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Global Footprint Network
Advancing the Science of Sustainability

AFRICA

Ecological Footprint and human well-being

CONTENTS

GLOBAL FOOTPRINT NETWORK
promotes a sustainable economy by advancing the Ecological Footprint, a tool that makes sustainability measurable. Together with its partners, the network coordinates research, develops methodological standards, and provides decision makers with robust resource accounts to help the human economy operate within the Earth's ecological limits.

Global Footprint Network
Advancing the Science of Sustainability

WWF
(also known as World Wildlife Fund in the USA and Canada) is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in over 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.

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SWISS AGENCY FOR DEVELOPMENT AND COOPERATION (SDC) is Switzerland's international cooperation agency within the Swiss Foreign Ministry. Together with other federal offices, the SDC is responsible for overall coordination of development activities and cooperation with Eastern Europe, as well as humanitarian aid. The SDC carries out its activities in Switzerland and abroad, with an annual budget of CHF 1.3 billion (2005). The agency undertakes direct actions, supports the programmes of multilateral organizations, and helps to finance programmes run by Swiss and international aid organizations involved in field conservation worldwide.

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FOREWORD

Chief Emeka Anyaoku, President, WWF International

Ten years ago WWF launched its Living Planet series. Using two innovative measures – the Living Planet Index and the Ecological Footprint – WWF has led the way in highlighting the state of the natural world and the human impact upon it. In the past decade, it's become clear that humans are consuming resources and degrading ecosystems at an ever increasing rate. Globally, we are now in what we call ecological overshoot. Put simply, we are using more resources and producing more waste than our planet can handle. WWF's goal is not only to stop this trend but to reverse it.

The *Africa – Ecological Footprint and human well-being* report shows the impact of the average African to be low by western standards. But it also reveals that a growing number of African countries are now depleting their natural resources – or will shortly be doing so – faster than they can be replaced. For the first time the water footprint is included alongside the Ecological Footprint and the Living Planet Index, giving us a more complete and accurate picture.

Ecological overshoot is already adding to the pressures on vulnerable local communities. The United Nations Millennium Ecosystem Assessment (MA), points out that healthy biodiversity is essential for both local and national economies. Degraded ecosystems jeopardise the Millennium Development Goals of reducing poverty, hunger, and disease.

The New Partnership for Africa's Development (NEPAD) aims to create national strategies for sustainable development. NEPAD wants to reverse the loss of natural resources by 2015. It is not too late for Africa to avoid the unsustainable consumption which blights some other regions – for example, by investing in clean energy supplies and low-impact infrastructures.

There is no doubt that Africa faces major ecological challenges. But there are positive signs that environmental impacts can be reversed. In Tanzania, for example, the environment is a key component in the government's Poverty Reduction Strategy. Elsewhere, there are signs that some wildlife populations are starting to recover.

Africa's Ecological Footprint is getting bigger – but it is not just Africa's problem. It is up to us all to help reverse the trend.

Martin Dahinden, Director, Swiss Agency for Development and Cooperation

There is no one single solution to the trials that we face in the 21st century. Intertwined challenges of large-scale poverty, climate change, biodiversity loss and over harvesting of resources are complex and daunting for any one player to tackle alone. However, unlike the natural resource scarcity we are confronted with, there is no limit to human innovation and the exchange of effective solutions. To succeed together on this small planet, we must learn from each other and for each other – from both our successes and our mistakes.

It is becoming abundantly clear: continuing on our current path no longer works. The strain our growing consumption and population puts on the planet, disproportionately fuelled by the resource hunger of the world's wealthiest countries, could have deadly consequences. The impact of biofuels on food prices exemplifies our need to analyze resource trade-offs from the perspective of both ecological health and social equity. To end poverty and make development last, we must take nature into account.

This makes *Africa – Ecological Footprint and human well-being* so timely. While emphasizing that Africa is not an isolated continent, it highlights the implications of living in the midst of an increasingly resource scarce world. At the same time, it recognizes the increasing value of Africa's ecological assets. The information provided suggests directions that can enhance the New Partnership for Africa's Development (NEPAD) action plan for the environment initiative. This report underlines the significance of the work and objective of Swiss Agency for Development and Cooperation (SDC) and its partners around the world: to strive for a world where all members of the human family have access to adequate resources for healthy and prosperous lives.

WHY WE WROTE THIS REPORT

"The loss of services derived from ecosystems is a significant barrier to the achievement of the Millennium Development Goals to reduce poverty, hunger, and disease."

Millennium Ecosystem Assessment Board, 2005

With growing global food scarcity and price hikes, loss of cropland from salinization, depletion of overharvested fisheries, and the impact of climate change on agricultural productivity, it is clear that human well-being is not separable from ecological health. Human development, in order to make lasting progress, must take into account the reality of ecological constraints. This means understanding both human demand for ecological resources, and the Earth's ability to meet this demand.

The Ecological Footprint is a resource accounting tool that makes this measurement possible. Cities, corporations and nations have applied it, primarily in Europe, North America and Asia. The authors hope that in Africa as well, the Ecological Footprint, and the analyses it generates, will support those actively striving to end poverty and to achieve other human development goals.

Policy makers and the international development community are increasingly recognizing the importance of ecological assets for successful human development. We therefore need tools to explore the interaction of ecological constraints and human development, in Africa as well as throughout the world.

With the generous support of the Swiss Agency for Development and Cooperation (SDC), Global Footprint Network launched an initiative to test such a tool in 2006. We first published an *Africa Fact Book* containing key indicators on human development and ecological performance derived from United Nations statistics (www.footprintnetwork.org/africa). We subsequently held expert workshops in Algiers, Dakar, Nairobi and Pretoria to test the value of the approach and gather feedback. This lead to the publication of the current report, which provides a global context for and a broader discussion of the implications of ecological limits for human development in Africa.

No doubt, the role of ecological resources and services will become more critical to human well-being than is often realized or acknowledged today. Those with a better understanding of these resource challenges will be at an advantage, able to shape policies and programmes that better position their economies in the global market.

Without the ambition of drawing a conclusive roadmap or offering specific policy advice, the report discusses the various factors that drive resource availability. Case stories tell how these factors have been addressed both within Africa and elsewhere. Examples show how best management practices in developing local resources and in the implementation of leapfrogging technologies can improve quality of life in the face of growing resource constraints.

Africa is unique because of the relatively small and stable per person Ecological Footprint of its citizens. However, Africa's lower than world average biocapacity per person and rapid population growth could increasingly thwart human development achievements.

We recognize that in many ways the report oversimplifies an extraordinarily complex situation. For instance, national average figures gloss over the wide range of differences within African countries in climate, ecosystems, cultures, economies and political systems. Also, official statistics may not fully represent the reality on the ground, and this report takes those statistics at face value. Further, while the Ecological Footprint addresses use and availability of biological resources, there are other biophysical factors, such as pollution and water scarcity, that can affect ecosystem or human health.

To broaden the picture of Africa's ecological health, two other indicators are therefore included: the Living Planet Index, a measure of biodiversity; and the water footprint, which reflects stress on freshwater resources.

The report uses the United Nations Development Programme's Human Development Index (HDI) to track well-being. This widely used index reflects life expectancy, literacy and education, and per person Gross Domestic Product. At the same time, we recognize that this limited focus excludes many other key dimensions of well-being, such as happiness, worker satisfaction, human rights and the other tangible and intangible socio-economic factors that are essential to human dignity and aspiration.

Our hope is that this report contributes to the dialogue on how best to make human development strategies succeed, both today and in the future. Bringing the reality of ecological limits into decision making is essential if we are to realize the human dream of rewarding lives for all.

Mathis Wackernagel
Executive Director
Global Footprint Network

In 1990 44.6 per cent of people in sub-Saharan Africa were living in extreme poverty, and this grew to 46.4 per cent in 2001. But because of population growth, the number of people in extreme poverty grew from 231 million to 318 million people.
UNFPA data, reported by APPGP, 2007

Humanity's well-being depends on nature's ability to provide food, fibre, and timber, and to absorb waste. Yet the Earth's biocapacity, its ability to supply these ecological services, has limits. In 2003, human demand exceeded what planet Earth could supply by more than 25 per cent. This global overshoot is growing (Fig. 1) and as a consequence, ecosystems are being run down and waste is accumulating in the air, land and water. The resulting deforestation, water shortages, declining biodiversity and climate change are putting the well-being and development of all nations at increasing risk

Development to improve quality of life will only last if it can function within the means of what supporting ecosystems can provide. In an increasingly resource-constrained world, we need to know how much biocapacity is available locally and globally, and how much of it we are using. The latter is our Ecological Footprint. Footprint accounts reveal to what extent development is confronting ecological limits.

Compared to the rest of the world, the average African's footprint is small – for many, too small even to meet basic needs. While Africa still has more biocapacity than it uses (Fig. 2), this margin is shrinking, largely due to population growth. If current trends continue, Africa will soon be facing an ecological deficit, with demand exceeding the continent's supply.

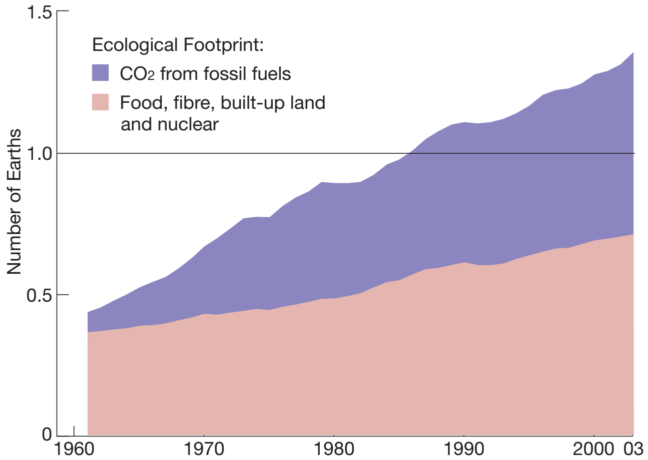
Some of Africa's biocapacity is being used to meet its own needs; some is being used, legally and illegally, for exports of natural resources; and some serves as part of the global commons that is absorbing carbon dioxide. Moving into ecological deficit will make it harder to even maintain existing living standards, and the loss of export potential combined with a growing need for more imports could weaken Africa's economy.

Effective management of ecological assets can help end cycles of poverty and can support changes, like those called for in the Millennium Development Goals, that improve quality of life. In contrast, gains built on liquidating ecosystems will only be short lived, and poorer countries will be most at risk of suffering the consequences.

The good news is that many opportunities exist to manage and use biocapacity more effectively. Whether providing exports or sequestering carbon, an accurate accounting of demand on, and supply of, biocapacity can help determine if its use is being valued appropriately.

The pressure that population growth puts on ecosystems can be addressed in ways that also serve to empower people. Infrastructure can be designed to make cities more resource efficient and thus more resilient and habitable in the face of increasingly scarce resources. Ecological Footprint accounting provides a novel perspective that can help stimulate practical solutions to the growing ecological challenges now facing Africa and the world.

Fig. 1: **HUMAN DEMAND ON THE BIOSPHERE,** 1961–2003



Global overshoot is liquidating the assets on which human well-being depends. It is creating social tensions and conflict, and it is making our existence ever more fragile. It is also taking away the development rights of future generations.

It is almost certainly those countries and regions with surplus ecological reserves – and not the ones relying on continued ecological deficit spending – which will emerge as the robust and sustainable economies and societies of the future.

Chief Emeka Anyaoku
President, WWF International

Fig. 2: **AFRICA'S FOOTPRINT AND BIOCAPACITY, AND WORLD BIOCAPACITY PER PERSON,** 1961–2003

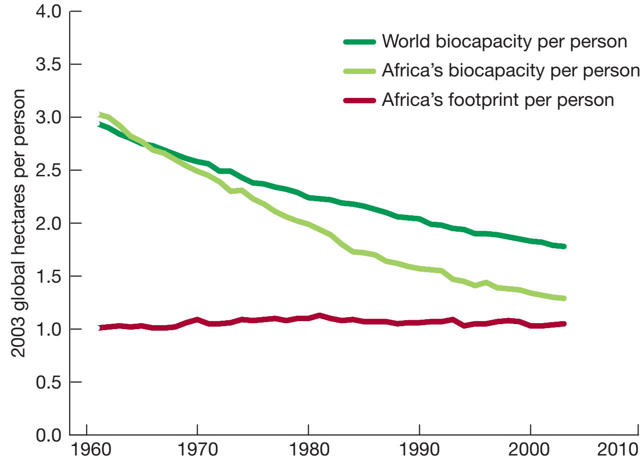
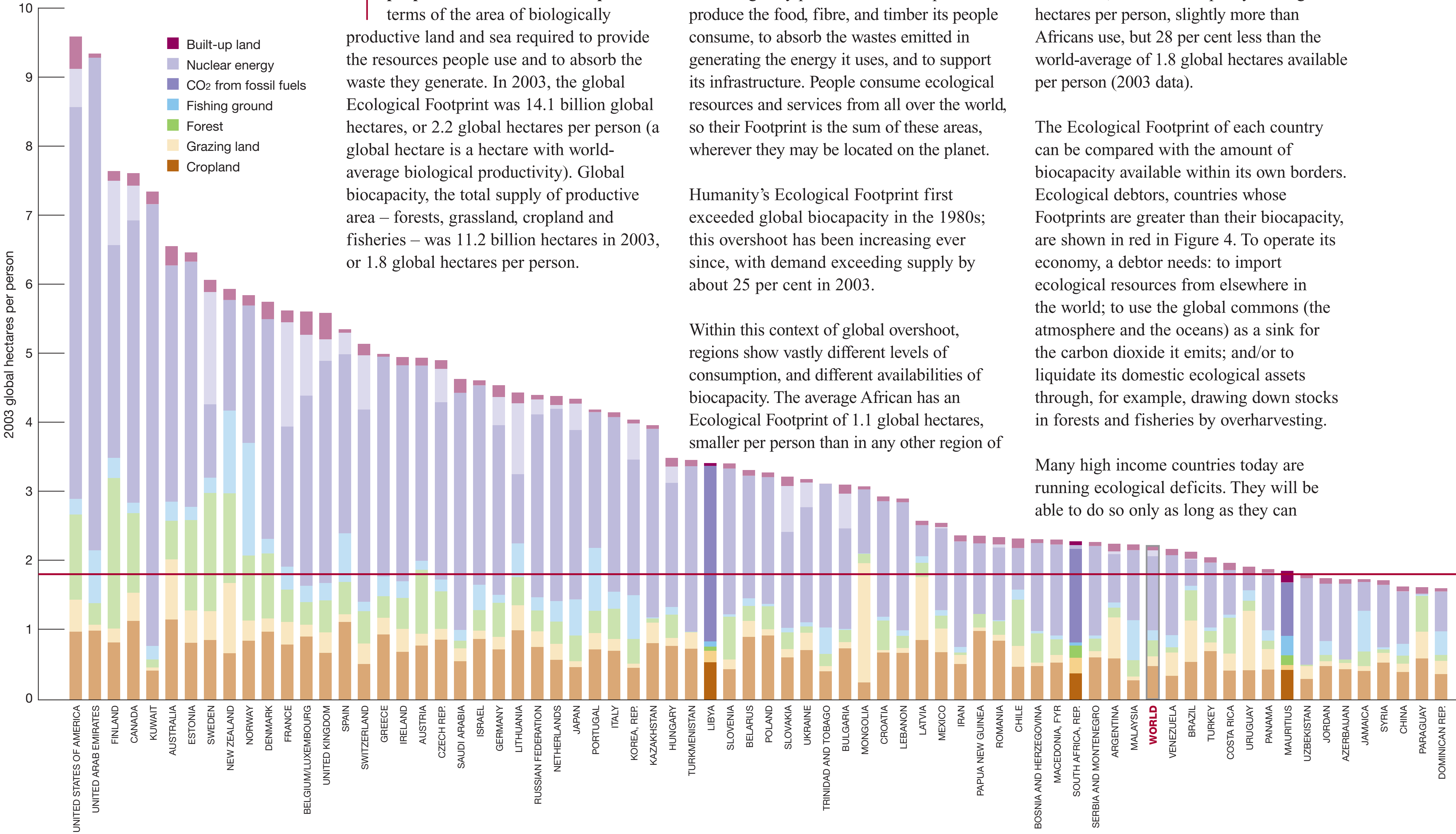


Fig. 3: ECOLOGICAL FOOTPRINT PER PERSON, BY COUNTRY, 2003



The Ecological Footprint measures people's demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources people use and to absorb the waste they generate. In 2003, the global Ecological Footprint was 14.1 billion global hectares, or 2.2 global hectares per person (a global hectare is a hectare with world-average biological productivity). Global biocapacity, the total supply of productive area – forests, grassland, cropland and fisheries – was 11.2 billion hectares in 2003, or 1.8 global hectares per person.

The Ecological Footprint of a country includes the biologically productive areas required to produce the food, fibre, and timber its people consume, to absorb the wastes emitted in generating the energy it uses, and to support its infrastructure. People consume ecological resources and services from all over the world, so their Footprint is the sum of these areas, wherever they may be located on the planet.

Humanity's Ecological Footprint first exceeded global biocapacity in the 1980s; this overshoot has been increasing ever since, with demand exceeding supply by about 25 per cent in 2003.

Within this context of global overshoot, regions show vastly different levels of consumption, and different availabilities of biocapacity. The average African has an Ecological Footprint of 1.1 global hectares, smaller per person than in any other region of the world, and about half the global average. In contrast, Africa's biocapacity is 1.3 global hectares per person, slightly more than Africans use, but 28 per cent less than the world-average of 1.8 global hectares available per person (2003 data).

