9	48	6	1	17	65	1	14	73	12	0	1
Gambia	1,728,000	50	13	12	5	3	16	93	46	3	17	29	5	84
Ghana	24,392,000	34	5	35	10	4	12	88	55	22	13	4	6	85
Guinea	9,982,000	34	25	29	3	4	6	95	20	32	27	18	2	41
Guinea-Bissau	1,515,000	27	24	41	1	4	4	92	17	12	11	59	2	28
Kenya	40,513,000	24	26	29	4	4	13	134	40	47	3	3	7	133
Lesotho	2,171,000	21	43	34	0	1	0	130	12	86	0	0	2	108
Liberia	3,994,000	16	3	63	1	3	14	123	7	24	56	11	2	42

Region/country	Population (2010)	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Global Footprint per capita ranking	Cropland	Grazing land	Forest land	Fishing grounds	Built-up land	Global biocapacity per capita ranking
		2010 Footprint composition (*as percentage of total Footprint*)							2010 biocapacity composition (*as percentage of total biocapacity*)					
Libya	6,355,000	22	16	4	4	1	53	47	23	35	3	36	3	119
Madagascar	20,714,000	27	34	22	6	6	4	127	11	51	30	6	2	39
Malawi	14,901,000	56	5	25	1	7	6	144	68	12	4	9	8	114
Mali	15,370,000	44	37	8	2	5	4	83	36	31	27	2	4	55
Mauritania	3,460,000	16	61	9	0	3	12	71	3	64	1	30	1	18
Mauritius	1,299,000	11	12	3	42	0	32	32	29	0	2	69	0	134
Morocco	31,951,000	45	14	9	3	3	25	105	51	21	11	12	5	107
Mozambique	23,391,000	43	3	35	5	8	7	141	15	46	28	7	3	52
Niger	15,512,000	70	20	4	1	3	2	72	70	24	2	0	3	49
Nigeria	158,423,000	49	8	15	7	4	18	115	72	17	2	2	7	104
Rwanda	10,624,000	52	7	29	1	6	5	140	77	10	2	1	9	127
Senegal	12,434,000	41	20	16	5	4	15	113	36	14	35	12	3	74
Sierra Leone	5,868,000	31	16	34	11	5	4	128	30	33	16	17	5	91
Somalia	9,331,000	12	34	45	2	5	2	124	8	46	18	23	4	80
South Africa	50,133,000	14	8	11	3	1	63	64	25	52	2	18	3	88
Sudan	43,552,000	26	51	14	0	2	6	107	20	52	17	9	2	72
Swaziland	1,186,000	19	32	28	1	4	17	91	29	58	6	1	7	103
Tanzania	44,841,000	35	28	19	6	5	6	121	42	34	12	6	6	94
Togo	6,028,000	40	10	28	6	3	14	132	68	20	5	3	4	115
Tunisia	10,481,000	36	6	12	7	1	37	81	46	11	7	33	3	109
Uganda	33,425,000	33	12	39	9	3	4	114	64	22	2	6	6	110
Zambia	13,089,000	28	17	38	2	5	11	139	11	43	44	1	2	48
Zimbabwe	12,571,000	20	26	22	0	2	30	112	25	50	20	2	3	111
Asia Pacific														
Australia	22,268,000	17	13	16	3	1	51	13	16	41	18	26	0	5
Bangladesh	148,692,000	48	2	11	4	11	24	146	67	1	1	13	18	142
Cambodia	14,138,000	52	0	21	7	5	15	125	54	10	19	12	5	95
China	1,372,148,000	25	6	7	5	5	51	75	47	11	23	7	12	101
India	1,224,614,000	41	0	13	2	6	39	135	78	1	4	6	11	138

Region/country	Population (2010)	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Global Footprint per capita ranking	Cropland	Grazing land	Forest land	Fishing grounds	Built-up land	Global biocapacity per capita ranking
		2010 Footprint composition (*as percentage of total Footprint*)							2010 biocapacity composition (*as percentage of total biocapacity*)					
Indonesia	239,871,000	33	4	13	15	5	31	111	38	4	23	30	5	81
Japan	126,536,000	12	4	6	12	1	65	42	16	0	61	13	10	132
North Korea	24,346,000	22	0	10	4	5	58	117	39	0	41	10	9	116
Republic of Korea	48,184,000	15	4	6	8	2	66	31	23	0	11	56	10	118
Laos	6,201,000	43	11	29	2	9	7	116	37	11	43	2	8	66
Malaysia	28,401,000	21	9	11	16	3	40	55	34	1	28	34	3	47
Mongolia	2,756,000	6	66	3	0	1	25	22	1	58	40	1	0	3
Myanmar	47,963,000	54	1	17	17	7	3	79	51	0	28	14	6	53
Nepal	29,959,000	42	6	23	0	11	18	143	63	8	10	1	17	136
New Zealand	4,368,000	22	0	25	0	6	47	51	4	28	47	20	2	9
Pakistan	173,593,000	45	1	12	2	8	32	147	73	1	3	9	14	143
Papua New Guinea	6,858,000	11	6	19	23	6	35	61	12	1	66	16	4	26
Philippines	93,261,000	31	7	8	25	5	24	129	59	3	16	12	10	128
Singapore	5,086,000	7	13	6	4	0	70	7	2	0	1	31	67	152
Sri Lanka	20,860,000	27	6	12	27	5	23	118	64	4	8	10	13	139
Thailand	69,122,000	31	2	7	16	3	41	73	63	1	18	12	6	87
Timor-Leste	1,124,000	45	17	9	6	13	9	152	28	7	59	0	6	106
Viet Nam	87,848,000	37	2	12	9	7	32	98	54	1	15	20	10	93
EU														
Austria	8,394,000	20	7	10	2	4	57	17	23	5	65	0	7	31
Belgium	10,712,000	29	14	8	4	3	43	5	44	3	27	5	20	98
Bulgaria	7,494,000	27	7	11	2	5	47	52	50	3	39	3	5	34
Cyprus	1,104,000	25	6	8	7	1	53	35	51	0	17	19	13	146
Czech Republic	10,493,000	19	4	17	1	3	56	19	39	3	52	0	6	45
Denmark	5,550,000	36	12	14	8	3	27	4	49	0	7	39	5	19
Estonia	1,341,000	16	3	41	3	1	36	20	9	1	43	46	1	13
Finland	5,365,000	17	4	3	7	3	67	15	6	0	74	19	1	6
France	62,787,000	25	9	12	5	4	45	23	52	6	31	5	7	35
Germany	82,302,000	26	6	10	1	4	53	25	48	3	36	4	9	61

Region/country	Population (2010)	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Global Footprint per capita ranking	Cropland	Grazing land	Forest land	Fishing grounds	Built-up land	Global biocapacity per capita ranking
		2010 Footprint composition (*as percentage of total Footprint*)							2010 biocapacity composition (*as percentage of total biocapacity*)					
Greece	11,359,000	23	14	7	7	1	48	30	56	10	14	16	4	76
Hungary	9,984,000	26	4	13	1	5	51	58	62	3	29	0	6	51
Ireland	4,470,000	25	7	7	2	2	57	14	15	24	14	44	3	24
Italy	60,551,000	23	10	10	6	1	50	26	52	5	31	6	7	97
Latvia	2,252,000	18	1	37	8	1	35	44	13	4	54	28	1	16
Lithuania	3,324,000	22	3	27	10	2	36	36	34	2	53	8	2	27
Netherlands	16,613,000	25	17	7	3	2	46	12	31	5	8	45	11	102
Poland	38,277,000	25	2	18	3	2	51	37	49	4	38	5	4	60
Portugal	10,676,000	21	8	7	22	1	41	27	21	5	64	6	4	82
Romania	21,486,000	34	5	12	3	6	40	70	40	5	45	4	6	46
Slovakia	5,462,000	16	6	21	1	3	53	45	26	2	68	0	4	43
Slovenia	2,030,000	18	6	12	2	1	61	24	15	3	81	0	1	50
Spain	46,077,000	29	7	8	10	1	45	40	62	7	23	4	4	73
Sweden	9,380,000	14	9	22	3	3	49	10	6	2	66	23	2	11
United Kingdom	62,272,000	17	9	11	3	3	56	28	35	9	9	36	10	79
Latin America														
Argentina	40,412,000	42	19	9	0	4	26	59	41	25	9	23	2	15
Bolivia	9,930,000	18	56	7	0	3	16	68	4	13	83	0	0	2
Brazil	194,946,000	25	32	19	1	4	18	53	11	11	75	2	1	12
Chile	17,114,000	20	16	30	0	4	29	56	10	12	56	19	3	22
Colombia	46,295,000	19	44	8	0	6	23	82	6	32	58	1	3	23
Costa Rica	4,659,000	15	13	27	6	4	36	69	27	21	40	6	6	68
Cuba	11,258,000	28	12	5	2	1	52	94	35	12	31	20	3	112
Dominican Republic	9,927,000	29	10	8	7	3	42	108	41	20	28	3	8	129
Ecuador	14,465,000	21	18	14	4	4	38	80	19	15	54	8	4	57
El Salvador	6,193,000	23	15	21	10	2	28	77	48	19	7	19	7	124
Guatemala	14,389,000	23	13	31	3	3	27	87	39	17	34	4	6	96
Haiti	9,993,000	47	11	19	3	5	16	149	68	13	3	5	10	149

