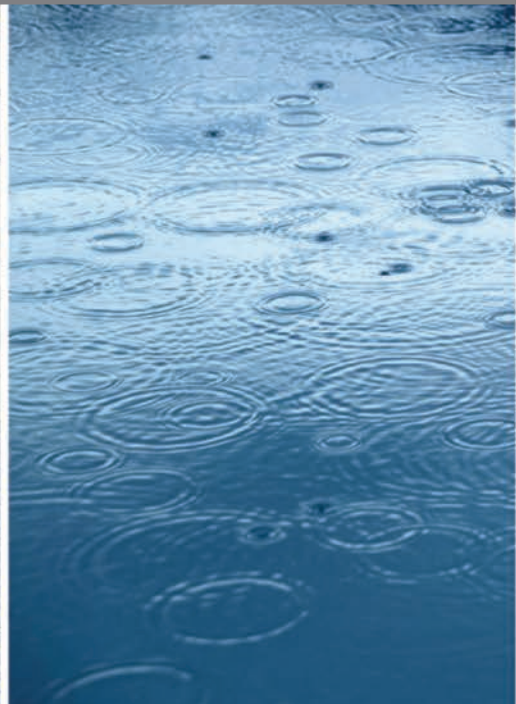
FOOTPRINT FACTBOOK
AFRICA 2009


Securing Human Development in a Resource Constrained World

Global Footprint Network
Advancing the Science of Sustainability

CONTENTS

Africa's natural wealth represents a critical asset, one that will become ever more valuable as intact ecosystems become more scarce around the globe. Yet Africa's resources are under increasing pressure. Growing resource demand from local and international populations, exacerbated by predicted effects of climate change on ecosystem health, poses a significant threat to Africa's natural capital.

If current trends continue, Africa's consumption Footprint will exceed its biocapacity within the next 20 years, while a number of countries, including Niger, Malawi, and Uganda have already bumped against these limits. Other countries including Senegal, Kenya and Tanzania, are about to reach that threshold. Though this is reflective of a global trend, it is particularly alarming for Africa, where many people directly depend on local ecosystems for their livelihood. People in subsistence economies suffer first and most tragically when humanity's demand on ecosystems exceeds what those ecosystems can provide.

It has become increasingly clear that, for progress in human development to be more than fleeting advances, development must work with, and not against nature's budget. Those efforts which will succeed in the long-term will be those that strengthen, rather than undermine, the ecological resources upon which the well-being of the region's people depend.

Dr. Mathis Wackernagel

President
Global Footprint Network

Such advances are possible. They simply require a new type of decision-making: one which involves carefully managing ecological assets and recognizing nature as a core asset.

Since infrastructure shapes the way we live, today's investment decisions will determine our resource consumption for decades to come. Poor investment choices can lock us into ecologically (and economically) risky scenarios, while responsible, well-informed choices will build the foundation for prosperity.
Possibly the most undervalued asset that would benefit from investment are women. The dividends of investing in women are overwhelming, bringing not only higher standards of health, income and education for the entire family, but also smaller families (leaving more biocapacity per person) and, as many statistics have shown, a significant reduction in violence and conflict.

I am convinced we can advance human well-being in a way that produces lasting results. Protecting the underlying assets upon which human well-being depends is not a luxury that comes at the expense of progress. In fact, it is the only way lasting progress can be secured.

Consider this: if current trends in biocapacity and Footprint were financial curves, every planner, economist or minister would know what would need to be done. They would huddle and identify an aggressive agenda for action. Nothing less is required with our current resource trends. After all, money can be printed, but resources cannot.

The Footprint Factbook, Africa 2009 contains vital and up-to-date information on Africa's Ecological Footprint, accompanied by valuable guest perspectives from African environmental and development experts..

At a time of global ecological crises, when humankind's Ecological Footprint has exceeded natural capacity by almost a third, it is imperative that reliable accounting tools be available to support effective management of natural resources, as well as consumption of and demand upon those resources.

Mr. Walter Erdelen

Assistant Director-General for Natural Sciences

United Nations Educational, Scientific and Cultural Organization (UNESCO)

This factbook represents just such a tool, and I welcome its publication, along with the continued efforts of the Global Footprint Network to advance our understanding of the relationship between human beings and the biosphere.

UNESCO and the Global Footprint Network stand together in supporting the application of science to the construction of sustainable futures built on green economies, in Africa and beyond.

The publication of the Africa Ecological Footprint Factbook 2009 comes at the most opportune possible moment. In the middle of an economic and financial crisis – added to the plethora of problems which people in developing countries have to face – the nations of the entire world are poised to make a decision in Copenhagen about the attitude to adopt towards climate change and the financing of mitigation and adaptation measures starting in 2012. Only a courageous and responsible agreement at Copenhagen will allow our policies to be judged with leniency by future generations. Such an agreement must acknowledge that world poverty and climate change are the most important challenges we face today – and that they are intrinsically linked.

Although responsibility for these challenges is shared, it is essential that industrialised countries accept that theirs will be the lion's share. By committing to a sustainable and substantial increase in official development assistance (ODA), we can begin to fight the effects of climate change in the places where it will have some of the most drastic impacts. ODA is not the only instrument to finance sustainable development in developing countries, but the financial crisis has shown that it is the most reliable and predictable one.

H.E. Ms Marie-Josée Jacobs

Minister for Development Cooperation and Humanitarian Affairs of Luxembourg

From this perspective, providing official development assistance on the level of 0.7 percent of gross national income is no longer simply a matter of respecting a global collective commitment towards human development. When faced with the enormous consequences of climate change, sustainable development investments are in the best interest of the developing and the industrialised world, and all future generations. This will require a creative and sustained joint effort by governments, civil society and the private sector.

The Ecological Footprint Factbook for Africa serves as a reference framework for all partners in the common fight against poverty and climate change. By comparing environmental capacities and limits – the Ecological Footprint and biocapacity – and by exploring their link with human development, this report allows us to perceive a model of sustainable development that is based on working with, rather than against our "ecological budget".

Source: NASA, Visible Earth.

Africa has vast amounts of natural resources, yet its population often suffers first and most tragically when human demand on nature exceeds what nature can renewably provide. The countries of Africa have some of the lowest per capita Ecological Footprints in the world – in many cases too small to meet basic needs for food, shelter, health and sanitation. For the region to reduce poverty, hunger and disease, large segments of the population must have greater access to natural resources. Yet Africa's growing population and the world's escalating resource consumption are making this increasingly difficult. If Africa's countries are to make advances in human development that can persist, they will need to find approaches that work with, rather than against, the Earth's ecological budget constraints.

Effectively managing the region's natural wealth requires accounting tools that can track resource consumption against the capacity available to regenerate these resources. This is what the Ecological Footprint provides. The Africa Factbook is a project of Global Footprint Network, supported in funding and partnership by the Swiss Agency for Development and Cooperation, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), the Development Cooperation Directorate of the Luxembourg Ministry of Foreign Affairs, Luxembourg Ministry of Foreign Affairs, the Luxembourg Agency for Development Cooperation and the United Nations Education Scientific and Cultural Organization (UNESCO). It reports key indicators on human development and ecological performance derived from a variety of sources, including United Nations statistics. Data on 24 different countries in eastern, western, sub-Saharan and northern regions of the continent are included. The Factbook builds on analysis presented in a preliminary Africa Factbook published in 2006, and the 2008 report, *Africa: Ecological Footprint and Well-being*, published in conjunction with WWF. Both studies served as the basis for discussion on human development and natural resource constraints at a series of workshops throughout Africa in 2007 and 2008.

We selected countries that provided a representative sampling of the region's geography and had the best quality data available. By providing data on each country's development, its resource consumption, and the capacity of its ecosystems to generate resources, the report helps clarify the relationship between human well-being and the availability of ecological assets.

The Factbook does not capture all relevant factors shaping human well-being. For instance, national average figures do not capture the wide range of differences within individual African countries in climate, ecosystems, cultures, economies and political systems. Further, while the Ecological Footprint addresses the use and availability of biological capacity, there are other biophysical factors, such as pollution, that can affect ecosystems or human health. However, the data shown here can play an instrumental role in shaping dialogue and informing policy priorities. As ecological resources grow increasingly scarce in the 21st century, biological capacity will play a more central role in economic, social, and policy planning worldwide. At this stage the available data supports discussions at the national level. However, the debate must continue at a more local scale as well. For instance, urbanization in many African countries is a critical factor shaping development and contributing to pressure on local resources.

For specific queries about Global Footprint Network's Human Development Initiative or to comment on this Factbook, please write to *info@footprintnetwork.org*. National governments are invited to enter into research collaboration with Global Footprint Network to improve the quality of their national Footprint accounts, and to explore ways of using the data to support policy and other decision-making.

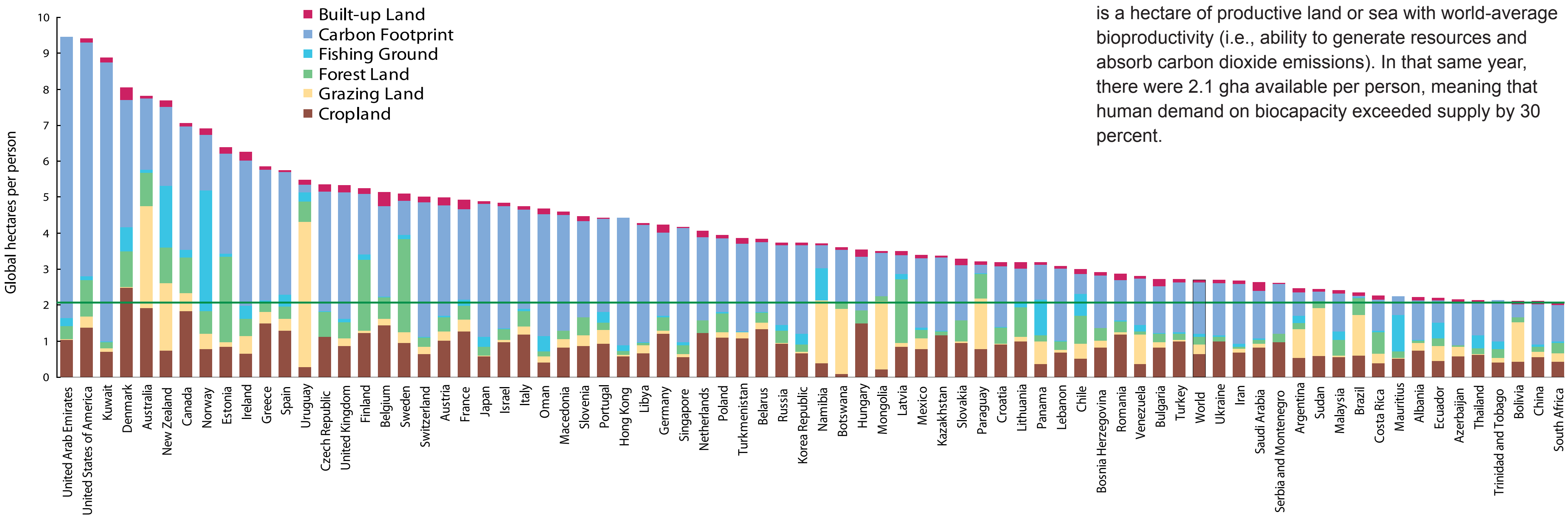
The Ecological Footprint measures humanity's demand on the biosphere by accounting for the area of biologically productive land and sea required to provide the resources we use and to absorb our waste. This area includes the cropland, grazing land, forest and fishing grounds required to produce the food, fiber, and timber consumed by humanity, and the productive land on which we build infrastructure. It also includes the area needed to absorb and store humanity's carbon dioxide emissions, which come from burning fossil fuels, land-use changes such as conversion of forest to cropland, chemical processes in cement production and from flaring of natural gas. The carbon component of the Ecological Footprint is calculated in terms of the forest area required to absorb these emissions. The Footprint can be directly compared to the amount of productive area, or biocapacity, that is available. Because the amount of biocapacity on the planet is finite, the various ecological services that humanity uses compete for productive area.

The globalized economies of today bring African goods to consumers far away, and products from around the world to Africa. The Ecological Footprint takes trade into account by summing all the biocapacity a population demands regardless of where that biocapacity is located on the planet. In other words, resources (including those embedded in products) that are exported to consumers abroad are reflected in the Footprint of the consuming rather than the producing country.

In a world of growing resource constraints, development that ignores ecological limits simply will not last. For a time, wealthier countries may be able to obtain increasingly expensive resources by importing them from other countries. Less wealthy countries will not have this option, and may need to depend more on their own biocapacity. But globally, when humanity's Footprint exceeds the planet's biocapacity, buying our way out is not an option, as there is no one else with whom to trade. The result of this overshoot is two-fold: an accumulation of wastes such as carbon dioxide in the atmosphere, and the liquidation of ecosystem stocks (trees in the forest, fish in the ocean) that have gradually amassed over time. Today we are seeing clear consequences of ecological overshoot in land degradation, collapsed fisheries, a rapid rate of biodiversity loss, and a changing climate. When ecosystem depletion is too extensive or has gone on for too long, restoration can take a long time, and even with a tremendous amount of effort a degraded ecosystem may not return to former levels of productivity and biodiversity.

In 2005, the most recent year for which data is available, humanity's Ecological Footprint was 17.4 billion global hectares (gha), or 2.7 gha per person. A global hectare is a hectare of productive land or sea with world-average bioproductivity (i.e., ability to generate resources and absorb carbon dioxide emissions). In that same year, there were 2.1 gha available per person, meaning that human demand on biocapacity exceeded supply by 30 percent.

Figure 1.1. Ecological Footprint per person, by country, 2005



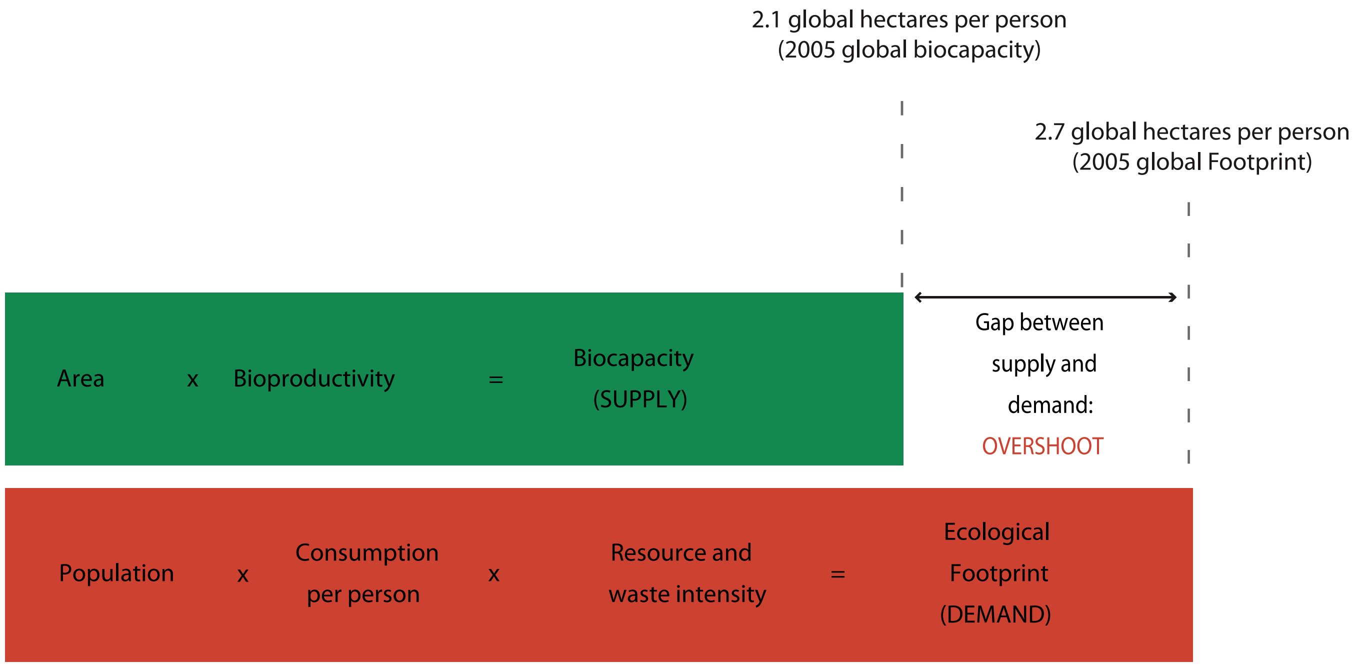
Source: Global Footprint Network, The Ecological Footprint Atlas, 2008.

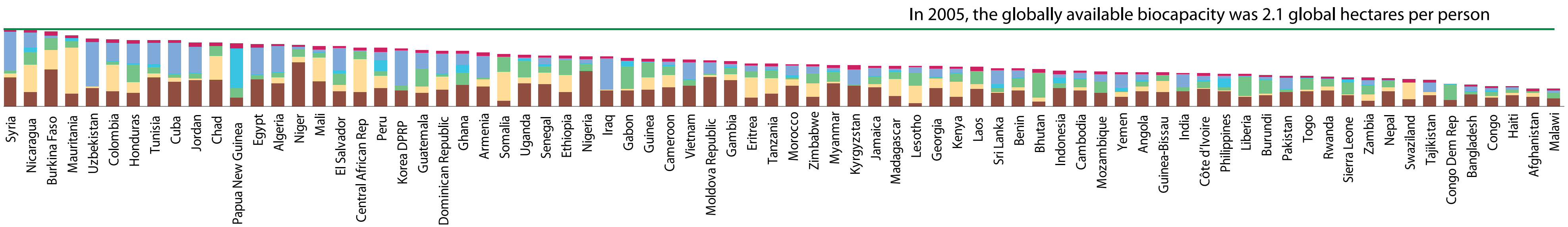
Three factors determine a population's Ecological Footprint: the number of people consuming, the amount of goods and resources consumed by the average person, and the resource and waste intensity of the goods and services that are consumed. Two factors determine available biocapacity: the amount of productive area, and how much it yields per hectare.

In 2005, Africa had more biocapacity than it was using, in part because the continent as a whole had an average Footprint of 1.4 gha per person, about half the global average. While per capita consumption in Africa has been relatively constant from 1961 to 2005, its total Footprint increased by 2.5 times – largely as a result of its population growing three-fold over the same period.

If benefits from progress in human development are to last, stocks of natural capital and the health of these assets will need to be maintained. Minimizing resource and waste intensity of goods and services is one key to reducing pressure on natural capital, and there are many opportunities to do so in Africa, as elsewhere. Technological and management advances that support leapfrogging of outmoded, resource-intensive modes of production can help African nations maintain biocapacity while simultaneously advancing human well-being and prosperity.

Figure 1.2. Footprint and biocapacity factors that determine global overshoot





With 14 percent of the world's population, Africa has 12 percent of total global biocapacity, concentrated primarily in its sub-Saharan region. In 2005 Africa's biocapacity was 1.6 billion global hectares, and while that is still greater than its total Footprint of 1.2 billion global hectares, the gap is quickly narrowing. This is largely because population has been increasing at a much faster rate than biocapacity. In 1961, Africa's biocapacity was more than triple the size of its Footprint; by 2005 the margin of difference between biocapacity and Footprint had decreased to less than one third.

Map 1.1 shows the changes in per capita biocapacity from 1961 to 2005 for all countries. The average biocapacity available per person declined in every African country, with losses ranging from a third in Egypt to 75 percent or more in Togo, Tanzania, Congo, Zimbabwe, Democratic Republic of Congo, Niger and Benin.

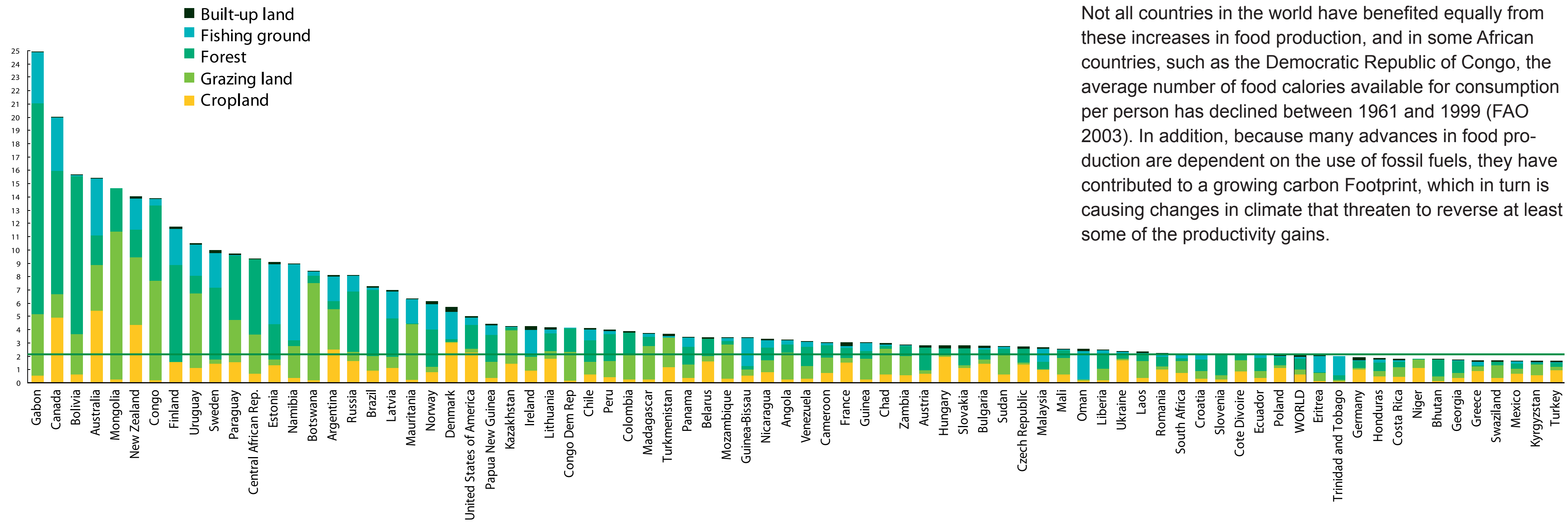
As competition for ecological resources and services increases, effective management of biocapacity will help ensure a nation's well-being, and can provide a potential source of continuing income through trade. The majority of African countries are still ecological creditors, with more biocapacity than they use to meet their own consumption demands. In a globalized economy, this does not mean they are meeting all of their own needs with their domestic biocapacity, nor does it necessarily imply that they should be doing so. But it also does not necessarily mean that there is excess biocapacity in creditor nations that is lying idle, as this biocapacity may be supporting consumption in other countries through exports or the sequestering of global carbon dioxide emissions.

In a recently developing global trend, rather than purchasing exported goods produced with another country's biocapacity, countries and businesses are buying the direct rights to that biocapacity itself. African biocapacity has become increasingly attractive to investors from both outside and within the continent seeking to ensure continued access to food, biofuel crops, and other resources. China, for example, has leased 2.8 million hectares in the Congo for the rights to its palm oil production, while Egypt has obtained the rights to hundreds of thousands of wheat-producing hectares in the Sudan (*Economist,* May 2009).

As shown in Figure 1.4, there are two ways in which biocapacity can be increased: by expanding the area of bioproductive land, and by improving yields. In the agricultural sector, increases in global food production over the last 40 years were due in varying degrees to the use of higher yielding crops, greater reliance on fertilizer and pesticide inputs, and an increase in irrigation. During that time the area of cropland under cultivation globally grew by 12 percent and land reliant on irrigation increased by 70 percent (Khan and Hanjra 2009).