The Ecological Footprint of each country can be compared with the amount of biocapacity available within its own borders. Ecological debtors, countries whose Footprints are greater than their biocapacity, are shown in red in Figure 4. To operate its economy, a debtor needs: to import ecological resources from elsewhere in the world; to use the global commons (the atmosphere and the oceans) as a sink for the carbon dioxide it emits; and/or to liquidate its domestic ecological assets through, for example, drawing down stocks in forests and fisheries by overharvesting.

Many high income countries today are running ecological deficits. They will be able to do so only as long as they can continue using the biocapacity of others, or have not yet fully depleted their own resource stocks. But if global overshoot continues the resources available per person will shrink, and countries may become less willing to share their biocapacity; climate change treaties may restrict the use of the global commons as a dumping ground for carbon dioxide, or make it costly to do so; and overuse may reduce productivity of domestic ecosystems.

Operating with an ecological deficit therefore represents a significant risk to future economic prosperity and societal well-being. At the very least, it will require increasing expenditures of financial capital, at worst, it will cause conflicts among nations as they compete for limited resources.

Conversely, ecological creditor countries – those whose biocapacity exceeds their footprint – may be advantageously positioned in a world where the distinction between ‘developed’ and ‘developing’ countries is becoming less meaningful than the distinction between those who have ecological reserves and those who do not.

Having an Ecological Footprint smaller than biocapacity does not necessarily mean a country’s biocapacity is going unused. These countries (shown in green) may be exporting resources for use by other nations, or sequestering carbon dioxide emitted by others.

A reserve, in itself, does not imply human well-being. Countries with small Ecological Footprints and severe internal conflicts such as Afghanistan, Chad, Somalia and Sudan may have reserve biocapacity in part because the conflicts impede people from accessing the country’s full biocapacity. On the other hand, a reserve represents the basis for long-term economic viability and material well-being. If managed with solid know-how, robust accounting and good governance, this ecological wealth can help ensure that resources will be available to meet a nation’s future needs and to support its economic health.

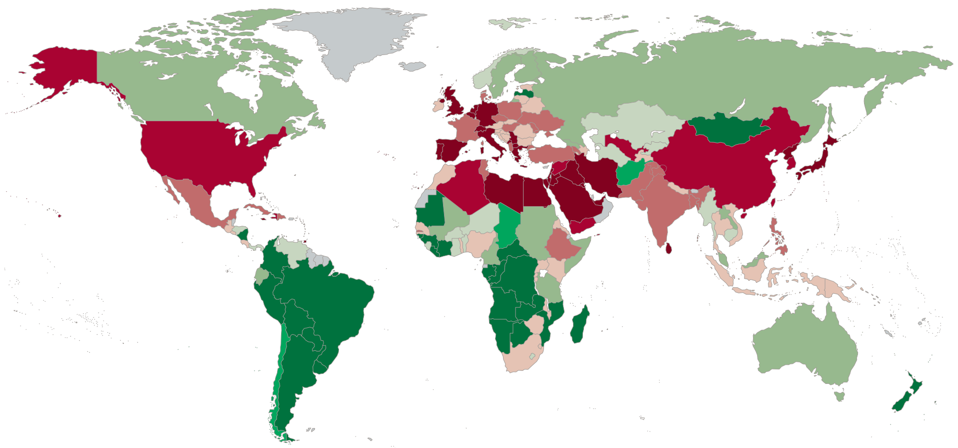
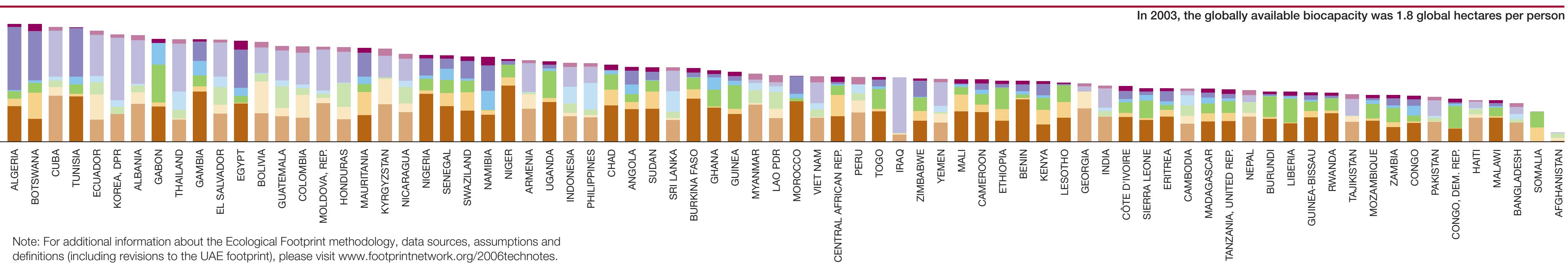


Fig 4: ECOLOGICAL DEBTOR AND CREDITOR COUNTRIES, 2003

Ecodebt
- Footprint more than 150% larger than biocapacity
- Footprint 100-150% larger than biocapacity
- Footprint 50-100% larger than biocapacity
- Footprint 0-50% larger than biocapacity

Ecocredit
- Biocapacity 0–50% larger than footprint
- Biocapacity 50–100% larger than footprint
- Biocapacity 100-150% larger than footprint
- Biocapacity more than 150% larger than footprint
- Insufficient data



Note: For additional information about the Ecological Footprint methodology, data sources, assumptions and definitions (including revisions to the UAE footprint), please visit www.footprintnetwork.org/2006technotes.

In 2003, Africa had 13 per cent of the world's population, but contributed only 6 per cent of the global Footprint. If in that year everyone had consumed at the same rate as an average African, instead of using 125 per cent of the Earth's biocapacity, humanity would have used just 60 per cent. Should Africa then be concerned about overshoot?

When global and local ecological limits are exceeded, consequences such as collapsed fisheries, biodiversity loss, climate change and water scarcity impact all countries, rich or poor. Higher income countries may temporarily buffer these by importing resources and exporting waste. Africa's many lower income countries may lack the financial resources to do this, and thus may be affected disproportionally by the consequences of overshoot.

While Africa's biocapacity is still greater than its footprint, projections of Africa's population growth and age distribution suggest that the continent's total Ecological Footprint may soon exceed its total biocapacity. This will leave Africa, for the first time in its history, with an ecological deficit. Twenty African countries are already running ecological deficits, relying on the biocapacity of others to meet their needs, or drawing down their own ecosystems.

Poverty and unmet needs can exist even with an ecological reserve, particularly if a county's biocapacity is not well managed, or if resources are being exported, legally or illegally, to support demand elsewhere. If local overharvesting leads to liquidation and collapse of productive ecosystems, revenue streams that might have come from the renewable resources produced by these ecosystems may be permanently lost.

For these reasons, effective management of their ecological assets is in the best interest of all countries, and is key to maintaining and improving the well-being of their citizens.

Five factors determine the degree of global overshoot or a nations' ecological deficit. On the supply side, biocapacity is determined by how much biologically productive area is available; and the productivity of that area.

Bioproductive area can be extended. Degraded lands can be reclaimed through careful management. Irrigation can make marginal land productive, though without sufficient water, the gains do not persist. Good land management can also ensure that bioproductive areas are not lost to preventable factors including urbanization, erosion, pollution, and desertification.

Yields can often be increased through technology but this needs to be managed carefully to avoid harming human and ecological health. Mechanized agriculture and the use of fertilizers can increase yields, though at the expense of a larger energy footprint, and require care to prevent soil degradation.

On the demand side, the footprint is a function of the number of people consuming, the amount each person consumes, and the resource intensity used in production.

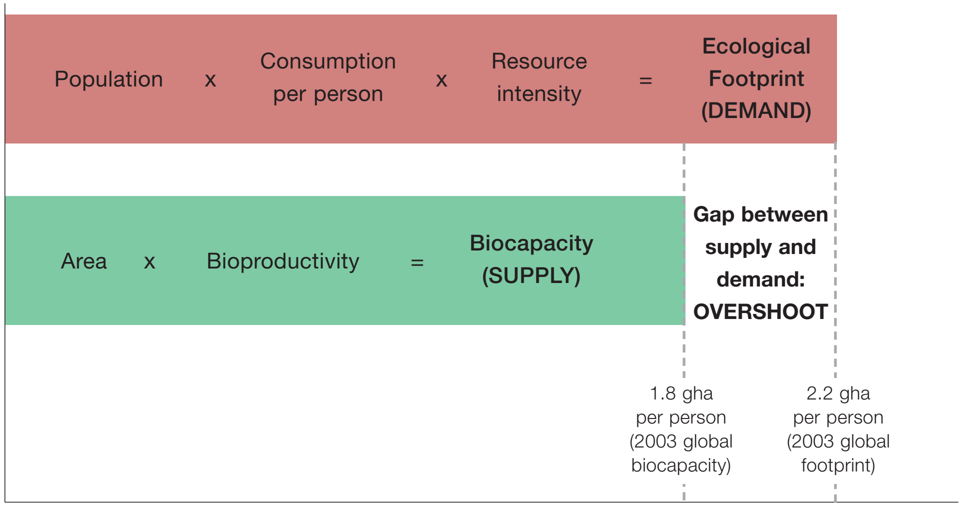
Population. Offering women better access to education, economic opportunities, health care and family planning are proven ways to reduce family size while enhancing human well-being.

Individual consumption. The potential for reducing consumption depends in part on an individual's economic situation. In higher income areas, consumption of goods and services can be greatly reduced without negatively impacting quality of life; in many regions of Africa, consumption may need to increase for people to move out of poverty.

Resource intensity. Technical innovation can reduce the resources used to provide goods and services. Through better design, material and energy can be used more efficiently, and waste minimized. In many places in Africa, leapfrogging to lean modern technologies, and developing resource-efficient infrastructure, especially in cities, can help minimize resource use while maximizing quality of life.

How much and how fast local deficits should shrink, and how biocapacity is shared, are choices society must make. Should the focus be on reducing high per person consumption in Europe and North America, on slowing population growth in Asia and Africa, on preserving biocapacity in South America, or all of these? Footprint accounting can show how these options would affect overshoot, but society must decide which are politically, economically, and morally acceptable. Regardless of what others do, each nation faces the impacts of its own deficit and its exposure to global trends. Hence addressing overshoot is primarily in a nation's interest. The alternative, failing to choose, means accepting the consequences of

Fig. 5: **FOOTPRINT AND BIOCAPACITY FACTORS THAT DETERMINE OVERSHOOT**



overshoot, with the greatest initial impact on the world's poorest and most vulnerable nations.

Africa's population more than doubled between 1975 and 2007, and grew at a faster rate than in any other region. With its total biocapacity growing more slowly than population over this period, per person biocapacity is diminishing.

The average African's footprint is smaller than that of all other regions (Figure 6) and has been relatively steady over time: in 2003 the average African's footprint was 2 per cent smaller than in 1975. In contrast, Africa's per person biocapacity dropped by 42 per cent; the average global decline for that period was 25 per cent. Africa's biocapacity per person in 2003 was 1.3 global hectares, just slightly larger than its average footprint of 1.1 global hectares. If this continues, Africa will soon begin to run an ecological deficit.

The risk of developing an ecological deficit varies considerably across countries. In 2003, Gabon had a large ecological reserve of 18 global hectares per person, followed by the Congo at 7.2 and Mauritania at 4.5. Other countries showed either considerably smaller reserves, or are already running deficits.

In 2003, Africa had 847 million people, 13 per cent of the world population. Moderate United Nations projections suggest that Africa's population will more than double by 2050, reaching 2 billion people. Africa would then be home to 22 per cent of the projected 9 billion people on Earth. This rapid growth would mean that more African countries will move into ever deeper ecological deficits at the same time that demand on limited biocapacity is increasing worldwide. Countries that cannot meet their needs from their own biocapacity will either have to liquidate their ecological assets – a time-limited possibility at best – or rely on the biocapacity of other nations. That will become more difficult as global overshoot increases and competition for imports grow. With limited global resources, commodities will become increasingly unaffordable or disruptions will make them unavailable.

The alternative is for a country to explore options that will allow its footprint to remain within its biocapacity. Maintaining an ecological reserve will play an increasingly important role in reducing hardship and poverty, and improving quality of life. In addition to careful management of ecological assets, this will mean addressing population growth to make sure that people in Africa are not exposed to potentially brutal resource constraints with possibly tragic consequences for human well-being.

WHEN BIOCAPACITY FAILS…

In 2003, Niger had a population of 12 million, and its cropland biocapacity was 6 per cent larger than its cropland footprint. With a rapidly growing population, and 85 per cent of its population depending on subsistence agriculture for food and income, this minimal ecological reserve represented a risk to well-being. In 2004-2005 drought and a locust infestation led to a severe decline in agricultural productivity, resulting in widespread hunger and economic hardship.

Niger's population is projected to more than quadruple by 2050 to 56 million people. Even with sufficient rainfall, this increasing demand almost guarantees a growing ecological deficit, with severe repercussions for Nigeriens' well-being,

Source: UNDP, 2007; Ryerson, 2007.

Fig. 6: **ECOLOGICAL FOOTPRINT AND POPULATION BY REGION,** 2003

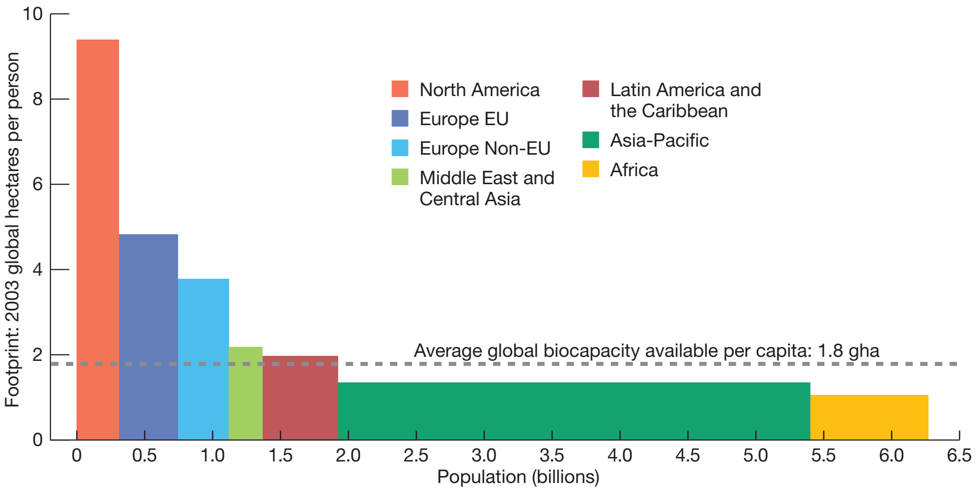
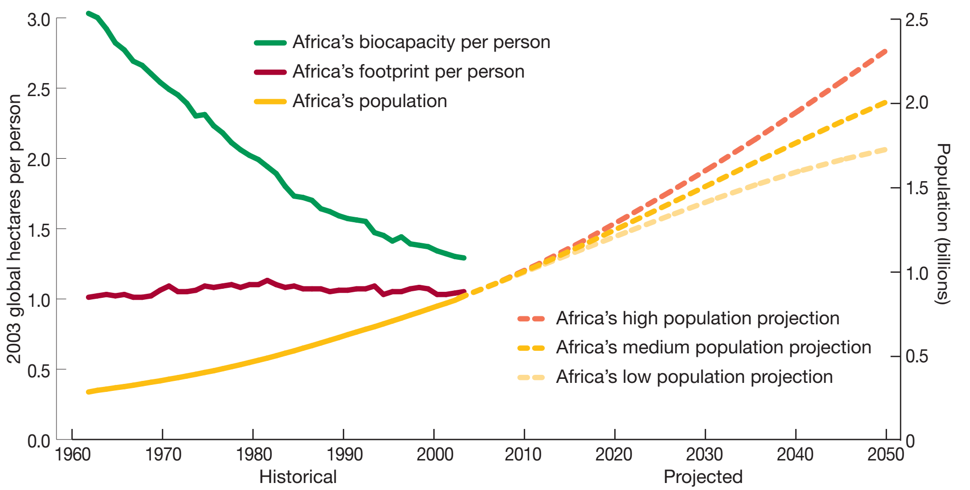


Fig. 7: **AFRICA'S FOOTPRINT, BIOCAPACITY AND POPULATION,** 1961–2050



Sustainable development is a commitment to **"improving the quality of human life while living within the carrying capacity of supporting ecosystems"** (IUCN et al., 1991).

Countries' progress towards sustainable development can be assessed using the United Nations Development Programme's (UNDP) Human Development Index (HDI) as an indicator of well-being, and the Footprint as a measure of demand on the biosphere. The HDI is calculated from life expectancy, literacy and education, and per person Gross Domestic Product. UNDP considers an HDI value of more than 0.8 to be "high human development". An Ecological Footprint lower than 1.8 global hectares per person, the average biocapacity available per person on the planet, would be replicable at the global level.

Successful sustainable development requires that the world, on average, meets, at a minimum these two criteria, with countries moving into the blue quadrant shown in Figure 8. As world population grows, less bioproductive area is available per person and the quadrant's height shrinks.

In 2003, Asia-Pacific and Africa were using less than world average per person biocapacity, while the EU and North America had crossed the threshold for high human development. No region, nor the world as a whole, met both criteria for sustainable development. Cuba alone did, based on the data it reports to the United Nations.

Changes in footprint and HDI between 1975 and 2003 for some nations are illustrated on pages 11-13. During this period, wealthy nations such as the United States of America significantly increased their resource use while increasing their quality of life. This did not hold for poorer nations, notably China or India, where significant increases in HDI were achieved while their per person Ecological Footprints remained below global per person biocapacity.