Region/country	Population (2010)	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Global Footprint per capita ranking	Cropland	Grazing land	Forest land	Fishing grounds	Built-up land	Global biocapacity per capita ranking
		2010 Footprint composition (*as percentage of total Footprint*)							2010 biocapacity composition (*as percentage of total biocapacity*)					
Honduras	7,601,000	19	18	31	1	4	27	96	18	15	51	12	3	62
Jamaica	2,741,000	19	10	9	7	2	54	76	46	0	28	14	13	144
Mexico	113,423,000	22	11	8	2	2	55	49	35	17	34	10	4	77
Nicaragua	5,788,000	22	17	30	5	3	23	106	17	25	33	22	2	54
Panama	3,517,000	18	23	9	0	1	49	74	7	19	50	23	1	44
Paraguay	6,455,000	26	36	20	0	3	14	41	21	22	56	1	1	8
Peru	29,077,000	34	19	12	0	7	29	103	10	13	68	6	3	20
Trinidad and Tobago	1,341,000	5	6	4	2	0	83	6	3	0	9	87	0	70
Uruguay	3,369,000	11	51	23	1	2	12	16	15	50	12	22	1	10
Venezuela	28,980,000	14	25	4	4	3	49	50	6	20	60	10	3	36
Middle East/ Central Asia														
Afghanistan	31,412,000	41	30	11	0	5	13	148	47	42	4	0	7	140
Armenia	3,092,000	30	19	17	1	2	31	101	35	45	12	3	6	123
Azerbaijan	9,188,000	33	16	5	0	3	42	100	46	31	14	2	7	117
Bahrain	1,262,000	7	10	3	1	2	76	9	2	0	0	79	19	120
Georgia	4,352,000	30	21	9	4	2	33	122	9	33	52	4	3	92
Iran	73,974,000	23	6	3	4	3	62	57	50	8	7	27	8	100
Iraq	31,672,000	23	3	1	1	3	70	102	61	7	16	2	15	147
Israel	7,418,000	20	8	9	3	1	58	34	59	3	12	5	22	148
Jordan	6,187,000	25	22	8	4	5	36	78	44	8	11	1	36	150
Kazakhstan	16,026,000	12	8	2	0	1	77	29	29	60	7	2	1	30
Kuwait	2,737,000	6	5	2	2	1	84	1	6	2	1	62	30	137
Kyrgyzstan	5,334,000	38	20	4	1	5	33	110	33	50	7	4	6	83
Lebanon	4,228,000	21	18	9	2	1	48	46	50	15	18	3	15	145
Occupied Palestinian Territory	4,039,000	36	10	0	4	0	51	151	76	18	4	0	2	151
Oman	2,782,000	14	17	4	6	4	56	21	5	3	0	84	8	56
Qatar	1,759,000	9	15	2	3	1	70	2	1	0	0	92	7	65

Region/country	Population (2010)	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Global Footprint per capita ranking	Cropland	Grazing land	Forest land	Fishing grounds	Built-up land	Global biocapacity per capita ranking
		2010 Footprint composition (as percentage of total Footprint)							2010 biocapacity composition (as percentage of total biocapacity)					
Saudi Arabia	27,448,000	18	10	6	3	1	62	33	22	22	11	35	10	130
Syria	20,411,000	36	9	6	2	3	45	97	67	18	7	1	7	125
Tajikistan	6,879,000	57	19	1	0	10	12	142	57	27	1	2	13	122
Turkey	72,752,000	35	4	12	2	2	46	63	50	6	38	3	3	69
Turkmenistan	5,042,000	17	14	0	0	3	65	43	23	68	1	5	3	37
United Arab Emirates	8,264,000	10	8	4	4	0	74	3	14	0	11	75	0	121
Uzbekistan	27,445,000	30	8	4	0	4	53	89	58	23	7	3	9	105
Yemen	24,053,000	34	19	3	3	6	34	138	23	21	7	39	10	126
North America														
Canada	34,017,000	16	7	18	2	3	55	11	17	2	56	24	1	4
United States of America	310,384,000	16	5	10	2	1	67	8	39	7	41	12	2	21
Other Europe														
Albania	3,204,000	43	12	6	1	3	34	85	46	19	24	6	5	89
Belarus	9,595,000	34	0	14	3	2	47	38	38	9	50	1	2	29
Bosnia and Herzegovina	3,760,000	28	9	17	2	1	43	66	22	11	66	0	1	63
Croatia	4,403,000	25	5	16	3	2	49	48	26	7	54	12	2	40
Macedonia TFYR	2,061,000	25	6	10	3	1	54	54	32	9	57	1	2	67
Moldova	3,573,000	44	3	7	5	3	39	99	81	6	8	1	4	90
Russia	142,958,000	15	5	13	4	1	63	39	10	5	67	17	1	17
Serbia	9,856,000	31	1	18	2	3	45	67	66	1	28	0	4	71
Switzerland	7,664,000	13	5	10	3	3	67	18	16	10	62	1	11	86
Ukraine	45,448,000	31	5	6	4	2	51	62	65	6	20	6	3	58

Unless otherwise noted, all data is from Global Footprint Network, National Footprint Accounts 2014 edition. For more information consult www.footprintnetwork.org/atlas

The water footprint FAQ

The water footprint of a nation, business or product is an empirical indicator of how much water is consumed, when and where, measured over the whole supply chain. The water footprint is a multidimensional indicator, showing volumes but also making explicit the type of water use (evaporation of rainwater, surface water or groundwater, or pollution of water) and the location and timing of water use.

1. How is the water footprint different from previously used methods of calculating water use?

Traditionally statistics on water use focus on measuring water withdrawals and direct water use. The water footprint accounting method takes a much broader perspective. It measures both direct and indirect water use, where the latter refers to the water use in the supply chain of a product. The water footprint thus links final consumers and intermediate businesses and traders to the water use along the whole production chain of a product. This is relevant, because generally the direct water use of a consumer or business is much smaller than the total water used along the supply chain. So the picture of the actual water dependency of a consumer, business or country can change radically.

The water footprint method further differs in that it looks at water consumption (as opposed to withdrawal). This refers to water that does not return to the system from which it was withdrawn (e.g., the water lost through evaporation). Besides this, the water footprint goes beyond looking at blue water use only (i.e., use of ground and surface water). It also includes a green water footprint component (use of rainwater) and a grey water footprint component (polluted water).

2. Water is a renewable resource, it remains in the cycle, so what's the problem?

Water is a renewable resource, but that does not mean that its availability is unlimited. In a certain period, precipitation is always limited. So is the amount of water that recharges groundwater reserves and that flows through a river. Rainwater can be used in agricultural production, and water in rivers and aquifers can be used for irrigation or industrial or domestic purposes. But in a given period, one cannot use more water than is available – rivers can run dry, and in the long term water cannot be sustainably taken from lakes and groundwater reservoirs faster than they are recharged. The water footprint measures the amount of water available in a certain period that is consumed (i.e., evaporated) or polluted. In this way, it provides a measure of the amount of available water appropriated by humans. The remainder is left for nature. The rainwater not used for agricultural production is left to sustain natural vegetation. The ground- and surface-water flows not evaporated for human purposes or polluted is left to sustain healthy aquatic ecosystems.

3. Is there agreement on how to measure a water footprint?
The methods for water footprint accounting have been published in peer-reviewed scientific journals. In addition, there are also practical examples available of how to apply the methods to calculate the water footprint of a specific product, an individual consumer, a community or a business or organization. While there is general agreement about the definition and calculation of a water footprint, practical questions arise according to specific circumstances: what should be included and what can be excluded, how to deal with situations where the supply chain cannot be properly traced, what water quality standards to use when calculating the grey water footprint, and so on. Discussion therefore focuses on how to handle those practical issues. There is also still discussion about the precise method of how to estimate the local impacts of a water footprint.