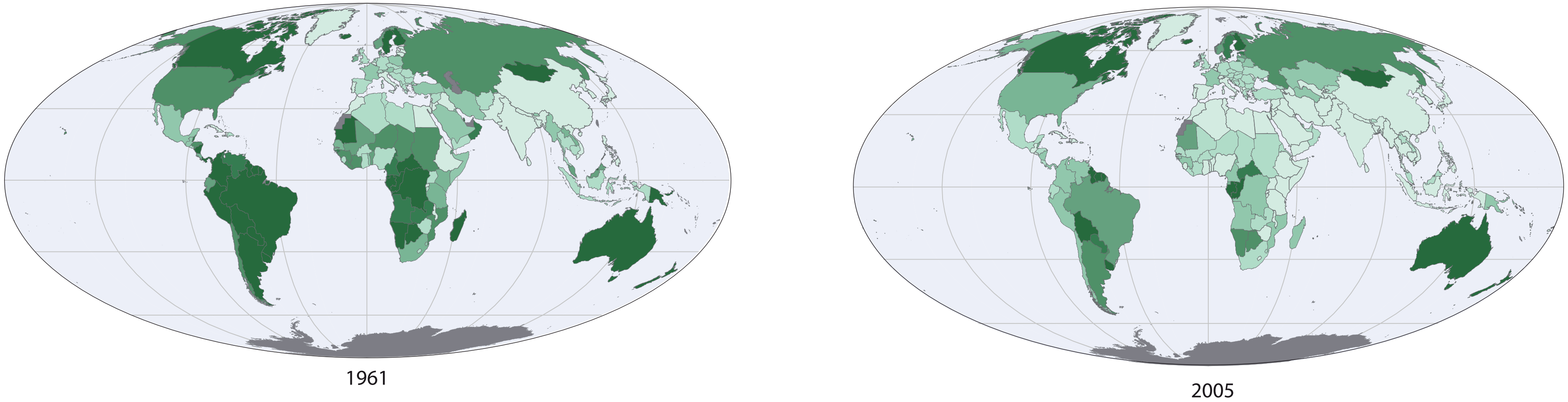
Not all countries in the world have benefited equally from these increases in food production, and in some African countries, such as the Democratic Republic of Congo, the average number of food calories available for consumption per person has declined between 1961 and 1999 (FAO 2003). In addition, because many advances in food production are dependent on the use of fossil fuels, they have contributed to a growing carbon Footprint, which in turn is causing changes in climate that threaten to reverse at least some of the productivity gains.

re 1.3. Biocapacity per person, by country, 2005



Source: Global Footprint Network, The Ecological Footprint Atlas, 2008.

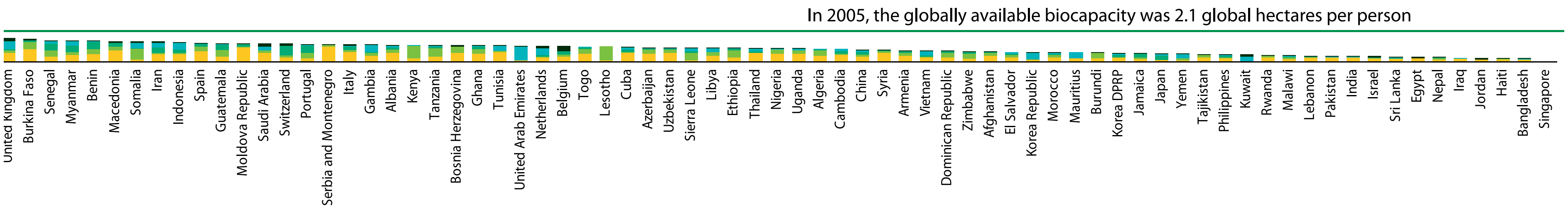
Map 1.1. Biocapacity per person, by country (1961 and 2005)



Biocapacity per capita

- 0 to 1.5 gha per capita
- 1.5 to 3.0 gha per capita
- 3.0 to 4.5 gha per capita
- 4.5 to 6.0 gha per capita
- 6.0 to 7.5 gha per capita
- 7.5 to 9.0 gha per capita
- 9.0 to 10.5 gha per capita
- More than 10.5 gha per capita
- Insufficient data

Source: Global Footprint Network, The Ecological Footprint Atlas, 2008.



The well-being of human society is intricately linked to the biological capital on which it depends. Accounting for the biological capacity available to, and used by, a society can help identify opportunities and challenges in meeting human development goals.

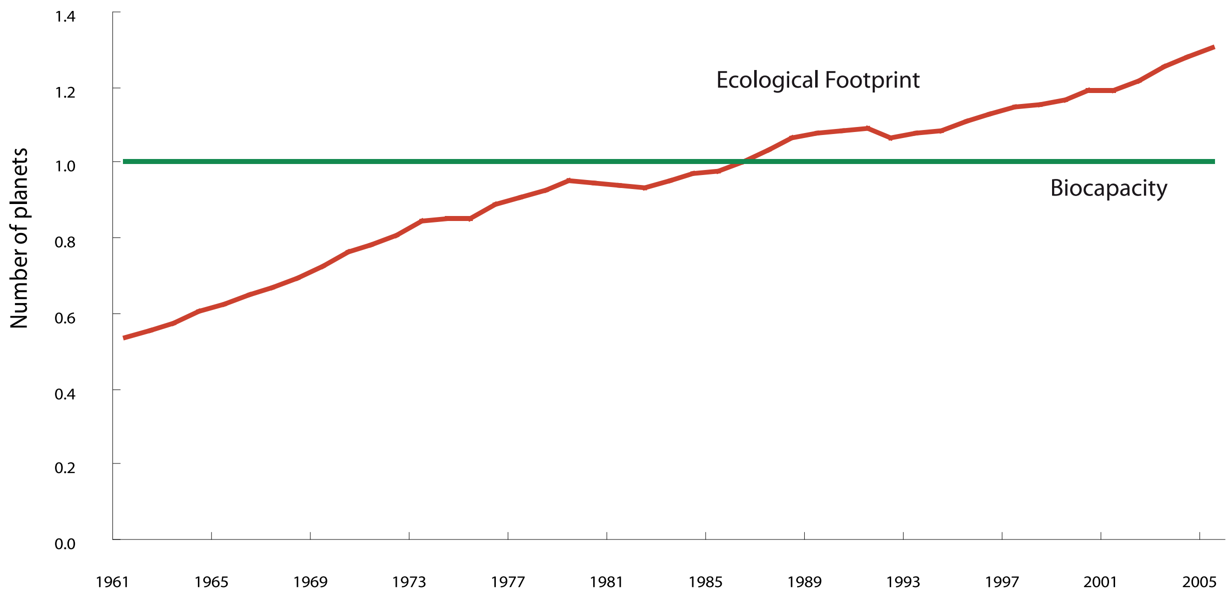
The loss in human well-being due to ecological degradation often comes after a significant time delay, and is difficult to reverse (e.g., over fishing can occur for many years before catches start to plummet). Short-term methods to improve human lives – such as water purification, basic medicine, and electricity for hospitals – must be complemented by effective resource management in order to address and reverse the cumulative ecological degradation that results from ecological overshoot (when human demand on ecosystems exceeds biocapacity).

Overshoot can continue for some time, by liquidating resource stocks, and allowing wastes such as carbon dioxide to accumulate in the biosphere. But eventually, fisheries will collapse, surface water and groundwater will grow scarce, and forests will disappear. Such resource scarcity will disproportionately impact those who cannot immigrate to more plentiful regions or afford imports.

The challenge of reaching a high level of human well-being while ensuring long-term resource availability is illustrated at the global level on the facing page.

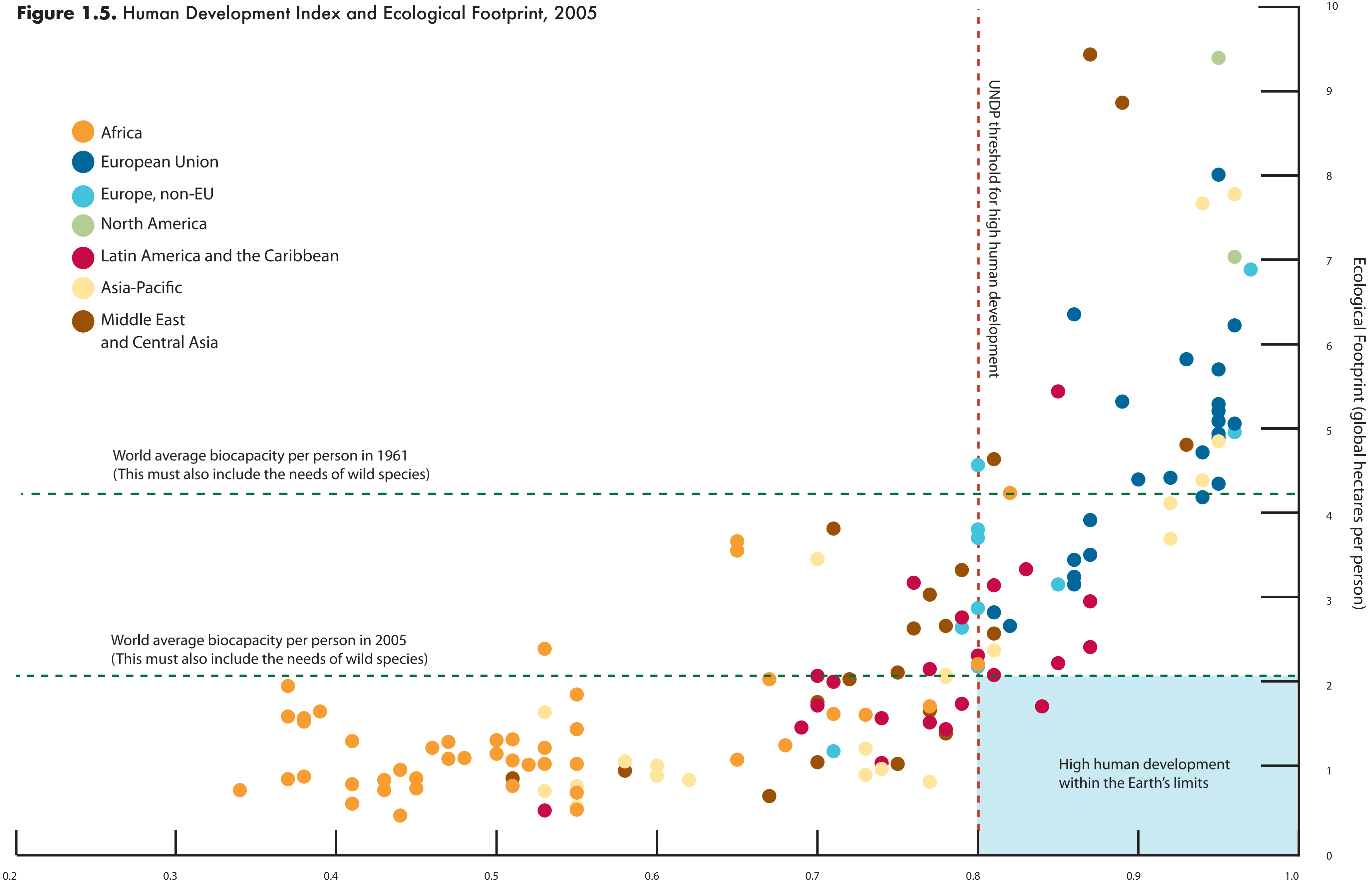
The United Nations Development Programme (UNDP) defines a high level of development as an HDI score of 0.8 or above, while 2.1 global hectares is the average productive area available for each person on the planet. A country with an HDI score of 0.8 or higher and a Footprint of 2.1 global hectares per person or lower meets two minimum criteria for global sustainable development: a high level of development, and a resource demand that could be globally replicated. Countries that meet both criteria are shown in the lower right quadrant. Despite growing adoption of sustainable development as an explicit policy goal, most countries do not meet both minimum conditions.

Figure 1.4. Ratio of humanity's Ecological Footprint to world's available biocapacity, 1961-2005



Source: Global Footprint Network; The Ecological Footprint Atlas, 2008.

Figure 1.5. Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; UNDP. Human Development Report, 2007.

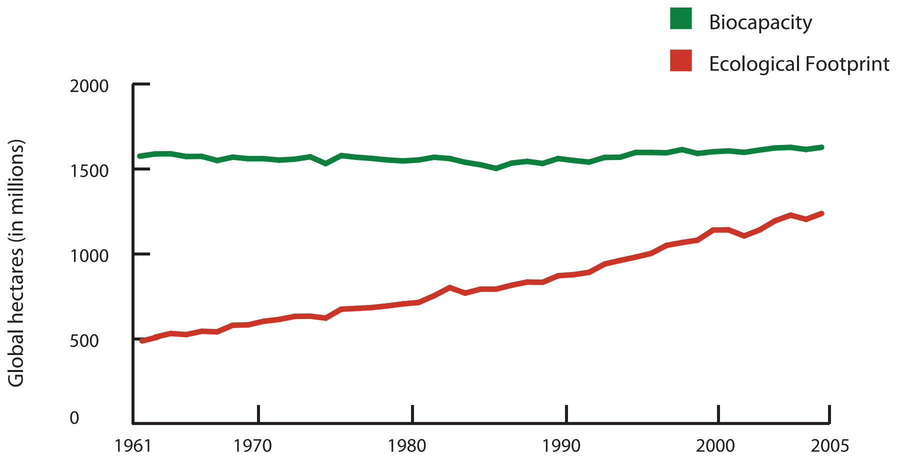


Figure 2.1. Africa total biocapacity and Ecological Footprint, 1961-2005

Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Africa occupies 3,031.5 million hectares of land. Of those, 632.5 million are forest, 238.7 million are cropland, 899.8 million are grazing land, and 26.8 million support the continent's built infrastructure. Bordering the Mediterranean Sea, Atlantic Ocean, and Indian Ocean, Africa also has 119.6 million hectares of continental shelf and 67.1 million hectares of inland water.

Taking into account differences between average African yields for cropland, grazing land, forest and fisheries as compared with corresponding global yields, Africa's total biocapacity is 1,627.1 million global hectares (gha). This is more than its total Ecological Footprint of 1,237.5 million gha.

Africa's average Ecological Footprint per person is 1.4 gha, while the global average Footprint is 2.1 gha. Compared to the rest of the world, the average African's footprint is small, and for many, it is too small to meet basic food, shelter, health and sanitation needs. In order to make vital quality of life improvements, large segments of Africa's population must have greater access to natural resources. Yet Africa's growing population and the world's escalating resource consumption are making this increasingly difficult.

Africa's Ecological Footprint per person is also smaller than the 1.8 global hectares of biocapacity available per person within Africa. At the moment, Africa has more biocapacity than it is using, but this margin is rapidly shrinking due largely to population growth. The continent's population grew from 287.3 million to 902.0 million between 1961 and 2005. During this same period, the biocapacity available per person in Africa decreased by 67 percent.

Although there are many resource-rich countries throughout the African continent, Africa as a continent is on the verge of an ecological deficit. If current population, consumption and export trends continue, Africa's ecological demand will eventually exceed its supply.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro-Ecological Zones, 2008; Global Land Cover, 2000.

Table 2.1. Ecological Footprint, Economy and Human Development (2005)

	Africa	World
Population	901,966,000	6,475,634,000
Total Ecological Footprint (Thousands of global hectares)	1,237,531	17,443,626
Total Biocapacity (Thousands of global hectares)	1,627,091	13,360,955
Per person Ecological Footprint (Global hectares)	1.4	2.7
Per person Biocapacity (Global hectares)	1.8	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2008.

	Sub-Saharan Africa	World
Total GDP (Billions of USD)	639.8	45,179.2
Per person GDP (USD in Purchasing Power Parady)	1,643	8,713

Source: The World Bank. World Development Indicators database, 2005.

Human Development Index Value (0=min. 1=max.)	0.49	0.74
Adult Literacy Rate (percent adults over 18)	60.3	78.6
Gross Enrollment Ratio (percent eligible students enrolled)	50.6	67.8
Life Expectancy (years)	49.6	68.1
Access to Improved Water (percent of population, 2004)	55	83
Domestic Electrification (percent of population, 2005)	26	76

Sources: UNDP. Human Development Report, 2007;
The World Bank. World Development Indicators database, 2007;
International Energy Agency (IEA). World Energy Outlook, 2002.

Figure 2.2. Africa Ecological Footprint per person, 1961-2005

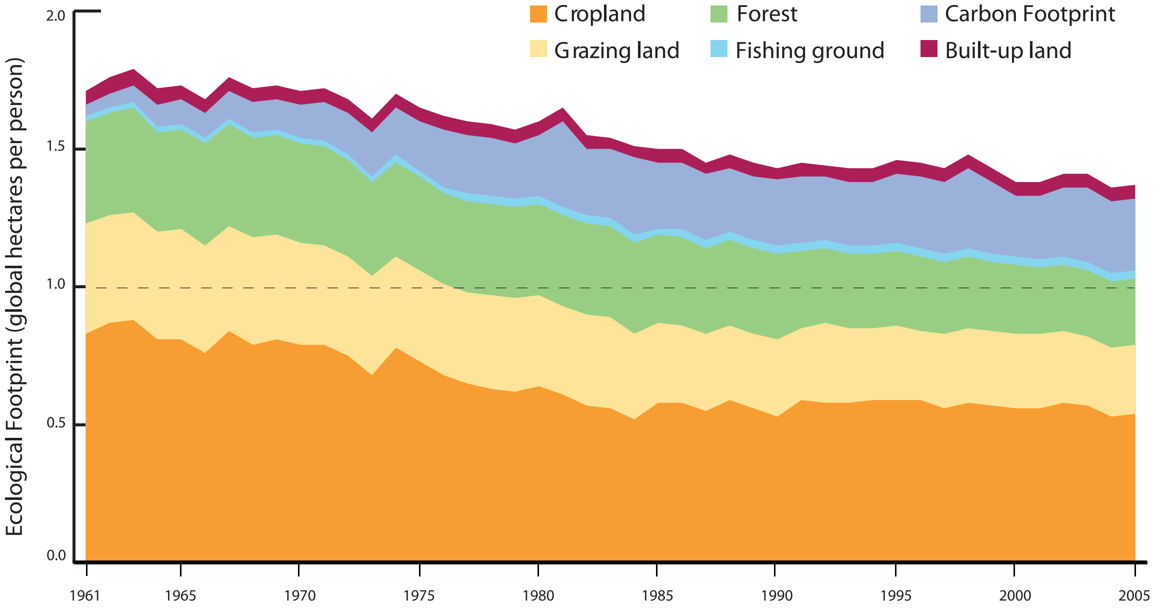


Table 2.2. Africa Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.83	0.40	0.37	0.02	0.04	0.05	1.70
1965	0.81	0.40	0.36	0.02	0.09	0.05	1.71
1970	0.79	0.37	0.36	0.02	0.12	0.05	1.70
1975	0.73	0.33	0.34	0.02	0.18	0.05	1.64
1980	0.64	0.33	0.33	0.03	0.22	0.05	1.58
1985	0.58	0.29	0.32	0.02	0.24	0.05	1.48
1990	0.53	0.28	0.31	0.03	0.24	0.04	1.41
1995	0.59	0.27	0.27	0.03	0.25	0.05	1.46
2000	0.56	0.27	0.25	0.03	0.22	0.05	1.37
2005	0.54	0.25	0.24	0.03	0.26	0.05	1.37

Figure 2.3. Africa biocapacity per person, 1961-2005

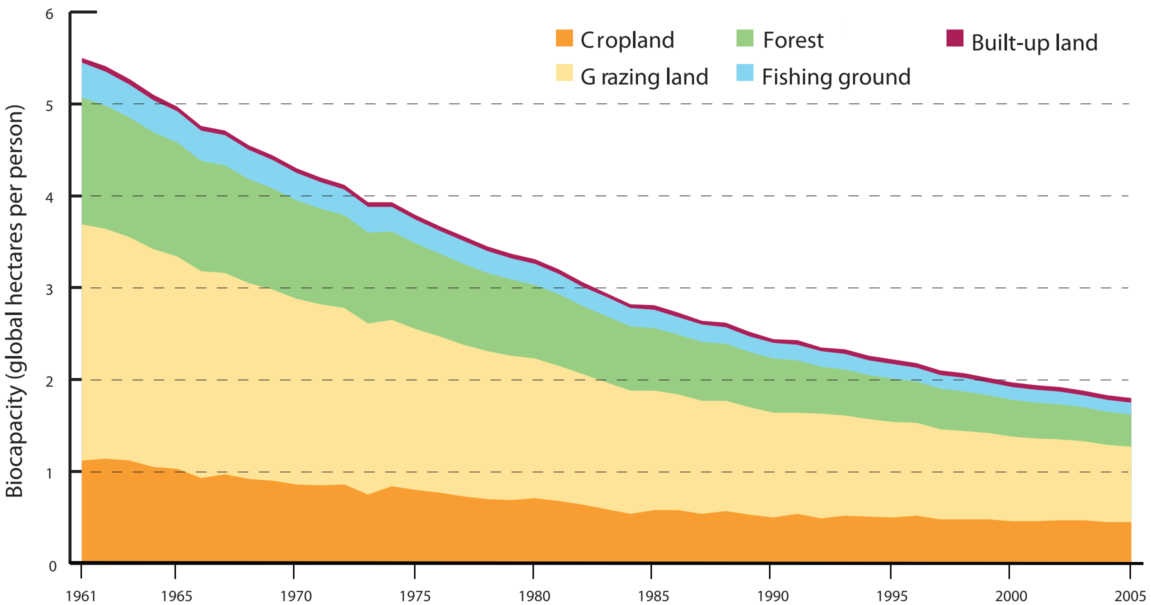


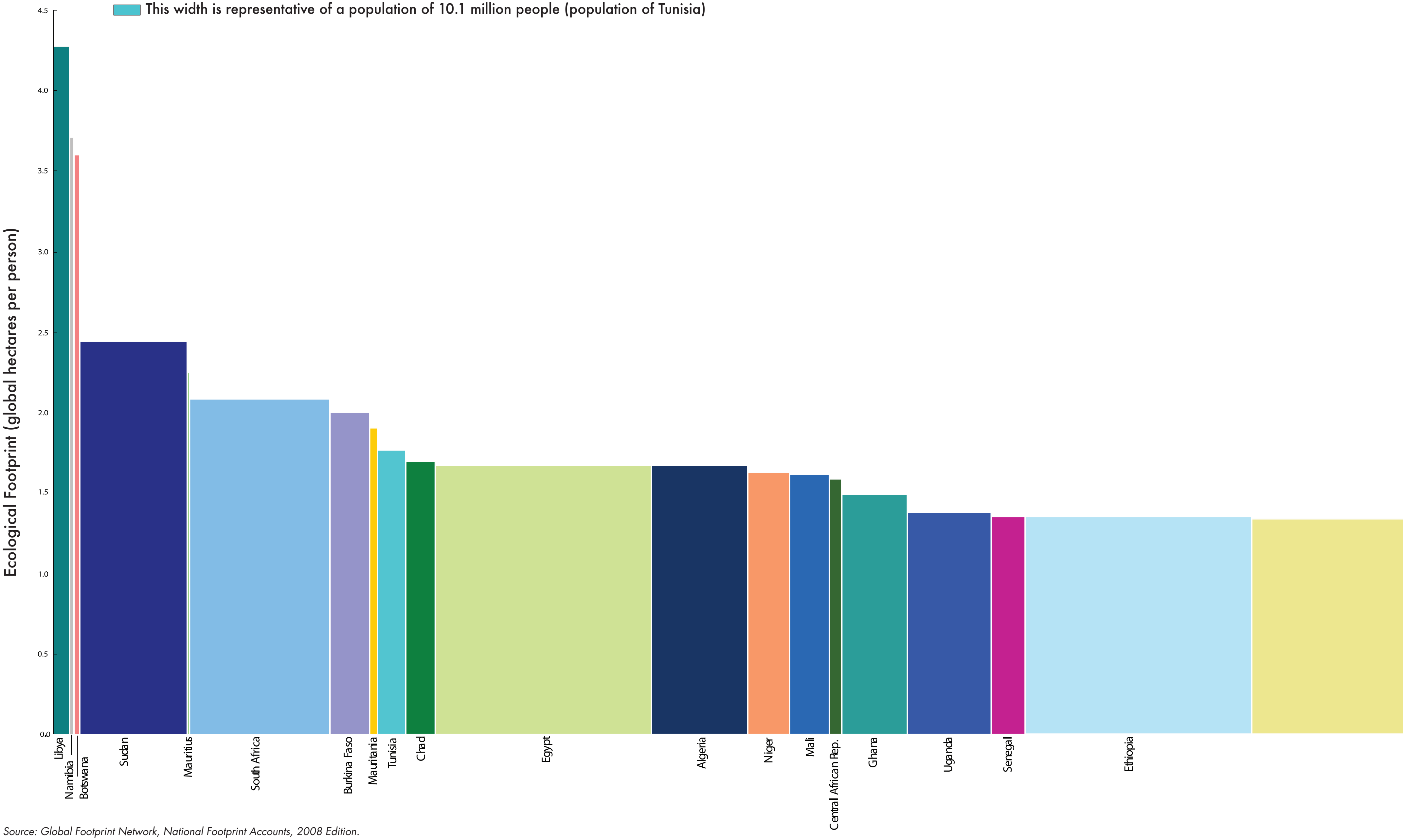
Table 2.3. Africa biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.12	2.57	1.38		0.38	0.05	5.48
1965	1.03	2.31	1.24		0.34	0.05	4.96
1970	0.86	2.02	1.07		0.30	0.05	4.29
1975	0.80	1.75	0.93		0.26	0.05	3.79
1980	0.71	1.52	0.80		0.23	0.05	3.29
1985	0.58	1.30	0.68		0.20	0.05	2.79
1990	0.50	1.14	0.59		0.17	0.04	2.43
1995	0.50	1.04	0.47		0.16	0.05	2.22
2000	0.46	0.92	0.40		0.14	0.05	1.97
2005	0.45	0.82	0.35		0.13	0.05	1.80