Comparing a country's average Ecological Footprint per person with global average biocapacity does not presuppose equal sharing of resources. Rather it indicates which nations' consumption patterns, if extended worldwide, would continue global overshoot, and which would not. The Ecological Footprint and the HDI need supplementing by other ecological and socio-economic measures – freshwater scarcity and civic engagement, for example – to more fully define sustainable development.

Fig. 8: **HUMAN DEVELOPMENT INDEX AND ECOLOGICAL FOOTPRINTS,** 2003

From 1990 to 2003, HDI scores increased for most African nations, indicating greater average well-being. Some African nations, however, were not so fortunate. Zimbabwe's HDI score showed the largest percentage decrease during this period, while Swaziland and Botswana also had HDI decreases greater than 15 per cent. In a number of African countries, war, internal conflicts and the HIV/AIDS crisis contributed to declining HDI scores.

Some African nations with medium HDI scores (0.5 to 0.8) show a pattern of development similar to that of most high-income nations, where improvements in quality of life have come at the expense of a rapid growth in Ecological Footprint. This development path will prove increasingly risky for nations and difficult to follow in a resource-constrained world. The alternative is to find a path that leapfrogs the resource-intensive phase of development, one which will lead to a high quality of life without requiring an unsustainably high level of resource throughput.

Both the global and Africa's average per person Footprint remained fairly constant from 1990 to 2003. But Africa is far from homogeneous, and some countries experienced significant declines in per person consumption. Somalia, Guinea-Bissau, and Liberia experienced the steepest decreases, with their per capita Ecological Footprints dropping more than 20 per cent. At the same time, the total Ecological Footprint of each of these nations increased as its population grew. From 1990 to 2003 Somalia's population increased by more than 30 per cent, Guinea-Bissau's by more than 40 per cent, and Liberia's by more than 50 per cent.

Over the same period, per person biocapacity in these countries dropped dramatically: 28 per cent in Somalia, 36 per cent in Guinea-Bissau, 39 per cent in Liberia.

Africa's average per person biocapacity dropped 18 per cent from 1990 to 2003; for the globe as a whole, the average dropped 13 per cent. In both cases this change is driven primarily by more people sharing the same amount of resources, rather than by a decline in the Earth's biological productivity.

There are large differences among the African countries in terms of both their ecological and their monetary wealth. Consumption in nations with limited income available for importing resources is more likely to be directly constrained by what their domestic biocapacity can provide. As per person biocapacity declines in these countries, quality of life is therefore likely to decline as well. Within many African countries, a widening gap between rich and poor can have a similar impact on access to biocapacity, and as a consequence, material and other aspects of human well-being.

Fig. 9: **AFRICA'S BIOCAPACITY AND WORLD BIOCAPACITY PER PERSON,** 1961–2003

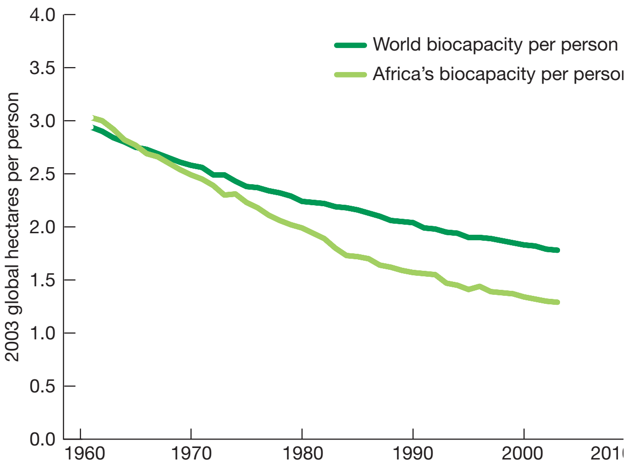


Fig. 10: **AFRICA'S FOOTPRINT PER PERSON,** 1961–2003 (by land type)

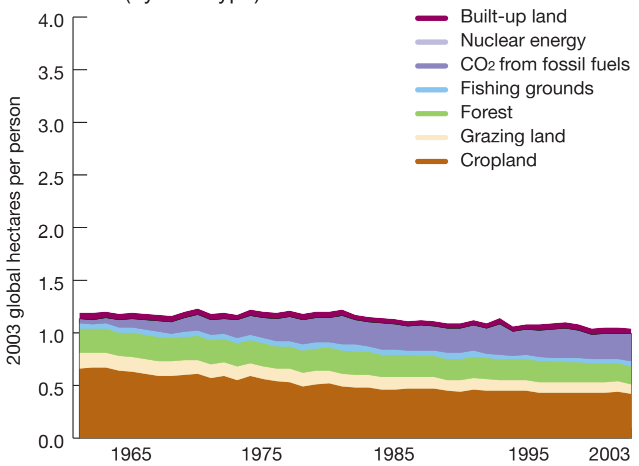
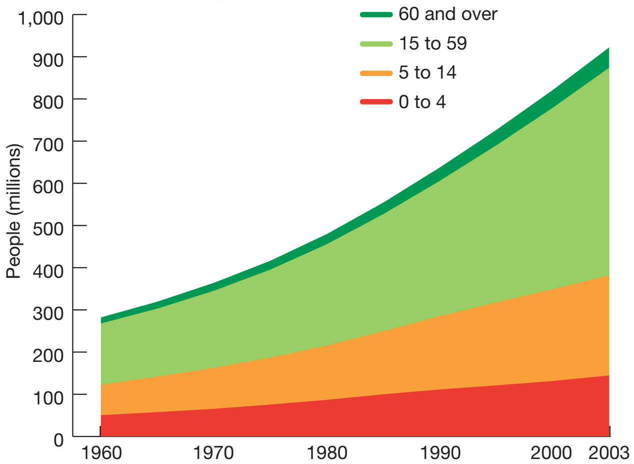


Fig. 11: **AFRICA'S POPULATION,** 1961–2003

Source: United Nations Population Division, 2007



INDIVIDUAL AFRICAN COUNTRIES

The African continent stretches over multiple climate zones, geographies, and cultures. Yet, many of its countries are experiencing a similar trend, and confronting a similar challenge: ecological margins are shrinking, and countries are, or if current trends continue, will soon be, facing ecological deficits. This is true not only in Africa, but in many places around the world.

With the help of United Nations datasets that go back to1961, it is possible to reconstruct historical ecological resource balances for most countries. Examples of these time trends are shown for a number of countries on the following pages. In the upper graphs, the solid light green lines represent the biocapacity available per person in a particular country, which can be compared with the dotted green line showing the world average biocapacity per person. In contrast, the red line represents the per person Ecological Footprint in a country, the biocapacity required to provide the goods and services consumed by an average resident.

If its Ecological Footprint exceeds its biocapacity, the country is running an ecological deficit. This means that the country either uses foreign biocapacity for the resources it consumes or to absorb its wastes; or it is liquidating its own productive ecosystems by using resources faster than they can be regenerated.

Net export of biocapacity is shown by the yellow line. Values greater than zero mean that a nation is using more domestic biocapacity in producing exports than the amount of foreign biocapacity used to produce what that county's imports. Values less than zero mean the opposite: that it has a negative biocapacity balance in trade, with its imports representing the use of more biocapacity than its exports.

The lower graph follows two socioeconomic trends over the same time period. The orange line shows population growth indexed to 1 in 1961: the African continent's population tripled by 2003. The dark blue line shows historical movement of a country's Human Development Index (HDI) score.

Individual country case studies

AFRICA

With a population of 847 million people in 2003, Africa had an Ecological Footprint of 1.1 global hectares (gha) per person, just slightly up from 1.0 gha per person in 1961. Its biocapacity shrank from 3.0 gha per person in 1961 to 1.3 in 2003, or from 200 per cent larger than its Ecological Footprint in 1961 to just 20 per cent larger in 2003. Over this period Africa's biocapacity of trade balance went from positive to negative; from being a net exporter at 0.22 gha per person in 1961, to a net importer at -0.03 gha per person in 2003.

Fig. 12: **Africa's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

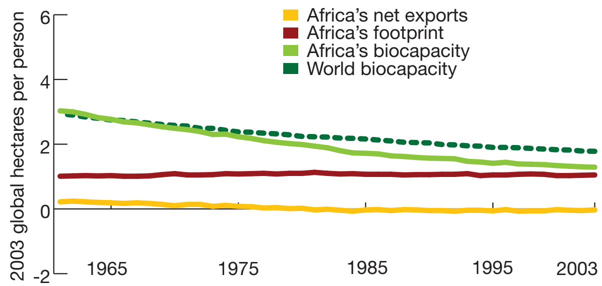
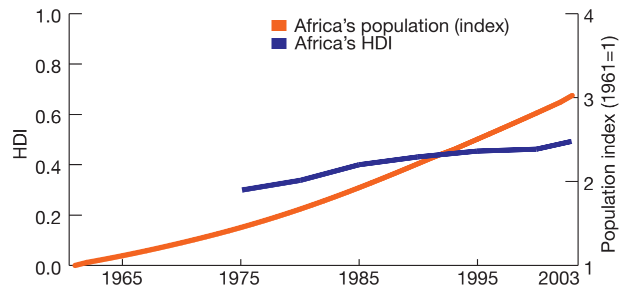


Fig. 13: **Africa's population growth and Human Development Index,** 1961-2003



MOZAMBIQUE

Mozambique's Ecological Footprint, at 0.6 gha per person, was the same in 2003 as in 1961. With a population that more than doubled to 19 million people from 1961 to 2003, its per person biocapacity shrank from 4.3 gha in 1961 to 2.1 gha in 2003. Over the same period it went from being a net exporter of biocapacity, 0.05 gha per person in 1961, to being an importer in 2003 at -0.08 gha per person. Nevertheless, in 2003 Mozambique's biocapacity was still almost three times the size of its Ecological Footprint.

ALGERIA

From 1961 to 2003, when Algeria's population reached 32 million people, its Ecological Footprint doubled, going from 0.08 to 1.6 gha per person. Conversely, its per person biocapacity more than halved, going from 1.6 gha per person in 1961 to 0.7 in 2003. Already a net importer of biocapacity in 1961, it became more so in 2003, going from a net export of -0.12 gha per person to -0.42 over that period. By 2003, Algeria's biocapacity was only about a third the size of its Ecological Footprint.

MALI

Mali, with a population of 13 million people in 2003, had an Ecological Footprint of 0.8 gha per person, down from 1.1 in 1961. Over that period its biocapacity fell from 2.8 gha per person in 1961 to 1.3 in 2003. Yet at the same time it went from being a net importer of biocapacity, with a net export of -0.09 gha per person in 1961, to a net exporter at 0.03 gha per person in 2003. In 2003, Mali's biocapacity was 1.6 times the size of its Ecological Footprint.

Fig. 14: **Mozambique's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

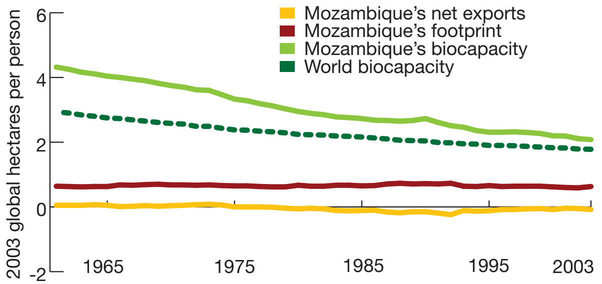


Fig. 16: **Algeria's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

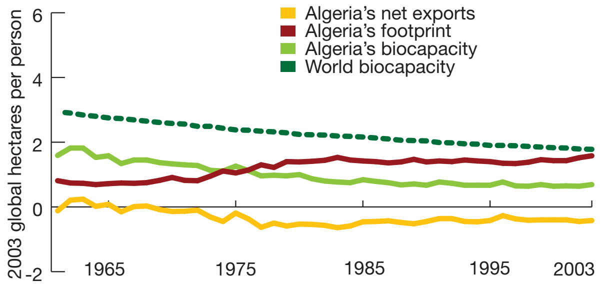


Fig. 18: **Mali's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

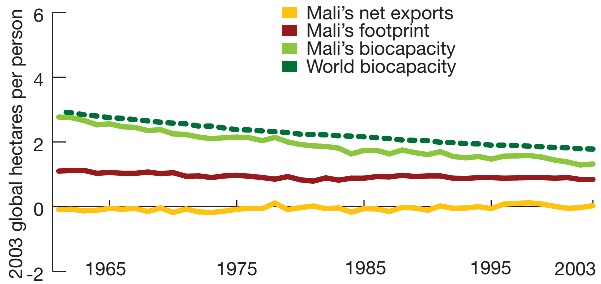


Fig. 15: **Mozambique's population growth and Human Development Index,** 1961-2003

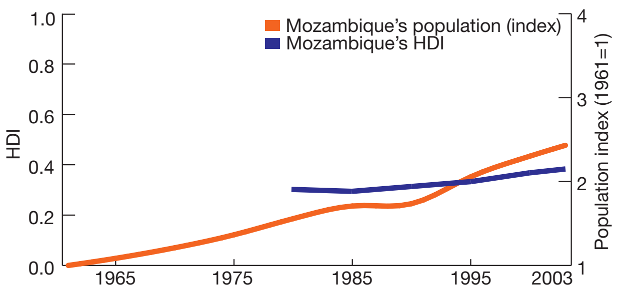


Fig. 17: **Algeria's population growth and Human Development Index,** 1961-2003

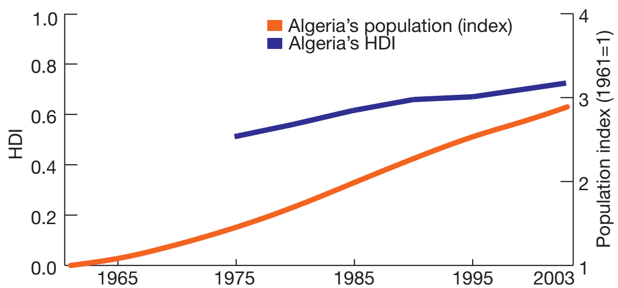
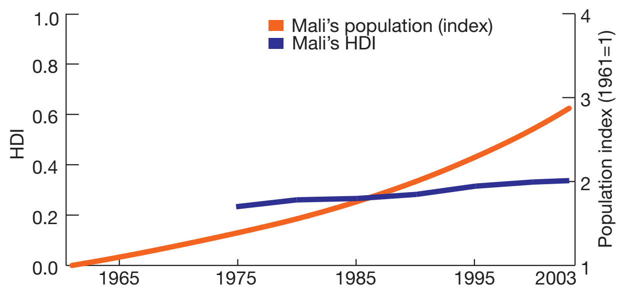


Fig. 19: **Mali's population growth and Human Development Index,** 1961-2003



KENYA

Kenya, with a population of 32 million people in 2003, had an Ecological Footprint of 0.8 gha per person, down slightly from 0.9 in 1961. Its biocapacity during this period shrunk from 1.9 gha per person in 1961 to 0.7 in 2003. In 1961 Kenya was a net exporter of biocapacity, at 0.19 gha per person in 1961; in 2003 it was a net importer, at -0.11 gha per person. Despite starting the period with an ecological reserve, in recent years Kenya became an ecological debtor, and by 2003 its biocapacity was approximately only three-quarters the size of its footprint.

EGYPT

Despite rapid population growth, similar to that of many other African countries, Egypt's per person biocapacity, at 0.5 gha, was the same in 2003 as it was in 1961. This is due to increased cropland productivity boosting Egypt's total biocapacity, offsetting the per person decline from population growth. With 72 million people in 2003, Egypt's Ecological Footprint was 1.4 gha per person, up from 0.8 in 1961. Already a net importer of biocapacity in 1961, by 2003 this had increased by 50 per cent. Egypt's 2003 biocapacity was about one-third of its Ecological Footprint.

SOUTH AFRICA

South Africa's Ecological Footprint increased from 1.8 gha per person in 1961 to 2.3 gha in 2003, although in recent years it has declined. With a population that grew to 45 million people in 2003, South Africa's biocapacity of 2.0 gha per person in that year was half of what it was in 1961. At the same time, over this period its net export of biocapacity more than doubled, from 0.44 gha per person in 1961 to 1.01 in 2003. South Africa's biocapacity was 90 per cent of the size of its Ecological Footprint in 2003.