4. Why distinguish between a green, blue and grey water footprint?
Freshwater availability is determined by annual precipitation above land. One part of the precipitation evaporates and the other part runs off to the ocean through aquifers and rivers. Both the evaporative flow and the run-off flow can be made productive for human purposes. The evaporative flow can be used for crop growth or left for maintaining natural ecosystems; the green water footprint measures which part of the total evaporative flow is actually appropriated for human purposes. The run-off flow – the water flowing in aquifers and rivers – can be used for all sorts of purposes, including irrigation, washing, processing and cooling. The blue water footprint measures the volume of groundwater and surface water consumed, i.e., withdrawn and then evaporated. The grey water footprint measures the volume of water flow in aquifers and rivers polluted by humans. In this way, the green, blue and grey water footprints measure different sorts of water appropriation.

5. Isn't it too simplistic to add all cubic metres of water used into one aggregate indicator?

The aggregate water footprint shows the total volume of fresh water consumed or polluted annually. It serves as a rough indicator, instrumental in awareness raising and for getting an idea of where most of the water goes. The water footprint can be presented as one aggregate number, but in fact it is a multidimensional indicator of water use, showing different sorts of water consumption and pollution. Developing strategies for sustainable water use requires the more detailed layer of information embedded in the composite water footprint indicator.

6. How does water footprint relate to the Ecological Footprint?

The water footprint concept is part of a larger family of concepts that have been developed in the environmental sciences over the past decade. A "footprint" in general has become known as a quantitative measure showing the appropriation of natural resources or pressure on the environment by human beings. The water footprint complements the Ecological Footprint. An important feature of the water footprint is the importance of specifying space and time. This is necessary because the availability of water varies highly depending on the river basin and the time of year, so that water appropriation should always be considered in its local context.

For more information consult www.waterfootprintnetwork.org

GLOSSARY OF TERMS

Adaptation	The process of adjustment to actual or expected climate change and its effects in human and natural systems.
Biocapacity	The capacity of ecosystems to produce useful biological materials and to absorb waste materials (specifically, carbon dioxide) generated by humans, using current management schemes and technologies. Biocapacity is measured in global hectares (Global Footprint Network, 2014).
Biocapacity deficit and reserve	The difference between a population's Ecological Footprint and the biocapacity of its region or country. A biocapacity deficit occurs when the Footprint of a population exceeds its region's or country's biocapacity. A biocapacity reserve occurs when the opposite is the case. It is measured in global hectares (Global Footprint Network, 2014).
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 (Hoekstra et al., 2011).
Built-up land	In the Ecological Footprint, the biologically productive area covered by human infrastructure, including transportation, housing and industrial structures (Global Footprint Network, 2014).
Cropland	In the Ecological Footprint, the area that produces crops for food and fibre for human consumption, feed for livestock, oil crops and rubber. It is measured in global hectares (Global Footprint Network, 2014).
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. Also referred to in short as Footprint (Global Footprint Network, 2012).
Ecological overshoot	When a population's demands on an ecosystem exceed the capacity of that ecosystem to regenerate the resources demanded. Overshoot results in ecological assets being diminished and carbon waste accumulating in the atmosphere (Global Footprint Network, 2014).

Ecoregions	Large unit of land or water containing a geographically distinct assemblage of species, natural communities and environmental conditions.
Environmental flows	The quality, quantity and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems which provide goods and services to people (World Bank).
Externality	A cost (or benefit) that affects a party who did not choose to incur it, not accounted for in market prices or otherwise compensated.
Fishing grounds	In the Ecological Footprint, the area of marine and inland waters required/available to harvest fish and other seafood (Global Footprint Network, 2014).
Forest product Footprint	In the Ecological Footprint, the area of forest required to support the harvest of fuel wood, pulp and timber products. This is distinct from the carbon Footprint, which is the area of forested land required to sequester anthropogenic CO_2 emissions that are not absorbed by the oceans (Global Footprint Network, 2014).
Global hectare (gha)	A hectare of biologically productive land or sea area with world average bioproductivity in a given year. Both Ecological Footprint and biocapacity results are expressed in this globally comparable, standardized unit. Since 2012, all Footprint and biocapacity results are expressed in *constant global hectares*, global hectares which for all previous years have been normalized based on the average yields of productive area in the most recent year being reported (Global Footprint Network, 2014).
Green water footprint	Volume of rainwater consumed during the production process. This is particularly relevant for agricultural and forestry products (products based on crops or wood), where it refers to the total rainwater evapotranspiration (from fields and plantations) plus the water incorporated into the harvested crop or wood (Hoekstra et al., 2011).
Grey water footprint	Volume of water required to dilute pollutants to such an extent that the quality of the water remains above agreed water quality standards (Hoekstra et al., 2011).
Grazing land	In the Ecological Footprint, the land used to raise livestock for meat, dairy, hide and wool products. This grazing Footprint is in addition to the land used to grow animal feed, which is included under the cropland footprint (Global Footprint Network, 2014).

Human Development Index (HDI)	Generated by UNDP, the HDI ranks countries' human development using a score based on levels of education, income and life expectancy.
Inequality adjusted Human Development Index (IHDI)	The 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.
Megacity	A metropolitan area with a total population in excess of 10 million people.
Natural capital	The stock of natural assets (land, water, biodiversity) that supports the provision of ecosystem services.
Presumptive environmental flow requirement	Presumptive environmental flow requirement refers to restricting hydrologic alterations to within a percentage-based range around natural or historic flow variability. It tells us how much water should stay in the river (Richter et al., 2012).
Representative Concentration Pathways (RCP)	Benchmark emission scenarios that represent a broad range of literature-based climate outcomes and are used for climate modelling and research.
Resilience	The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity and structure, while also maintaining the capacity for adaptation, learning, and transformation (Arctic Council, 2013).
Water footprint of national production	The total volume of freshwater a country uses (in cubic metres per year, m^3/y) to produce good and services, whether they are consumed locally or exported (Hoekstra et al., 2011).
Water scarcity	The lack of sufficient available water resources to meet the demands of water usage within a region. Water scarcity varies within the year and from year to year (Hoekstra et al., 2011).

LIST OF ABBREVIATIONS

ADB Asian Development Bank
ASC Aquaculture Stewardship Council
BRIICS Brazil, Russia, India, Indonesia, China, South Africa
CBD Convention on Biological Diversity
CBS Central Bureau of Statistics
CCAMLR Commission for Conservation of Antarctic Marine Living Resources
CDIAC Carbon Dioxide Information Analysis Centre
CFC Chlorofluorocarbon
CO_2 Carbon dioxide
CISL Cambridge Institute for Sustainability Leadership
FAO United Nations Food and Agricultural Organization
FLORON Floristisch Onderzoek Nederland
GDP Gross Domestic Product
gha Global hectares
Gm^3 Billion cubic metres
GRID Global Resource Information Database (UNEP)
HDI Human Development Index
ICEM International Centre for Environmental Management
IGCP International Gorilla Conservation Programme
IHDI Inequality-adjusted Human Development Index
IPCC Intergovernmental Panel on Climate Change
IUCN International Union for the Conservation of Nature
LPI *Living Planet Index®*
LPI-D Diversity-weighted LPI
LPI-U Unweighted LPI
MEA Millennium Ecosystem Assessment
NGO Non-governmental organization
N_r Reactive Nitrogen
OBIS Ocean Biogeographic Information System (Intergovernmental Oceanographic Commission of UNESCO)
OECD Organisation for Economic Cooperation and Development
PES Payment for ecosystem services
ppm Parts per million
RCP Representative Concentration Pathways (IPCC)
REDD Reducing emissions from deforestation and forest degradation
SEI Stockholm Environment Institute
SOFIA State of World Fisheries and Aquaculture report
SRC Stockholm Resilience Centre
SSC Species Survival Commission of IUCN
TEEB The Economics of Ecosystems and Biodiversity
TNC The Nature Conservancy
UNDESA United Nations Department of Economic and Social Affairs
UNDP United Nations Development Programme
UNEP FI United Nations Environment Programme Finance Initiative
UNFCCC United Nations Framework Convention on Climate Change
UNFPA United Nations Population Fund
UNICEF United Nations Children's Fund
WCED World Commission on Environment and Development
WFC World Future Council
WFN Water Footprint Network
WHO World Health Organization (United Nations)
WRG Water Resources Group
ZNDD Zero net deforestation and forest degradation
ZSL Zoological Society of London