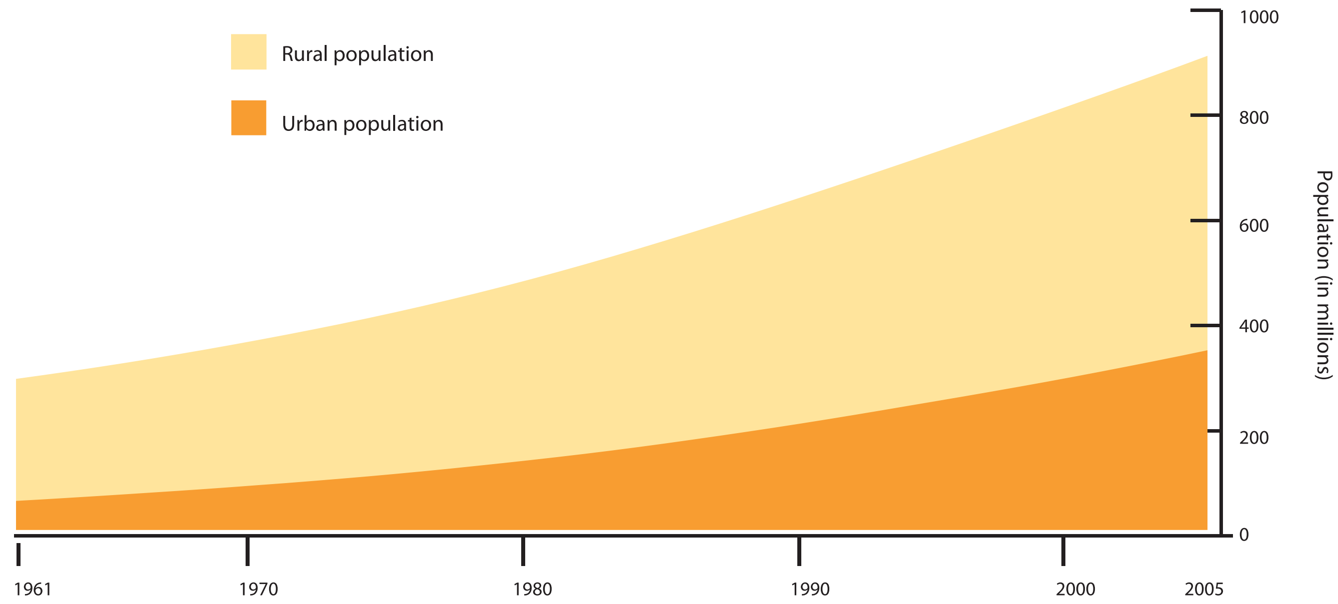
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 2.4. Ecological Footprint and population by African nation, 2005
Width of bar is proportional to population
This width is representative of a population of 10.1 million people (population of Tunisia)

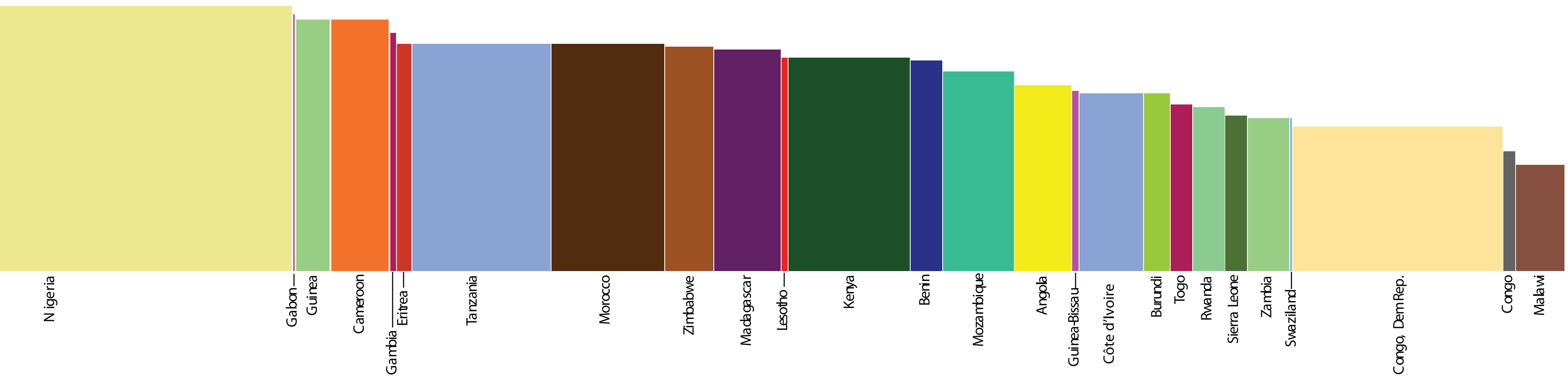


Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 2.5. Africa population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.



Availability of freshwater, especially in areas with low precipitation, is a critical factor in determining the biocapacity of forest, cropland, and grazing land. It is estimated that today 70 percent of human demand on global freshwater resources comes from the agricultural sector (FAO 2003).

Africa's climates vary widely, from an average annual rainfall of only 89 mm in the desert country of Algeria to 2,500 mm in tropical Sierra Leone (FAO 2006). The amount of water available both for domestic and for agricultural use can have a major impact on a region's ability to achieve economic and humanitarian goals. Figure 2.6 compares the amount of renewable water resources (surface and groundwater) available per country. Countries with a high population density and modest rainfall such as Egypt, Tunisia and Algeria use their renewable water resources well beyond the 20 percent threshold that is commonly used to define water scarcity (see Figure 2.6).

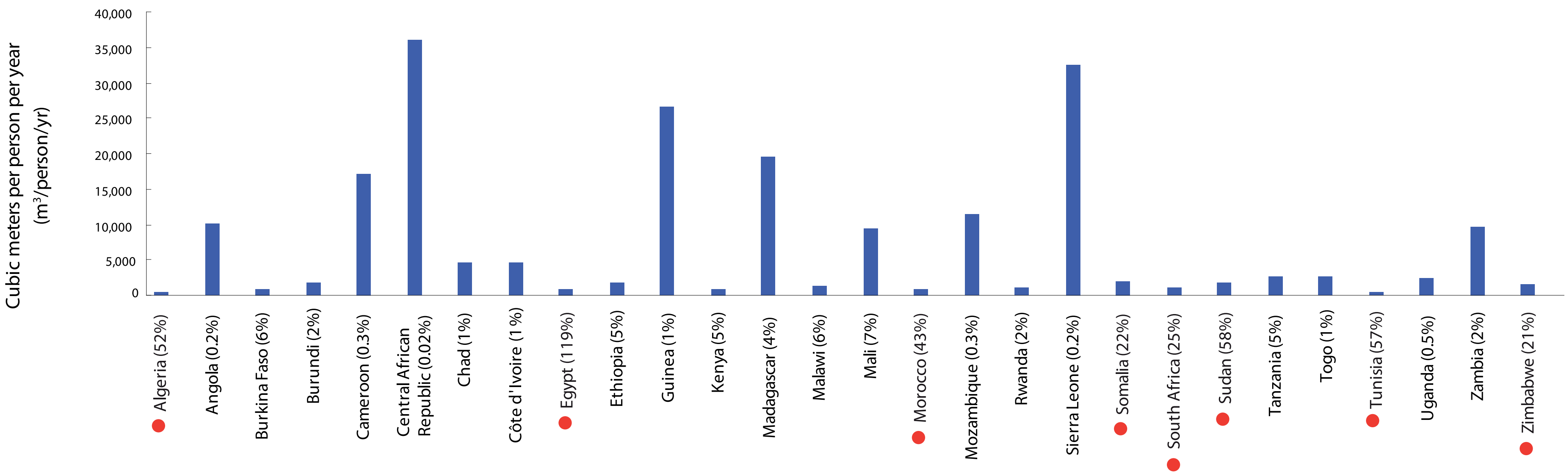
Water-scarce countries can meet some of their needs by importing foods that require high water volumes to produce. The Water Footprint (Hoekstra and Chapagain 2008) is a metric that tracks virtual water through the global trade of products, much as the Ecological Footprint tracks the embodied biocapacity in trade. While the consumption of virtual water can help alleviate local demand on scarce water resources, it may also increase the carbon portion of the Ecological Footprint, as water intensive products are transported from afar.

In sub-Saharan Africa, many countries with abundant water resources have very low per capita water usage. Even where local water supplies are abundant, lack of infrastructure is a major barrier to making water readily available for domestic use and livelihoods. For example, Cameroon has less than one percent of its total cultivated area equipped for irrigation (FAO 2006). Investment in water storage cisterns and irrigation technology can help boost cropland biocapacity and maintain crop yields during dry periods.

However, irrigation is not without its challenges. Salts present in irrigation water can accumulate in the soil leading to land degradation and loss of productivity. If energy for pumping comes from fossil fuels, this can significantly increase a country's carbon Footprint. One study estimates that a full third of India's power demand comes from the use of irrigation pumps (Khan and Hanjra 2005).

Figure 2.6. Renewable water resources per person, 1998-2002

Percentages following country names indicate the ratio of total water withdrawal to renewable water resources.
Red dots indicate water-scarce countries, defined as countries whose withdrawals exceed 20% of their annual available water (Rijsberman 2006).



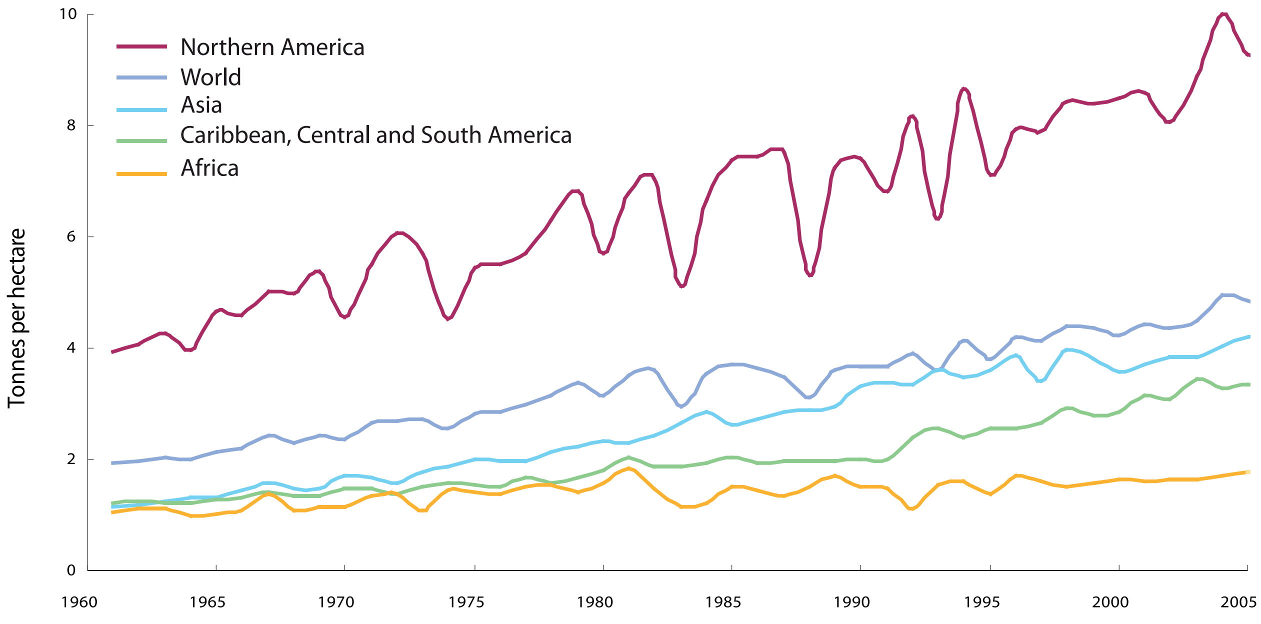
Sources: Food and Agriculture Organization (FAO). AQUASTAT, 2006.

Thirty percent of sub-Saharan Africans were malnourished in 2005; in Africa as a whole, 212 million people were malnourished that year (FAO 2008d). The shortage of food in Africa is directly related to the continent's relatively low food productivity, compared to population growth rates. Productivity gains in the last 40 years have been more modest in Africa than in other regions (Figure 2.7).

Soil fertility in Africa is limited in part by soils inherently low in nutrients, particularly in the sub-Saharan region (Koning and Smaling 2005). In addition, farmers are either unaware of or not incentivized to implement management practices that replenish soil nutrients. For example, because of population and economic pressures, an increasing number of African farmers are shortening or eliminating fallow periods from their crop rotations, which allow nutrient regeneration (Khan and Hanjrah 2009).

The result has been that Africa has been rapidly losing soil fertility. A study of soils from 37 African countries showed that on average 22 kilograms of nitrogen, 2.5 kilograms of phosphorous and 15 kilograms of potassium have been lost per cultivated hectare per year over the last 30 years. Fossil-based fertilizers to replace these nutrients not only increase a nation's carbon Footprint, but they are much more expensive in Africa than elsewhere, and are too costly for many African farmers to use (Sanchez 2002).

Figure 2.7. Maize yields, by region, 1961-2005



Source: Food and Agriculture Organization (FAO). ProdSTAT 2008b.

Solutions that make use of local resources can help alleviate the downward spiral of poverty and environmental degradation that restricts food availability with devastating results on human well-being.

The International Centre for Research in Agroforestry (ICRAF) advocates for a suite of local technologies that promote soil productivity without producing other negative environmental effects. One such example is the use of leguminous native trees. These trees improve soil quality by fixing nitrogen in the soil during the fallow season. The trees can also provide firewood revenue for farmers, decreasing the demand for wood from nearby forests. Phosphorous deficiency, prevalent in East Africa, can be ameliorated through the addition of locally available phosphate rocks which readily dissolve in the region's acidic soils. ICRAF also recommends amending the soil with leaves from a nutrient-rich species, *Tithonia diversifolia*, which is common on roadsides and is especially effective in boosting maize productivity (Sanchez 2002).

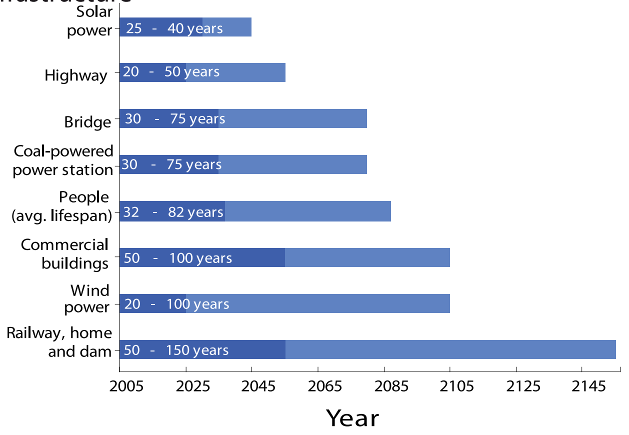
While these techniques may not be effective in all regions of the continent, they are successfully being used to boost agricultural biocapacity in Tanzania, Kenya, Uganda, Malawi, Zambia, Zimbabwe and Mozambique (Sanchez 2002). Such sustainable soil management techniques often provide benefits beyond increasing productivity. Composting, cover cropping and conservation tillage, for example, can increase retention of water in soils, improving water efficiency, as well as increase the amount of carbon that remains sequestered in soil.

Future well-being and resource requirements will depend to a great degree on the infrastructure investments that are made today. Because of the long life span of most types of infrastructure, what we build can influence resource use for decades or more. Power plants, highways, dams, and buildings, for example, often last 50 to over 100 years (Figure 2.8.).

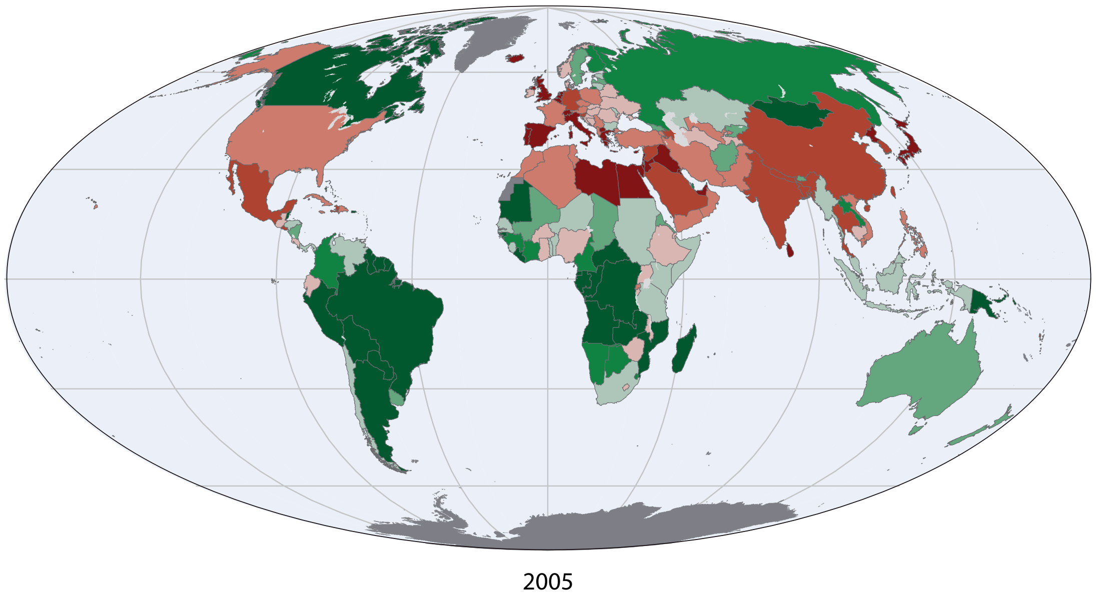
As a growing majority of the world's population resides in urban areas, cities will play an increasingly important role in meeting the sustainable development challenge. The infrastructure choices cities make can lock them into economically and ecologically risky paths of high resource dependence, or they can increase cities' resilience in the face of growing resource constraints.

Africa has some of the fastest growing cities in the world. In many cases, infrastructure is not keeping pace with soaring demand. As a result, a high percentage of residents are living in slums (UN-HABITAT 2003). Infrastructure investments in energy, transportation, and buildings for health clinics and schools provide benefits that increase a country's literacy, wealth and health, the three indices reflected in the Human Development Index. If these infrastructure choices can be made in a way that also promotes the city's or region's resource efficiency, they will provide gains in human well-being that can persist for future generations.

Figure 2.8. Lifespan of people, assets and infrastructure



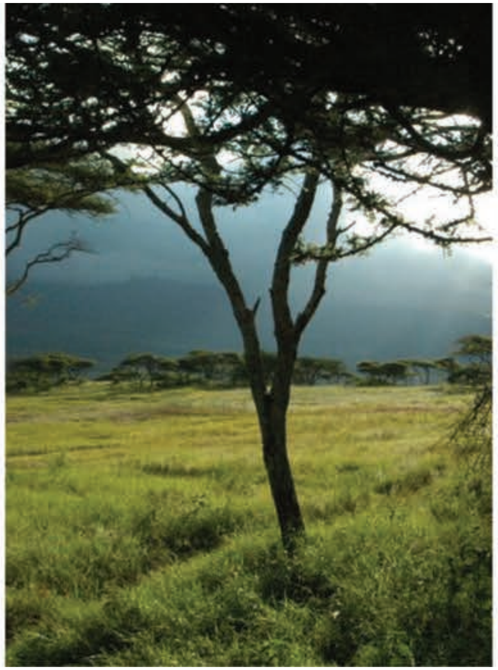
Map 2.1. Ecological Creditor and Debtor Countries, 2005



Source: Global Footprint Network, The Ecological Footprint Atlas, 2008.

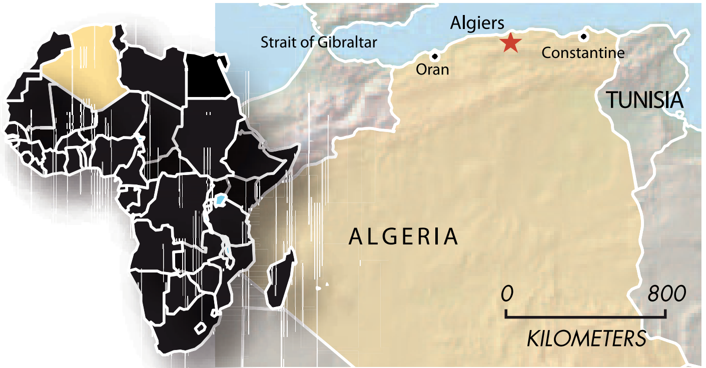
To make optimal infrastructure and development decisions, countries need accurate information about their resource demands and their ability to satisfy these demands. Ecological Footprint and biocapacity data provide part of this needed information. In order to ensure that the data are as accurate and useful as possible, Global Footprint Network invites collaborations with nations to improve their own National Footprint Accounts, which convert resource consumption and carbon emissions data into Ecological Footprint and biocapacity values. Nations including Switzerland, Japan, and the United Arab Emirates are currently engaged in or have concluded research collaborations.

Global Footprint Network also develops initiatives to help countries better understand and use their Ecological Footprint results for policy and decision-making. One key initiative is designed to help countries explore the implications of being an ecological creditor nation, with more biocapacity than it uses for its own consumption, or conversely, an ecological debtor nation (Map 2.1.). The initiative focuses on managing the use and preservation of biocapacity as a way to ensure continuing national and global well-being.


"Development that ignores the limits of our natural resources ultimately ends up imposing disproportionate costs on the most vulnerable."

Mathis Wackernagel, Ph.D., President
Global Footprint Network



Algeria occupies 238.2 million hectares. Of those, 2.3 million are forest, 8.3 million cropland and 34.4 million grazing land, and 1.0 million are covered by built infrastructure. In addition, bordering the Mediterranean Sea, Algeria has 1.0 million hectares of continental shelf. The second largest country in Africa after Sudan, Algeria is largely desert, with its southern area extending into the Sahara.

Adjusting for its cropland, grazing land, forest and fishery yields, which are lower than the global averages, Algeria's biocapacity is 30.6 million global hectares (gha). This is less than its Ecological Footprint of 54.6 million gha. Algeria has been running an ecological deficit since 1976.