Fig. 20: **Kenya's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

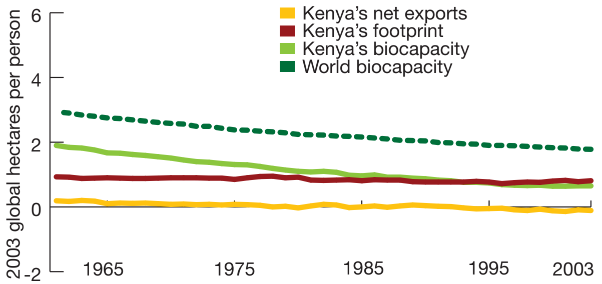


Fig. 22: **Egypt's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

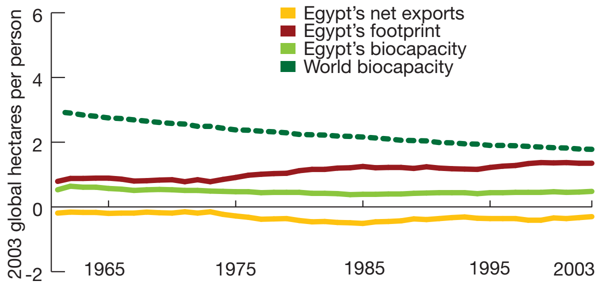


Fig. 24: **South Africa's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

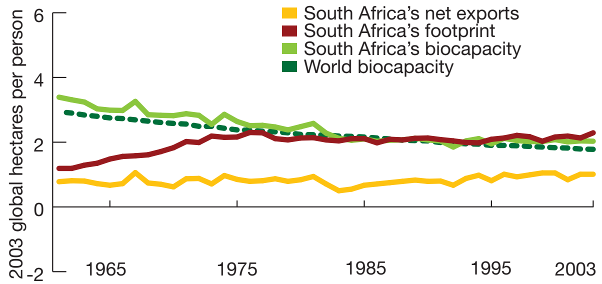


Fig. 21: **Kenya's population growth and Human Development Index,** 1961-2003

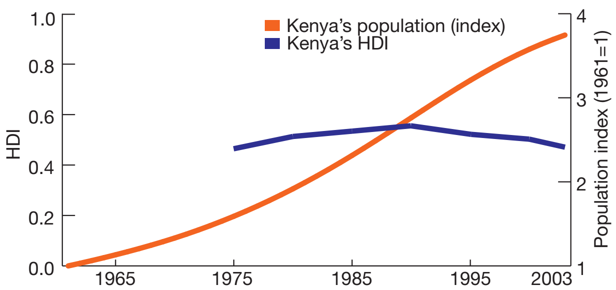


Fig. 23: **Egypt's population growth and Human Development Index,** 1961-2003

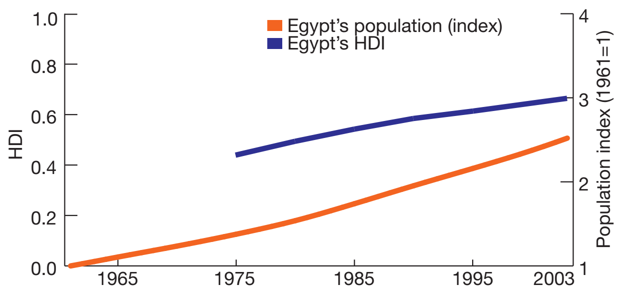
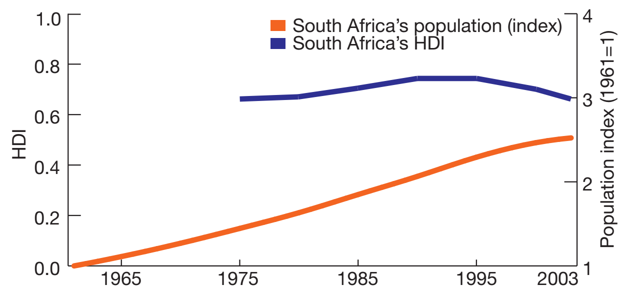


Fig. 25: **South Africa's population growth and Human Development Index,** 1961-2003



Note: Due to the absence of UN COMTRADE data for 1961 to 2000, some South African trade data for that period were estimated

TANZANIA

Tanzania's Ecological Footprint of 0.7 gha per person in 2003 was just slightly down from 0.8 in 1961. As its population rose to 37 million people in 2003, its per person biocapacity shrank, from 3.5 gha in 1961 to 1.3 in 2003. Its net export of biocapacity also declined, from a positive trade balance of 0.04 gha per person in 1961 to a negative one of -0.07 in 2003. Tanzania's biocapacity was still nearly double the size of its Ecological Footprint in 2003.

SENEGAL

Senegal's per capita Ecological Footprint remained fairly constant at approximately 1.4 gha per person, while its population increased threefold. With this rapid population growth, its per person biocapacity declined from 2.5 gha per person in 1961 to 0.8 gha per person in 2003. When Senegal's biocapacity fell below its Ecological Footprint in 1990, the nation went from being a net exporter to a net importer of biocapacity. With a population of 10 million people, Senegal's Ecological Footprint exceeded its biocapacity by 35 per cent in 2003.

BOTSWANA

With the more than tripling of its population to 1.8 million from 1961 to 2003, Botswana's biocapacity declined precipitously from 13.7 gha per person to 4.5 gha over that period. Despite having the fourth highest per person biocapacity among African nations, Botswana has become a net importer of biocapacity, going from a net export of 0.54 gha per person in 1961 to -0.02 gha in 2003. Yet in 2003 Botswana's biocapacity, despite its decline, was still almost three times the size of its Ecological Footprint.

Note scale difference from other graphs.

Fig. 26: **Tanzania's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

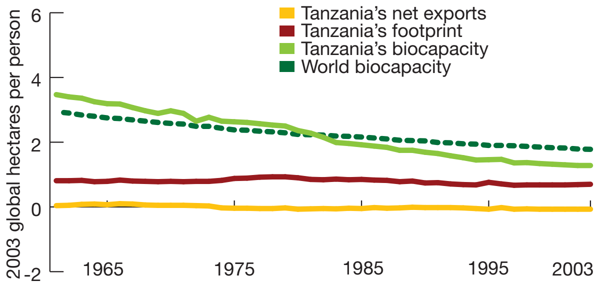


Fig. 28: **Senegal's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

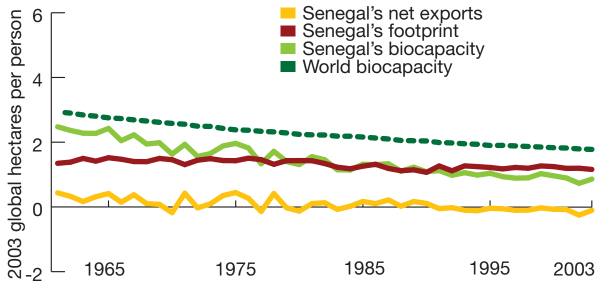


Fig. 30: **Botswana's biocapacity, Ecological Footprint and net export footprint per person,** 1961-2003

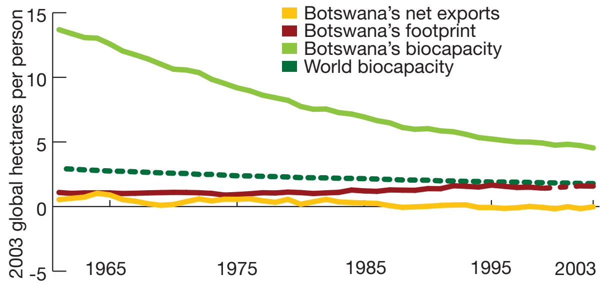


Fig. 27: **Tanzania's population growth and Human Development Index,** 1961-2003

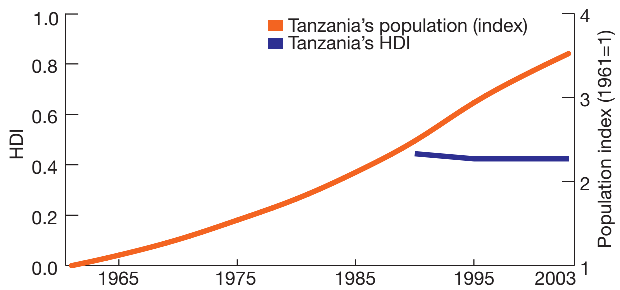


Fig. 29: **Senegal's population growth and Human Development Index,** 1961-2003

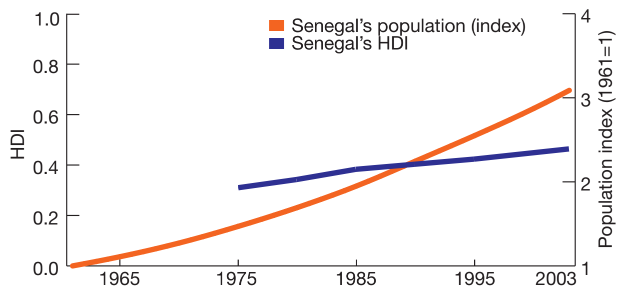
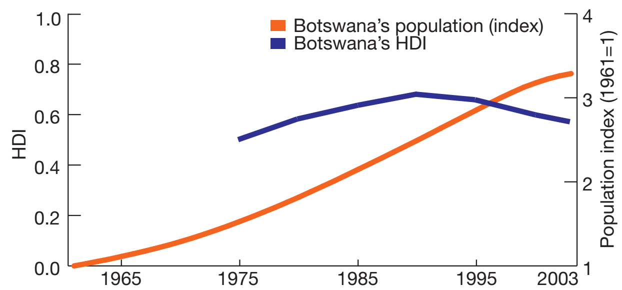


Fig. 31: **Botswana's population growth and Human Development Index,** 1961-2003



BIODIVERSITY: THE LIVING PLANET INDEX

When the biosphere's productivity cannot keep pace with human consumption and waste generation, biodiversity suffers. Biodiversity is therefore a good indicator of ecosystems overall health. But in itself, biodiversity is also a significant and valuable resource asset.

The Living Planet Index (LPI) is a way of measuring the health of biodiversity. On this page, the LPI is used to document the state of the world's biodiversity. The measure is based on trends from 1970 to 2005 in nearly 4,000 populations of 1,477 vertebrate species. It is calculated as the average of three separate indices that measure trends in populations of 813 terrestrial species, 320 marine species and 344 freshwater species. The index shows an overall decline over the 35-year period, as do each of the terrestrial, marine and freshwater indices individually (Figures 32, 33 and 34).

The global LPI shows an overall decline from 1970 to 2005 of approximately 27 percent.

No attempt is made to select species on the basis of geography, ecology or taxonomy, so the LPI dataset contains more population trends from well-researched regions, biomes and species. At present there is insufficient data to produce separate indices for Africa, but an overall index as been calculated for East Africa (Figure 35). In compensation, temperate and tropical regions are given equal weight within the terrestrial and freshwater indices, as are the four ocean basins within the marine LPI. Equal weight is given to each species within each region or ocean basin. An assumption is made that the available population time series data are representative of vertebrate species in the selected ecosystems or regions, and that vertebrates are a good indicator of overall biodiversity trends.

The terrestrial LPI is the average of two indices which measure trends in terrestrial and tropical species respectively. It shows an overall decline of about 25 per cent between 1970 and 2005 (Figure 32). The marine LPI shows a decline of about 28 per cent between 1970 and 2005, with a dramatic decline between 1995 and 2005 (Figure 33). One recent study estimates that over 40 per cent of the world's ocean area is strongly affected by human activities while few areas remain untouched (Halpern et al., 2008). In spite of only covering about 1 per cent of the total land surface of the Earth, inland waters are home to an enormous diversity of over 40,000 vertebrate species. The overall freshwater LPI fell by about 29 per cent between 1970 and 2003 (Figure 34).

Figure 32: Terrestrial Living Planet Index. The terrestrial LPI represents average trends in 813 species (1,820 populations) and shows an overall decline of about 25 per cent from 1970 to 2005.

Figure 33: Marine Living Planet Index. The marine LPI represents overall trends in 320 species (1,180 populations) and falls rapidly over the last 10 years of the period. Four ocean basin indices are aggregated to produce the marine LPI.

Figure 34: Freshwater Living Planet Index. The freshwater LPI represents trends in 344 species (988 populations) and shows an overall decline of about 30 per cent. Tropical and temperate regional indices are aggregated with equal weighting to produce the freshwater LPI.

Fig. 32: **TERRESTRIAL LIVING PLANET INDEX,**
1970–2005

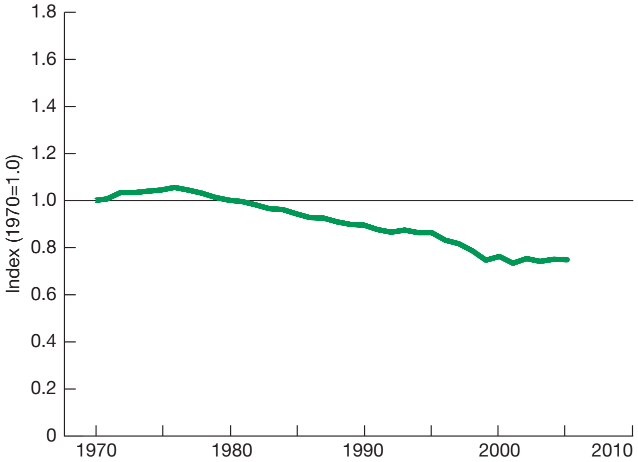


Fig. 33: **MARINE LIVING PLANET INDEX,**
1970–2005

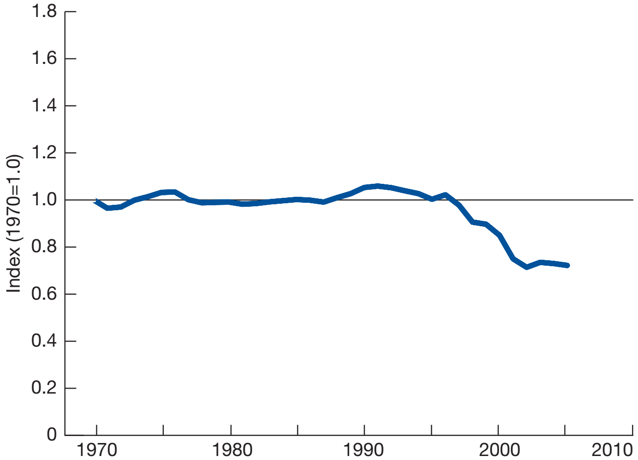
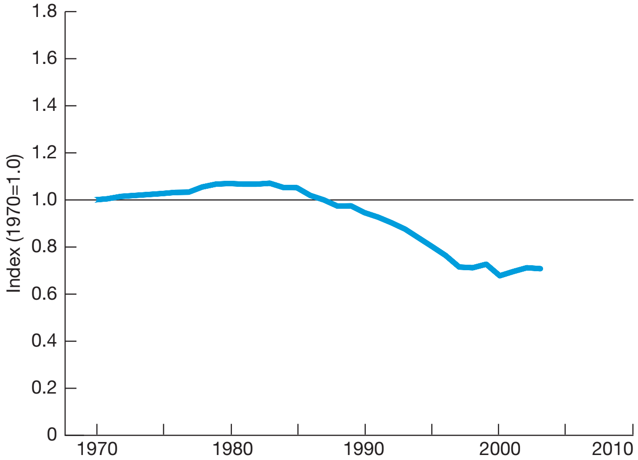


Fig. 34: **FRESHWATER LIVING PLANET INDEX,**
1970–2003



The Living Planet Index for East Africa (Figure 35) is based on 231 populations of 73 animal species from Kenya, Tanzania and Uganda. These species include 55 mammals, 15 birds, 1 reptile and 2 fishes.

The index shows a decline of over 60 per cent between 1970 and the mid-1990s, followed by a recovery from about 1997-98 onwards so that the index value in 2005 was about half of the 1970 value. This means that populations of vertebrate species in East Africa halved on average over a period of 35 years.

A number of different factors have contributed to the decline in animal populations in East Africa including the expansion of agriculture and grazing into areas previously occupied or used as migration corridors by wild species. One management response has been to reserve habitat for wild species in protected areas and wildlife management areas. Other responses that can benefit both people and biodiversity include involving local communities in the management of their wildlife resources.

Other factors contributing to declines in populations of wild species in Africa include over-exploitation, particularly hunting for bushmeat; habitat degradation, for example as a result of pollution; damaging harvesting practices; or diversion of freshwater and invasive alien species.

Average temperatures in Africa have risen by 0.7°C in the past century (IPCC, 2001). Predicted temperature increases combined with greater climate variability and changes in rainfall patterns are expected to exert an increasing range of direct and indirect pressures on wild species, and will affect ecosystem services that are fundamental to human well-being. In this context, reinforcing and conserving ecosystem resilience is a vital coping strategy.

Biodiversity contributes directly and indirectly to local and national economies by underpinning the range of ecosystem services – supporting, provisioning, regulating and cultural – that are vital to human well-being (MEA, 2005). Some of these contributions – for example in the tourism sector – are readily expressed in economic terms but most are not.

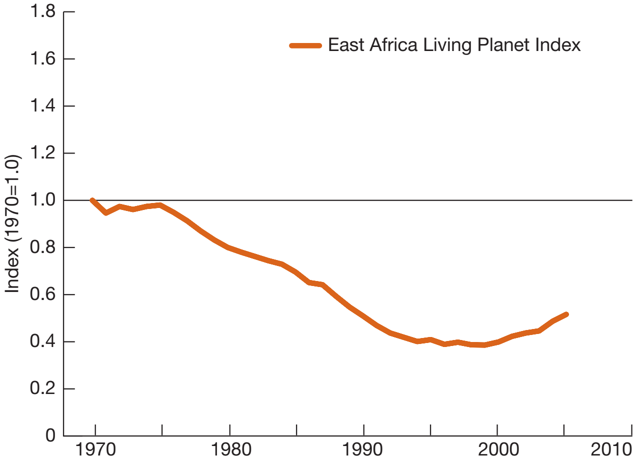
All too often the true value of ecosystem services may be appreciated only when they have been lost.

The good news is that East African species populations are showing signs of recovery. The Convention on Biological Diversity set a target to reduce the rate of biodiversity loss significantly by the year 2010, and these data would indicate that East Africa as a whole will meet this target. Nevertheless, there is still some way to go before wild animal populations significantly recover.