REFERENCES

Abell, R., Allan, J.D. and B. Lehner. 2007. Unlocking the potential of protected areas for freshwaters. *Biological Conservation* 134:48–63.
ADB. 2013. *Moving from Risk to Resilience – Sustainable Urban Development in the Pacific*. Asian Development Bank, Manila, Philippines.
Ahlenius, H. 2008. *Human impact on coastal zones*. UNEP/GRID-Arendal, Arendal, Norway. Available at: www.grida.no/graphicslib/detail/human-impact-in-the-coastal-zones_80d7 [accessed 8 June 14].
AIMS. 2012. Personal communication from the Australian Institute of Marine Science (AIMS) to WWF Australia.
Arctic Council. 2013. *Arctic Resilience Interim Report 2013*. Stockholm Environment Institute and Stockholm Resilience Centre, Stockholm, Sweden.
Atkinson, G., Bateman, I. and S. Mourato. 2012. Recent advances in the valuation of ecosystem services and biodiversity. *Oxford Review of Economic Policy* 28(1).
Barthlott, W., Mutke, J., Rafiqpoor, M. D., Kier, G. and H. Kreft. 2005. Global centres of vascular plant diversity. *Nova Acta Leopoldina* 92, 61-83.
Baum, J. K. and Myers, R. A. 2004. Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico. *Ecology Letters* 7: 135–145, doi: 10.1111/j.1461-0248.2003.00564.
Baumert, K. A., Herzog, T. and J. Pershing. 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*. World Resources Institute, Washington, DC, USA.
BirdLife International. 2012. *Diomedea exulans*. In: IUCN. 2013. IUCN Red List of Threatened Species. Version 2013.2. Available at: www.iucnredlist.org [accessed 8 June 14].
Blake, S. and Hedges, S. 2004. Sinking the flagship: the case of forest elephants in Asia and Africa. *Conservation Biology* **18**(5): 1191-1202.
Bleeker, A., Sutton, M., Winiwarter, W. and A. Leip. 2013. *Economy-Wide Nitrogen Balances and Indicators: Concept and Methodology*. OECD, Environment Directorate, Environment Policy Committee, Working Party on Environmental Information, Paris, France.
Bobbink, R., Hicks, K., Galloway, J., Spranger, T., Alkemade, R., Ashmore, M., Bustamante, M., Cinderby, S., Davidson, E., Dentener, F., Emmett, B., Erisman, J.W., Fenn, M., Gilliam, F., Nordin, A., Pardo, L. and W. De Vries. 2010. Global assessment of nitrogen deposition effects on terrestrial plant diversity: a synthesis. *Ecological Applications* 20: 30-59.
Borucke, M., Moore, D., Cranston, G., Gracey, K., Iha, K., Larson, J., Lazarus, E., Morales, J.C., Wackernagel, M. and A. Galli. 2013. Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework. *Ecological Indicators* 24 (2013): 518–533.
Boston Consulting Group. 2013. *Turning adversity into opportunity: A business plan for the Baltic Sea*. Report commissioned by WWF-Sweden. Available at: www.wwf.se/source.php/1536768/Ostersjorapporten%202013%20-%20BCG%20Turning%20Adversity%20into%20Opportunity%20Aug%202013.pdf [accessed 8 June 14].
Buhaug, H. and Urdal, H. 2013. An Urbanization Bomb? Population growth and social disorder in cities. *Global Environmental Change* 23(1).
Caddy, J.F. and Griffiths, R.C. 1995. *Living marine resources and their sustainable development: some environmental and institutional perspectives*. FAO Fisheries Technical Paper No. 353. FAO, Rome, Italy.
CDIAC. 2011. *Global CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee, USA. Available at: cdiac.ornl.gov/ftp/ndp030/global.1751_2008.ems [accessed 8 June 14].
Clarke, C., Canto, M. and S. Rosado. 2013a. *Belize Integrated Coastal Zone Management Plan*. Coastal Zone Management Authority and Institute, Belize City. Draft for public review.
Clarke, S.C., Harley, S.J., and J.S. Rice. 2013b. Population trends in Pacific Oceanic Sharks and the Utility of Regulations on Shark Finning. *Conservation Biology* 27:197-209, doi: 10.1111/j.1523-1739.2012.01943.

Coastal Zone Management Act of 1998. Ch. 329. Revised Edition 2000. Belmopan, Belize: Government Printer.

Collen, B., Loh, J., McRae, L., Whitmee, S., Amin, R. and J. Baillie. 2009. Monitoring change in vertebrate abundance: the Living Planet Index. *Conservation Biology* 23: 317-327.

Collen, B., Whitton, F., Dyer, E., Baillie, J.E.M., Cumberlidge, N., Darwall, W.R.T., Pollock, C., Richman, N.I., Souldby, A-M. and M. Bohm. 2014. Global patterns of freshwater species diversity, threat and endemism. *Global Ecology and Biogeography* **23**: 40-51.

Collins, M., Knutti, R., Arblaster, J., Dufresne, J.-L., Fichefet, T., Friedlingstein, P., Gao, X., Gutowski, W.J., Johns, T., Krinner, G., Shongwe, M., Tebaldi, C., Weaver, A.J. and M. Wehner. 2013. Long-term Climate Change: Projections, Commitments and Irreversibility. In: IPCC. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, USA.

CCAMLR. 2014. About CCAMLR: *History*. *Commission for Conservation of Antarctic Marine Living Resources*. Available at: www.ccamlr.org/en/organisation/history [accessed 8 June 2014].

Conniff, R. 2014. *Urban Nature: How to Foster Biodiversity in World's Cities*. *Yale Environment 360*. Available at: e360.yale.edu/content/print.msp?id=2725 [accessed 8 June 2014].

Cooper, E., Burke, L. and N. Bood. 2009. *Belize's Coastal Capital: The Economic Contribution of Belize's Coral Reefs and Mangroves*. WRI Working Paper, World Resources Institute, Washington DC, USA. Available at: www.wri.org/publication/belizes-coastal-capital [accessed 8 June 2014].

Costanza, R., de Grootb, R., Sutton, P., van der Ploegb, S., Anderson, S., Kubiszewskia, I., Farbere, S. and R.K. Turner. 2014. Changes in the global value of ecosystem services. *Global Environmental Change* 26: 152-158.

Craigie, I.D., Baillie, J.E.M., Balmford A., Baillie, J.E.M., Carbone, C., Collen, B. and J.M. Hutton. 2010. Large mammal population declines in Africa's protected areas. *Biological Conservation* **143**: 2221–2228.

Cumberlidge, N., Ng, P.K.L., Yeo,D.C.J., Magalhães, C., Campos, M.R., Alvarez, F., Naruse, T., Daniels, S.R., Esser, L.J., Attipoe, F.Y.K., Clotilde-Ba, F.-L., Darwall, W., McIvor, A., Baillie, J.E.M., Collen, B. and M. Ram. 2009. Freshwater crabs and the biodiversity crisis: importance, threats, status, and conservation challenges. *Biological Conservation* 142: 1665–1673.

Danish Energy Agency. 2012. Danish Energy Statistics, p.12. Available at: www.ens.dk/sites/ens.dk/files/dokumenter/publikationer/downloads/energy_statistics_2012.pdf [accessed 8 June 14].

Danish Energy Agency. 2014. Danish Energy Statistics. Available at: www.ens.dk [accessed 8 July 2014].

Danish Wind Industry Association. 2000. *Vindformation*. "Møllebyggeren fra Skærbæk", article by Hanne Jersild based on an interview with Christian Riisager. December 2000.

Danish Wind Industry Association. 2014. Available at: www.windpower.org/en/knowledge/publications.html [accessed 8 June 14].

Darwall, W., Smith, K., Allen, D., Holland, R., Harrison, I. and E. Brooks (eds). 2011. *The diversity of life in African freshwaters: underwater, under threat*. IUCN, Cambridge, UK and Gland, Switzerland.

Davis, S., Caldeira, K. and H. Matthews. 2010: Future CO_2 emissions and climate change from existing energy infrastructure. *Science* 329: 1330–1333.

de Vries, W., Kros, J., Kroeze, C. and S.P. Seitzinger. 2013. Assessing planetary and regional nitrogen boundaries related to food security and adverse environmental impacts. *Current Opinion in Environmental Sustainability* 5 (2013): 3-4.

De'ath, G., Fabricius, K.E., Sweatman, H. and M. Puotinen. 2012. The 27-year decline of the coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 109 (44): 17995–17999. Available at: www.pnas.org/cgi/doi/10.1073/pnas.1208909109 [accessed 8 June 14].

Deloitte Access Economics. 2013. *Economic contribution of the Great Barrier Reef*. Great Barrier Reef Marine Park Authority, Townsville, Australia. Available at: www.environment.gov.au/resource/economic-contribution-great-barrier-reef-march-2013 [accessed 8 June 14].

Dong Energy. Undated. *The Anholt offshore wind farm project*. Available at: www.dongenergy.com/anholt/EN/Projektet1/Pages/default.aspx [accessed 8 June 14].

Dudley, N. & Stolton, S., eds. 2003. *Running pure: the importance of forest protected areas to drinking water*. Gland, Switzerland. WWF/ World Bank Alliance for Forest Conservation and Sustainable Use.