Algeria's average Ecological Footprint per person is 1.7 gha, smaller than both the global average Footprint and the biocapacity available per person on the planet. However, this is considerably larger than the 0.9 gha of biocapacity available per person within Algeria. As the country's population grew from 11 million to 32.9 million between 1961 and 2005, biocapacity per person in Algeria decreased by 55 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 3.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Algeria	32,854,000	54,682	30,641	1.66	0.93
World	6,475,634,000	17,443,626	13,360,955	2.70	2.10

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	102.3	6,062

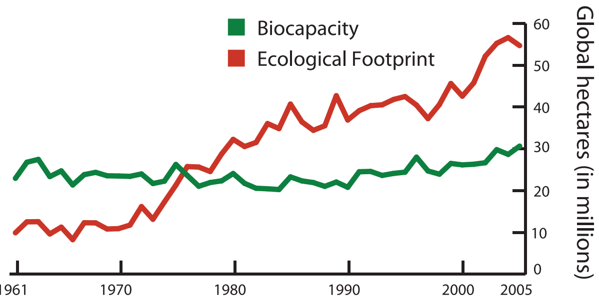
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	42.6	22.7	16.1	11.6	7.0

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Algeria	Female	Male
Human Development Index Value (0=min. 1=max.)	0.733	–	–
Adult Literacy Rate (percent adults over 18)	69.9	60.1	79.6
Gross Enrollment Ratio (percent eligible students enrolled)	74.0	75	73
Irrigated Cropland (percent of total, 2000)	6.9	–	–
Access to Improved Water (percent of population, 2002)	85	–	–
Domestic Electrification (percent of population, 2000)	98	–	–
Undernourishment (percent of population, 2000)	1	–	–
Life Expectancy (years)	71.7	73.0	70.4

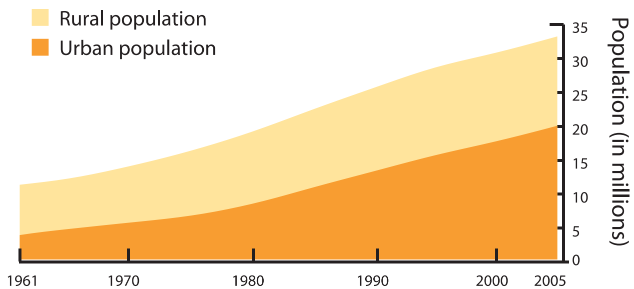
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 3.1. Algeria total Ecological Footprint and biocapacity, 1961-2005



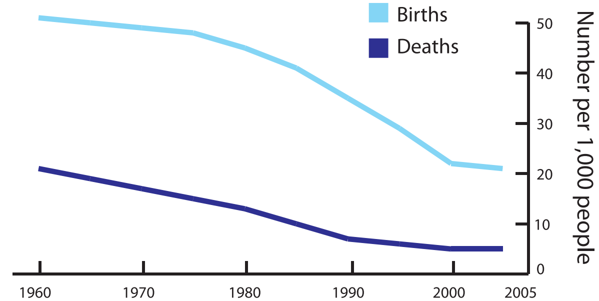
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 3.2. Algeria population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 3.3. Algeria birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 3.4. Algeria Ecological Footprint per person, 1961-2005

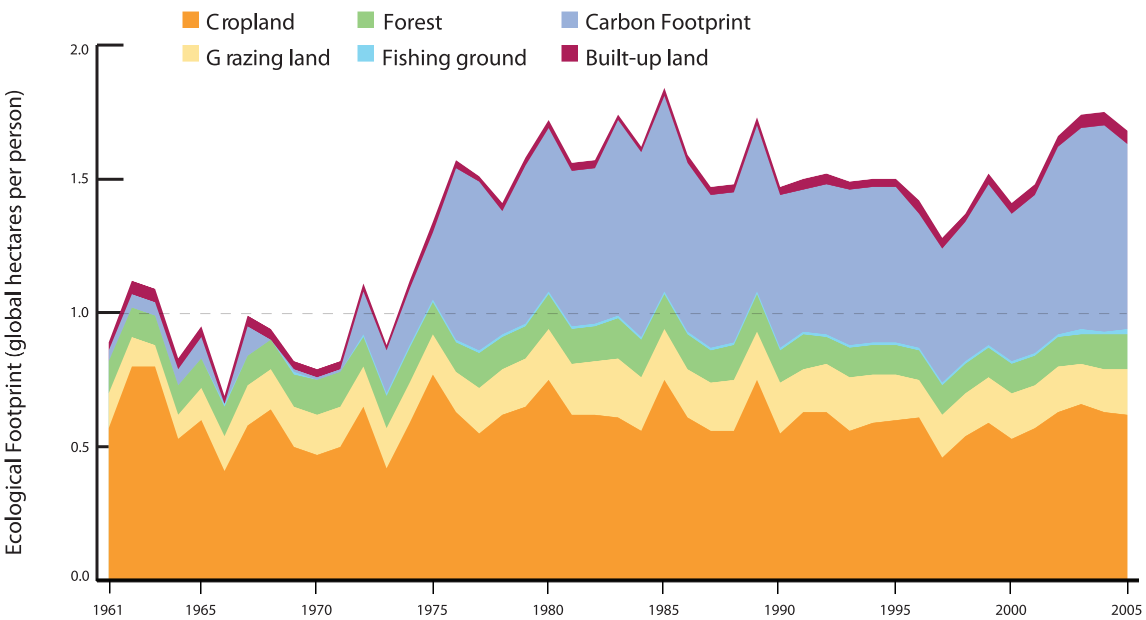


Figure 3.5. Algeria biocapacity per person, 1961-2005

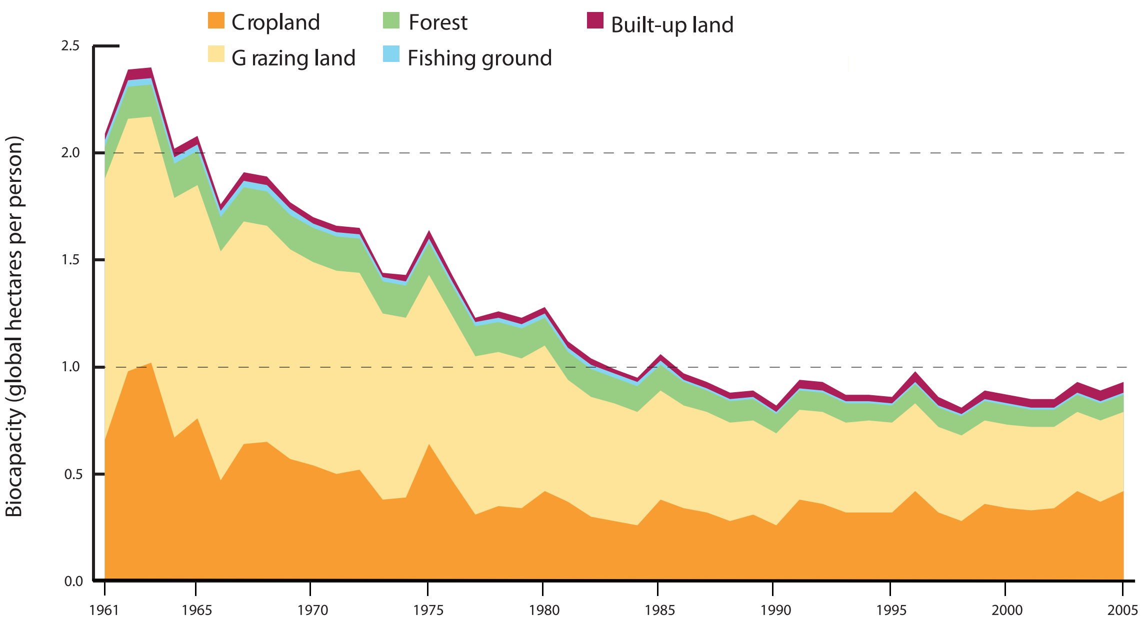


Table 3.2. Algeria Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.57	0.13	0.12	0.04	0.00	0.03	0.90
1965	0.60	0.12	0.11	0.08	0.00	0.04	0.95
1970	0.47	0.15	0.13	0.01	0.00	0.03	0.79
1975	0.77	0.15	0.12	0.25	0.01	0.04	1.33
1980	0.75	0.19	0.13	0.61	0.01	0.03	1.72
1985	0.75	0.19	0.13	0.73	0.01	0.03	1.84
1990	0.55	0.19	0.12	0.57	0.01	0.03	1.46
1995	0.60	0.17	0.11	0.58	0.01	0.03	1.50
2000	0.53	0.17	0.11	0.55	0.01	0.04	1.40
2005	0.62	0.17	0.13	0.69	0.02	0.05	1.66

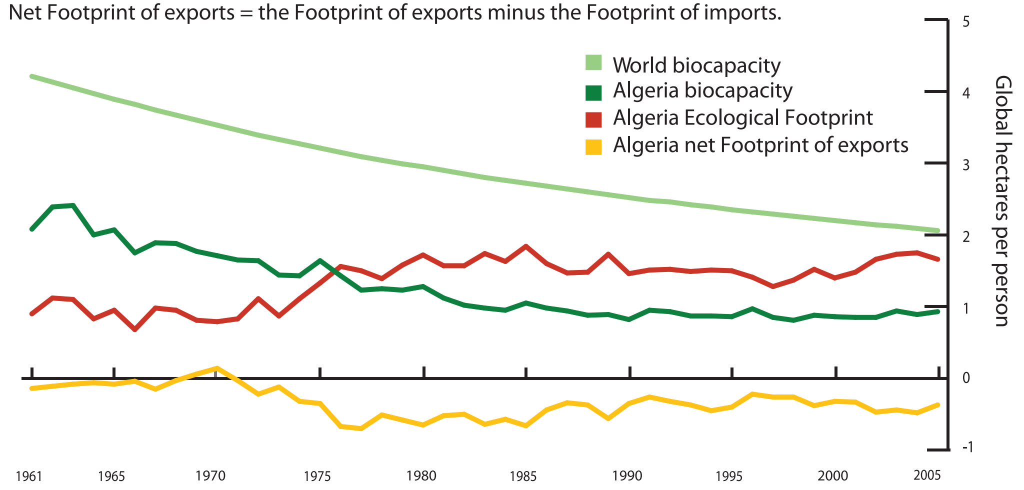
Table 3.3. Algeria biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.66	1.22	0.15		0.03	0.03	2.08
1965	0.76	1.09	0.16		0.03	0.04	2.07
1970	0.54	0.95	0.16		0.02	0.03	1.71
1975	0.64	0.79	0.15		0.02	0.04	1.64
1980	0.42	0.68	0.13		0.02	0.03	1.28
1985	0.38	0.51	0.12		0.02	0.03	1.05
1990	0.26	0.43	0.09		0.01	0.03	0.82
1995	0.32	0.42	0.08		0.01	0.03	0.86
2000	0.34	0.39	0.09		0.01	0.04	0.86
2005	0.42	0.37	0.08		0.01	0.05	0.93

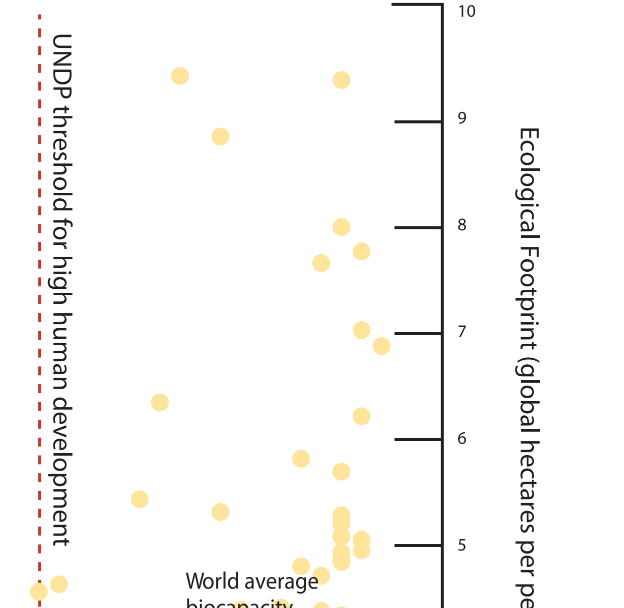
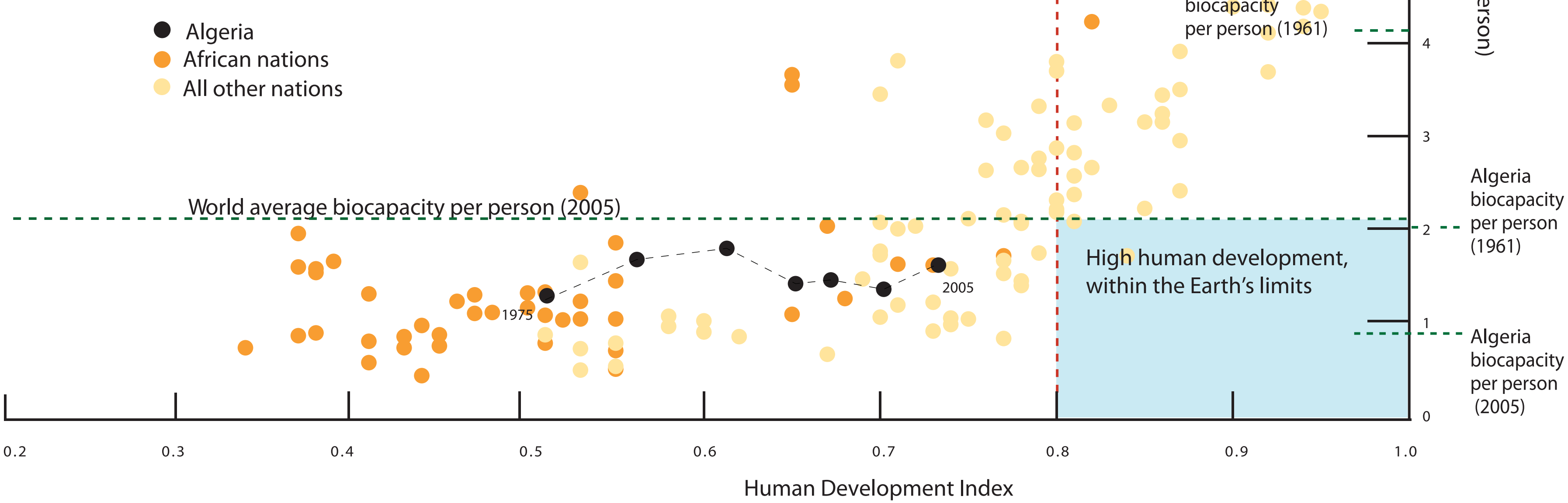
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 3.6. Algeria Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 3.7. Algeria Human Development Index and Ecological Footprint, 2005

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP. Human Development Report, 2007.

Urban Growth in Algeria Versus Ecological Carrying Capacity

Prof. Ewa Berezowska-Azzag

Research Director
Architect & Urban Planner

VUDD Research Laboratory;
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Algeria is endowed with rich natural resources and a diversity of climates and landscapes. Together, Algeria's 10 nature reserves, Five sustainable development pilot areas and 42 sites protected under the 1971 Ramsar Convention occupy more than 22 percent of the country's land area. Its energy resources include geothermal, oil and solar power (MATE 2005).

With 60 percent of Algeria's population living in cities, it is predicted that by 2025 nearly 80 percent of the country's residents will reside in one of Algeria's four metropolitan areas. These urban areas account for the majority of the country's natural resource consumption.

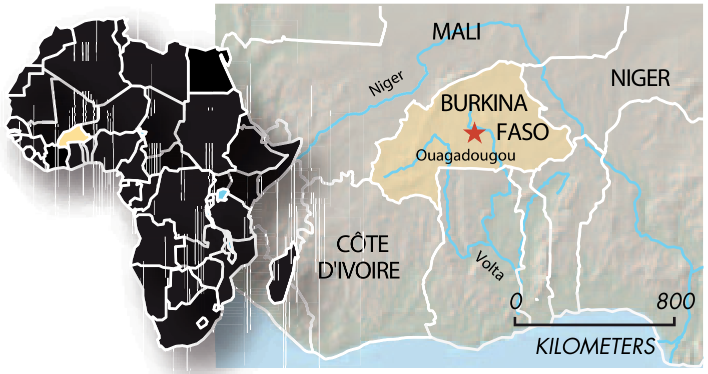
In Algeria, 5-10 billion cubic meters of freshwater are available for consumption per year; however predictions show that beyond 2010 this will not be sufficient to meet Algeria's water needs (MATE 2007). Each year, 100 million meters cubed of waste water are released into Algeria's environment without treatment. Twenty million hectares of arable land are impacted by desertification, while 12 million hectares are impacted by soil erosion. Since 1995, forest stocks have declined 21 percent, and 250,000 hectares of agricultural land have been lost to construction. Seven million tonnes of solid wastes are produced each year in Algeria, with only a 12 percent recycling rate (MATE 2005). It is clear that decreasing natural resource stocks in Algeria will impact the ability to sustain a high level of human development within the urban ecosystem.

According to the National Territory Management Scheme (SNAT), development in the majority of Algeria's urban communities has been slowed because of a lack of or destruction of natural capital (MATE 2007). Despite its wealth of natural resources, by 2030, Algeria is predicted to suffer serious food shortages, water stresses and energy depletion, within the global context of a world economic crisis and climate change (CIHEAM 2009).

The Algiers metropolitan area is a critical economic center and home to 5.4 million inhabitants, 15 percent of the entire Algerian population. With a rapid influx of migrants fueling a boom in the area's population, Greater Algiers requires significant infrastructure, housing and transportation upgrades, as well as investment to foster industry and job creation (ONS 2008).

Yet Algiers faces a clear development paradox. At the same time it seeks to provide a reasonable quality of life for its growing number of residents, the city's available productive land, water and energy resources are disappearing. The decline of local ecological resources is curbing the possibility of metropolitan development. In Greater Algiers, land for urbanization use has been restricted, and the once-rich agricultural plain of Mitidja is shrinking due to urban sprawl, desertification and erosion, with over 15,000 hectares lost in the last 20 years. (CNES 2008). Water stress is a growing issue. Biodiversity is declining, with only 1.9 square meters of green space per inhabitant. Waste treatment is insufficient to keep up with the country's production of solid waste. Currently in Algiers. 1.6 million tonnes of solid waste are produced annually, and this number is expected to grow to 2.5 million tonnes by 2025 (PAC 2005).

If Algiers, and other rapidly-growing Algerian cities such as Annaba, Constantine, Oran, El Oued, Ghardaïa and Djelfa (Berezowska-Azzag 2008), want to succeed in the future, they must find ways to reconcile the demand for urban development with the preservation of the natural resources which sustain society. New planning and creative technical solutions will be required to provide adequate infrastructure and economic bases for Algeria's cities while working within the region's tight ecological constraints.



Burkina Faso occupies 27.4 million hectares. Of those, 6.8 million hectares are covered by forest, 4.9 million by cropland and 13.4 by grazing land, with 0.5 million hectares supporting its built infrastructure. Landlocked between six countries, Burkina Faso has 40,000 hectares of inland water.

Adjusting for its cropland, fishery and forest yields, which are lower than corresponding global averages, and its grazing land yield, which is higher than the global average, Burkina Faso has a biocapacity of 21.2 million global hectares (gha). This is less than its total Ecological Footprint of 26.5 million gha. Burkina Faso has been operating with an ecological deficit since 1985.

Burkina Faso's average Ecological Footprint per person is 2.0 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still larger than the 1.6 gha of biocapacity available per person within Burkina Faso. As Burkina Faso's population grew from 4.5 million to 13.2 million between 1961 and 2005, its biocapacity per person decreased by 35 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 4.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Burkina Faso	13,228,000	26,518	21,157	2.00	1.60
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	5.4	1,061

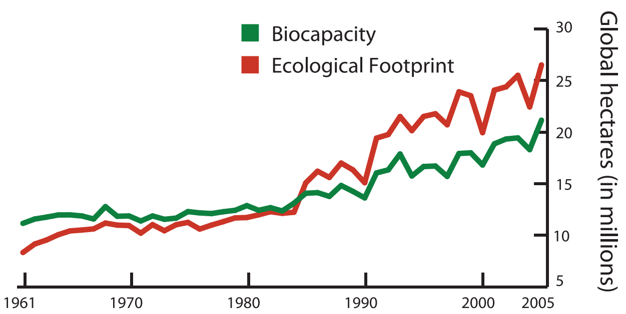
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	47.2	20.5	14.5	10.9	6.9

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Burkina Faso	Female	Male
Human Development Index Value (0=min. 1=max.)	0.370	–	–
Adult Literacy Rate (percent adults over 18)	23.6	16.6	31.4
Gross Enrollment Ratio (percent eligible students enrolled)	28.4	25	32
Irrigated Cropland (percent of total, 2000)	0.5	–	–
Access to Improved Water (percent of population, 2002)	61	–	–
Domestic Electrification (percent of population, 2000)	7	–	–
Undernourishment (percent of population, 2000)	2	–	–
Life Expectancy (years)	51.4	52.9	49.8

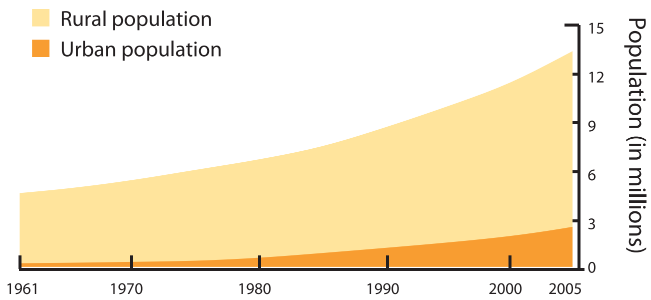
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 4.1. Burkina Faso total Ecological Footprint and biocapacity, 1961-2005



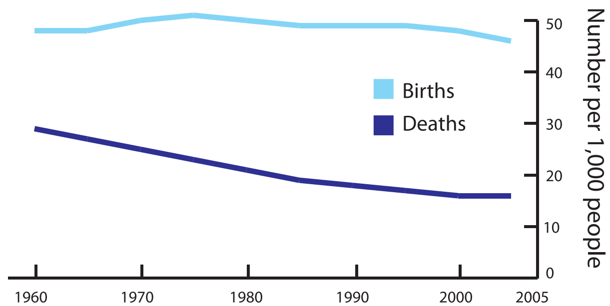
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 4.2. Burkina Faso population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 4.3. Burkina Faso birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 4.4. Burkina Faso Ecological Footprint per person, 1961-2005

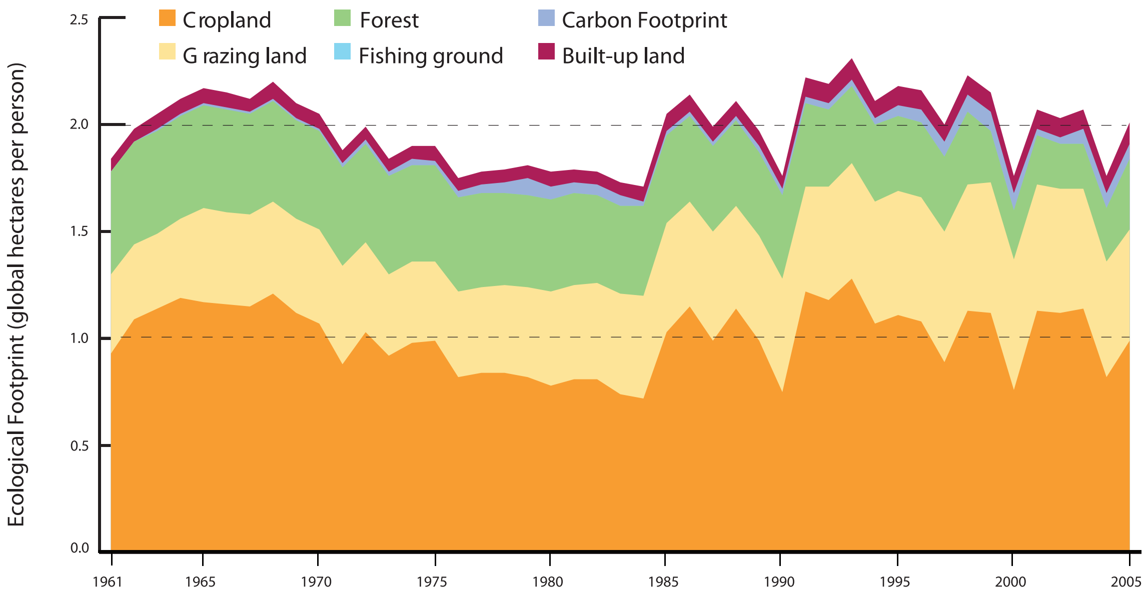


Figure 4.5. Burkina Faso biocapacity per person, 1961-2005

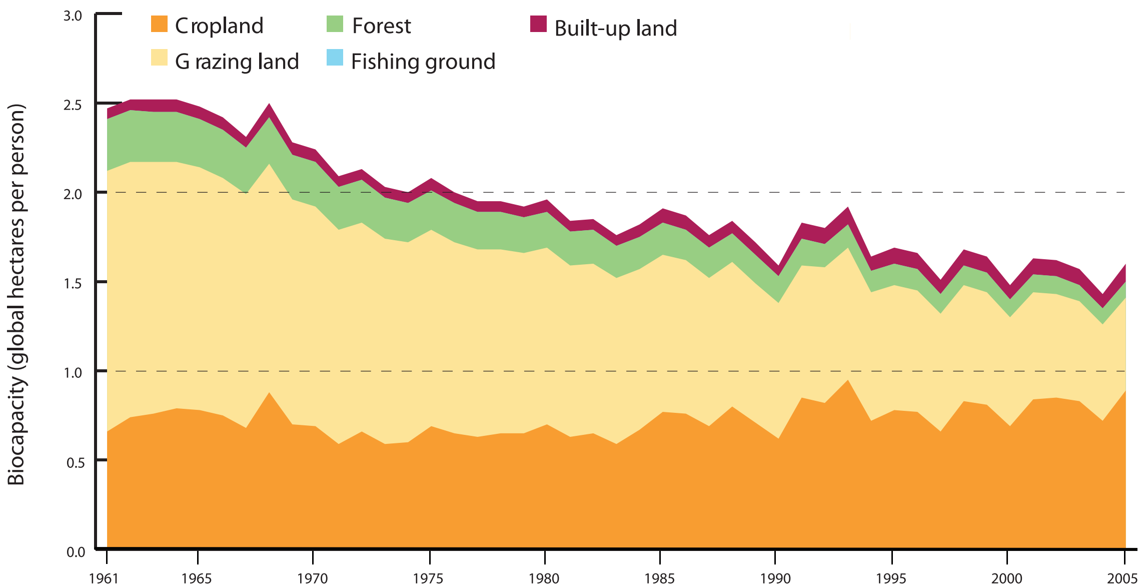


Table 4.2. Burkina Faso Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.93	0.37	0.48	0.00	0.00	0.06	1.84
1965	1.17	0.44	0.48	0.01	0.00	0.07	2.16
1970	1.07	0.44	0.46	0.01	0.00	0.07	2.05
1975	0.99	0.37	0.45	0.02	0.00	0.07	1.89
1980	0.78	0.44	0.43	0.06	0.00	0.07	1.78
1985	1.03	0.51	0.41	0.02	0.00	0.08	2.04
1990	0.75	0.53	0.39	0.03	0.00	0.06	1.77
1995	1.11	0.58	0.35	0.05	0.00	0.09	2.19
2000	0.76	0.61	0.23	0.08	0.00	0.08	1.77
2005	0.99	0.52	0.33	0.07	0.00	0.10	2.01