Sustainable fishing, Mafia Island Marine Park, Tanzania

P Denton/WWF-Canon

Fig. 35: **LIVING PLANET INDEX FOR EAST AFRICA,** 1970–2005

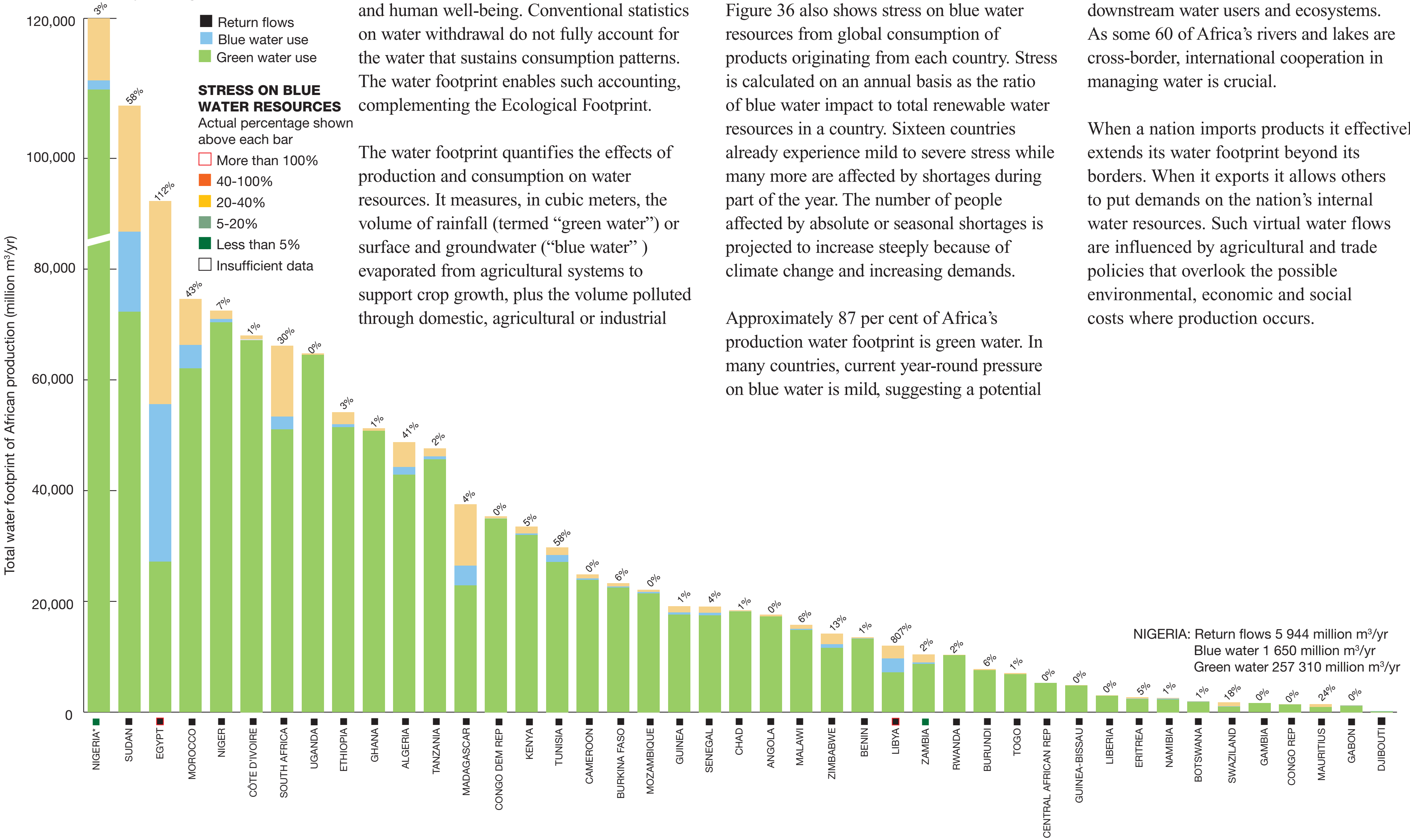


Mountain gorilla mother and baby, Rwanda

T Geer/WWF-Canon

WATER FOOTPRINT OF AFRICAN COUNTRIES

Fig 36: THE WATER FOOTPRINT OF AFRICAN PRODUCTION,
total water used (Mm³ per year) from national water resources for household, industry and agriculture, 2003



Freshwater resources across Africa are unevenly distributed and many areas suffer from water shortages for periods of the year, affecting ecosystems, agriculture, and human well-being. Conventional statistics on water withdrawal do not fully account for the water that sustains consumption patterns. The water footprint enables such accounting, complementing the Ecological Footprint.

The water footprint quantifies the effects of production and consumption on water resources. It measures, in cubic meters, the volume of rainfall (termed "green water") or surface and groundwater ("blue water") evaporated from agricultural systems to support crop growth, plus the volume polluted through domestic, agricultural or industrial use ("grey water"). Figure 37 shows demand on national water resources to produce goods and services used domestically or exported.

Figure 36 also shows stress on blue water resources from global consumption of products originating from each country. Stress is calculated on an annual basis as the ratio of blue water impact to total renewable water resources in a country. Sixteen countries already experience mild to severe stress while many more are affected by shortages during part of the year. The number of people affected by absolute or seasonal shortages is projected to increase steeply because of climate change and increasing demands.

Approximately 87 per cent of Africa's production water footprint is green water. In many countries, current year-round pressure on blue water is mild, suggesting a potential to enhance agriculture through irrigation in suitable areas. However, to be sustainable, options must take account of seasonal water availability and potential impacts on downstream water users and ecosystems. As some 60 of Africa's rivers and lakes are cross-border, international cooperation in managing water is crucial.

When a nation imports products it effectively extends its water footprint beyond its borders. When it exports it allows others to put demands on the nation's internal water resources. Such virtual water flows are influenced by agricultural and trade policies that overlook the possible environmental, economic and social costs where production occurs.

Figure 37 shows the use of national water resources for production of goods and services that are consumed domestically (internal per person water footprint); and the use of water in other countries to produce goods that are imported for consumption (external water footprint). Across Africa, 93 per cent of the water footprint falls inside country borders.

Figure 38 illustrates components of national water consumption footprints for selected countries.

Libya's internal water footprint is high because much water is used for agricultural production in hot and dry conditions. With limited rainfall, the country draws heavily on non-renewable groundwater for irrigation, the oil industry and domestic users.

In contrast, neighbouring Algeria has a significant external water footprint due to agricultural imports, an effective strategy for countries with limited water.

Ghana's production water footprint is dominated by rainfed cocoa, an export crop of significant economic value. Ghana imports a variety of agricultural commodities, but its external water footprint is equivalent to just 10 per cent of the virtual water it exports in cocoa.

South Africa's water resources are under considerable stress due to limited and uneven rainfall. Domestic water use is between 100-200 litres per person per day but, like most African countries, the largest share of blue water use is for agriculture. South Africa imports a significant amount of virtual water in agricultural commodities.

Fig 38: **NATIONAL WATER CONSUMPTION FOOTPRINT COMPONENTS**

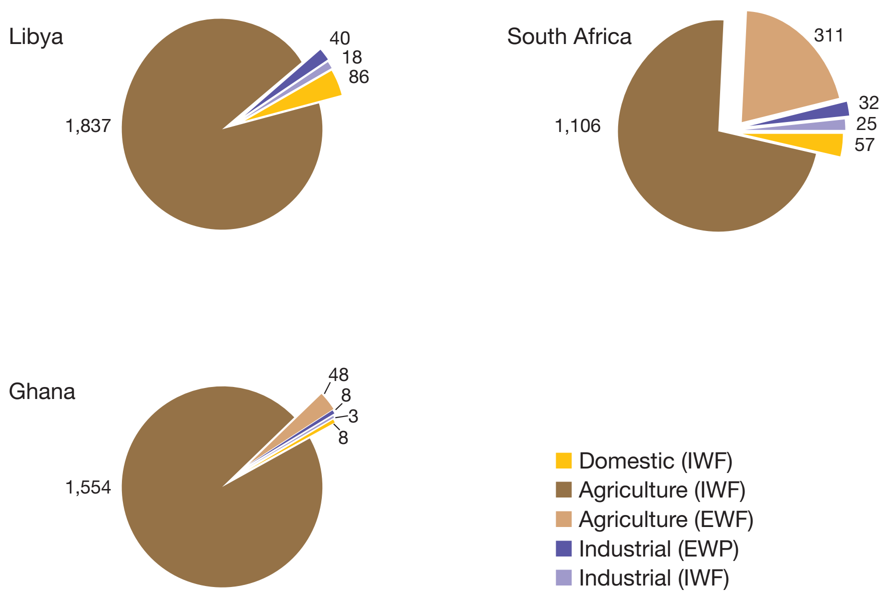
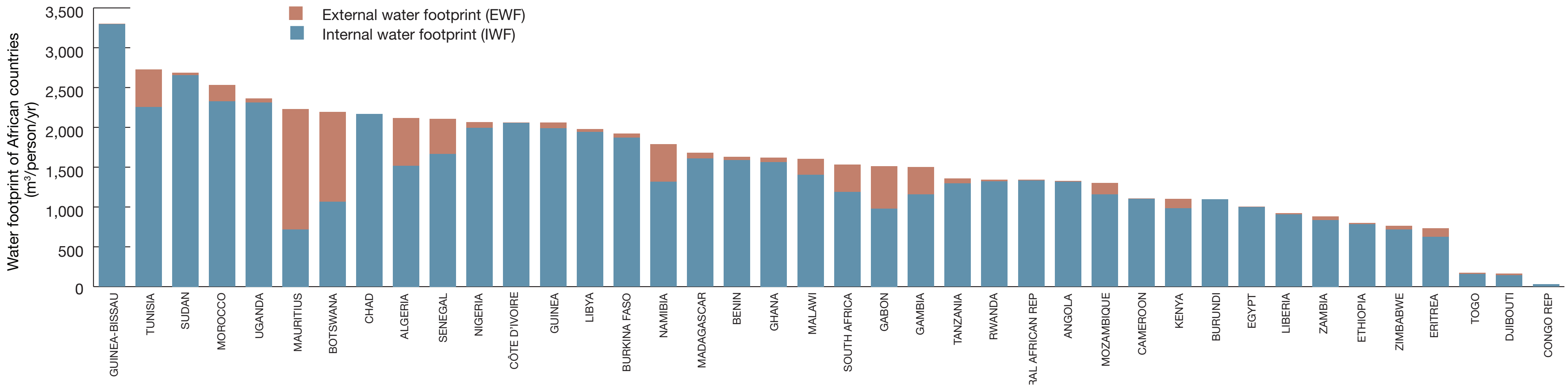


Fig 37: **CONSUMPTION WATER FOOTPRINT OF AFRICAN COUNTRIES** (m^3/person/yr)



Using less material and energy to produce goods and services not only eases ecological constraints; it also increases economic competitiveness. Gains can come both from using local innovation, and adopting resource-efficient technologies from elsewhere.

Innovation that makes use of locally available biocapacity and local know-how can reduce the need for imported resources and lessen dependency. The use of resources produced by local ecosystems often has other benefits as well: lower costs, reduced pollution, support for local economies and creation of new opportunities for meaningful employment.

In Tanzania, for example, as deforestation near Lake Victoria has made wood for fuel increasingly scarce, the Mwanza Rural Housing Programme has promoted a switch to burning agricultural waste from rice and cotton in manufacturing bricks. This has not only enabled the construction of brick homes that are considerably more durable and flood-resistant than the mud homes they are replacing, it has also stimulated the local economy and provided a trade education and regular employment for hundreds of individuals (Ashden, 2008).

In addition to local innovation, technology can be adopted that was created outside the society in which it is being implemented. Leapfrogging directly to the most resource efficient technologies can help communities meet development goals in ways that are less resource dependent and often less expensive than older technologies.

Bypassing intermediate phases of technological development in this way can also eliminate the need for the kind of large scale, resource intensive and difficult to modify infrastructure that is found in many of today's industrialized countries.

Perhaps the best example of leapfrogging in Africa is the explosive growth of cell phone usage, providing communication that relies on cellular towers rather than on kilometres of wire and the poles necessary to support it.

Africa is currently the fastest growing market for cell phones, with an average annual subscription increase of 58 per cent. In 2001, the number of cell phone users in Africa surpassed the number of landline users and by 2007, cell phones users represented 90 per cent of Africa's total phone subscribers (International Telecommunication Union, 2008).

Lack of access to safe, reliable energy is a large barrier to meeting development goals in many parts of the world, especially in Africa. Accordingly, the energy initiative established by the New Partnership for African Development (NEPAD) seeks in the next twenty years to expand access to reliable energy from 10 per cent to 35 per cent of Africa's population. Similarly, African countries such as Zambia and Ghana respectively include targets for electrification

Mwanza Rural Housing Programme, Tanzania. Bricks fired in kiln fuelled by agricultural waste.

Ashden Awards for Sustainable Energy

Cell phone usage in Africa is rapidly growing. They require less infrastructure than land lines.

kevinzim

and renewable energy in their Poverty Reduction Strategy Papers (UNEP, 2006).

Some African nations are already leapfrogging over fossil fuel-based energy infrastructure to the implementation of renewable and low-carbon technologies. There are multiple benefits to investing in low-carbon technology including poverty reduction, women's empowerment, universal education and children's health (Figure 39).

Also, energy technologies that reduce greenhouse gas emissions are of great importance to Africa's well-being because of the continent's severe vulnerability to climate change (IPCC, 2001).

Low–carbon technology can range from individual scale installations to large industrial plants depending on individual and community needs. The following are a handful of low-carbon energy projects in Africa that are currently in different phases of development:

Landfill Gas Capture: The eThekwini Municipality in Durban, South Africa produces 1.5 megawatt of electricity from landfill methane (IMIESA, 2007).

Wind Turbines: The Zarafarana wind farm in Egypt powers 340,000 homes with a total of 160 megawatts of electricity (Deutschland, 2007).

Concentrated Solar Power: The proposed 140 megawatt El-Koraimat Plant in Egypt will use mirrors to concentrate solar thermal radiation to produce electricity (UNEP, 2006).

Geothermal: The Olkaria II plant in Kenya is the largest geothermal plant in Africa and produces 70 megawatts of electricity (World Bank, 2007).

Individual photovoltaic solar cells and small hydroelectric installations also provide energy with a low-carbon footprint. In addition, countries such as Nigeria and Cameroon which currently flare natural gas during oil production could benefit from investing in natural gas technology and local market development (UNEP, 2006).

Investment in low-carbon energy technology is becoming more and more economically competitive. Financing through market mechanisms such as the Kyoto Protocol's Clean Development Mechanism (CDM) provides economic incentives for avoiding or mitigating carbon emissions. Only 2.5 per cent of registered CDM projects are located in Africa (UNFCCC, 2008) even though the continent has tremendous potential for the adoption of low-carbon technology. As compensation for avoided carbon emissions continues to gain momentum around the world, countries that commit to low-carbon energy infrastructure attract foreign investment and provide tremendous benefits to their citizens while effectively managing the energy component of their Ecological Footprint.

Fig 39 BENEFITS OF RENEWABLE OR LOW-CARBON TECHNOLOGY

Benefits of access to renewable or low-carbon energy	Access to renewable technology promotes the following MDGs
Alleviation of indoor and outdoor pollution associated with the burning of biomass and fossil fuels, which primarily impacts women and children	Goal 3: Promote gender equality Goal 4: Reduce child mortality Goal 5: Improve maternal health
Shortening of collection times for food provisions, which disproportionately deprive women of educational and job training opportunities	Goal 2: Achieve universal education Goal 3: Promote gender equality
Slowing and potential reversal of deforestation	Goal 7: Ensure environmental sustainability
Diminishing the dependence on fossil fuels that are becoming increasingly expensive	Goal 7: Ensure environmental sustainability
Promotion of health from refrigeration of vaccines and other temperature sensitive medications, particularly in rural areas	Goal 4: Reduce child mortality Goal 5: Improve maternal health

Olkaria II geothermal plant in Kenya.

P Oberle/WWF

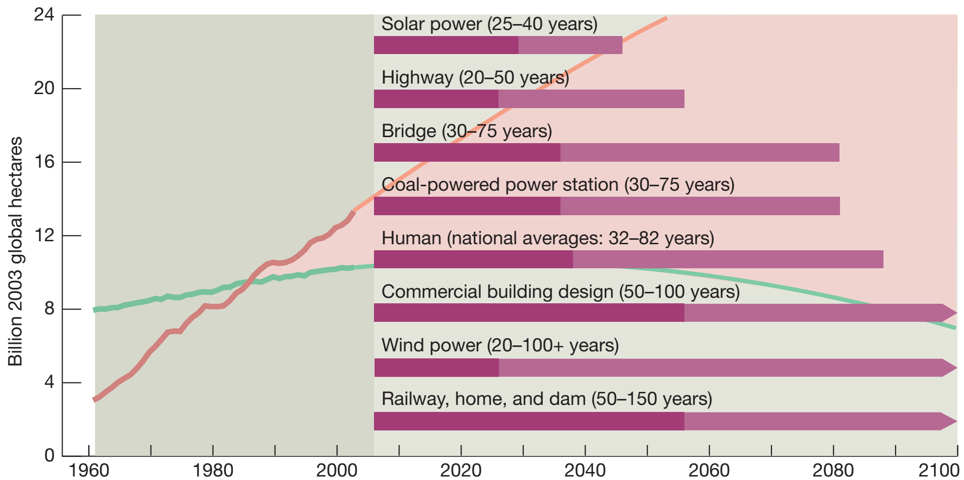
African cities are among the fastest growing in the world, with many residents housed in slums. This growth is fueled by demographic pressure and the environmental deterioration caused by resources overuse and changing climate patterns in rural areas (UN-Habitat 2003).

Urban design provides a significant opportunity to address both well-being and sustainable use of resources. Because of their long-life spans, land-use and infrastructure choices influence resource use for decades or more (Figure 40). Power plants, dams, highways and buildings can last from 50 to over 100 years. This means that decisions made today can lock cities into an economically and ecologically risky scenario of high resource use, or help them become more resilient in the face of growing resource constraints.