Edgar, G., Stuart-Smith, R., Willis, T., Kininmonth, S., Baker, S., Banks, S., Barrett, N., Becerro, M., Bernard, A., Berkhout, J., Buxton, C., Campbell, S., Cooper, A., Davey, M., Edgar, S., Försterra, G., Galván, D., Irigoyen, A., Kushner, D., Moura, R., Parnell, P., Shears, N., Soler, G., Strain, E. and R. Thomson. 2014. Global conservation outcomes depend on marine protected areas with five key features. *Nature* 506: 216–220.

Emslie, R. 2012a. *Diceros bicornis*. In: IUCN. 2013. IUCN Red List of Threatened Species. Version 2013.2. Available at: www.iucnredlist.org [accessed 8 June 14].

Emslie, R. 2012b. *Ceratotherium simum*. In: IUCN. 2013. IUCN Red List of Threatened Species. Version 2013.2. Available at: www.iucnredlist.org [accessed 8 June 14].

Erisman, J.W. and Larsen, T.A., 2013. *Nitrogen Economy of the 21st Century. Source separation and decentralisation for wastewater management*. IWA Publishing, London, UK.

Erisman, J.W., Galloway, J.N., Seitzinger, S., Bleeker, A., Dise, N.B., Petrescu, R., Leach, A.M. and W. de Vries. 2013. Consequences of human modification of the global nitrogen cycle. *Philosophical Transactions of the Royal Society* 368(1621), doi: 10.1098/rstb.2013.0116

FAO. 2008. *Small-scale fisheries – People and communities* [online]. FAO Fisheries and Aquaculture Department, Rome, Italy. Available at: www.fao.org/fishery/ssf/people/en [accessed 8 June 14].

FAO. 2011. *Global food losses and food waste – Extent, causes and prevention*. FAO, Rome, Italy. Available at: www.fao.org/docrep/014/mb060e/mb060e00.pdf [accessed 8 June 14].

FAO. 2012a. *State of the World's Forests 2012*. FAO, Rome, Italy.

FAO. 2012b. *State of World Fisheries and Aquaculture 2012*. FAO, Rome, Italy.

FAO. 2012c. *Road to Rio: Improving energy use key challenge for world's food systems*. Available at: www.fao.org/news/story/en/item/146971/icode [accessed 8 June 14].

FAO. 2013. *Statistical Yearbook 2013 - World Food and Agriculture*. FAO, Rome, Italy.

FAO. 2014. *The State of World Fisheries and Aquaculture – Opportunities and Challenges*. FAO, Rome, Italy.

Field, C.B., Barros, V.R., Mastrandrea, M.D., Mach, K.J., Abdrabo, M.A., Adger, W.N., Anokhin, Y.A., Anisimov, O.A., Arent, D.J, Barnett, J., Burkett, V.R., Cai, R., Chatterjee, M., Cohen, S.J., Cramer, W., Dasgupta, P., Davidson, D.J., Denton, F., Döll, P., Dow, K., Hijioka, Y., Hoegh-Guldberg, O., Jones, R.G., Jones, R.N., Kitching, R.L., Kovats, R.S., Lankao, P.R., Larsen, J.N., Lin, E., Lobell, D.B.,Losada, I.J., Magrin, G.O, Marengo, J.A., Markandya, A., McCarl, B.A., McLean, R.F., Mearns, L.O., Midgley, G.F., Mimura, N., Morton, J.F., Niang, I., Noble, I.R., Nurse, L.A., O'Brien, K.L., Oki, T., Olsson, L., Oppenheimer, M., Overpeck, J.T., Pereira, J.J., Poloczanska, E.S., Porter, J.R., Pörtner, H., Prather, M.J., Pulwarty, R.S., Reisinger, A.R., Revi, A., Ruppel, O.C., Satterthwaite, D.E., Schmidt, D.N., Settele, J., Smith, K.R., Stone, D.A., Suarez, A.G., Tschakert, P., Valentini, R., Villamizar, A., Warren, R., Wilbanks, T.J., Wong, P.P., Woodward, A., and G.W. Yohe. 2014. Summary for policymakers. In: IPCC. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report*. Cambridge University Press, Cambridge, UK and New York, USA.

Fields, S. 2004. Global Nitrogen: Cycling out of Control. *Environmental Health Perspectives*. 112(10): A556–A563.

Folke, C. 2013. Respecting Planetary Boundaries and Reconnecting to the Biosphere. In: *State of the World 2013: Is sustainability still possible?* The Worldwatch Institute. Island Press, Washington DC, USA.

Frieler, K., Meinshausen, M., Golly, A., Mengel, M., Lebek, K., Donner, S.D., and O. Hoegh-Guldberg. 2013. Limiting global warming to 2°C is unlikely to save most coral reefs. *Nature Climate Change* 3: 165-170.

Galewski, T., Collen, B., McRae, L., Loh, J., Grillas, P., Gauthier- Clerc, M. and V. Devictor. 2011. Long-term trends in the abundance of Mediterranean wetland vertebrates: from global recovery to localized declines. *Biological Conservation* 144: 1392–1399.

Galloway, J.N., Aber, J.D., Erisman, J.W., Seitzinger, S.P., Howarth, R.W., Cowling, E.B. and B.J. Cosby. 2003. The nitrogen cascade. *BioScience* 53(4): 341-356.

Galloway, J.N., Townsend, A.R., Erisman, J.W., Bekunda, M., Cai, Z.E, Freney, J.R., Martinelli, L.A., Seitzinger, S.P. and M.A. Sutton. 2008. Transformation of the nitrogen cycle: Recent trends, questions, and potential solutions. *Science* 320 (5878): 889-892.

Global Environmental Flows Network. 2007. *Brisbane Declaration*. Available at: www.eflownet.org/download_documents/brisbane-declaration-english.pdf [accessed 8 June 14].

Global Footprint Network. 2012. *National Footprint Accounts, 2012 Edition*. Available at: www.footprintnetwork.org [accessed 8 June 14].

Global Footprint Network. 2014. *National Footprint Accounts, 2014 Edition*. Available at www.footprintnetwork.org [accessed 8 June 14].

Global Partnership for Oceans. 2013. *Indispensable Ocean – Aligning Ocean Health and Human Well-being*. Guidance from the Blue Ribbon Panel to the Global Partnership for Oceans. Available at: www.globalpartnershipforoceans.org/indispensable-ocean [accessed 8 June 14].

Gomez, E. 1998. Fragile Coasts: Our Planet, in *Oceans*. UNEP, Nairobi.

Gosbell, K. and Grear, B. 2005. The importance of monitoring shorebird utilisation of the Coorong and surrounding wetlands in South Australia. In: Straw, P. (ed.) *Status and conservation of shorebirds in the east Asian–Australasian flyway*, pp.52–61. Wetlands International, Sydney, Australia.

Harmon, D. 2002. *In Light of Our Differences: how diversity in nature and culture makes us human*. Smithsonian Institution Press, Washington and London.

Harmon, D. and Loh, J. 2010. The index of linguistic diversity: A new quantitative measure of trends in the status of the world's languages. *Language Documentation & Conservation* 4: 97-151.

Hoekstra, A.Y. and Mekonnen, M.M. 2012. The water footprint of humanity. *Proceedings of the National Academy of Sciences* 109(9): 3232–3237

Hoekstra, A.Y., Mekonnen, M.M., Chapagain, A.K., Mathews, R.E. and B.D. Richter. 2012. Global monthly water scarcity: Blue water footprints versus blue water availability, *PLOS ONE* 7(2): e32688.

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and M.M. Mekonnen. 2011. The water footprint assessment manual: Setting the global standard, *Earthscan*, London, UK.

Hoekstra, J.M., Molnar, J.L., Jennings, M., Revenga, C., Spalding, M.D., Boucher, T.M., Robertson, J.C., Heibel, T.J. and K. Ellison. 2010. *The Atlas of Global Conservation: Changes, Challenges, and Opportunities to Make a Difference* (ed. Molnar, J.L.). University of California Press, Berkley, USA.

ICEM. 2010. *Strategic Environmental Assessment of Hydropower on the Mekong Mainstream – Final Report*. Prepared for the Mekong River Commission by International Centre for Environmental Management. Available at: www.mrcmekong.org/assets/Publications/Consultations/SEA-Hydropower/ SEA-Main-Final-Report.pdf [accessed 8 June 2014]

IGCP. *Analysis of the Economic Significance of Gorilla Tourism in Uganda*. Available at: www.igcp.org/wp-content/themes/igcp/docs/pdf/MoyiniUganda.pdf [accessed 8 June 14]/

IGCP. 2012. *Population of mountain gorillas in Bwindi determined by census. international Gorilla Conservation Programme*. Available at: igcp.org/blog/population-of-mountain-gorillas-in-bwindi-determined-by-census [accessed 7 July 14]

IPCC. 2013. Summary for Policymakers. In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and P.M. Midgley (eds.) *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA.