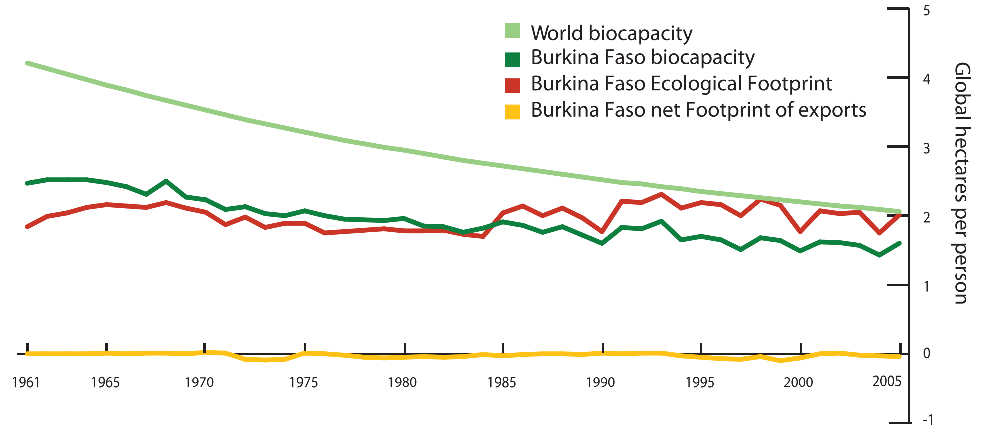
Table 4.3. Burkina Faso biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.66	1.46		0.29	0.00	0.06	2.47
1965	0.78	1.36		0.27	0.00	0.07	2.48
1970	0.69	1.23		0.25	0.00	0.07	2.23
1975	0.69	1.10		0.22	0.00	0.07	2.07
1980	0.70	0.99		0.20	0.00	0.07	1.96
1985	0.77	0.88		0.18	0.00	0.08	1.91
1990	0.62	0.76		0.15	0.00	0.06	1.60
1995	0.78	0.70		0.12	0.00	0.09	1.70
2000	0.69	0.61		0.10	0.00	0.08	1.49
2005	0.89	0.52		0.09	0.00	0.10	1.60

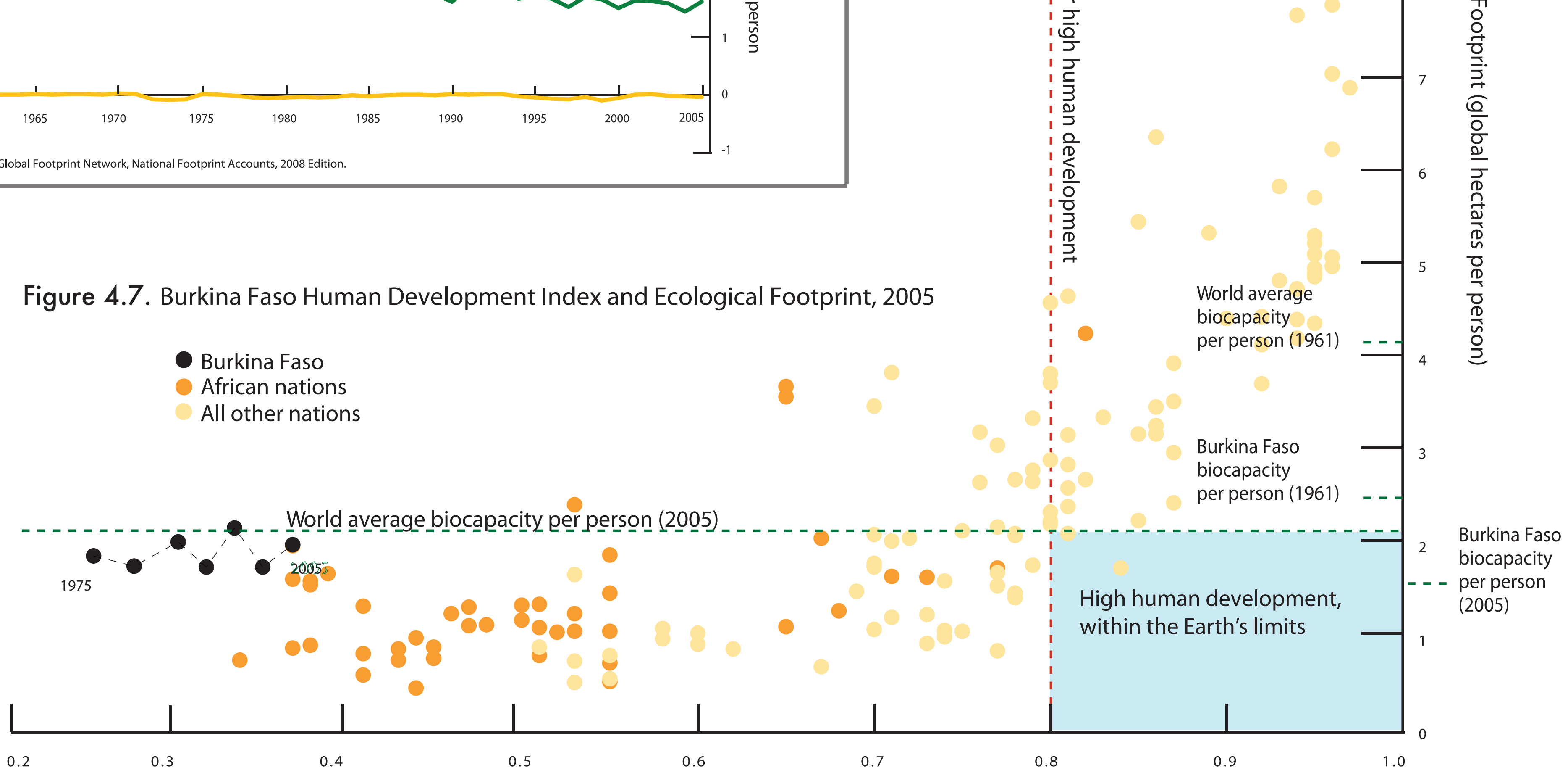
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 4.6. Burkina Faso Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 4.7. Burkina Faso Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP. Human Development Report, 2007.

Burkina Faso: Protecting the Environment by Profiting from Garbage

Urbanization levels in Africa are rising dramatically (3.3 percent per year between 2000 and 2005), a matter of increasing concern both nationally and internationally. The number of city dwellers in Africa reached 210 million in 2000, 34 percent of the total African population. By 2020, 46 percent of all Africans are projected to be living in cities (UN-Habitat 2001), and by 2050, according to UN-Habitat, Africa could have an urban population of 1.2 billion – nearly a quarter of the world's total urban population (UN-Habitat 2008).

Many African countries face financial problems, and as a result struggle to implement coherent and sustainable development policies. These problems will only be exacerbated as urbanization rates increase. One urban management issue that increasingly plagues African cities, especially in the Sahelian area, is the lack of industrial planning and poor waste management. The dumping of high plastic-content wastes has begun to contaminate peri-urban regions (the area 15-20 kilometers outside the urban boundary) that support livestock and agricultural economies (Alban and Gueye 2003).

Traditionally, urban waste was comprised primarily of organic materials, and these wastes were often used to fertilize outlying farmlands (Smith 1999). Today, plastic content in urban waste in Africa may exceed 10-15 percent of the total waste content (Gestion durable 2005). These plastics are indiscriminately diffused into the environment, impacting public health and food safety for local populations. In Ouagadougou, the capital of Burkina Faso, according to the Municipal Hygiene Service and the Waste Management Department (Rapport Ouagadougou 2000) 300,000 tonnes of waste are generated annually by the city's population, including 16,000 tonnes of plastics (Meunier-Nikiema 2007). These wastes damage farmland soil and grazing land, and are responsible for increasing livestock mortality rates.

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To combat this problem, the Italian organization Lay Volunteers International Association (LVIA) which promotes plastic recycling in West Africa, launched a partnership with the city of Ouagadougou.

In 2003, the team was selected to receive funding by the World Bank's Development Marketplace for construction of Burkina Faso's first plastics recycling center. The project integrated public and private institutions in order to create a market-based system for recycled plastics.

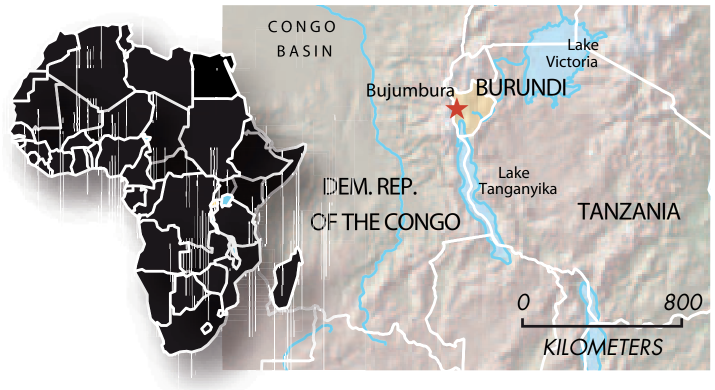
The recycling center serves as a source of revenue for local residents who gather and deliver the plastic waste. The environment is getting cleaner, and people are receiving cash for their plastic trash, which is then being recycled for productive use by local industries.

Over the past two years, the centre has produced goods including plastic buckets, as well as rulers, goniometers and normographes for local schools. The centre and LVIA have also been working with local and Italian partners to raise public awareness about the importance of environmental protection and impacts of domestic waste production.

Among the centre's accomplishments:

- 30 women and 5 men are working full time in Burkina Faso's first Plastic Recycling centre, supporting local employment
- 200-400 impoverished people per month collect and sell plastic refuse to the centre
- 4-6 tonnes of plastic garbage is recycled each month in the form of goods and sold to local enterprises.
- Approximately 5,000 people in Ouagadougou have been sensitized through the centre's outreach including street theatre, advertisement by local media and educational visits.
- More than 200 tonnes of plastic have been recycled since 2005.

(LVIA 2007, 2008)



Burundi occupies 2.8 million hectares. Of those, 0.2 million hectares are covered by forest, 1.3 million by cropland and 1.7 million by grazing land, with 0.2 million hectares supporting its built infrastructure. A landlocked country, Burundi has 0.2 million hectares of inland water, including the second largest freshwater lake in the world by volume, Lake Tanganyika.

Adjusting for its cropland, forest and fishery yields, which are lower than corresponding global averages, and its grazing land yield, which is higher than the global average, Burundi has a biocapacity of 5.1 million global hectares (gha). This is less than its total Ecological Footprint of 6.3 million gha. Burundi first began operating with an ecological deficit in 1966.

Burundi's average Ecological Footprint per person is 0.8 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still larger than the 0.7 gha of biocapacity available per person within Burundi. As its population grew from 3 million to 7.5 million between 1961 and 2005, biocapacity per person in Burundi decreased by 57 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 5.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Burundi	7,548,000	6,312	5,184	0.84	0.69
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	0.8	319

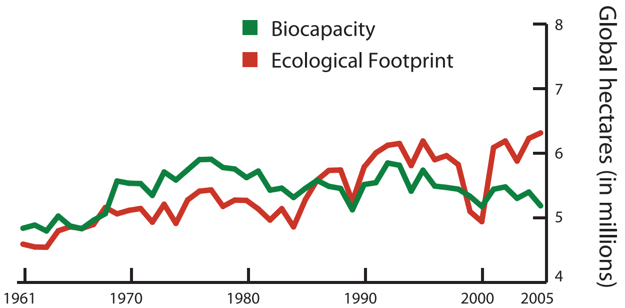
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	48.0	21.5	15.1	10.3	5.1

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Burundi	Female	Male
Human Development Index Value (0=min. 1=max.)	0.413	–	–
Adult Literacy Rate (percent adults over 18)	59.3	52.2	67.3
Gross Enrollment Ratio (percent eligible students enrolled)	37.1	34	41
Irrigated Cropland (percent of total, 2000)	1.6	–	–
Access to Improved Water (percent of population, 2002)	79	–	–
Domestic Electrification (percent of population, 2000)	–	–	–
Undernourishment (percent of population, 2000)	5	–	–
Life Expectancy (years)	48.5	49.8	47.1

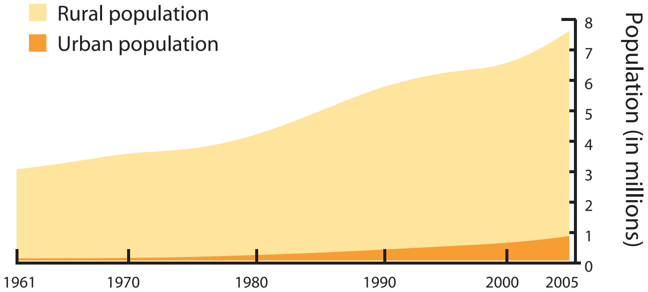
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 5.1. Burundi total Ecological Footprint and biocapacity, 1961-2005



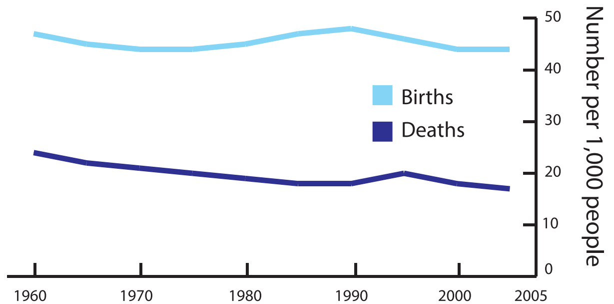
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 5.2. Burundi population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 5.3. Burundi birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 5.4. Burundi Ecological Footprint per person, 1961-2005

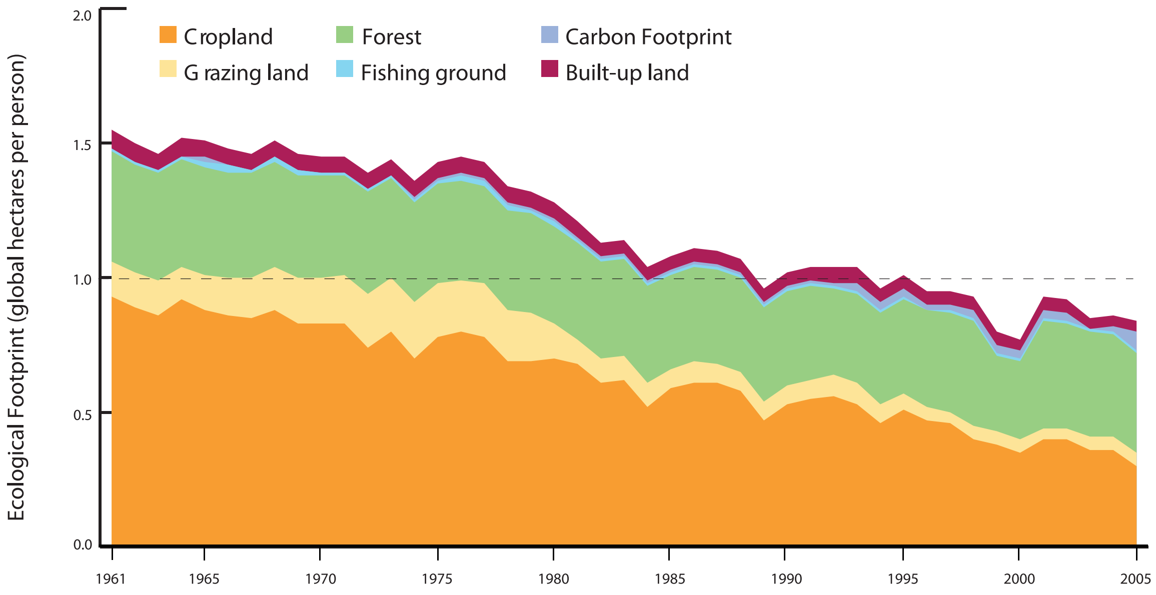


Figure 5.5. Burundi biocapacity per person, 1961-2005

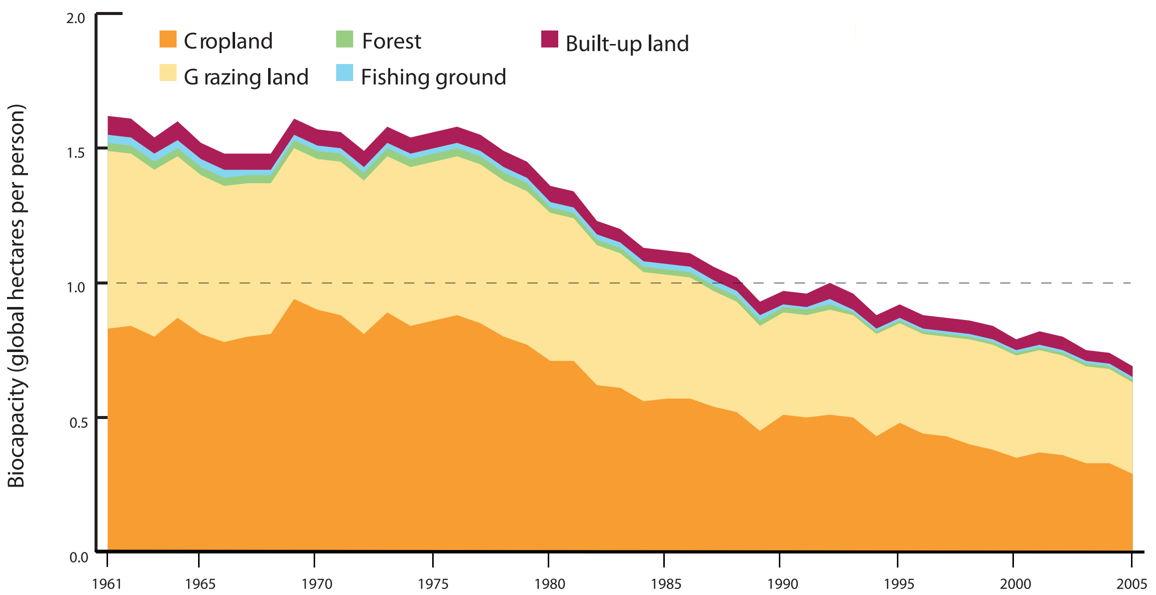


Table 5.2. Burundi Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.93	0.13	0.41	0.00	0.01	0.07	1.53
1965	0.88	0.13	0.40	0.02	0.02	0.06	1.51
1970	0.83	0.17	0.38	0.00	0.01	0.06	1.46
1975	0.78	0.20	0.37	0.01	0.01	0.06	1.43
1980	0.70	0.13	0.36	0.01	0.02	0.06	1.28
1985	0.59	0.07	0.35	0.01	0.01	0.05	1.08
1990	0.53	0.07	0.35	0.01	0.01	0.05	1.02
1995	0.51	0.06	0.35	0.03	0.01	0.05	1.01
2000	0.35	0.05	0.29	0.03	0.01	0.04	0.76
2005	0.30	0.05	0.37	0.07	0.01	0.04	0.84

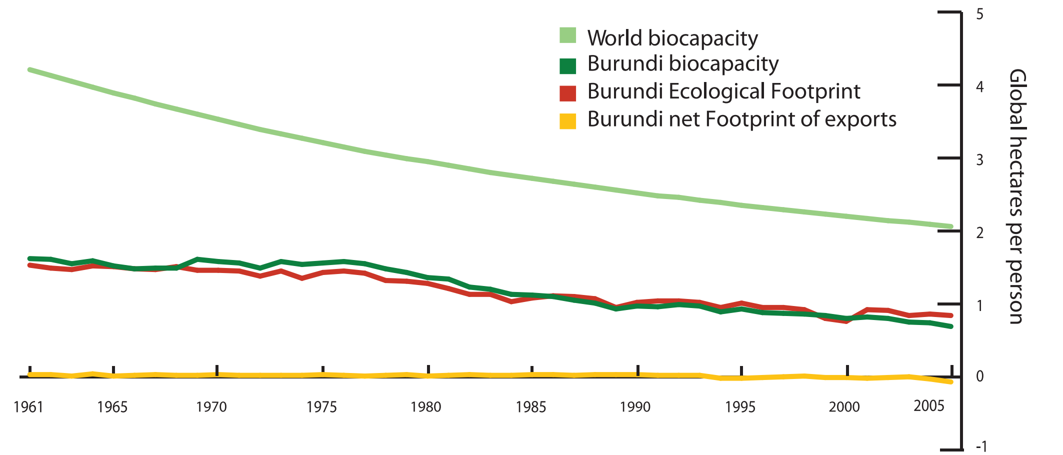
Table 5.3. Burundi biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.83	0.66	0.03		0.03	0.07	1.62
1965	0.81	0.59	0.03		0.03	0.06	1.52
1970	0.90	0.56	0.03		0.02	0.06	1.58
1975	0.86	0.59	0.03		0.02	0.06	1.56
1980	0.71	0.55	0.02		0.02	0.06	1.36
1985	0.57	0.46	0.02		0.02	0.05	1.12
1990	0.51	0.38	0.02		0.01	0.05	0.97
1995	0.48	0.37	0.01		0.01	0.05	0.93
2000	0.35	0.38	0.01		0.01	0.04	0.80
2005	0.29	0.34	0.01		0.01	0.04	0.69

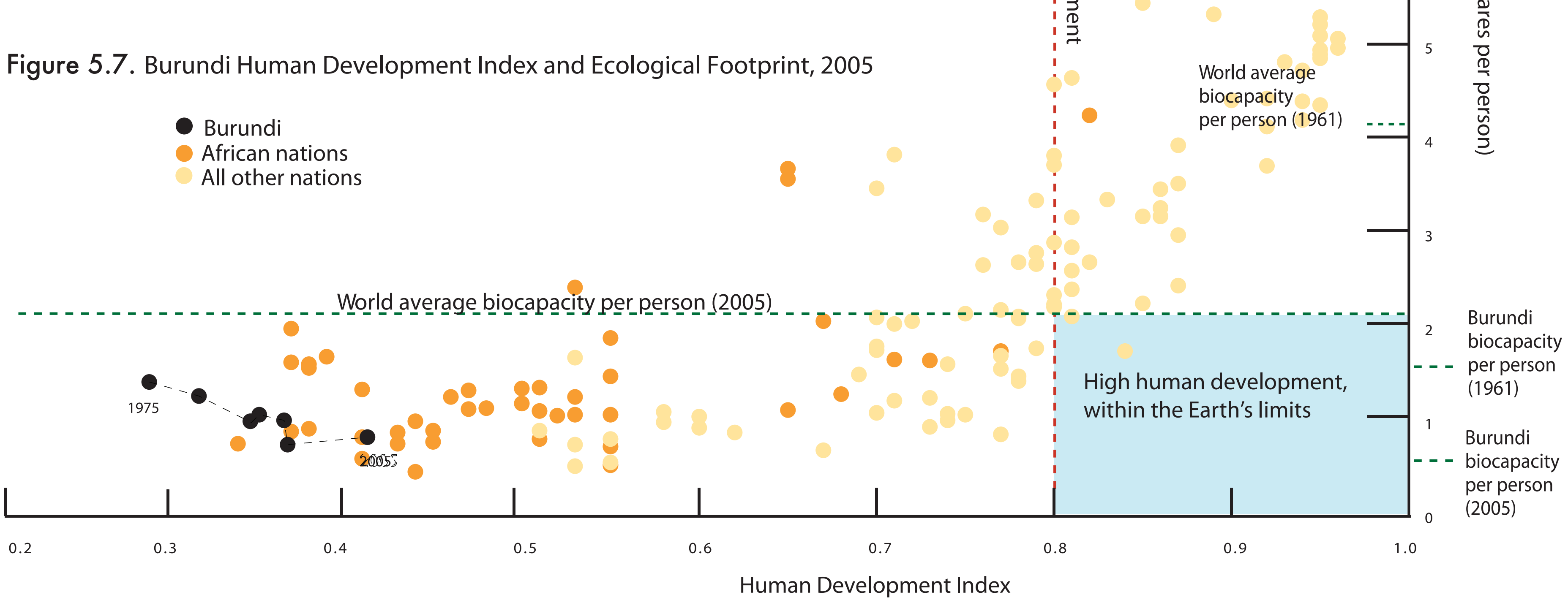
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 5.6. Burundi Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 5.7. Burundi Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

The Status of Inland Fisheries in Burundi

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As a landlocked nation, fishery resources in Burundi are centered upon lakes, rivers and aquaculture. Lake Tanganyika dominates fishery production in Burundi, while smaller lakes in the north of the country provide artisanal fishing for local consumption. These Northern lakes include Lake Cohoha, Lake Rweru (lying on the Rwandan border), Lake Kanzigiri, Lake Rwihinda and Lake Gacamirindi. River fisheries are of less significance in Burundi; however, the country has 530 kilometers of major rivers including the Ruzizi, Akanyaru, Ruvubu, Kagera and Malagarazi rivers, with potential annual yields of 320 tonnes (Corsi, Dunn, and Felicioni 1986; Vanden Bossche and Bernacsek 1991).