Eco-cities are now being designed that combine advances in land-use planning and new infrastructure technology with place-based knowledge of available resources. These approaches are applicable not just in the design of new developments, but also in upgrading existing infrastructure. General principles of eco-city design include low material throughput, use of resource-efficient technology, and innovative re-use of waste products.

Curitiba, Brazil began implementing some of these principles in the 1970s, establishing pedestrian-only streets, parks in flood-prone areas and an extensive bus system which today accounts for up to 60 per cent of all travel inside the city. In the late 1980s, the city also began the *Cambio Verde* (or Green Exchange), a poverty reduction programme that provides the urban poor with excess crops that local farmers are unable to sell, in exchange for recyclables (Gnatek, 2003).

Fig. 40: **LIFESPANS OF PEOPLE, ASSETS, AND INFRASTRUCTURE**



Currently in design, Dongtan, China is intended to be a model eco-city providing a high quality of life on a Ecological Footprint of 2.3 gha or less per person through zoning, effective public transport, local agriculture, high tree cover for local climate regulation and integrated water, energy and waste management systems. Although residents will still use more than the 1.8 gha of biocapacity currently available per person on the planet, it is a step towards sustainability and will result in a considerably lower level of resource use.

While Curitiba and Dongtan may not provide complete solutions, they can serve as case studies for other cities seeking to achieve the goal of one planet living.

How does the Ecological Footprint apply to cities in Africa?

Each African city is an expression of a diverse population, with a unique history of governance, migration and infrastructure. Thus, to be successful, the adoption of policies and technologies that are meant to improve quality of life while maintaining a low footprint require solutions valued by residents. The Ecological Footprint is an effective tool for communicating resource trade-offs, engaging stakeholders in planning processes, and for informing government and aid programmes. In measuring the resource efficiency of infrastructure and land-use change, it can be used both for planning purposes, and to evaluate performance.

MDG 7: IMPROVING THE LIVES OF SLUM RESIDENTS

According to a 2003 UN-Habitat report, one billion people world-wide are estimated to live in slums, with figures projected to double by 2030. Residents of these high density, informal settlements often lack access to one more of the following services: water, sanitation, electricity, safe buildings and secure land tenure. Sub-Saharan Africa had the world's highest percentage of urban residents living in slums (72 per cent). In Nairobi, 60 per cent of residents live in slums with densities as high as 2,300 people housed per hectare (UN-Habitat 2003).

The importance of raising urban residents out of poverty is recognized in Millennium Development Goal 7, which aims to *"achieve significant improvement in the lives of at least 100 million slum dwellers, by 2020"* (UN, 2000). Slums result in a lack of dignity and opportunity for their citizens and can put significant pressure on the surrounding land base. Subsistence use of nearby land is often the primary means by which many urban poor attempt to meet their basic needs. But this can lead to overuse and the degradation of the very biocapacity on which they depend. The Ecological Footprint can help assess how much local biocapacity is available, how it is being used, and how this biocapacity might best be managed to meet their needs and help the urban poor achieve a more resource secure future.

BIOCAPACITY CONSERVATION AND MANAGEMENT

Forty percent of Africans already rely upon coastal and marine ecosystems, but if current patterns of migration continue, this figure is set to continue increasing, further degrading resources and leaving whole communities vulnerable to disaster.
Sir David King [APPGP, 2007]

From 1961 to 2003 Africa's total biocapacity to support resource demand increased by approximately 30 per cent, while its population and its total Ecological Footprint more than tripled. Millions of Africans today rely on local biological resources to meet needs such as fuel to cook, and fish and grain to eat. Export of biological resources is also a significant source of revenue for many of the continent's countries. Africa's future well-being, therefore, will be determined to a great extent by how well it manages its own biocapacity.

A first step is preserving existing biocapacity. Today, deforestation, declining fisheries, and over-cultivation of ecologically fragile land creates the risk that as overall need in Africa is increasing, less and less local biocapacity will be available to meet this need. If current trends continue, Africa, as a whole, may soon be running an ecological deficit, which would increase its dependence on foreign cropland, pasture and fisheries for its food supply. At the same time, population growth is driving migration from rural to urban areas, while resources to support the continent's rapidly growing cities are becoming less available, making sustainable development and poverty eradication that much more difficult to attain.

While Africa's margin of ecological reserves is shrinking, growing economies elsewhere are becoming increasingly dependent on Africa's biocapacity to meet their own needs.

China's hunger for timber, for example, is greatly increasing the demands on Africa's forests, driving both legal and illegal exports of forest products (see box).

At the same time, trawlers harvesting fish for foreign consumption have contributed to the rapid decline of West African fisheries (Palomares and Pauly, 2004).

Countries that are significant exporters of non-renewable resources such as diamonds, oils and ore often confront a "resource curse" in which the exploitation of this material wealth does not translate into economic benefits for the majority of their people. Similarly, countries with significant exports of renewable resources often find that, because of corruption and poor management, this use of their biocapacity benefits only a few.

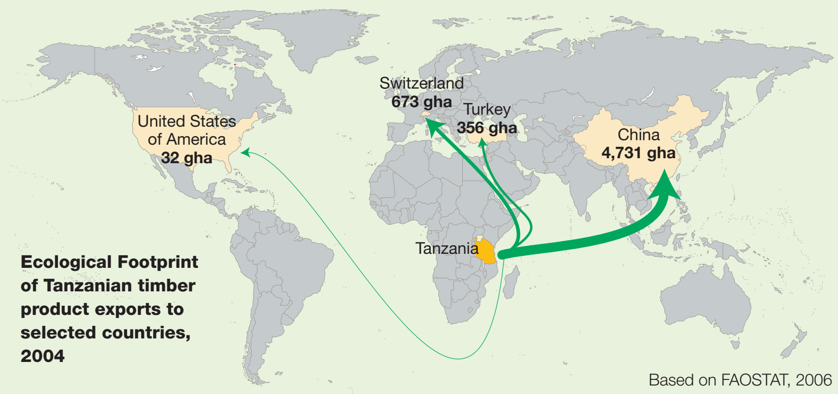
Poor management of an ecological asset can also lead to its degradation or even permanent loss, with the continuing material benefits and economic revenues that might have accrued to a local population forfeited forever.

Deforestation, for example, may mean lost opportunities for Africa to profit from the rapidly developing market for carbon sequestration credits.

Conversely, biocapacity can be managed to maintain or even increase yields, or to add bioproductive area. For example, renewable water resources might be used to irrigate marginally productive land. Effective management means understanding how increased biocapacity of one land type may entail losses in another, whether productivity increases necessitate footprint increases, and if biodiversity is being negatively impacted.

Fig 41: **ILLEGAL LOGGING AND LOSS OF BIOCAPACITY**

Illegal trade of timber is a significant problem for many African nations. TRAFFIC International estimates that the illegal timber trade in Tanzania, fueled by corruption and poor governance in the forestry sector, cost the country US$58 million in lost revenues in 2004 and 2005. The magnitude of illegal and underreported harvesting means official government statistics may underestimate the demand on forests, while overestimating remaining forest biocapacity. According to TRAFFIC, China imported ten times more timber from Tanzania than is documented by Tanzania's export records This illegal harvest contributes to the loss of forests, which in turn undermines biodiversity and can lead to a permanent loss of forest biocapacity. In addition to negatively impacting the livelihoods of future generations, making it more difficult to end cycles of poverty, forest depletion can negatively impact the productivity of other ecosystems through soil erosion, flooding, altered local temperature and precipitation patterns, and the spread of vector-borne disease. *Source: Milledge et al., 2007*



At the beginning of the 21st century, African nations are striving to meet the Millennium Development Goals: to eradicate poverty, and improve the well-being of their citizens. There are signs of progress, such as the reduction since 2000 in the percentage of people in sub-Saharan Africa living in extreme poverty. But the absolute number has not declined (UNDP, 2007).

This development will generate lasting results only if investments promote initiatives that enhance human well-being without exceeding what supporting ecosystems can provide. At the same time, overshoot and related resource constraints are continuing to grow, making it that much more difficult to meet this goal. If current trends continue unchanged, by 2050 humanity would need the productivity of two Earths in order to keep up with its demand on nature (Fig. 42).

The consequences of overshoot do not affect all countries in the same way or to the same extent. Agriculture in Southern African and South Asia, for instance, appears to be especially vulnerable to climate change. Maize production in Southern Africa may decline more than 30 per cent by 2030, and with other crops such as West African yams and sugarcane, and Sahel wheat also at risk, Africa's food production could significantly drop over the next 20 years (Lobell et al., 2008).

All nations are subject to the impacts of overshoot, thus ending overshoot is in the best interest of all. For every nation and for the world as a whole, this means figuring out how to move toward a high level of development with an average footprint that falls within the planet's available biocapacity. This target is represented by the blue sustainable development quadrant in Fig. 43.

Which policies and programs might countries adopt to meet this goal?
A first step is to take a careful look at the factors that determine ecological demand and supply, how they can be addressed, and the costs and benefits of doing so. What are the critical opportunities and the most productive intervention points? What options are there for influencing each of these factors in the desired direction?

Africa, then, has a dual challenge: first, to develop policies and strategies that will minimize the impact of the growing scarcity and cost of ecological resources on the well-being of its population; and second, along with the rest of the world, to help slow and eventually reverse the global ecological overshoot. Fortunately, African nations have many options in addressing these challenges.

Productive ecosystems can be managed to improve or at least maintain current biocapacity, in ways that do not increase the footprint of production or water stress, and that minimize impacts on biodiversity.

Better documentation and government regulation of existing biocapacity can reduce illegal trade or overharvesting and the ecosystem degradation this may cause.

Energy needs can be met using solar, wind, micro-hydro and other renewable, low-footprint energy systems. This can reduce demand on forests for fuelwood, and help minimize the use of environmentally damaging and increasingly expensive fossil fuels.

Fig. 42: **MODERATE UN PROJECTIONS AND HUMANITY'S FOOTPRINT**

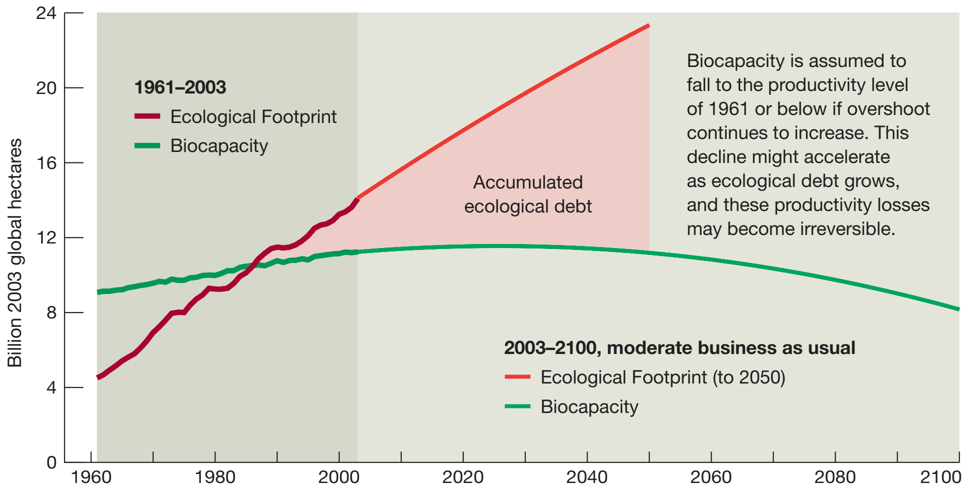
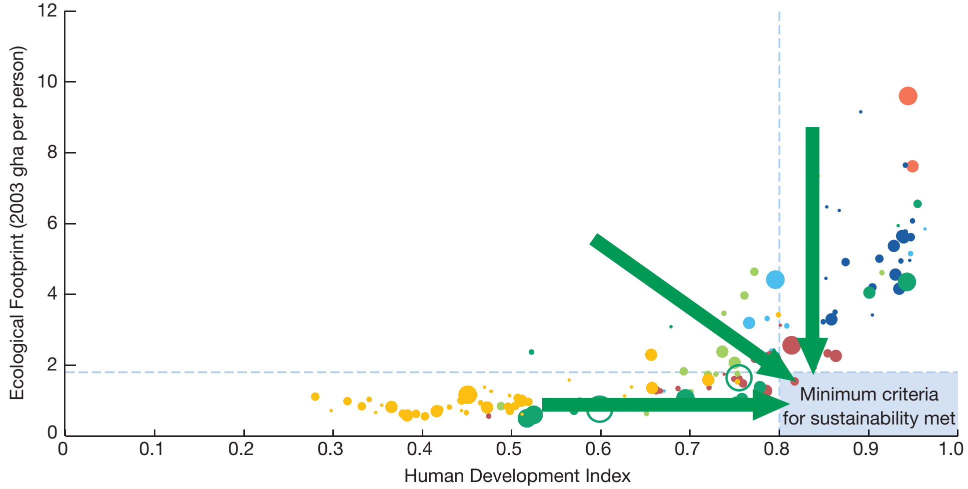


Fig. 43: **MOVING TOWARDS SUSTAINABLE DEVELOPMENT**



Transfer of high-technology can allow African nations to leapfrog resource-intensive phases of industrial development and directly apply better performing and more resource-efficient technical and industrial solutions.

Using food, timber and other resources grown locally can decrease the Ecological Footprint of goods and services by reducing reliance on costly fossil fuels, while strengthening local economies.

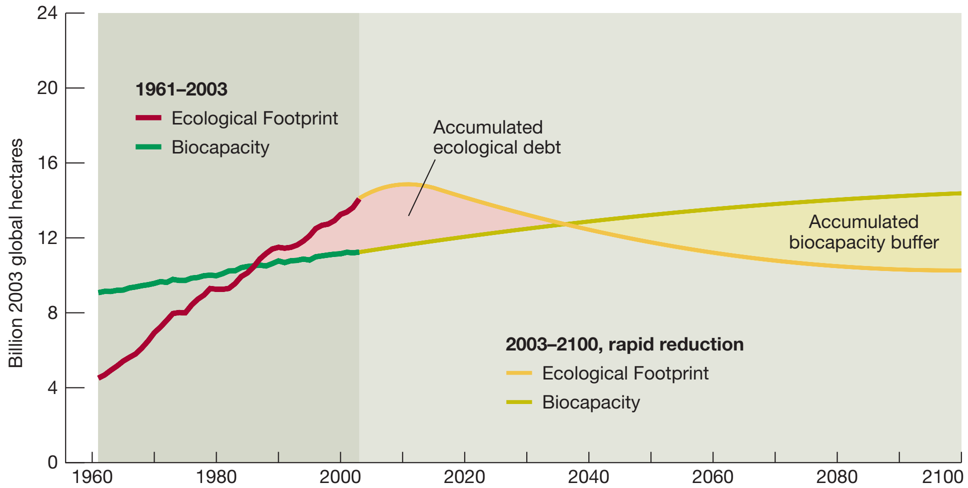
Investing in family planning, health care, education and the empowerment of women can not only slow population growth, but also improve the health, economic and education outcomes for both parents and children.

With the number of urban inhabitants projected to double from 1990 to 2015 (APPGP, 2007), cities are key to meeting the sustainability challenge. Today's investments in long-lasting infrastructure will determine the future of cities for decades to come. Either they will trap cities into high levels of resource demand, or stimulate designs that are resource efficient and can adapt to a resource-constrained world.

Effective management of this transition depends on effective measurement. Without transparent accounts like the Ecological Footprint to track the extent and use of renewable resources, the water footprint to show stress on water resources, and the Living Planet Index to monitor ecosystem health, it would be difficult for countries to use their ecological assets effectively in support of their economic vitality and the well-being of their citizens. Used in conjunction with other indicators, these measures provide a framework for considering ecological capacity and biodiversity while shaping human development strategies, and the domestic, trade and international policies that will make these strategies possible.

In an increasingly interconnected world, no nation and no continent acting alone can solve the sustainability challenge. Those who act first will be better positioned to cope with the impacts of overshoot, but it will take all, working together, to end it. This will make possible a future not of ecological debt, hardship and a depleted planet, but one in which all people can have good lives on a thriving planet (Fig. 44). Africa's efforts toward sustainable development will not only help reduce overshoot, they will make the continent more robust when facing outside pressures, and increase the likelihood that Africans and their children will be able to enjoy long, healthy and satisfying lives.