IUCN and UNEP. 2014. *The World Database on Protected Areas (WDPA)*. UNEP-WCMC, Cambridge, UK. Available at: www.protectedplanet.net [accessed 8 June 2014].

IUCN. 2013. IUCN *Red List of Threatened Species*. Version 2013.2. IUCN, Gland, Switzerland. Available at: www.iucnredlist.org [accessed 8 June 2014].

Khatiwala, S., Primeau, F. and T. Hall. 2009. Reconstruction of the history of anthropogenic carbon dioxide concentrations in the ocean. *Nature* 462: 346-350.

Kitzes, J., Peller, A., Goldfinger, S. and M. Wackernagel. 2007. Current methods for calculating national Ecological Footprint accounts. *Science for Environment & Sustainable Society* 4(1): 1-9.

La Marca, E., Lips, K.R., Lotters, S., Puschendorf, R., Ibanez, R., Rueda-Almonacid, J.V., Schulte, R., Marty, C., Castro, F., Manzanilla-Puppo, J., Garcia-Perez, J.E., Bolanos, F., Chaves, G., Pounds. A.J., Toral, E. and B.E. Young. 2005. Catastrophic population declines and extinctions in Neotropical harlequin frogs. *Biotropica* 37(2): 190-201.

Latham, J., Cumani, R., Rosati, I. and M. Bloise. 2014. *Global Land Cover (GLC-SHARE) Beta-Release 1.0 Database*. Land and Water Division, FAO, Rome, Italy.

Leach, A.M., Galloway, J.N., Bleeker, A., Erisman, J.W., Kohn, R. and J. Kitzes. 2012. A nitrogen footprint model to help consumers understand their role in nitrogen losses to the environment. *Environmental Development* 1: 40–66.

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L. and A. Geschke. 2012. International trade drives biodiversity threats in developing nations. *Nature* 486: 109-112.

Loh, J. and Harmon, D. 2014. *Biocultural Diversity: threatened species, endangered languages*. WWF-Netherlands, Zeist, Netherlands.

Lotze, H.K., Coll, M., Magera, A.M., Ward-Paige, C. and L. Airoldi. 2011. Recovery of marine animal populations and ecosystems. *Trends in Ecology & Evolution* 26(11): 595-605.

Mahoney, M. 1999. Review of the Declines and Disappearances within the Bell Frog Species Group (*Litoria aurea* species group). In: Campbell, A. (ed.) *Declines and Disappearances of Australian Frogs*, pp.81-93. Environment Australia, Canberra, Australia.

Maisels, F., Strindberg, S., Blake, S., Wittemyer, G., Hart, J., Williamson, E.,Rostand Aba'a, R., Abitsi, G., Ambahe, R.D., Amsini, F., Parfait C. Bakabana, P.C., Hicks, T.C., Bayogo, R.E., Bechem, M., Rene, R., Bezangoye, A.N., Boudjan, P., Bout, N., Akou, M.E., Bene, L.B., Fosso, B., Greengrass, E., Grossmann, F.,Ikamba-Nkulu, C., Ilambu, O., Inogwabini, B.-I., Iyenguet, F., Kiminou, F., Kokangoye, M., Kujirakwinja, D., Latour, S., Liengola, I., Mackaya, Q., Madidi, J., Madzoke, B., Makoumbou, C., Malanda, G.-A., Malonga, R., Mbani, O., Mbendzo, V., Ambassa, E., Ekinde, A., Mihindou, Y., Morgan, B.J., Motsaba, P., Moukala, G., Mounguengui, A., Mowawa, B.S., Ndzai, C., Nixon, S., Nkumu, P., Nzolani, F., Pintea, L., Plumptre, A., Rainey, H., De Semboli, B., Serckx, A., Stokes, E., Turkalo, A., Vanleeuwe, H., Vosper, A. and Y. Warren. 2013. Devastating Decline of Forest Elephants in Central Africa. *PLOS ONE* 8(3): e59469.

McNeely, J.A., Mittermeier, R.A., Brooks, T.M., Boltz, F. and N. Ash. 2009. *The Wealth of Nature: Ecosystem Services, Biodiversity, and Human Well-Being*. Conservation International, Washington DC, USA.

MEA. 2005. *Ecosystems and Human Well-being: Synthesis*. Millennium Ecosystem Assessment. Island Press, Washington DC, USA.

Mekong River Commission. 2005. *Overview of the hydrology of the Mekong basin*. Mekong River Commission, Vientiane, Lao PDR. Available at: www.mekonginfo.org/assets/midocs/0001968-inland-waters-overview-of-the-hydrology-of-the-mekong-basin.pdf [accessed 8 June 2014].

Milliken, T. and Shaw, J. 2012. *The South Africa–Viet Nam Rhino Horn Trade Nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. TRAFFIC, Johannesburg, South Africa.

Natural Capital Project. 2013. URL: http://naturalcapitalproject.org/belize.html [accessed October 22, 2013].

Nettle, D. 1999. *Linguistic Diversity*. Oxford University Press, Oxford.

Nettle, D. & S. Romaine. 2000. *Vanishing Voices: The Extinction of the World's Languages*. Oxford University Press, Oxford.

Nielsen, H. and Spenceley, A. 2010. *The success of tourism in Rwanda – Gorillas and more*. World Bank/SNV. Available at: siteresources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/Tourism_Rwanda.pdf [accessed 8 June 14]

Nyoka, B.I. 2003. *State of Forest and Tree Genetic Resources in Dry Zone Southern Africa Development Community Countries*. Working Paper FGR/41E, FAO, Rome, Italy. Available at: www.fao.org/docrep/005/ac850e/ac850e07.htm [accessed 8 June 14]

OBIS. 2012. *Data from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO*. Available at: www.iobis.org [accessed 21 September 2012]

OECD. 2008. *OECD environmental outlook to 2030*. Available at: www.worldwaterweek.org/sa/node.asp?node=567 [accessed 8 June 14]

Oppenheimer, M., Campos, M., Warren, R., Birkmann, J., Luber, G., O'Neill, B. and K. Takahashi. 2014. Emergent risks and key vulnerabilities. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Orr, S., Pittock, J., Chapagain, A. and D. Dumaresq. 2012. Dams on the Mekong River: Lost fish protein and the implications for land and water resources. *Global Environmental Change*, 22(4): 925–932.

Osborne, W.S., Hunter, D.A. and G.L. Hollis. 1999. Population declines and range contraction in Australian alpine frogs. In: Campbell, A. (ed.) *Declines and Disappearances of Australian Frogs*, pp.145-157. Environment Australia, Canberra, Australia.

Pörtner, H.-O., Karl, D.M., Boyd, P.W., Cheung, W.L., Lluch-Cota, S.E., Nojiri, Y., Schmidt, D.N. and P.O. Zavialov. 2014. Ocean systems. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Postel, S.L., Daily, G.C. and P.R. Ehrlich. 2009. Human appropriation of renewable fresh water. *Science*, New Series, Vol271, No.5250 (Feb. 9, 1996), 785-788. Available at: http://www.csrc.sr.unh.edu/~lammers/MacroscaleHydrology/Papers/PostelEtAl1996-HumanAppropriationOfRenewableFreshWater-Science.pdf [accessed 7 July 2014].

Raworth, K. 2012. *A safe and just space for humanity: can we live within the doughnut?* Oxfam Discussion Paper, Oxfam International, Oxford, UK. Available at: www.oxfam.org/en/grow/policy/safe-and-just-space-humanity [accessed 8 June 14].

Richter, B.D., Davis, M.M., Apse, C. and C. Konrad. 2012. A presumptive standard for environmental flow protection. *River Res. Applic.*, 28: 1312-1321. doi: 10.1002/rra.1511.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, III, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., De Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B.H., Liverman, D., Richardson, K., Crutzen, C. and J. Foley. 2009. A safe operating space for humanity. *Nature* 461: 472-475, doi:10.1038/461472a.

Ron, S.R., Duellman, W.E., Coloma, L.A. and M.R. Bustamante. 2003. Population Decline of the Jambato Toad *Atelopus ignescens* (Anura: Bufonidae) in the Andes of Ecuador. *Journal of Herpetology* 37(1): 116-126.

Sachs, J.D. 2008. *Common Wealth: Economics for a crowded planet*. Penguin, New York, USA.

Schiermeier, O. 2013. Water risk as world warms. *Nature* 505: 10–11.

SEI. 2012. Noone, K., Sumaila, R. and R.J. Diaz (eds.) *Valuing the Ocean*. Stockholm Environment Institute, Stockholm, Sweden.