Burundian fisheries are dominated by three species: *Limnothrissa miodon, Stolothrissa tanganicae* (both are known as Tanganyika sardines); and *Luciolates stappersii*. Aquaculture is under-developed in Burundi. The practice of fish farming is favoured by a suitable topography and hydrological network in Burundi that allows flow of water via natural gravity. However, the poor water characteristics in Burundi's water bodies, such as low pH levels of 5.5–6.5, low temperatures of 21°C and low conductivity below 100 microsiemens per centimetre (µ S/cm) inhibits successful fish farming. Common fish species used to stock aquaculture include *Oreochromis niloticus* (Nile Tilapia), *Tilapia rendalli* (Redbreast Tilapia), and *Oreochromis tanganicae, Clarias sp* (Catfish) (Corsi, Dunn, and Felicioni 1986; Ministère de l'Agriculture et de l'Elevage, Rèpublique du Burundi 1988). The total annual fish yield from Lake Tanganyika and the upper Kagera lakes and rivers ranges from 14,000 to 17,000 tonnes. It is estimated that the potential yield of this region is as high as 24,000 tonnes per year (Vanden Bossche and Bernacsek 1991).

Lake Tanganyika is the second deepest lake and the largest by volume in the world after Lake Baikal, and is an imperative resource for the people and the economy of Burundi. Although the lake covers a surface area of 320,000 km², Burundi has jurisdiction over only eight percent of this surface area (Vanden Bossche and Bernacsek 1991). The remaining lake surface area is shared among three nations: the Democratic Republic of Congo (45 percent), Tanzania (41 percent) and Zambia (six percent). The Cichlidae family serves as the dominant species in Lake Tanganyika. There are 172 species of the Cichlidae family in the Lake alone – 97 percent of which are endemic. There are 118 non-Cichlid species in the lake, only 26 percent of which are endemic (Patterson and Makin 1998).

Lake Tanganyika's fishing industry utilizes a mixture of traditional, small-scale and industrial fishing practices. Most industrial fishing practices ceased after Burundi's 1993 war (Ministère de l'Agriculture et de l'Elevage DAPA 1999). Today the majority of fishermen operate using dug-out canoes, hand nets, seine nets and gill nets. A few businesses operate as small-scale fisheries using catamarans with lift nets, and a scarce number of large businesses use industrial fishing techniques including large vessels with purse seines (Vanden Bossche and Bernacsek 1991).

The fishing sector in Burundi faces several constraints. The country's increasing population and the increasing number of people who have access to fishing technologies are putting pressure on fish stocks for commercial, subsistence and ornamental purposes. Fisheries management in Burundi is weak and there is not enough participation from local communities in the decision-making and monitoring of local fisheries management. Adding to these management difficulties, the fishing industry is subject to frequent theft of equipment, disproportionately impacting the small fishing enterprises. Burundi's lakes are subject to pollution from both domestic and industrial wastewater, which has a negative impact on the health of fish stocks (Ndabigengesere 1986 ; UNEP 2004). This pollution is carried into lakes as sediment in canals and rivers, and often contains heavy metal elements, fertilizers, pesticides and agricultural runoff (Ndabigengesere 1986).

Burundi, Democratic Republic of Congo, Tanzania and Zambia have uncoordinated national and regional (Lake Tanganyika Authority) institutions starved of critical resources to effectively manage this vital resource. Fisheries management in Lake Tanganyika Riparian Region is in desperate need of a holistic, regional agenda that can balance national interests, local dependence and international market demands.

It is clear to us that the sustainable solution to pressures put on fisheries in Burundi lies in the development of aquaculture. Several challenges highlight the urgent need to find new and innovative solutions: the increase in fishing export to maximize potential harvest; small size and low yield of Burundi's northern lakes; siltation due to increased deforestation, untreated wastewater effluents from Bujumbura; agricultural runoff composed of agrochemicals (UNEP 2004); and the anthropogenic constraints enumerated herein (such as overfishing and destructive fishing practices). What is needed is a promotion of river and lake basin-wide integrated conservation measures, coupled with sound fisheries management and a diversification of fish sources through aquaculture. This is the only way to avoid dire ecological and socio-economic impacts, such as the large-scale loss of employment in the fishery sector that occurred in the 1990s due to collapse of industrial fleet in Burundi (West 2001).

Cameroon occupies 47.5 million hectares. Of those, 21.2 million hectares are covered by forest, 7.2 million by cropland and 16.8 million by grazing land, with 0.6 million hectares supporting its built infrastructure. Cameroon borders 1.3 million hectares of continental shelf and has 1.0 million hectares of inland water.

Adjusting for its cropland and forest yields, which are lower than corresponding global averages, and its grazing land and fishery yields, which are higher than the global average, Cameroon has a biocapacity of 50.0 million global hectares (gha). This is more than its total Ecological Footprint of 20.7 million gha.

Cameroon's average Ecological Footprint per person is 1.3 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 3.1 gha of biocapacity available per person within Cameroon. As its population grew from 5.4 million to 16.3 million between 1961 and 2005, biocapacity per person in Cameroon decreased by 68 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 6.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Cameroon	16,322,000	20,696	50,050	1.27	3.07
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	16.6	1,993

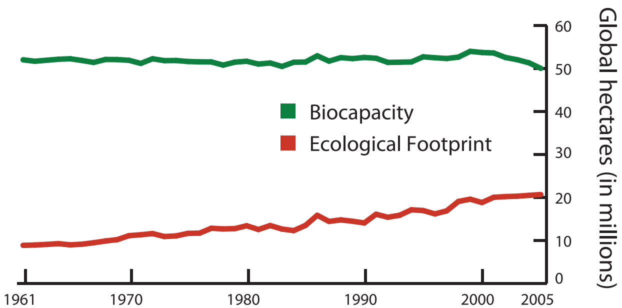
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	50.9	20.4	13.7	9.3	5.6

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Cameroon	Female	Male
Human Development Index Value (0=min. 1=max.)	0.532	–	–
Adult Literacy Rate (percent adults over 18)	67.9	59.8	77.0
Gross Enrollment Ratio (percent eligible students enrolled)	52.3	47	57
Irrigated Cropland (percent of total, 2000)	0.4	–	–
Access to Improved Water (percent of population, 2002)	66	–	–
Domestic Electrification (percent of population, 2000)	47	–	–
Undernourishment (percent of population, 2000)	4	–	–
Life Expectancy (years)	49.8	50.2	49.4

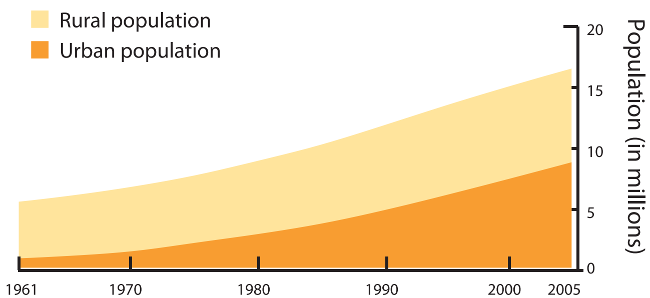
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 6.1. Cameroon total Ecological Footprint and biocapacity, 1961-2005



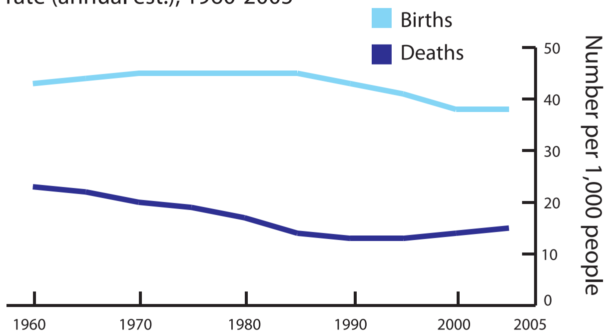
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 6.2. Cameroon population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 6.3. Cameroon birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 6.4. Cameroon Ecological Footprint per person, 1961-2005

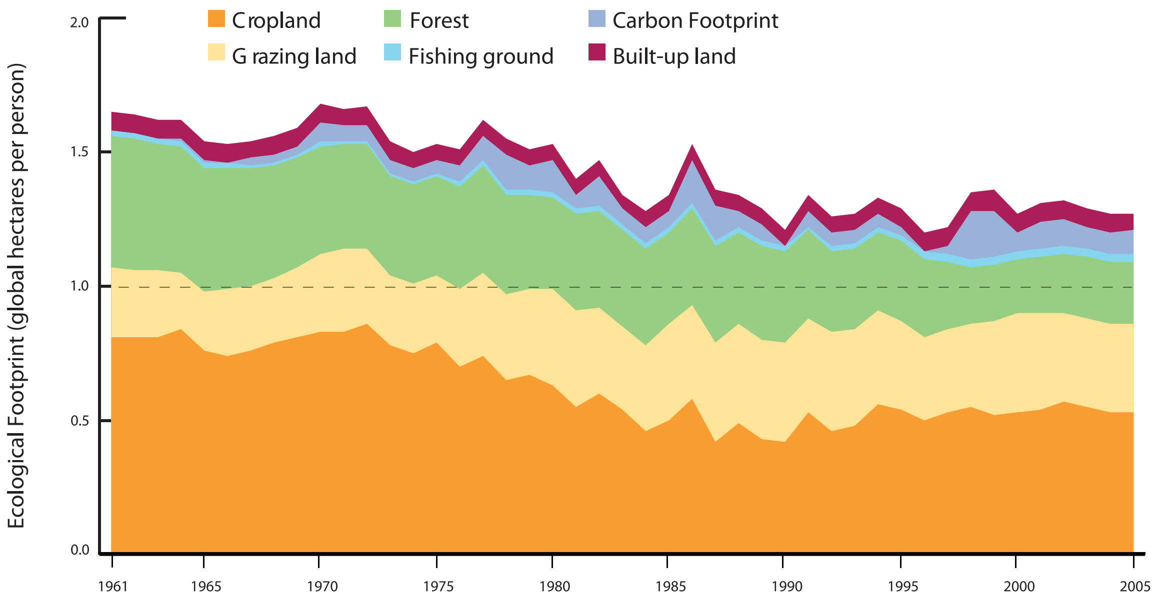


Figure 6.5. Cameroon biocapacity per person, 1961-2005

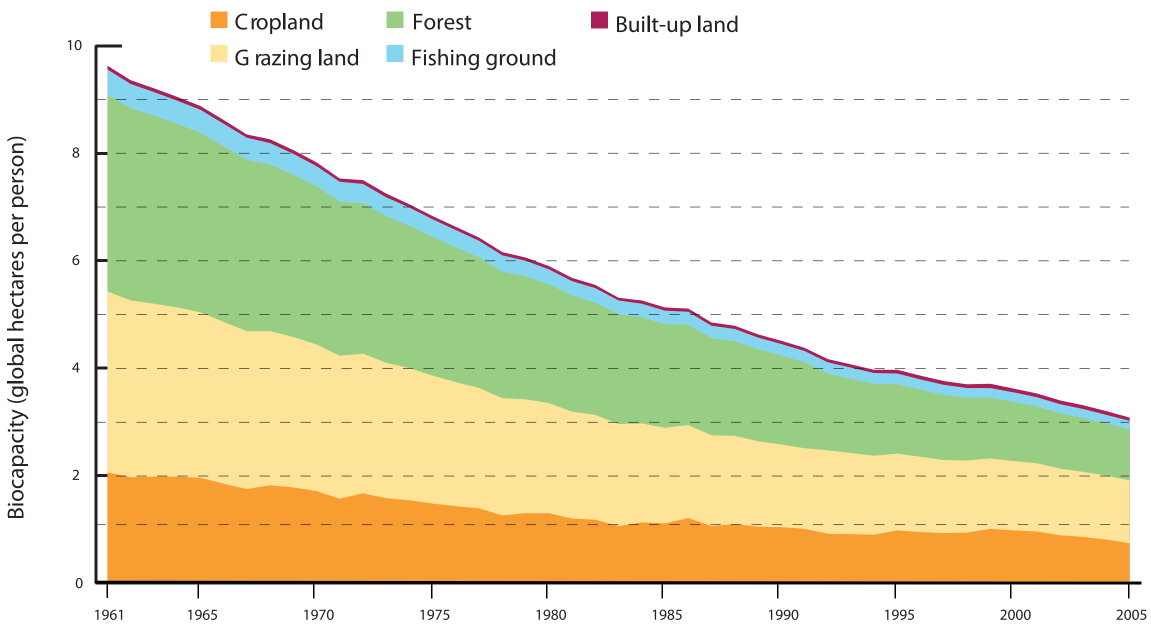


Table 6.2. Cameroon Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.81	0.26	0.49	0.00	0.02	0.07	1.64
1965	0.76	0.22	0.46	0.01	0.02	0.07	1.53
1970	0.83	0.29	0.40	0.07	0.02	0.07	1.68
1975	0.79	0.25	0.37	0.05	0.01	0.06	1.54
1980	0.63	0.36	0.34	0.12	0.02	0.06	1.54
1985	0.50	0.36	0.34	0.06	0.02	0.06	1.34
1990	0.42	0.37	0.34	0.00	0.02	0.06	1.21
1995	0.54	0.33	0.30	0.03	0.02	0.07	1.28
2000	0.53	0.37	0.20	0.07	0.03	0.07	1.27
2005	0.53	0.33	0.23	0.09	0.03	0.06	1.27

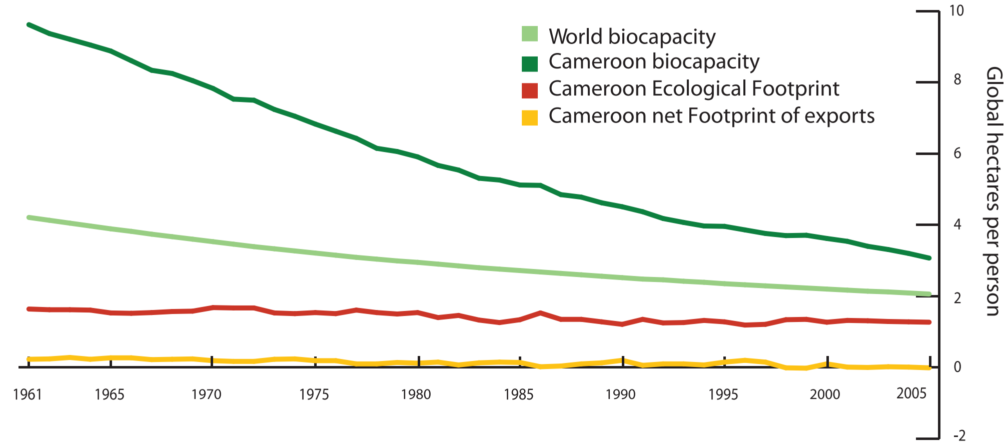
Table 6.3. Cameroon biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	2.06	3.37	3.66		0.47	0.07	9.62
1965	1.96	3.08	3.34		0.43	0.07	8.88
1970	1.71	2.73	2.94		0.38	0.07	7.83
1975	1.48	2.38	2.58		0.33	0.06	6.83
1980	1.30	2.05	2.21		0.28	0.06	5.91
1985	1.11	1.78	1.93		0.25	0.06	5.12
1990	1.04	1.54	1.66		0.21	0.06	4.51
1995	0.98	1.43	1.29		0.20	0.07	3.96
2000	0.98	1.29	1.10		0.18	0.07	3.62
2005	0.74	1.17	0.95		0.16	0.06	3.07

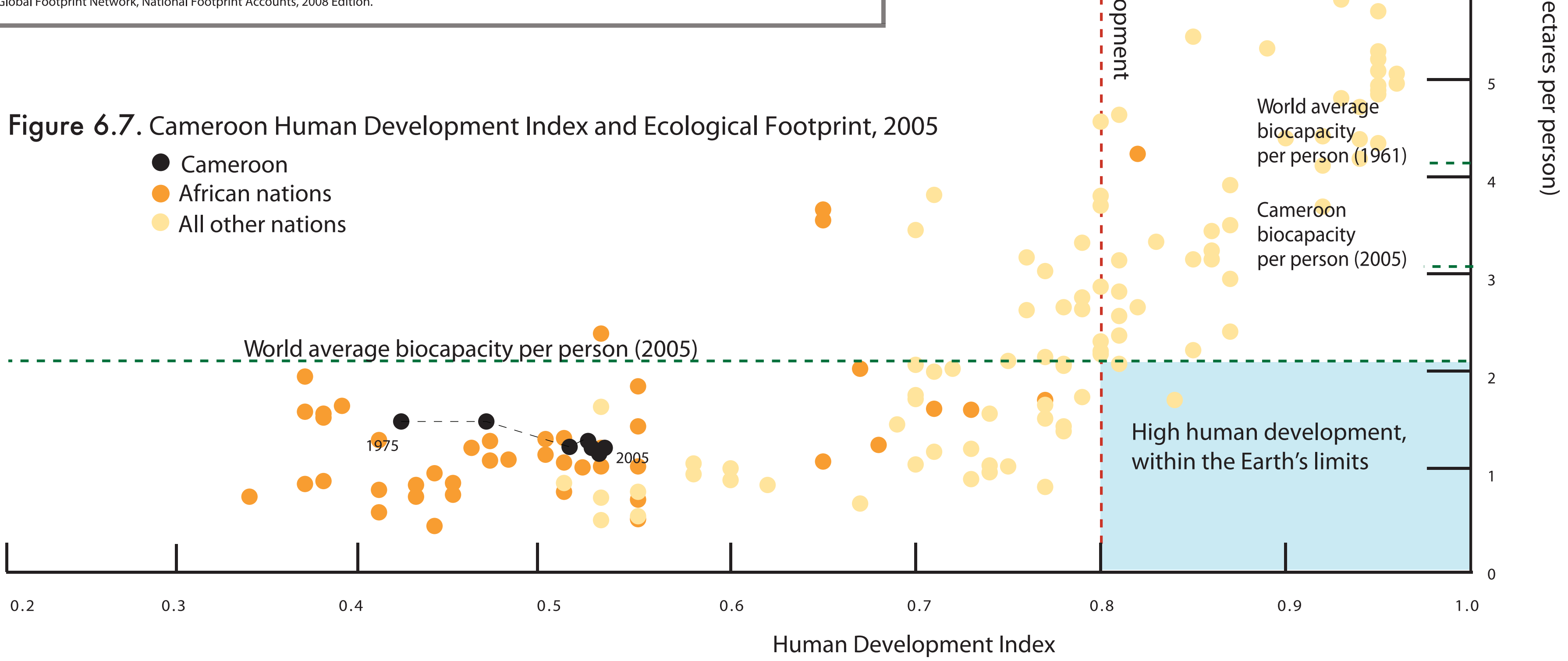
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 6.6. Cameroon Ecological Footprint, net exports and biocapacity per person,1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 6.7. Cameroon Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Cameroon: Exploitation Threatens a Key Resource

Cassava sticks are a popular traditional food in Cameroon. They are made from cassava roots which are ground into paste and wrapped with the leaves of *Halopegia azurea (H. azurea)* before cooking or preservation. Along with the cassava sticks themselves, the *H. azurea* leaves are in increasing demand in regional and international markets. In Cameroon's rural central and southern regions, the commercial exploitation and trade of *H. azurea* leaves is the only source of income for many families.

However, over time, *H. azurea* has suffered from a "tragedy of the commons" in Cameroon. Most of the humid forest zones where this plant flourishes are owned by the central government, while local village communities are responsible for land management. Unfortunately most village communities have no established natural resource or land management plans, resulting in uncontrolled harvesting of *H. azurea*. Without understanding sustainable harvesting techniques, villagers simply snap off the leaves by hand until there are no leaves remaining. This combination of pulling and twisting the leaf results in severe damage to the stem. This damage, in combination with the removal of all leaves at once, hinders the plant's natural re-growth cycle (Koechlin 1965).

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Biologist

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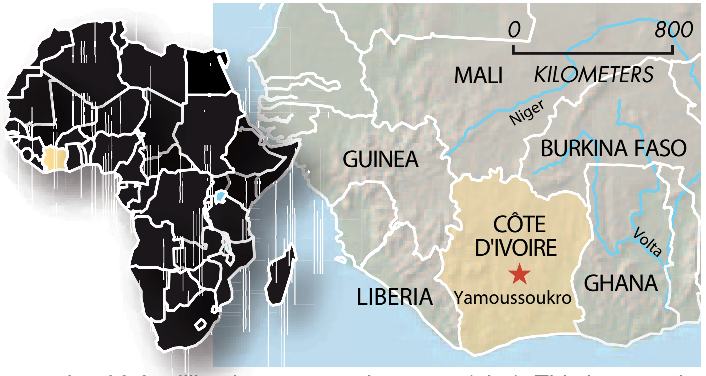
While there is currently not enough statistical evidence to prove the effects of this over-exploitation, rural villagers widely report that *H. azurea* harvesting grounds are now to be found further and further from the villages. In some regions, people have already stopped the harvest because it is inefficient to spend so much time hunting for the plant, which was once copious. Declining *H. azurea* stocks are resulting in the loss of a significant income source for families. At the same time, cassava sticks continue to be in high demand, putting increased pressure on remaining *H. azurea* stocks.

This species is now on the edge of extinction due to three main factors: a lack of knowledge of appropriate harvesting techniques; a lack of interest by government representatives and non-governmental organizations in preserving the species; and deforestation, which is causing a loss of habitat within the damp forest areas where *H. azurea* grows (Koechlin 1965).

If nothing is done to promote the sustainable use and harvest of *H. azurea* and ensure its preservation, Cameroon will soon face a national shortage of this natural resource. Not only will that affect the price and the availability of this basic plant, but it will also hinder the economic development of rural areas and exacerbate poverty. It is our opinion that we must begin now to promote sustainable harvesting of *H. azurea* by educating rural populations on sustainable techniques and researching possibilities for commercial cultivation of the *H. azurea* species.



Côte d'Ivoire occupies 32.2 million hectares. Of those, 10.4 million hectares are covered by forest, 7.1 million by cropland and 15.8 million by grazing land, with 0.6 million hectares supporting its built infrastructure. Located along the Atlantic Coast of Africa, Côte d'Ivoire has 0.9 million hectares of continental shelf and 0.5 million hectares of inland water.

Adjusting for its cropland and forest yields, which are lower than corresponding global averages, and its grazing land and fishery yields, which are higher than the global average, Côte d'Ivoire has a biocapacity of 39.5 million global hectares (gha). This is more than its total Ecological Footprint of 16.2 million gha.