Fig. 44: **REDUCTION OF OVERSHOOT AND RESTORATION OF ECOSYSTEM HEALTH**



Maintaining solar panels in South Africa

C Marais/WWF-Canon

Table 1: **THE ECOLOGICAL FOOTPRINT AND BIOCAPACITY,** 2003

		Ecological Footprint (global hectares per person, in 2003 gha)									
Country/Region	**Population** (millions)	**Total Ecological Footprint**	Cropland	Grazing land	Forest: timber, pulp, and paper	Forest: fuelwood	Fishing ground	CO_2 from fossil fuels	Nuclear	Built-up land[1]	**Consumption water footprint** (m^3/person)
WORLD	**6 301.5**	**2.23**	**0.49**	**0.14**	**0.17**	**0.06**	**0.15**	**1.06**	**0.08**	**0.08**	
High-income countries	**955.6**	**6.4**	**0.80**	**0.29**	**0.71**	**0.02**	**0.33**	**3.58**	**0.46**	**0.25**	
Middle-income countries	**3 011.7**	**1.9**	**0.47**	**0.17**	**0.11**	**0.05**	**0.15**	**0.85**	**0.03**	**0.07**	
Low-income countries	**2 303.1**	**0.8**	**0.34**	**0.04**	**0.02**	**0.08**	**0.04**	**0.21**	**0.00**	**0.05**	
AFRICA	**846.8**	**1.1**	**0.42**	**0.09**	**0.05**	**0.13**	**0.05**	**0.26**	**0.00**	**0.05**	
Algeria	31.8	1.6	0.47	0.10	0.05	0.05	0.02	0.85	0.00	0.04	2 117
Angola	13.6	1.0	0.44	0.09	0.06	0.05	0.13	0.18	0.00	0.05	1 328
Benin	6.7	0.8	0.57	0.02	0.04	0.00	0.05	0.09	0.00	0.05	1 633
Botswana	1.8	1.6	0.30	0.36	0.06	0.07	0.04	0.66	0.00	0.10	2 193
Burkina Faso	13.0	1.0	0.58	0.13	0.06	0.09	0.01	0.06	0.00	0.06	1 922
Burundi	6.8	0.7	0.31	0.03	0.03	0.24	0.01	0.02	0.00	0.04	1 099
Cameroon	16.0	0.8	0.39	0.10	0.02	0.12	0.06	0.08	0.00	0.06	1 107
Central African Rep.	3.9	0.9	0.34	0.29	0.02	0.10	0.02	0.03	0.00	0.07	1 343
Chad	8.6	1.0	0.49	0.22	0.06	0.15	0.05	0.00	0.00	0.07	2 170
Congo	3.7	0.6	0.25	0.03	0.01	0.06	0.13	0.09	0.00	0.05	na
Congo, Dem. Rep.	52.8	0.6	0.17	0.01	0.03	0.26	0.03	0.02	0.00	0.05	na
Côte d'Ivoire	16.6	0.7	0.33	0.06	0.04	0.10	0.05	0.11	0.00	0.07	2 062
Egypt	71.9	1.4	0.51	0.01	0.04	0.05	0.11	0.51	0.00	0.12	1 006
Eritrea	4.1	0.7	0.34	0.09	0.00	0.06	0.05	0.13	0.00	0.04	731
Ethiopia	70.7	0.8	0.28	0.16	0.03	0.26	0.00	0.05	0.00	0.04	800
Gabon	1.3	1.4	0.47	0.05	0.35	0.16	0.29	0.00	0.00	0.06	1 511
Gambia	1.4	1.4	0.67	0.07	0.06	0.09	0.20	0.26	0.00	0.03	1 502
Ghana	20.9	1.0	0.45	0.02	0.03	0.20	0.17	0.04	0.00	0.05	1 620
Guinea	8.5	0.9	0.37	0.07	0.05	0.27	0.06	0.06	0.00	0.06	2 059
Guinea-Bissau	1.5	0.7	0.32	0.09	0.07	0.06	0.02	0.06	0.00	0.04	3 299
Kenya	32.0	0.8	0.23	0.20	0.04	0.13	0.03	0.15	0.00	0.04	1 102
Lesotho	1.8	0.8	0.32	0.21	0.00	0.23	0.00	0.01	0.00	0.02	–
Liberia	3.4	0.7	0.24	0.01	0.00	0.32	0.04	0.01	0.00	0.06	921
Libya	5.6	3.4	0.54	0.17	0.04	0.02	0.08	2.53	0.00	0.04	1 981
Madagascar	17.4	0.7	0.27	0.11	0.01	0.12	0.08	0.07	0.00	0.06	1 679
Malawi	12.1	0.6	0.32	0.02	0.03	0.08	0.02	0.04	0.00	0.04	1 601
Mali	13.0	0.8	0.40	0.23	0.02	0.08	0.04	0.01	0.00	0.06	–
Mauritania	2.9	1.3	0.36	0.31	0.00	0.11	0.10	0.32	0.00	0.07	–
Mauritius	1.2	1.9	0.44	0.07	0.14	0.00	0.28	0.77	0.00	0.17	2 229
Morocco	30.6	0.9	0.54	0.00	0.04	0.00	0.06	0.23	0.00	0.00	2 534
Mozambique	18.9	0.6	0.28	0.03	0.02	0.18	0.05	0.03	0.00	0.04	1 300
Namibia	2.0	1.1	0.36	0.06	0.00	0.00	0.26	0.34	0.00	0.12	1 787
Niger	12.0	1.1	0.75	0.11	0.03	0.14	0.00	0.05	0.00	0.03	na
Nigeria	124.0	1.2	0.64	0.05	0.05	0.10	0.05	0.22	0.00	0.05	2 064
Rwanda	8.4	0.7	0.38	0.04	0.04	0.12	0.00	0.03	0.00	0.04	1 343
Senegal	10.1	1.2	0.48	0.18	0.07	0.10	0.15	0.13	0.00	0.04	2 105

Total biocapacity[2]	Cropland	Grazing land	Forest	Fishing ground	Ecological reserve or deficit (-) (gha/person)	Footprint change per person (%) 1975–2003[3, 4]	Biocapacity change per person (%) 1975–2003[3, 4]	Human Development Index, 2003[5]	Change in HDI (%) 1975–2003[5]	Stress on blue water resources (%)[6]	Country/Region
Biocapacity (global hectares per person, in 2003 gha)											
1.78	**0.53**	**0.27**	**0.78**	**0.14**	**-0.45**	**14**	**-25**	**0.74**	**–**		**WORLD**
3.3	**1.10**	**0.19**	**1.48**	**0.31**	**-3.12**	**40**	**-14**	**0.91**	**–**		**High-income countries**
2.1	**0.50**	**0.31**	**1.05**	**0.15**	**0.18**	**14**	**-11**	**0.77**	**–**		**Middle-income countries**
0.7	**0.31**	**0.17**	**0.12**	**0.05**	**-0.09**	**8**	**-48**	**0.59**	**–**		**Low-income countries**
1.3	**0.37**	**0.51**	**0.27**	**0.08**	**0.24**	**-2**	**-42**	**–**	**–**		**AFRICA**
0.7	0.29	0.35	0.00	0.01	-0.9	51	-45	0.72	43	41	Algeria
3.4	0.24	2.35	0.29	0.44	2.4	35	-51	0.45	–	0	Angola
0.9	0.64	0.06	0.09	0.04	0.1	-7	-1	0.43	42	1	Benin
4.5	0.30	3.04	1.11	0.00	3.0	70	-51	0.57	12	1	Botswana
1.0	0.59	0.23	0.11	0.00	0.0	19	1	0.32	25	6	Burkina Faso
0.6	0.28	0.21	0.06	0.01	-0.1	-28	-44	0.38	33	6	Burundi
1.3	0.59	0.14	0.43	0.07	0.4	-16	-46	0.50	19	0	Cameroon
3.7	0.61	0.71	2.26	0.00	2.8	-5	-38	0.36	35	0	Central African Rep.
2.5	0.48	1.81	0.13	0.05	1.5	6	-45	0.34	27	1	Chad
7.8	0.20	3.88	3.52	0.15	7.2	-34	-54	0.51	13	0	Congo
1.5	0.16	0.36	0.90	0.02	0.9	-19	-52	0.39	-7	0	Congo, Dem. Rep.
2.0	0.74	0.74	0.40	0.03	1.2	-28	-43	0.42	3	1	Côte d'Ivoire
0.5	0.30	0.00	0.00	0.06	-0.9	49	1	0.66	50	112	Egypt
0.5	0.09	0.30	0.00	0.08	-0.2	-17	-53	0.44	–	5	Eritrea
0.5	0.23	0.16	0.11	0.00	-0.3	-5	-51	0.37	–	3	Ethiopia
19.2	0.47	4.80	12.16	1.69	17.8	6	-50	0.64	–	0	Gabon
0.8	0.33	0.15	0.07	0.25	-0.5	64	-53	0.47	65	0	Gambia
1.3	0.49	0.34	0.35	0.07	0.3	1	-36	0.52	18	1	Ghana
2.8	0.28	1.10	0.97	0.35	1.8	-13	-45	0.47	–	1	Guinea
2.9	0.37	0.43	0.56	1.49	2.2	-17	-52	0.35	36	0	Guinea-Bissau
0.7	0.20	0.35	0.04	0.03	-0.2	-5	-50	0.47	3	5	Kenya
1.1	0.14	0.91	0.00	0.00	0.3	-16	-34	0.50	8	–	Lesotho
3.1	0.20	0.83	1.75	0.27	2.4	-20	-50	–	–	0	Liberia
1.0	0.34	0.27	0.02	0.31	-2.4	13	-43	0.80	–	807	Libya
2.9	0.25	1.16	1.23	0.21	2.2	-19	-49	0.50	24	4	Madagascar
0.5	0.27	0.11	0.03	0.02	-0.1	-33	-39	0.40	3	6	Malawi
1.3	0.43	0.76	0.03	0.04	0.5	-13	-39	0.75	–	–	Mali
5.8	0.17	4.15	0.00	1.37	4.5	31	-44	0.33	45	–	Mauritania
1.2	0.20	0.00	0.01	0.82	-0.7	80	-16	0.48	40	24	Mauritius
0.8	0.40	0.00	0.11	0.27	-0.1	4	-31	0.63	47	43	Morocco
2.1	0.21	1.39	0.40	0.03	1.4	-3	-38	0.38	–	0	Mozambique
4.4	0.60	1.98	0.00	1.74	3.3	26	-48	0.63	–	1	Namibia
1.5	0.80	0.67	0.04	0.01	0.4	-17	-43	0.28	29	7	Niger
0.9	0.53	0.23	0.09	0.03	-0.2	4	-32	0.45	42	3	Nigeria
0.5	0.31	0.09	0.08	0.00	-0.1	-19	-32	0.45	32	2	Rwanda
0.9	0.33	0.26	0.09	0.14	-0.3	-19	-56	0.46	47	4	Senegal

Country/Region	Population (millions)	Total Ecological Footprint	Cropland	Grazing land	Forest: timber, pulp, and paper	Forest: fuelwood	Fishing ground	CO_2 from fossil fuels	Nuclear	Built-up land[1]	Consumption water footprint (m^3/person)
		Ecological Footprint (global hectares per person, in 2003 gha)									
Sierra Leone	5.0	0.7	0.29	0.03	0.02	0.22	0.08	0.04	0.00	0.05	–
Somalia	9.9	0.4	0.01	0.18	0.01	0.21	0.00	0.00	0.00	0.00	–
South Africa, Rep.	45.0	2.3	0.38	0.23	0.12	0.05	0.05	1.35	0.06	0.05	1 531
Sudan	33.6	1.0	0.44	0.23	0.05	0.10	0.01	0.11	0.00	0.07	2 685
Swaziland	1.1	1.1	0.42	0.25	0.05	0.10	0.03	0.23	0.00	0.06	na
Tanzania, United Rep.	37.0	0.7	0.28	0.11	0.04	0.12	0.04	0.05	0.00	0.07	1 358
Togo	4.9	0.9	0.41	0.04	0.03	0.23	0.04	0.08	0.00	0.04	na
Tunisia	9.8	1.5	0.61	0.04	0.08	0.04	0.11	0.65	0.00	0.01	2 727
Uganda	25.8	1.1	0.53	0.05	0.09	0.28	0.04	0.05	0.00	0.05	2 360
Zambia	10.8	0.6	0.19	0.07	0.05	0.13	0.04	0.09	0.00	0.05	882
Zimbabwe	12.9	0.9	0.28	0.13	0.05	0.13	0.01	0.22	0.00	0.03	765

Table 2: AFRICA THROUGH TIME, 1961-2003

	Africa Population (millions)	Total Ecological Footprint	Total biocapacity	Africa as % of world Ecological Footprint	Africa as % of world Biocapacity
		(millions 2003 global hectares)			
1961	280	282	848	6	9
1965	312	321	865	6	9
1970	356	387	885	6	9
1975	406	437	906	5	9
1980	468	514	929	6	9
1985	539	580	930	6	9
1990	620	655	979	6	9
1995	704	742	994	6	9
2000	792	817	1 062	6	10
2003	847	889	1 093	6	10`

NOTES

World: Total population includes countries not listed in table.

Table includes all countries with populations greater than 1 million.

High-income countries: Australia, Austria, Belgium/Luxembourg, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea Rep., Kuwait, Netherlands, New Zealand, Norway, Portugal, Saudi Arabia, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America.

Middle-income countries: Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Belarus, Bolivia, Bosnia/Herzegovina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Rep., Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Gabon, Georgia, Guatemala, Honduras, Hungary, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Latvia, Lebanon, Libya, Lithuania, Macedonia FYR, Malaysia, Mauritius, Mexico, Morocco, Namibia, Panama, Paraguay, Peru, Philippines, Poland, Romania, Russian Federation (and USSR in 1975), Serbia/Montenegro, Slovakia, South Africa Rep., Sri Lanka, Swaziland, Syria, Thailand, Trinidad/Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, Uruguay, Venezuela.

Low-income countries: Afghanistan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Rep., Chad, Congo, Congo, Dem. Rep., Côte d'Ivoire, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Haiti, India, Kenya, Korea, DPR, Kyrgyzstan, Lao PDR, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Moldova, Rep., Mongolia, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Papua New Guinea, Rwanda, Senegal, Sierra Leone, Somalia, Sudan,

Total biocapacity[2]	Cropland	Grazing land	Forest	Fishing ground	Ecological reserve or deficit (-) (gha/person)	Footprint change per person (%) 1975–2003[3, 4]	Biocapacity change per person (%) 1975–2003[3, 4]	Human Development Index, 2003[5]	Change in HDI (%) 1975–2003[5]	Stress on blue water resources (%)[6]	Country/Region
Biocapacity (global hectares per person, in 2003 gha)											
1.1	0.17	0.46	0.10	0.29	0.4	-26	-39	0.30	–	–	Sierra Leone
0.7	0.00	0.63	0.02	0.07	0.3	-38	-54	–	–	–	Somalia
2.0	0.53	0.73	0.52	0.21	-0.3	-13	-23	0.66	0	30	South Africa, Rep.
1.8	0.53	1.07	0.10	0.01	0.8	-6	-44	0.51	47	58	Sudan
1.1	0.25	0.74	0.00	0.00	-0.1	-35	-46	0.50	-6	18	Swaziland
1.3	0.22	0.85	0.11	0.04	0.6	-20	-51	0.42	–	2	Tanzania, United Rep.
0.8	0.50	0.18	0.05	0.01	-0.1	-4	-56	0.51	21	1	Togo
0.8	0.56	0.00	0.02	0.18	-0.8	38	-36	0.75	47	58	Tunisia
0.8	0.47	0.22	0.06	0.04	-0.2	-27	-50	0.51	–	0	Uganda
3.4	0.41	1.99	0.95	0.03	2.8	-30	-49	0.39	-2	2	Zambia
0.8	0.19	0.52	0.03	0.01	-0.1	-12	-54	0.50	-7	13	Zimbabwe

Table 3: LIVING PLANET INDEX: NUMBERS OF SPECIES WITHIN EACH SYSTEM

CLASS	Terrestrial	Freshwater	Marine	Total
Fish		94	147	241
Amphibians	14	69		83
Reptiles	16	17	7	40
Birds	538	153	120	811
Mammals	245	11	46	302
Total	813	344	320	1 477

Tajikistan, Tanzania, United Rep., Togo, Uganda, Uzbekistan, Viet Nam, Yemen, Zambia, Zimbabwe.

Notes:

1. Built-up land includes hydropower.

2. Biocapacity includes built-up land (see column under Ecological Footprint).

3. Changes from 1975 are calculated based on constant 2003 global hectares.

4. For countries that were formerly part of Ethiopia PDR, the Soviet Union, former Yugoslavia, or Czechoslovakia, 2003 per capita footprints and biocapacity are compared with the per capita footprint and biocapacity of the former unified country.

5. UNDP HDI Statistics, http://hdr.undp.org/statistics/ (August 2006).

6. Stress on blue water resources calculated for the period 2000-2004 using the methodology in Chapagain and Hoekstra, 2004.

– = insufficient data.

0 = less than 0.5; 0.0 = less than 0.05; 0.00 = less than 0.005.

Totals may not add up due to rounding.

How is the Ecological Footprint calculated?
The Ecological Footprint measures the amount of biologically productive land and water area required to produce the resources an individual, population, or activity consumes and to absorb the waste they generate, given prevailing technology and resource management. This area is expressed in global hectares (gha), hectares with world-average biological productivity (1 hectare = 2.47 acres). Footprint calculations use yield factors (Table 4) to take into account national differences in biological productivity (for example, tonnes of wheat per United Kingdom or Argentinean hectare versus world average) and equivalence factors (Table 5) to take into account differences in world average productivity among land types (for example, world average forest versus world average cropland).

Table 4: **YIELD FACTORS,** selected countries

	Primary cropland	Forest	Pasture	Ocean fisheries
World	*1.0*	*1.0*	*1.0*	*1.0*
Algeria	0.6	0.0	0.7	0.8
Guatemala	1.0	1.4	2.9	0.2
Hungary	1.1	2.9	1.9	1.0
Japan	1.5	1.6	2.2	1.4
Jordan	1.0	0.0	0.4	0.8
Lao PDR	0.8	0.2	2.7	1.0
New Zealand	2.2	2.5	2.5	0.2
Zambia	0.5	0.3	1.5	1.0

Table 5: **EQUIVALENCE FACTORS,** 2003

	gha/ha
Primary cropland	2.21
Marginal cropland	1.79
Forest	1.34
Permanent pasture	0.49
Marine	0.36
Inland water	0.36
Built-up land	2.21

Table 6: **CONVERSION FACTORS**

	2003 gha/gha
1961	0.86
1965	0.86
1970	0.89
1975	0.90
1980	0.92
1985	0.95
1990	0.97
1995	0.97
2000	0.99
2003	1.00

Footprint and biocapacity results for nations are calculated annually by Global Footprint Network. The continuing methodological development of these National Footprint Accounts is overseen by a formal review committee (see www.footprint network.org/committees). A detailed methods paper and copies of sample calculation sheets can be obtained at www.Footprintnetwork.org.