Seitzinger, S.P., Mayorga, E., Bouwman, A.F., Kroeze, C., Beusen, A.H.W., Billen, G., Van Drecht, G., Dumont, E.,Fekete, B.M., Garnier, J. and J.A. Harrison. 2010. Global

river nutrient export: A scenario analysis of past and future trends. *Global Biogeochemical Cycles* 24: GB0A08, doi:10.1029/2009GB003587.
Shanghai DRC. 2014. Official website of Shanghai Municipal Development & Reform Commission (Shanghai DRC). http://www.shdrc.gov.cn/main?main_colid=319&top_id=312&main_artid=24296 (*Chinese*) [accessed: 21 April 2014].
Sharp, R., Tallis, H.T., Ricketts, T., Guerry, A.D., Wood, S.A., Chaplin-Kramer, R., Nelson, E., Ennaanay, D., Wolny, S., Olwero, N., Vigerstol, K., Pennington, D., Mendoza, G., Aukema, J., Foster, J., Forrest, J., Cameron, D., Arkema, K., Lonsdorf, E., Kennedy, C., Verutes, G., Kim, C.K., Guannel, G., Papenfus, M., Toft, J., Marsik, M., Bernhardt, J., Griffin, R., Glowinski, K., Chaumont, N., Perelman, A., Lacayo, M. Mandle, L., Griffin, R., and P. Hamel. 2014. *InVEST User's Guide*. The Natural Capital Project, Stanford.
SIL International (Summer Institute of Linguistics). *World Language Mapping system*. See www.sil.org
Steffen, W., Persson, A., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., Crumley, C., Crutzen, P., Folke, C., Gordon, L., Molina, M., Ramanathan, V., Rockström, J., Scheffer, M., Schellnhuber, H.J. and U. Svedin. 2011. The Anthropocene: From Global Change to Planetary Stewardship. *Ambio* 40(2011): 739-61.
Stirling, I., Lunn, N. and J. Iacozza. 1999. Long-term Trends in the Population Ecology of Polar Bears in Western Hudson Bay in Relation to Climatic Change. *Arctic* 52(3): 294-306.
Stocker, T.F., Qin, D., Plattner, G.-K., Alexander, L.V., Allen, S.K., Bindoff, N.L., Bréon, F.-M., Church, J.A., Cubasch, U., Emori, S., Forster, P., Friedlingstein, P., Gillett, N., Gregory, J.M., Hartmann, D.L., Jansen, E., Kirtman, B., Knutti, R., Krishna Kumar, K., Lemke, P., Marotzke, J., Masson-Delmotte, V., Meehl, G.A., Mokhov, I.I., Piao, S., Ramaswamy, V., Randall, D., Rhein, M., Rojas, M., Sabine, C., Shindell, D., Talley, L.D., Vaughan D.G. and S.-P. Xie. 2013. Technical Summary. In: IPCC. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, USA.
Stockholm Resilience Centre. 2009. *The nine planetary boundaries*. Available online at: www.stockholmresilience.org/21/research/research-programmes/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html [accessed 8 June 14].
Sukhdev, P. 2010. TEEB, public goods and forests. *Arborvitae* 41: 8–9. Available at: cmsdata.iucn.org/downloads/av41_english__3_.pdf [accessed 8 June 14].
Sutton, M.A., Oenema, O., Erisman, J.W., Leip, A., van Grinsven, H. and W. Winiwarter. 2011. Too much of a good thing. *Nature* 472: 159-161.
Thurstan, R.H., Brockington, S. and C.M. Roberts. 2010. The effects of 118 years of industrial fishing on UK bottom trawl fisheries. *Nature Communications* 1(15), doi: 10.1038/ncomms1013.
UN. 2012. *The Future We Want*: Outcome document adopted at Rio+20. Available at: www.un.org/en/sustainablefuture [accessed 8 June 14].
UNDESA. 2012. *World Urbanisation Prospects – The 2011 Revision*. United Nations Department of Economic and Social Affairs, New York, USA.
UNDESA. 2013a. Population Division, *Population Facts No. 2013*/10, December 2013. United Nations Department of Economic and Social Affairs, New York, USA.
UNDESA. 2013b. *Population Division: World Population Prospects 2012 Revision*. United Nations Department of Economic and Social Affairs, New York, USA.
UNDP. 2013. *Human Development Indicators and Thematic Tables*. United Nations Development Programme. Available at: hdr.undp.org/en/data [accessed 8 June 14].
UNEP FI. 2011. *Universal ownership: why environmental externalities matter to institutional investors*. Report prepared by Trucost Plc for PRI Association and United Nations Environment Programme Finance Initiative, Geneva, Switzerland.
UNFPA. 2007. *State of the World's Population 2007: Unleashing the Potential of Urban Growth*. United Nations Population Fund. New York, USA.
UN HABITAT. 2011. *Global report on human settlement*. Available at http://mirror.unhabitat.org/downloads/docs/E_Hot_Cities.pdf [accessed 9 July 2014].
Van Strien, A., Van Swaay, C. and T. Termaat. 2013. Opportunistic citizen science data of animal species produce reliable estimates of distribution trends if analysed with occupancy models. *Journal of Applied Ecology* 50: 1450–1458.

Vors, L.S. and Boyce, M.S. 2009. Global declines of caribou and reindeer. *Global Change Biology* 15(11): 2626-2633.

Walston, J., Robinson, J.G., Bennett, E.L., Breitenmoser, U., da Fonseca, G.A.B., Goodrich, J., Gumal, M., Hunter, L., Johnson, A., Karanth, K.U., Leader-Williams, N., MacKinnon, K., Miquelle, D., Pattanavibool, A., Poole, C., Rabinowitz, A.R., Smith, J.L.D., Stokes, E.J., Stuart, S.N., Vongkhamheng, C. and H. Wibisono. 2010. Bringing the tiger back from the brink – the six per cent solution. *PLOS Biology* **8**, e1000485.

Water, Energy and Food Security Nexus. 2011. *Bonn2011 Conference Press backgrounder* 1. Available at: www.water-energy-food.org/en/whats_the_nexus/press.html [accessed 8 June 14].

Water Footprint Network. 2014. WaterStat database. http://www.waterfootprint.org/?page=files/WaterStat [accessed: 14 July 2014].

WCED. 1987. *Our Common Future*. World Commission on Environment and Development. Oxford University Press, Oxford, UK.

WHO/UNICEF. 2013. *Joint Monitoring Programme for Water Supply and Sanitation (JMP)*. Available at: www.wssinfo.org

Williams, J.W., Blois, J.L. and B.N. Shuman. 2011. Extrinsic and intrinsic forcing of abrupt ecological change: case studies from the late Quaternary. *Journal of Ecology* 99(3): 664–677.

World Bank. 2013. *World Development Indicators 2013*. World Bank, Washington DC, USA, doi: 10.1596/978-0-8213-9824-1. License: Creative Commons Attribution CC BY 3.0.

World Future Council. 2013. *Sharing the experience of the food security system of Belo Horizonte*. Available at: www.fao.org/fileadmin/templates/FCIT/Meetings/Africites/presentations/WorldFutureCouncil_experience-Belo-Horizonte.pdf [accessed 8 June 14].

WRG. 2009. *Charting Our Water Future: Economic Frameworks to Inform Decision-Making*. 2030 Water Resources Group. Available at: www.2030wrg.org/publication/charting-our-water-future [accessed 8 June 14].

WWF 2014a. *The Water Risk Filter*. Available at: waterriskfilter.panda.org

WWF-Brazil. 2013. *Environmental service incentives system in the state of Acre, Brazil: Lessons for policies, programmes and strategies for jurisdiction-wide REDD+*. Available at: assets.wwf.org.uk/downloads/sisa_report_english.pdf [accessed 8 June 2014].

WWF-South Africa. 2013. *An Introduction to South Africa's Water Source Areas*. Available at: www.wwf.org.za/media_room/publications/?9322/an-introduction-to-south-africas-water-source-areas [accessed 8 June 2014].

WWF. 2006. *WildFinder: Online database of species distributions, ver. Jan-06*. Available at: www.worldwildlife.org/WildFinder

WWF. 2010. Reinventing the city: Three prerequisites for greening urban infrastructure http://www.wwf.se/source.php/1463977/wwf_reinventing_the_city_LR.pdf [accessed 14 July 2014].

WWF. 2011a. *The Energy Report*. WWF International, Gland, Switzerland.

WWF. 2011b. *WWF Living Forests Report*. WWF International, Gland, Switzerland.

WWF. 2012. *Living Planet Report 2012. Biodiversity, biocapacity and better choices*. WWF International, Gland, Switzerland.

WWF. 2014b. *PADDDtracker: Tracking Protected Area Downgrading, Downsizing, and Degazettement* [Beta version]. Available at: www.PADDDtracker.org [accessed 8 June 14].