Côte d'Ivoire's average Ecological Footprint per person is 0.9 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 2.2 gha of biocapacity available per person within Côte d'Ivoire. As its population grew from 3.7 million to 18.2 million between 1961 and 2005, biocapacity per person in Côte d'Ivoire decreased by 72 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 7.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint (Total global hectares (thousands))	Biocapacity (Total global hectares (thousands))	Ecological Footprint (Global hectares per person)	Biocapacity (Global hectares per person)
Côte d'Ivoire	18,154,000	16,207	39,521	0.9	2.2
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	16.3	1,614

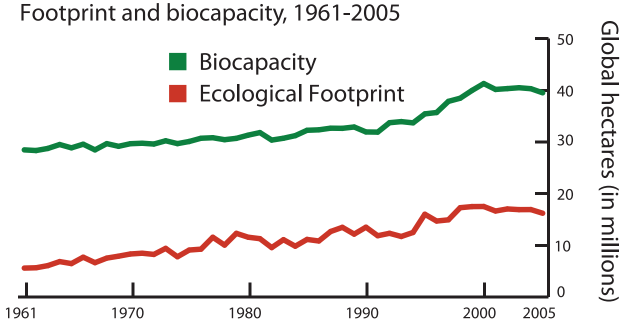
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	50.7	21.3	13.7	9.1	5.2

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Côte d'Ivoire	Female	Male
Human Development Index Value (0=min. 1=max.)	0.43	–	–
Adult Literacy Rate (percent adults over 18)	49	39	61
Gross Enrollment Ratio (percent eligible students enrolled)	–	.	.
Irrigated Cropland (percent of total, 2000)	–	–	–
Access to Improved Water (percent of population, 2002)		–	–
Domestic Electrification (percent of population, 2000)	50	–	–
Undernourishment (percent of population, 2000)	2.2	–	–
Life Expectancy (years)	47.4	48.3	46.5

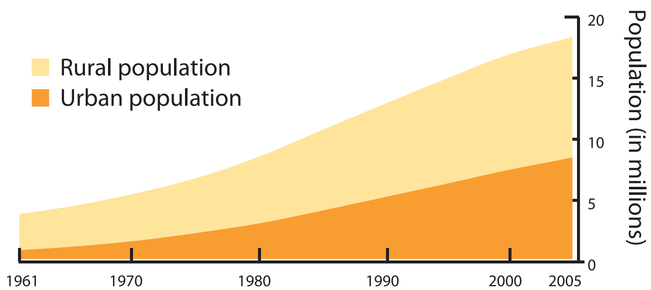
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 7.1. Côte d'Ivoire total Ecological Footprint and biocapacity, 1961-2005



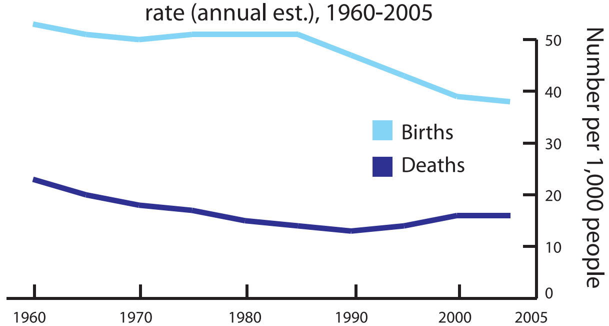
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 7.2. Côte d'Ivoire population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 7.3. Côte d'Ivoire birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 7.4. Côte d'Ivoire Ecological Footprint per person, 1961-2005

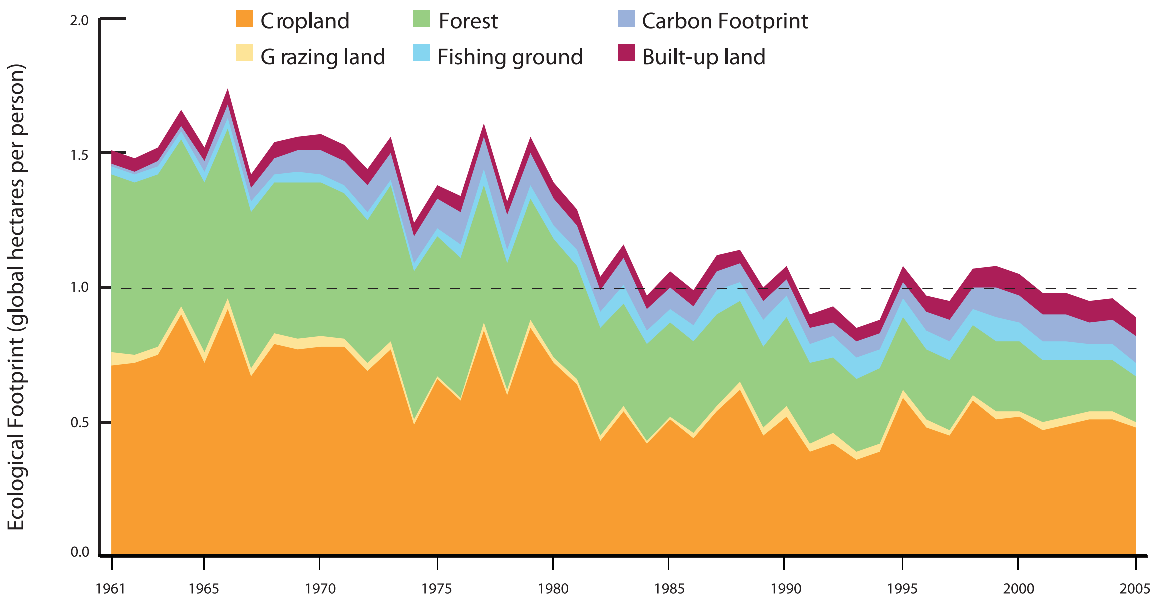


Figure 7.5. Côte d'Ivoire biocapacity per person, 1961-2005

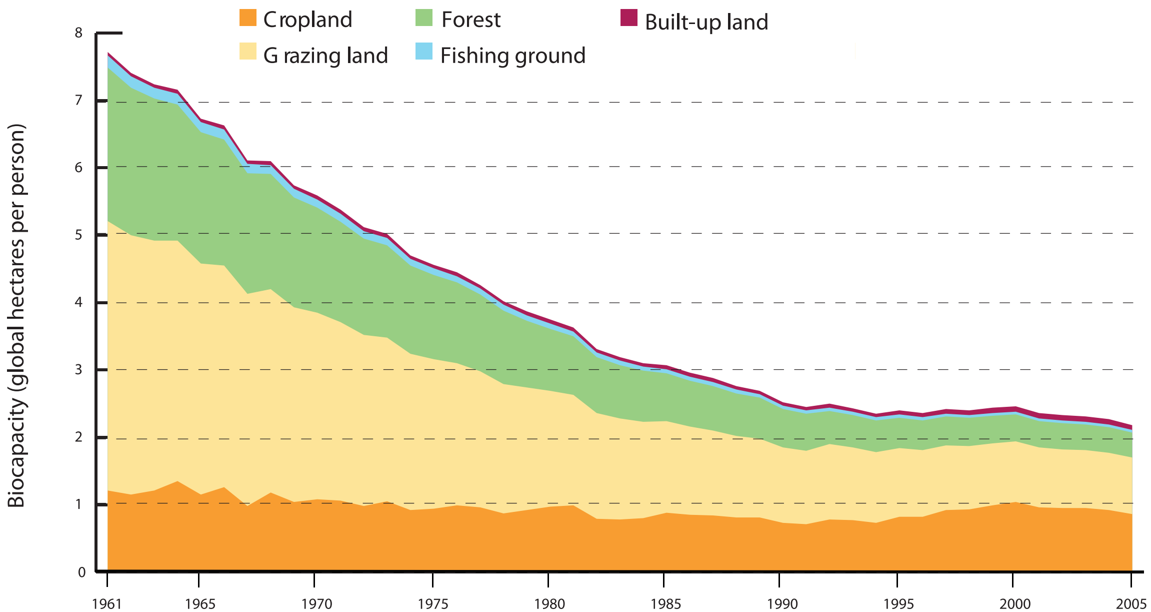


Table 7.2. Côte d'Ivoire Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.71	0.05	0.66	0.01	0.03	0.05	1.52
1965	0.72	0.04	0.63	0.04	0.04	0.05	1.51
1970	0.78	0.04	0.57	0.09	0.03	0.06	1.57
1975	0.66	0.01	0.52	0.11	0.03	0.05	1.38
1980	0.72	0.02	0.44	0.10	0.05	0.06	1.39
1985	0.51	0.01	0.35	0.08	0.05	0.06	1.06
1990	0.52	0.04	0.33	0.06	0.08	0.05	1.07
1995	0.59	0.03	0.27	0.06	0.07	0.06	1.09
2000	0.52	0.02	0.26	0.10	0.07	0.08	1.05
2005	0.48	0.02	0.17	0.10	0.05	0.07	0.89

Table 7.3. Côte d'Ivoire biocapacity, 1961-2005

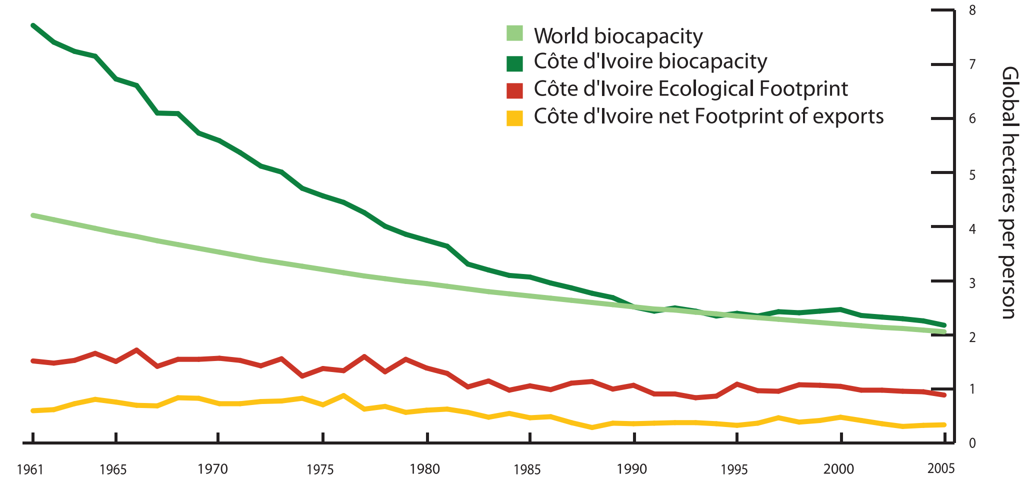
(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.21	4.00	2.28		0.18	0.05	7.72
1965	1.15	3.43	1.95		0.15	0.05	6.73
1970	1.08	2.77	1.56		0.12	0.06	5.59
1975	0.94	2.22	1.25		0.10	0.05	4.57
1980	0.97	1.72	0.92		0.08	0.06	3.75
1985	0.88	1.36	0.71		0.06	0.06	3.07
1990	0.73	1.12	0.57		0.05	0.05	2.52
1995	0.82	1.02	0.45		0.05	0.06	2.40
2000	1.04	0.90	0.40		0.04	0.08	2.47
2005	0.86	0.84	0.37		0.04	0.07	2.18

Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

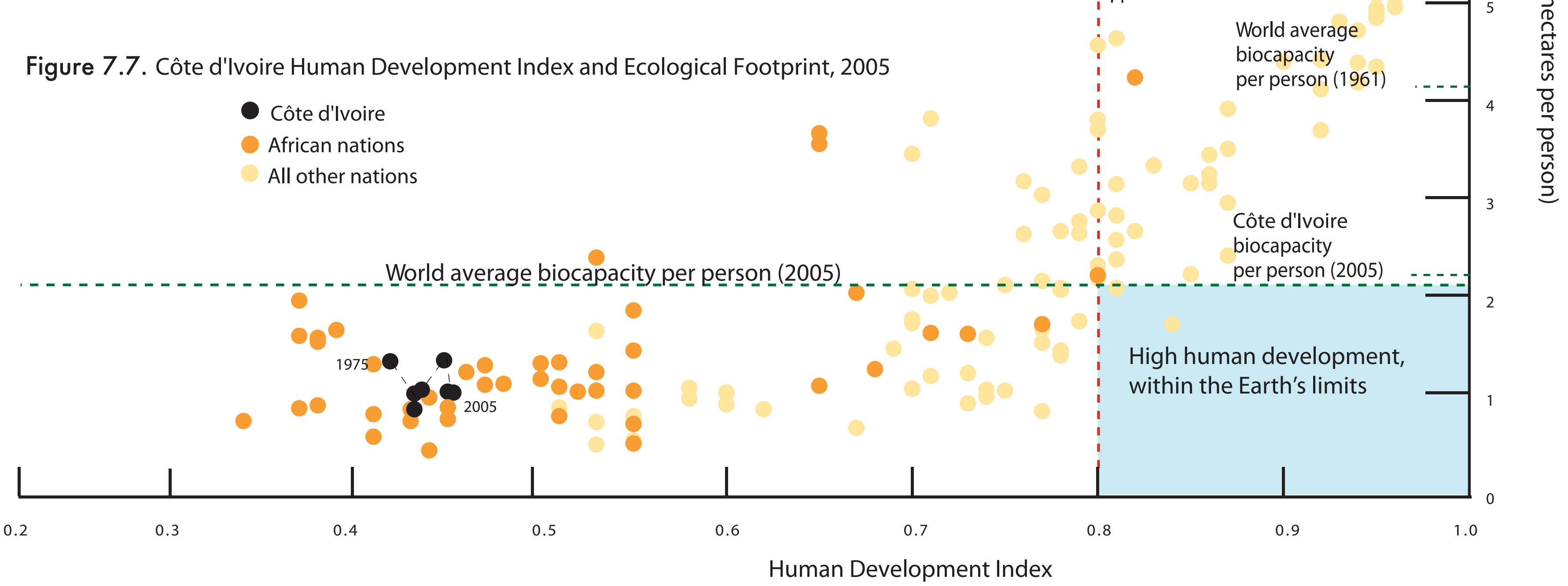
Figure 7.6. Côte d'Ivoire Ecological Footprint, net exports and biocapacity per person, 1961-2005

Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 7.7. Côte d'Ivoire Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP. Human Development Report, 2007.

Crop Production: A Threat to Côte d'Ivoire's Protected Forests

Côte d'Ivoire, a country located in West Africa, has an economy that depends largely on forest resource exploitation.

A significant portion of Côte d'Ivoire's GDP comes from natural or planted forest products, including teak, oil palm, silk-cotton (Ceiba Tree), rubber, edible and medicinal plants and coconut. Indeed, agriculture contributes 27 percent to GDP, employs two-thirds of the active population and provides the agro-industrial sector with 40 percent of export earnings. The country has two main forest types: evergreen and semi-deciduous rainforest (Guilllaumet and Adajanohoun 1971).

Côte d'Ivoire has a tropical forest corridor that extends inland for nearly 150 kilometers from the southwest coast. Because Côte d'Ivoire's forest ecosystems lie primarily in this region, the people and industry of the country also migrate here to take advantage of the forest's rich biodiversity. In recent history, we have seen a massive migration of Ivorian and expatriate communities to the country's southwest region. The population of foreign origin represents 26 percent of the total population (Ministére du plan et du Développement 2009).

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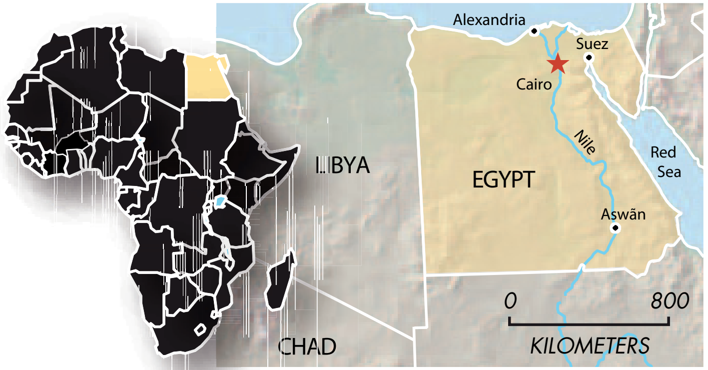
Migrants settle in communities within and nearby the country's protected forests, and they use the forest's resources, namely timber, plant oils, bamboo, palm raphia and rattan for basketry, rubber and wild meat, to meet their basic needs. Many of these migrants settle indefinitely, establishing a living from subsistence or industrial crop production and timber harvesting. It is estimated from 1990-2000, there was a deforestation rate of 265,000 hectares per year in Côte d'Ivoire (FAO 2005). The sustainability of Côte d'Ivoire's forests is contingent upon the resource management of the communities that live there.

For example, one of Côte d'Ivoire's regions, the Marahoué, is home to one of the country's largest national parks. Marahoué National Park was established in 1968 (by the law 68-80 of 09 February 1968), and originally covered 101,000 hectares. Over the last decade Marahoué National Park has lost 93 percent of its forest cover due to deforestation and human settlement. Today, the park exists primarily in name only, as expanding agriculture activities have destroyed Marahoué's endemic zones (Laugini 2007).

The rapid depletion of protected forests in Côte d'Ivoire demands political will from the government in order to protect these valuable forests from over-exploitation. A large portion of the country's deforestation is driven by increasing rural poverty and a need for subsistence agriculture, supplemented by high rates of illegal logging and timber theft (ITTO 2005). Given this, we must ask how the Nation-state of Côte d'Ivoire can reconcile the necessity for agricultural land with the importance of forest preservation. How can it create policies that consider the livelihood of the rural poor and the long term value of forest conservation?



Egypt occupies 100.1 million hectares. Of those, 67,000 hectares are covered by forest, 3.5 million by cropland and 20,000 by grazing land, with 1.3 million hectares supporting its built infrastructure. Bordering both the Mediterranean and the Red Sea, Egypt has 5.0 million hectares of continental shelf and 0.6 million hectares of inland water.

Adjusting for its grazing land, forest and fishery yields, which are lower than corresponding global averages, and its cropland yield, which is higher than the global average, Egypt has a biocapacity of 27.6 million global hectares (gha). This is less than its total Ecological Footprint of 123.3 million gha. Egypt has been operating with an ecological deficit since prior to 1961.

Egypt's average Ecological Footprint per person is 1.7 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still considerably larger than the 0.4 gha of biocapacity available per person within Egypt. Despite a population that grew from 28.5 million to 74 million between 1961 and 2005, biocapacity per person in Egypt increased by 15 percent over the period, mostly due to significant gains in cropland productivity.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 8.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Egypt	74,033,000	123,347	27,557	1.67	0.37
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	89.7	4,574

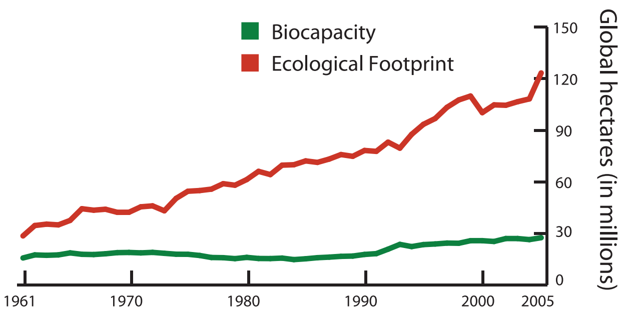
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	43.6	20.4	15.4	12.1	8.6

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Egypt	Female	Male
Human Development Index Value (0=min. 1=max.)	0.708	–	–
Adult Literacy Rate (percent adults over 18)	71.4	59.4	83.0
Gross Enrollment Ratio (percent eligible students enrolled)	76.9	–	–
Irrigated Cropland (percent of total, 2000)	99.9	–	–
Access to Improved Water (percent of population, 2002)	98	–	–
Domestic Electrification (percent of population, 2000)	98	–	–
Undernourishment (percent of population, 2000)	3	–	–
Life Expectancy (years)	70.7	73.0	68.5

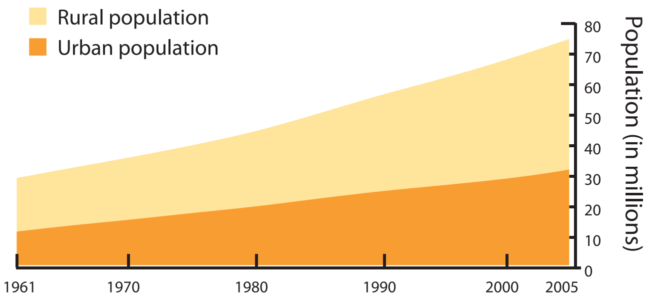
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 8.1. Egypt total Ecological Footprint and biocapacity, 1961-2005



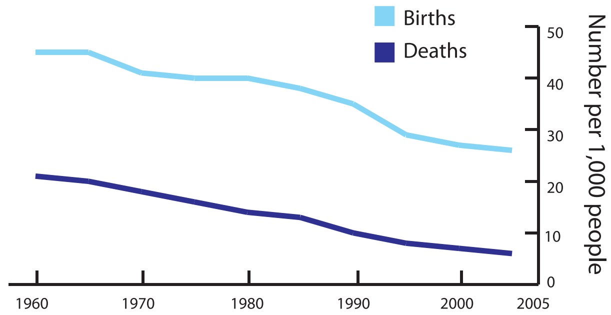
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 8.2. Egypt population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 8.3. Egypt birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 8.4. Egypt Ecological Footprint per person, 1961-2005

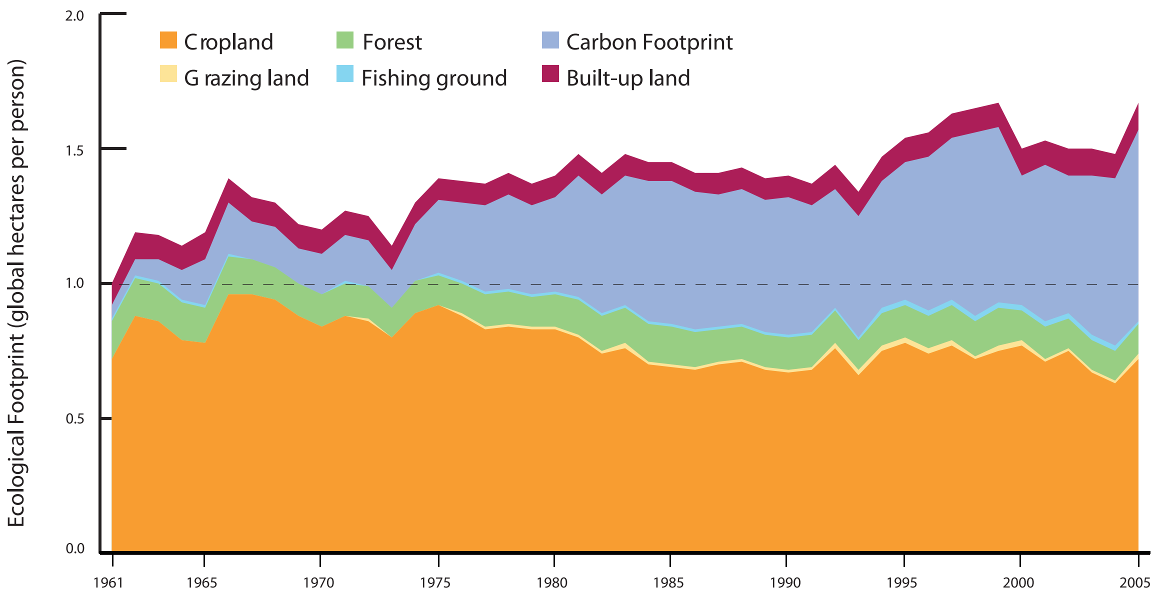


Table 8.2. Egypt Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.72	0.00	0.14	0.05	0.01	0.08	1.00
1965	0.78	0.00	0.13	0.17	0.01	0.10	1.19
1970	0.84	0.00	0.12	0.15	0.00	0.09	1.20
1975	0.92	0.00	0.11	0.27	0.01	0.08	1.39
1980	0.83	0.01	0.12	0.35	0.01	0.08	1.40
1985	0.69	0.01	0.14	0.53	0.01	0.07	1.46
1990	0.67	0.01	0.12	0.51	0.01	0.08	1.41
1995	0.78	0.02	0.12	0.51	0.02	0.09	1.53
2000	0.77	0.02	0.11	0.48	0.02	0.10	1.49
2005	0.72	0.02	0.11	0.71	0.01	0.10	1.67