What is included in the Ecological Footprint? What is excluded?
To avoid exaggerating human demand on nature, the Ecological Footprint includes only those aspects of resource consumption and waste production for which the Earth has regenerative capacity, and where data exist that allow this demand to be expressed in terms of productive area. For example, freshwater withdrawals are not included in the footprint, although the energy used to pump or treat water is. Ecological Footprint accounts provide snapshots of past resource demand and availability. They do not predict the future. Thus, while the footprint does not estimate future losses caused by present degradation of ecosystems, if persistent this is likely to be reflected in future accounts as a loss of biocapacity. Footprint accounts also do not indicate the intensity with which a biologically productive area is being used, nor do they pinpoint specific biodiversity pressures. Finally, the Ecological Footprint, as a biophysical measure, does not evaluate the essential social and economic dimensions of sustainability.

What are "2003 constant global hectares"?
A "global hectare" is a hectare with world-average biological productivity in a given year. Because total global productivity varies each year, the amount of regenerative capacity represented by a global hectare is not the same each year. To simplify comparison of footprint and biocapacity results from year to year, in this report all time trends are shown in "constant 2003 global hectares." These constant hectares represent a fixed amount of regenerative capacity, based on world average productivity per hectare in 2003, the reference year.

Similar to the use of inflation-adjusted dollars in economic statistics, the use of constant global hectares makes it easier to understand how absolute levels of ecological supply and demand are changing over time. Conversion into constant global hectares does not affect the ratio between footprint and biocapacity in any given year, nor the amount of overshoot in that year. Table 6 shows the values used to convert global hectares into constant 2003 global hectares for selected years.

How does the Ecological Footprint account for the use of fossil fuels?
Fossil fuels – coal, oil, and natural gas – are extracted from the Earth's crust rather than produced by ecosystems. When burning this fuel, carbon dioxide (CO_2) is produced. In order to avoid carbon accumulation in the atmosphere, the goal of the United Nations Framework Convention on Climate Change, two options exist: human technological sequestration, such as deep well injection; or natural sequestration. Natural sequestration corresponds to the biocapacity required to absorb and store the CO_2 not sequestered by humans, less the amount absorbed by the oceans. This is the footprint for CO_2. Although negligible amounts of CO_2 are currently sequestered through human technological processes, these technologies will lower the carbon footprint associated with burning fossil fuels as they are brought online.

The sequestration rate used in Ecological Footprint calculations is based on an estimate of how much carbon the world's forests can remove from the atmosphere and retain. One 2003 global hectare can absorb the CO_2 released by burning approximately 1 450 litres of petrol per year.

The CO_2 footprint does not suggest that carbon sequestration is the key to resolving global warming. Rather the opposite: it shows that the biosphere does not have sufficient capacity to cope with current levels of CO_2 emissions. As forests mature, their CO_2 sequestration rate approaches zero, and they may even become net emitters of carbon.

How does the Ecological Footprint account for nuclear energy?
The demand on biocapacity associated with the use of nuclear power is difficult to quantify, in part because many of its impacts are not addressed by

the research question underlying the footprint. For lack of conclusive data, the footprint of nuclear electricity is assumed to be the same as the footprint of the equivalent amount of electricity from fossil fuels. Global Footprint Network and its partners are working to refine this assumption. Currently, the footprint of nuclear electricity represents less than 4 per cent of the total global Ecological Footprint.

How is international trade taken into account?
The National Footprint Accounts calculate each country's net consumption by adding its imports to its production and subtracting its exports. This means that the resources used for producing a car that is manufactured in Japan, but sold and used in India, will contribute to the Indian, not the Japanese, consumption footprint. The resulting national Footprints can be distorted, since the resources used and waste generated in making products for export are not fully documented. This affects the Footprints of countries whose trade-flows are large relative to their overall economies. These misallocations, however, do not affect the total global Ecological Footprint.

Does the Ecological Footprint take other species into account?
The Ecological Footprint describes human demand on nature. Currently, there are 1.8 global hectares of biocapacity available per person on Earth, less if some of this biological productivity is allocated for consumption by wild species. The value society places on biodiversity will determine how much productivity is reserved as a buffer. Efforts to increase biocapacity, such as monocropping and the application of pesticides, may also increase pressure on biodiversity; this can increase the size of the buffer required to achieve the same conservation results.

Does the Ecological Footprint say what is a "fair" or "equitable" use of resources?
The footprint documents what has happened in the past. It quantifies the ecological resources used by an individual or a population, but it cannot prescribe what they should be using. Resource allocation is a policy issue, based on societal beliefs about what is or is not equitable. Thus, while footprint accounting can determine the average biocapacity that is available per person, it cannot stipulate how that biocapacity should be shared between individuals or nations. However, it does provide a context for such discussions.

Does the Ecological Footprint matter 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 those demands? Footprint analysis reflects both increases in the productivity of renewable resources (for example, if the productivity of cropland is increased, then the footprint of 1 tonne of wheat will decrease) and technological innovation (for example, if the paper industry doubles the overall efficiency of paper production, the footprint per tonne of paper will be cut by half). Ecological Footprint accounts capture these changes as they occur and can determine the extent to which these innovations have succeeded in bringing human demand within the capacity of the planet's ecosystems. If there is a sufficient increase in ecological supply and a reduction in human demand due to technological advances or other factors, footprint accounts will show this as the elimination of global overshoot.

Does the Ecological Footprint ignore the role of population growth as a driver in humanity's increasing consumption?
The total Ecological Footprint of a nation or of humanity as a whole is a function of the number of people consuming, the amount of goods and services an average person consumes, and the resource intensity of these goods and services. Since footprint accounting is historical, it does not predict how any of these factors will change in the future. However, if population grows or declines (or any of the other factors change), this will be reflected in future footprint accounts.

Footprint accounts can also show how resource consumption is distributed among regions. For example, the total footprint of the Asia-Pacific region, with its large population but low per person footprint, can be directly compared to that of North America, with its much smaller population but much larger per person footprint.

How do I calculate the Ecological Footprint of a city or region?
While the calculations for global and national Ecological Footprints have been standardized within the National Footprint Accounts, there are a variety of ways used to calculate the footprint of a city or region. The family of "process-based" approaches use production recipes and supplementary statistics to allocate the national per person footprint to consumption categories (such as for food, shelter, mobility, goods, and services).

Regional or municipal average per person Footprints are calculated by scaling these national results up or down based on differences between national and local consumption patterns. The family of input-output approaches use monetary, physical, or hybrid input-output tables for allocating overall demand to consumption categories.

There is growing recognition of the need to standardize sub-national footprint application methods in order to increase their comparability across studies and over time. In response to this need, methods and approaches for calculating the footprint of cities and regions are currently being aligned through the global Ecological Footprint Standards initiative. For more information on current footprint standards and ongoing standardization debates, see: www.Footprintstandards.org/

For additional information about footprint methodology, data sources, assumptions, and definitions please visit: www.Footprintnetwork.org/2006technotes

Living Planet Index
The species population data used to calculate the LPI are gathered from a variety of sources published in scientific journals, NGO literature, or on the worldwide web. All data used in constructing the index are time series of either population size or a proxy of population size.

The terrestrial and marine datasets comprise data from 1960 to 2005 and the freshwater dataset from 1960 to 2003 owing to fewer numbers of time series from recent years. Annual data points were interpolated for each population using generalized additive modelling, and the average rate of change in each year across all species populations was calculated to make an index. All indices were calculated using population data from 1960 to 2005, or the most recent year for which data were available, and set equal to 1.0in 1970 (pre-1970 trends are not shown). The global LPI was aggregated according to the hierarchy of indices shown in Figure 15. For further details please refer to Loh et al. (2005).

Figure 45: Hierarchy of indices within the Living Planet Index. Each population carries equal weight within each species; each species carries equal weight within tropical and temperate realms or within each ocean basin; temperate and tropical realms, or ocean basins, carry equal weight within each system; each system carries equal weight within the overall LPI.

Fig. 45 **HIERARCHY OF INDICES WITHIN THE LIVING PLANET INDEX**

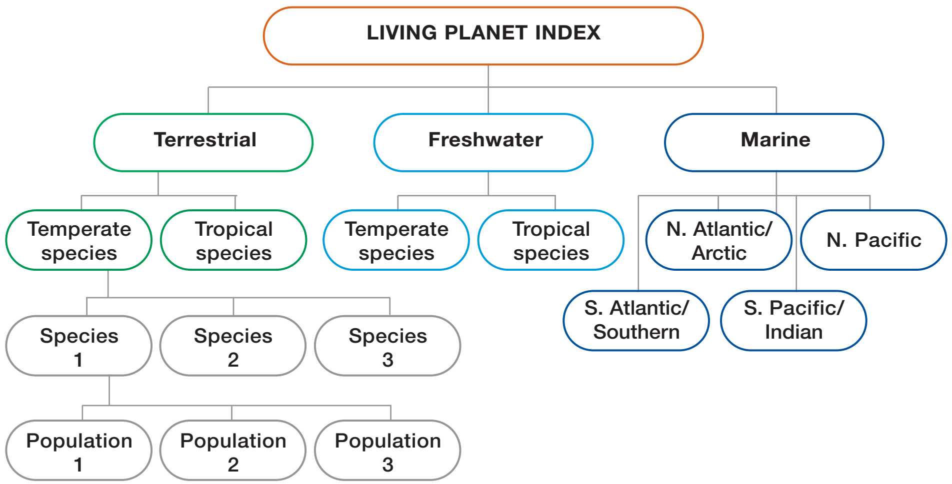


Table 7: **SPECIES INCLUDED IN LIVING PLANET INDEX FOR EAST AFRICA**

Class	Species
Fish	*Lates niloticus*
	Oreochromis niloticus
Birds	*Balearica regulorum*
	Ceryle rudis
	Corvus albus
	Gyps africanus
	Haliaeetus vocifer
	Leptoptilos crumeniferus
	Milvus migrans
	Necrosyrtes monachus
	Pelecanus rufescens
	Ploceus cucullatus
	Ploceus nigerrimus
	Pycnonotus barbatus
	Struthio camelus
	Torgos tracheliotus
	Trigonoceps occipitalis
Mammals	*Acinonyx jubatus*
	Aepyceros melampus
	Alcelaphus buselaphus
	Canis aureus
	Canis mesomelas
	Ceratotherium simum
	Cercocebus galeritus
	Cercopithecus ascanius
	Cercopithecus mitis
	Colobus guereza
	Connochaetes taurinus
	Crocuta crocuta
	Damaliscus hunteri
	Damaliscus lunatus
	Diceros bicornis
	Dugong dugon
	Eidolon helvum
	Equus burchellii
	Equus grevyi
	Galerella sanguinea
	Gazella granti
	Gazella thomsonii
	Giraffa camelopardalis
	Gorilla beringei
	Helogale parvula
	Hippopotamus amphibius
	Hippotragus equinus
	Hippotragus niger
	Kobus ellipsiprymnus
	Kobus kob
	Lophocebus albigena
	Loxodonta africana
	Lycaon pictus
	Mastomys natalensis
	Mungos mungo
	Oryx dammah
	Otocyon megalotis
	Ourebia ourebi
	Pan troglodytes
	Panthera leo
	Papio anubis
	Papio hamadryas
	Phacochoerus aethiopicus
	Phacochoerus africanus
	Procolobus badius
	Procolobus pennantii
	Procolobus rufomitratus
	Pteropus voeltzkowi
	Syncerus caffer
	Tragelaphus derbianus
	Tragelaphus imberbis
	Tragelaphus oryx
	Tragelaphus scriptus
	Tragelaphus spekii
	Tragelaphus strepsiceros
Reptiles	*Crocodylus niloticus*

The **water footprint of production** shown in Figure 36 measures all water used for household, industrial and agricultural purposes in a country.

Agricultural water use is measured as the evaporative water demand of crops at field level. The agricultural water use includes both effective rainfall (the portion of total precipitation which is retained by the soil) and any irrigation water used for crop production. The water used for crop growth, or crop water requirement (CWR) is calculated per crop and per country using a methodology developed by FAO (Allen et al., 1998). Agricultural water use (m^3) of a primary crop is then estimated by multiplying the CWR (m^3/ha) with the total harvested area (ha) of that crop. Data for crop production and area harvested per country are from FAOSTAT (FAO, 2006).

Data for **irrigation water withdrawal, irrigation water use efficiencies, domestic water supply and industrial water withdrawal** are from AQUASTAT (FAO, 2003).

The water footprint is composed of three categories of water use: **green** water, **blue** water, and **return flows** (or, **grey** water). Green water use accounts for the part of the soil moisture derived from rainfall that is subsequently evaporated during crop growth. Additional crop needs may be met by irrigation using **blue water supplies**; the water drawn from rivers, lakes or aquifers. The total volume of water evaporated in the process of growing crops is called the **evaporative water footprint**.

Grey water use refers to the return flows from agricultural land, industry and domestic (household) water supplies that have often been polluted during their utilisation (e.g. sewage).

The volume of water that is not available for further downstream uses as a result of return flows is called the **non-evaporative water** footprint (Figure 46).

The **stress** on internal blue water resources is calculated as (blue water evaporated + blue water polluted) / total internal renewable blue water available.

The net volume of water consumption in a nation, called the **water footprint of consumption,** shown in Figures 37 and 38, is calculated by adding its **internal and external water footprints**. The external water footprint of a country is the sum of virtual water flows of imported products minus the virtual water in re-exported products. The **internal water footprint** of a country is the total **production water footprint** minus the virtual water of exported domestic products (Figure 47).

Virtual water flows in and out of each country are calculated by multiplying commodity trade flows by their associated virtual water content, based on trade data from ITC (2006). Further details on the calculation methodology are available from Chapagain and Hoekstra (2004) and Orr and Chapagain (2008).

Fig. 46: **COMPONENTS OF THE WATER FOOTPRINT OF PRODUCTION**

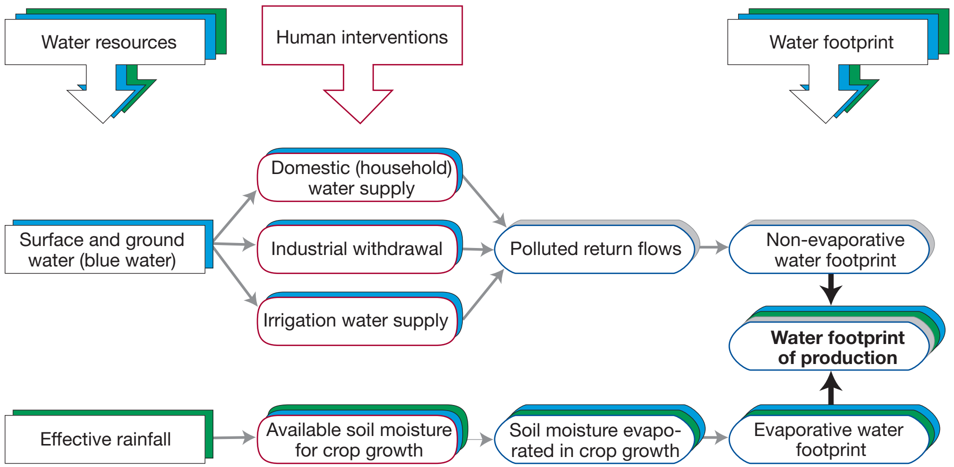
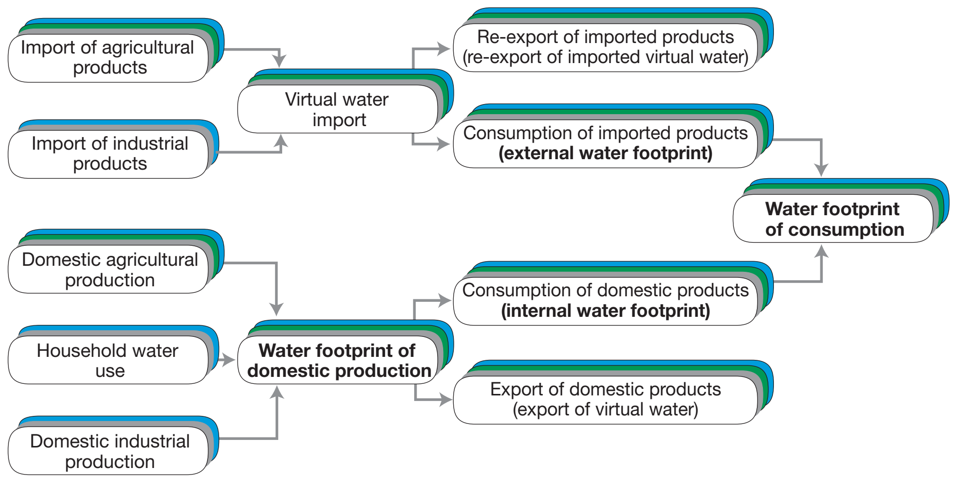


Fig. 47: **INTERNAL AND EXTERNAL WATER FOOTPRINT OF A NATION**



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Additional Ecological Footprint references can be found at: www.footprintnetwork.org/2006references
Additional information on the water footprint can be found at: www.waterfootprint.org/

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