WWF/Dalberg. 2013. *The Economic Value of Virunga National Park*. WWF International, Gland, Switzerland.

WWF/TNC. 2013. *Freshwater Ecoregions of the World*. Available at: www.feow.org [accessed 8 June 2014].

Zalasiewicz, J., Williams, M., Smith, A., Barry, T., Coe, A., Bown, P., Brenchley, P., Cantrill, D., Gale, A., Gibbard,P., Gregory, F., Hounslow, M., Kerr, A., Pearson, P., Knox, R., Powell, J., Waters, C., Marshall, J., Oates, M., Rawson, P. and P. Stone. 2008. Are we now living in the Anthropocene? *GSA Today* 18(2): 4-8 doi: 10.1130/GSAT01802A.1.

WWF WORLDWIDE NETWORK

WWF Offices*

Armenia
Australia
Austria
Azerbaijan
Belgium
Belize
Bhutan
Bolívia
Brazil
Bulgaria
Cambodia
Cameroon
Canada
Central African Republic
Chile
China
Colombia
Cuba
Democratic Republic of Congo
Denmark
Ecuador
Finland
Fiji
France
French Guyana
Gabon
Gambia
Georgia
Germany
Ghana
Greece
Guatemala
Guyana
Honduras
Hong Kong
Hungary
India
Indonesia
Italy
Japan
Kenya
Laos
Madagascar
Malaysia
Mauritania
Mexico
Mongolia
Mozambique
Myanmar
Namibia
Nepal
Netherlands
New Zealand
Norway
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Republic of Korea
Romania
Russia
Senegal
Singapore
Solomon Islands
South Africa
Spain
Suriname
Sweden
Switzerland
Tanzania
Thailand
Tunisia
Turkey
Uganda
United Arab Emirates
United Kingdom
United States of America
Viet Nam
Zambia
Zimbabwe

WWF Associates

Fundación Vida Silvestre (Argentina)
Pasaules Dabas Fonds (Latvia)
Nigerian Conservation Foundation (Nigeria)

***As at July 2014**

Publication details

Published in September 2014 by WWF – World Wide Fund for Nature (Formerly World Wildlife Fund), Gland, Switzerland ("WWF"). Any reproduction in full or in part of this publication must be in accordance with the rules below, and mention the title and credit the above mentioned publisher as the copyright owner.

Recommended citation:
WWF. 2014. *Living Planet Report 2014: species and spaces, people and places.* [McLellan, R., Iyengar, L., Jeffries, B. and N. Oerlemans (Eds)]. WWF, Gland, Switzerland.

Zoological Society of London
The authors are extremely grateful to the following individuals and organizations for sharing their data: Richard Gregory, Petr Voříšek and the European Bird Census Council for data from the Pan-European Common Bird Monitoring scheme; the Global Population Dynamics Database from the Centre for Population Biology, Imperial College London; Derek Pomeroy, Betty Lutaaya and Herbert Tushabe for data from the National Biodiversity Database, Makerere University Institute of Environment and Natural Resources, Uganda; Kristin Thorsrud Teien and Jorgen Randers, WWF-Norway; Pere Tomas-Vives, Christian Perennou, Driss Ezzine de Blas, Patrick Grillas and Thomas Galewski, Tour du Valat, Camargue, France; David Junor and Alexis Morgan, WWF Canada and all data contributors to the LPI for Canada; Miguel Angel Nuñez Herrero and Juan Diego López Giraldo, the Environmental Volunteer Programme in Natural Areas of Murcia Region, Spain; Mike Gill from the CBMP, Christoph Zockler from UNEP-WCMC and all data contributors to the ASTI report (www.asti.is); Arjan Berkhuysen, WWF-Netherlands and all data contributors to the LPI for global estuarine systems. A full list of data contributors can be found at www.livingplanetindex.org.

We would like to acknowledge the following individuals for their help adding data to the LPI database over the years: Rachel Burrows, Jenny Beschizza, Audrey Bourgois, Tharsila Carranza, Ffion Cassidy, Olivia Daniel, Adriana De Palma, Annemarie Greenwood, Jonathan Gunasekera, Nicola Harrison, Peter Hill, David Jacoby, Gayle Kothari, Julia Latham, Nicole Maddock, Robyn Manley, Valentina Marconi, Jenny Martin, Hannah MacGregor, Amy Munro-Faure, Charlotte Outhwaite, Fiona Pamplin, Victoria Price, Louise Raggett, Elizabeth Robinson, Jo Roche, Michael Taylor, Carolyn Thomson, Sandra Tranquilli, Ellie Trezise and Sarah Whitmee.

Global Footprint Network
The authors would like to thank the following national governments for testing the Ecological Footprint with Global Footprint Network and its partners to improve the quality of the National Footprint Accounts: Switzerland, United Arab Emirates, Finland, Germany, Ireland, Japan, Belgium, Luxembourg, Indonesia, Ecuador, Spain, and the Philippines.

Much of the research for this report would not have been possible without the generous support of: Avina Stiftung, Foundation for Global Community, Funding Exchange, MAVA - Fondation pour la Protection de la Nature, Mental Insight Foundation, Skoll Foundation, Stiftung ProCare, The Winslow Foundation; Flora Family Foundation; Karl Mayer Foundation; Zayed International Prize for the Environment; VIVA Trust; Environment Agency – Abu Dhabi; Barr Foundation, Rockefeller Foundation, Deutsche Gesellschaft für Internationale Zusammenarbeit, V. Kann Rasmussen, Keidanren Nature Conservation Fund, Dr. Med Arthur und Estella Hirzel-Callegari Stiftung; Daniela Schlettwein-Gsell; Oliver and Bea Wackernagel; Marie-Christine Wackernagel-Burckhardt; Ader B. Gandi; Sarosh Kumana; Terry and Mary Vogt and many other individual donors.

We would also like to acknowledge the Global Footprint Network's 76 partner organizations; and the Global Footprint Network National Accounts Committee for their guidance, contributions, and commitment to robust National Footprint Accounts.

Water Footprint Network
The Water Footprint Network would like to extend special thanks to Prof. Arjen Hoekstra , Dr. Mesfin Mekonnen and their team from the University of Twente for their extensive data and research support. Their contribution is of immense value to our work at Water Footprint Network.

We would also like to acknowledge the Water Footprint Network's 180+ partner organizations for their active support to Water Footprint Network's mission; and the Scientific Peer Review Committee of the Water Footprint Network for their peer review of the global standards and tools for Water Footprint Assessment.

WWF International
WWF International would like to thank WWF-Netherlands and WWF-Switzerland for funding the *Living Planet Report* 2014.

And for their invaluable support, we would like to thank: Carlos Drews (Director, Species, WWF International), Li Lifeng (Director, Freshwater, WWF International), John Tanzer (Director, Marine, WWF International), Lasse Gustavsson (former WWF International), Louise Lumholt (WWF-Denmark), and Phil Dickie, Pierre Bouvier, Stéphane Mauris, Matthew Lee and Naze Teo (Communications and Marketing Division, WWF International).

LIVING PLANET REPORT 2014

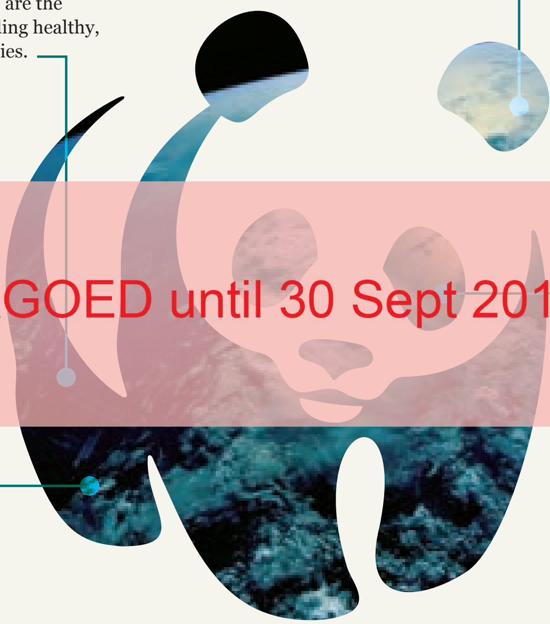
100% RECYCLED

SPECIES

Populations of vertebrate species have fallen by half since 1970, according to the *Living Planet Index.*

PLACES

From forests to rivers to reefs, natural ecosystems are the foundation of building healthy, resilient communities.



EMBARGOED until 30 Sept 2014 - 00:01 CET

SPACES

With humanity currently demanding 1.5 planets' worth of resources, pressure on ecosystems is increasing.

PEOPLE

Our needs, our well-being and our prosperity depend on nature.

WWF

Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

panda.org/lpr