Figure 8.5. Egypt biocapacity per person, 1961-2005

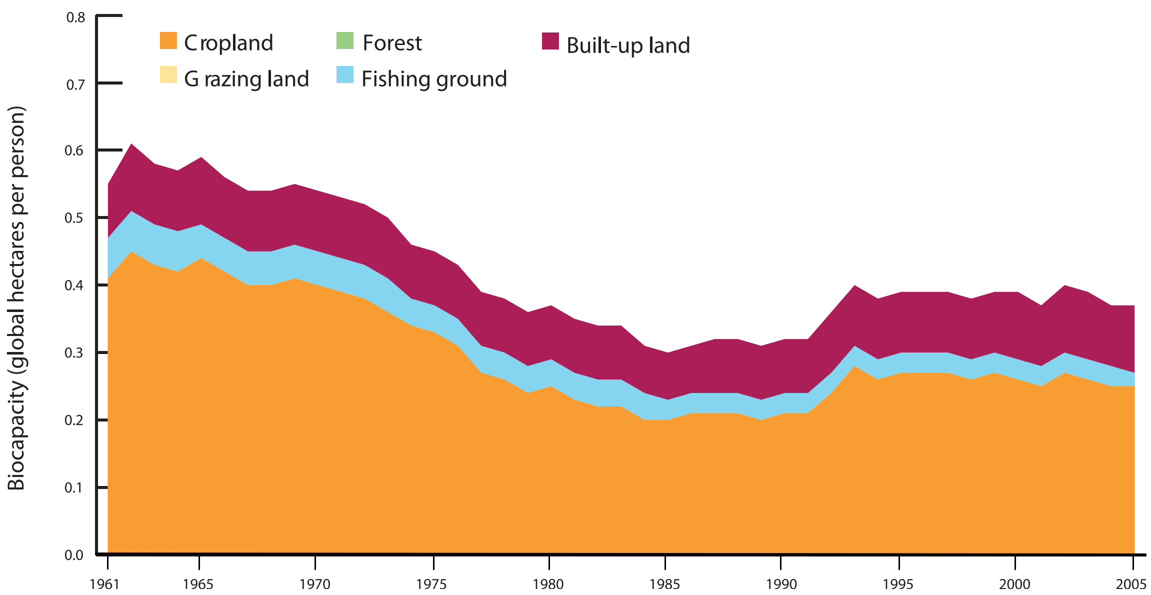


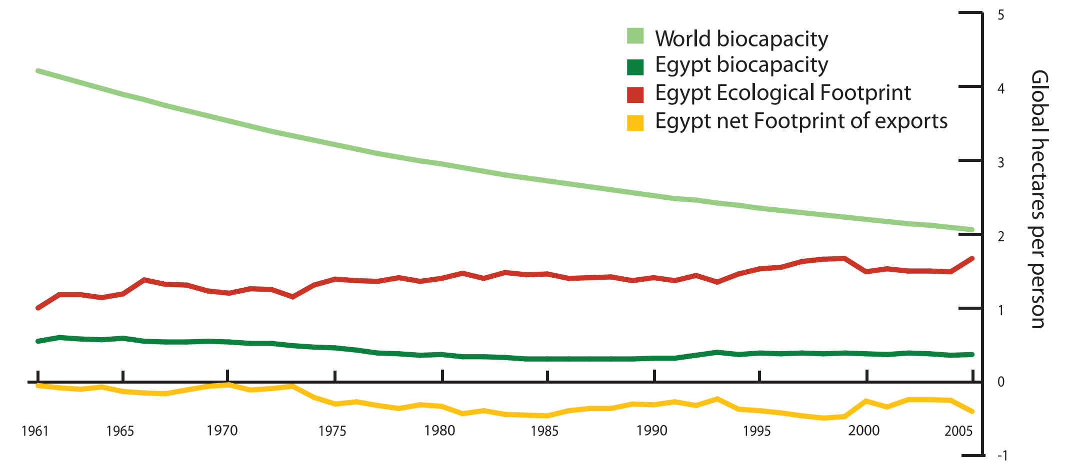
Table 8.3. Egypt biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.41	0.00	0.00		0.06	0.08	0.55
1965	0.44	0.00	0.00		0.05	0.10	0.59
1970	0.40	0.00	0.00		0.05	0.09	0.54
1975	0.33	0.00	0.00		0.04	0.08	0.46
1980	0.25	0.00	0.00		0.04	0.08	0.37
1985	0.20	0.00	0.00		0.03	0.07	0.31
1990	0.21	0.00	0.00		0.03	0.08	0.32
1995	0.27	0.00	0.00		0.03	0.09	0.39
2000	0.26	0.00	0.00		0.03	0.10	0.38
2005	0.25	0.00	0.00		0.02	0.10	0.37

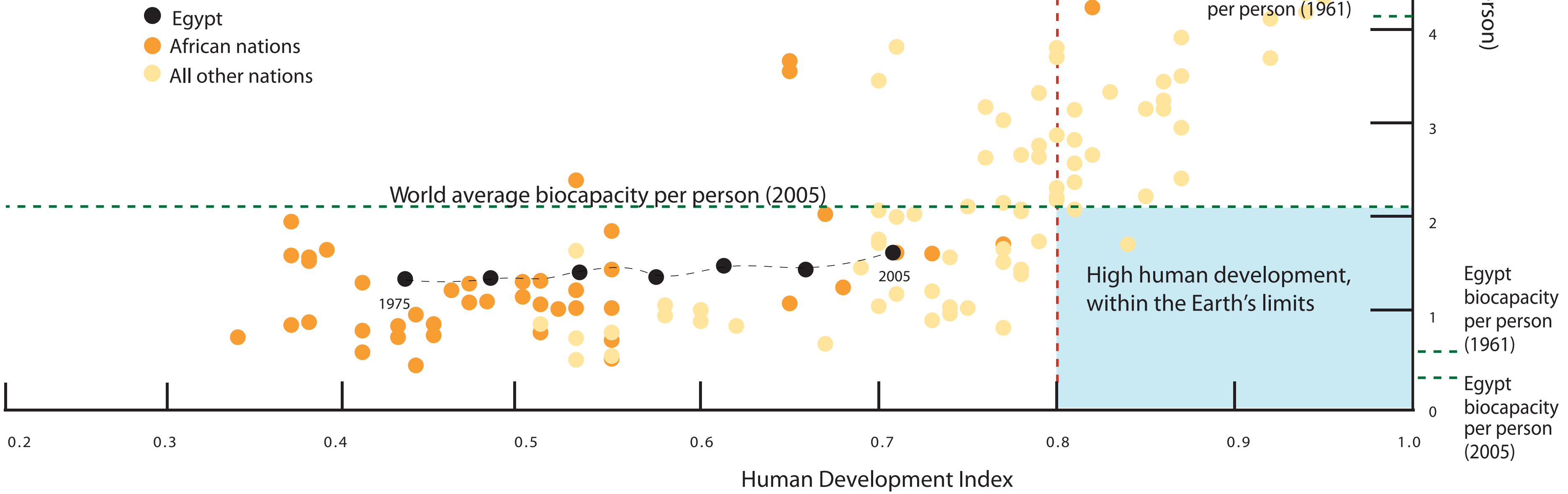
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 8.6. Egypt Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 8.7. Egypt Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Irrigation and Agriculture Technology in Egypt

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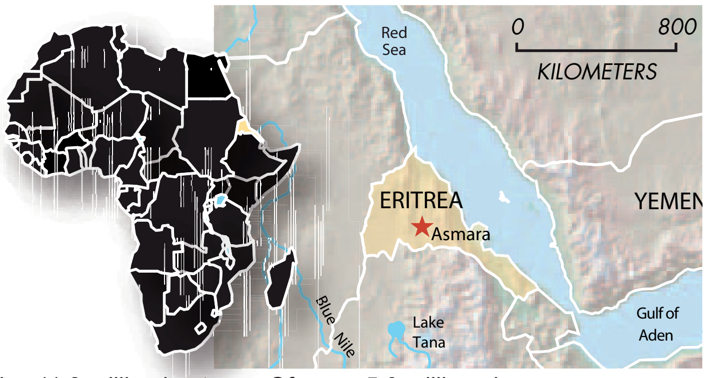
Egypt, located in the Northeastern corner of Africa, has a unique nature that blends Arab, African and Mediterranean heritage in a well-distinguished mosaic fabric. With a population of approximately 80 million, Egypt is the second most populous country in Africa, and the most populous country in the Arab world. Cairo, the capital of Egypt, is one of the world's mega-cities with a population that exceeds 14 million (CAPMAS 2008). With a population growth rate of 2.1 percent, one of Egypt's most daunting challenges is providing enough resources for the country's rapidly growing population (UNDP 2008). Most observers regard overpopulation as Egypt's largest problem.

Egypt is embarking on a general policy of increasing the cultivated areas in order to meet the needs of the growing population. Vast areas of desert are converted into cropland in different parts of the country, including the Eastern and Western deserts and Sinai. Among the major projects in this domain are the El Salam canal and the Toshka project that provide significant horizontal expansion of cropland (MWRI).

The El Salam canal provides a regular supply of water to North Sinai. The canal is providing 4 billion cubic meters of water to irrigate an area of approximately 660,000 Feddan (one Feddan is equal to 0.420 hectares). The water supplied is a mix of fresh Nile water with drain water harvested from three major drain systems in the Eastern Nile Delta. Water is conveyed through the Suez Canal through a siphon, located some 28 kilometers south of Port Said. Water emerges from the siphon on the Sinai Peninsula as El Sheikh Gaber El Sabah Canal, bringing water to El Areesh Valley in Sinai (MWRI). The El Salam canal currently covers a range of 60,000 Feddan, with regular water to parts of Sinai. The canal is also providing a regular supply of water to old farms and orchards established before the canal, increasing their productivity.

The Toshka Project exploits the natural Nile overflow phenomenon as the driving force to pump water out of Lake Nasser and, taking advantage of gravity, conveys the water hundreds of kilometers into the desert via a canal or pipeline on a permanent basis. The project should provide a new valley with about 500,000 Feddan of arable land when fully operational (MWRI). The current cultivated area of Toshka at the present time is only 30,000 Feddan, mostly producing high quality organic food for exportation and local consumption.

Support from the government in Egypt has led to unprecedented records in terms of crop production per unit of land. Egypt is one of the leading countries in the production of wheat, barely, rice and maize per unit-area. Improvement of crop production was the result of a successful research campaign funded by the local government to introduce new hybrids and varieties of crops, with high-intensity yield and sound environmental traits. Conventional breeding and selection processes were the main techniques used in the program with no inclusion of genetically manipulated crops. These methods were supplemented by improvements in agricultural practices that included proper cultivation timing, integrated pest management and sound harvesting, all of which helped to achieve higher agriculture production rates. Egypt is also adopting an extensive farming system whereby the same piece of land is cultivated two to three times a year. With such a high rate of harvesting, production rates are one of the highest in the Northern Africa region.



Eritrea occupies 11.8 million hectares. Of those, 1.6 million hectares are covered by forest, 0.6 million by cropland and 14.2 million by grazing land, with 0.2 million hectares supporting its built infrastructure. Located on the Red Sea, Eritrea has 4.7 million hectares of continental shelf and 1.7 million hectares of inland water.

Adjusting for its cropland, grazing land and forest yields, which are lower than corresponding global averages, and its fishery yield, which is higher than the global average, Eritrea has a biocapacity of 9.1 million global hectares (gha). This exceeds its total Ecological Footprint of 5.0 million gha.

Eritrea's average Ecological Footprint per person is 1.1 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 2.1 gha of biocapacity available per person within Eritrea. As its population grew from 3.1 million to 4.4 million between 1993 and 2005, biocapacity per person in Eritrea decreased 27 percent. From 1962 until 1993, Eritrea and Ethiopia were united to form the People's Democratic Republic of Ethiopia. The UN first began reporting data for Eritrea when it gained its independence in 1993.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 9.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Eritrea	4,401,000	5,047	9,067	1.15	2.06
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	1.2	692

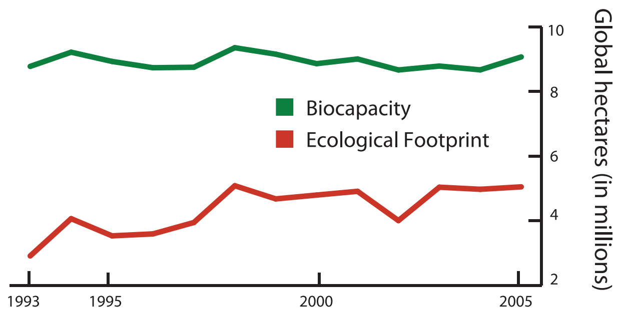
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	–	–	–	–	–

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Eritrea	Female	Male
Human Development Index Value (0=min. 1=max.)	0.483	–	–
Adult Literacy Rate (percent adults over 18)	–	71.5	71.5
Gross Enrollment Ratio (percent eligible students enrolled)	34.2	28	40
Irrigated Cropland (percent of total, 2000)	5.5	–	–
Access to Improved Water (percent of population, 2002)	60	–	–
Domestic Electrification (percent of population, 2000)	20	–	–
Undernourishment (percent of population, 2000)	3	–	–
Life Expectancy (years)	56.6	59.0	54.0

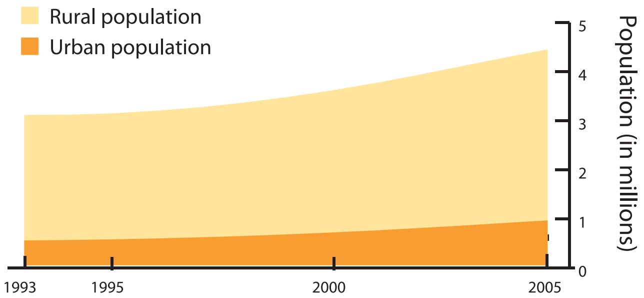
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 9.1. Eritrea total Ecological Footprint and biocapacity, 1993-2005



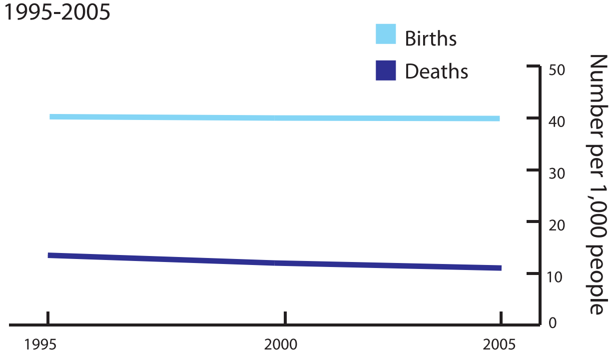
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 9.2. Eritrea population, 1993-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 9.3. Eritrea birth and death rate (annual est.), 1995-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 9.4. Eritrea Ecological Footprint per person, 1993-2005

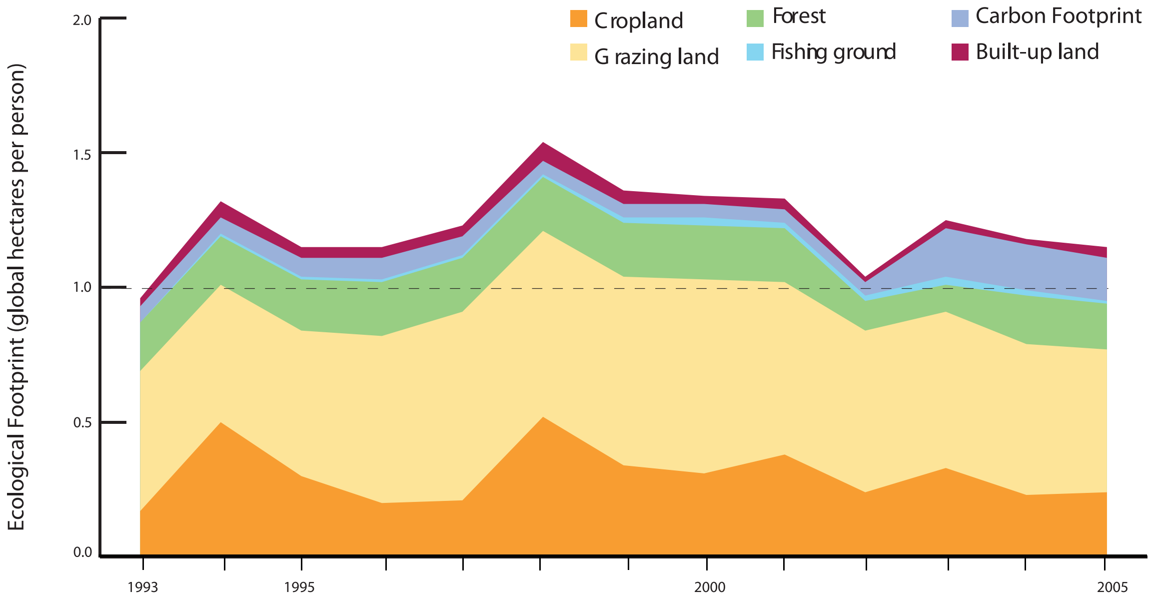


Table 9.2. Eritrea Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	–	–	–	–	–	–	–
1965	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–
1980	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–
1995	0.30	0.54	0.19	0.07	0.01	0.04	1.14
2000	0.31	0.72	0.20	0.05	0.03	0.03	1.35
2005	0.24	0.53	0.17	0.16	0.01	0.04	1.15

Figure 9.5. Eritrea biocapacity per person, 1993-2005

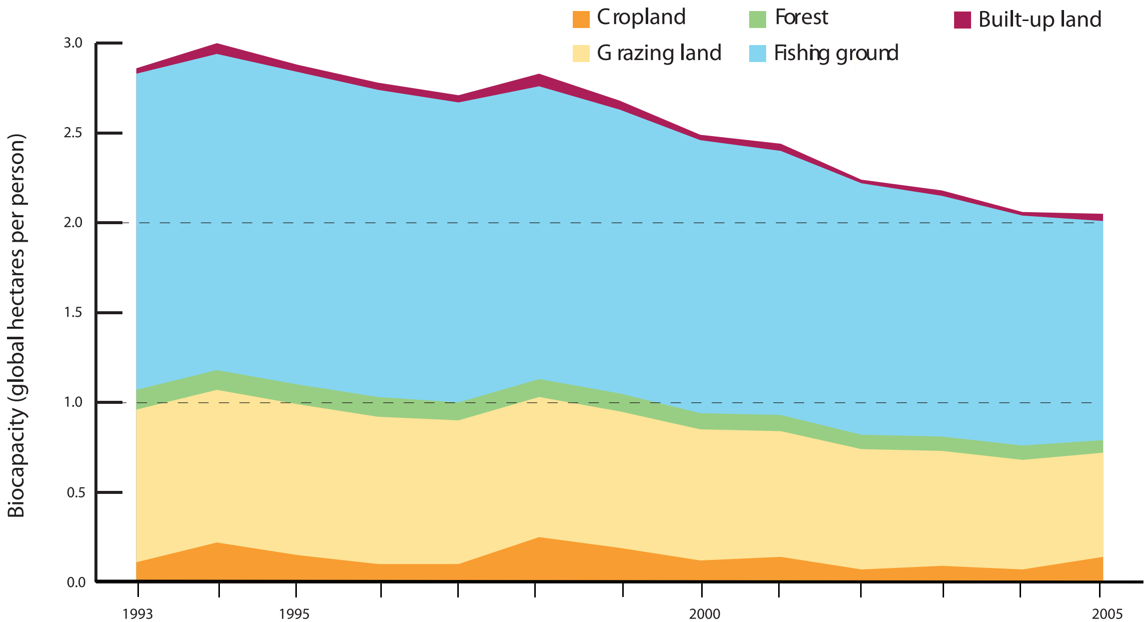


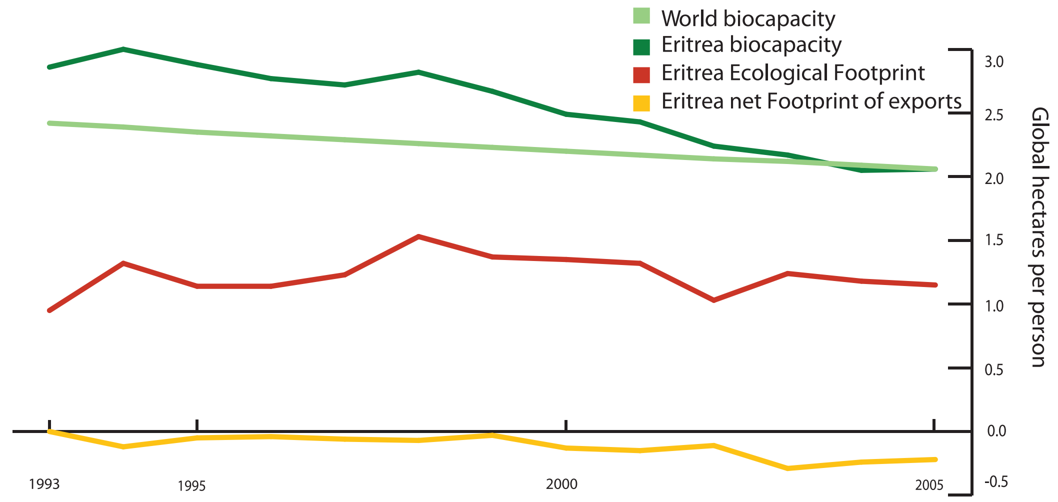
Table 9.3. Eritrea biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	–	–	–		–	–	–
1965	–	–	–		–	–	–
1970	–	–	–		–	–	–
1975	–	–	–		–	–	–
1980	–	–	–		–	–	–
1985	–	–	–		–	–	–
1990	–	–	–		–	–	–
1995	0.15	0.84	0.11		1.74	0.04	2.88
2000	0.12	0.73	0.09		1.52	0.03	2.49
2005	0.14	0.58	0.07		1.22	0.04	2.06

Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 9.6. Eritrea Ecological Footprint, net exports and biocapacity per person, 1993-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 9.7. Eritrea Human Development Index and Ecological Footprint, 2005

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Eritrea: Pasture Land Shortage and its Impact on Pastoralist Livelihoods

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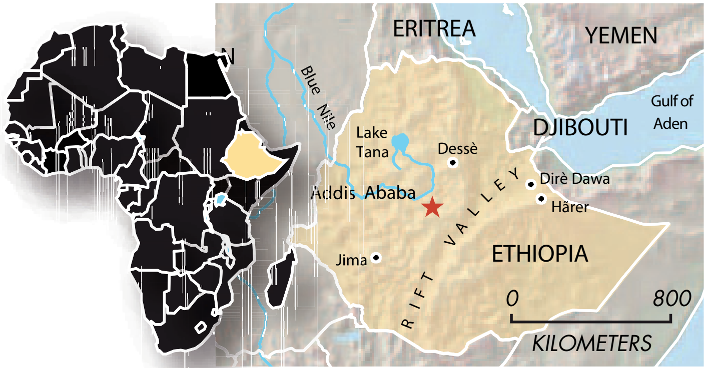
More than half of Eritrea's total land mass is suitable for grazing, most of it situated within the semi-arid Western Lowlands and the Eastern Escarpments separated from one another by Eritrea's highlands. Grazing areas, including valuable rangelands such as the riverine forests along Gash Barka's seasonal streams, are utilised by pastoralists, agro-pastoralists and farmers for subsistence. Agro-pastoralists and pastoralists are the key stakeholders in Eritrea's livestock sector, which has one of the highest stock densities in Africa. The agricultural sector (including livestock) contributes 25-30 percent of Eritrea's GDP but, in spite of little investment into the livestock sector, it makes up almost half of the revenue generated by the agriculture sector (Ministry of Agriculture 2002; FAO 1999).

Fertile pastures in Eritrea have been dwindling at an extraordinary rate over the last decade. This has resulted in serious fodder and water shortages for livestock production, affecting both domestic food security and export markets. The predominant causes of pasture shortages are decreases in land area, land productivity and land accessibility.

The total area of pasture land is shrinking due to the vast expansion of agriculture production driven by population growth and national development policies. The increased pressure on the remaining pasturelands has led to overuse, resulting in land degradation. This land degradation is intensified by recurring droughts. Of specific concern to local communities is the spread of the alien Prosopis juliflora, a wild shrub introduced to Eritrea in the 1980s. It is drought-resistant, which allows it to spread rapidly and form inaccessible thorny thickets at the expense of native plant species, which are more palatable to livestock. Lastly, livestock migration routes have been cut off by agricultural expansion in key corridors. Since Eritrea's war with Ethiopia (1998-2000), key grazing areas have become inaccessible due to mine fields, military camps and security zones. Further exacerbating the situation, access to valuable dry-season pastures across the border in Northern Ethiopia has been impossible since the border closure in 1998 (PENHA and NUEYS 2002).

Approximately one-third of Eritrea's population are pastoralists and agro-pastoralists, who depend on sufficient grazing resources for livestock production. The increasing scarcity of pasture land heavily impacts such communities, forcing adaptive changes within their traditional and socio-economic structures. An early sign of a population's adaptation to grazing land shortage is prolonged periods of migration, increasingly further from the homestead. This leads to both family separation and an increase in the amount of labour needed for herding livestock. In Western Eritrea, farmers who own livestock reported that they, too, have begun to practice a form of migration in order to maintain their livestock. The lack of fodder resources near their villages has transformed their previously sedentary livelihoods into those of agro-pastoralists (Bokrezion 2000). Conversely, pastoralists in the same region are shifting towards sedentarisation due to fodder shortages. This is prompting them to seek alternative sources of income such as horticulture or wage labour.

The severe lack of grazing resources is the key concern for pastoralist communities in Eritrea. Livestock productivity and domestic consumption of livestock by-products have declined, leaving pastoralists increasingly impoverished and dependent on food aid. In Eritrea, disputes over grazing resources have been reported, although to date they have not escalated into serious conflict (Kibreab et al. 2002).



The Federal Democratic Republic of Ethiopia occupies 110.4 million hectares. Of those, 13.0 million hectares are forest, 13.9 million cropland and 64.7 million grazing land, with 2.3 million hectares supporting its built infrastructure. Landlocked Ethiopia has 10.4 million hectares of inland water.

Adjusting for its cropland, forest and fishery yields, which are lower than corresponding global averages, and its grazing land yield, which is higher, Ethiopia has a biocapacity of 77.8 million global hectares (gha). This is less than its total Ecological Footprint of 104.7 million gha. Eritrea and Ethiopia were united to form the People's Democratic Republic of Ethiopia from 1962 until 1993, when the UN first began reporting data for Federal Democratic Republic of Ethiopia. Ethiopia has operated with an ecological deficit since 1993.

Ethiopia's average Ecological Footprint per person is 1.35 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is larger than the 1.0 gha of biocapacity available per person within Ethiopia. As its population grew from 56.4 million to 77.4 million between 1993 and 2005, biocapacity per person in Ethiopia decreased 23 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 10.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint (Total global hectares (thousands))	Biocapacity (Total global hectares (thousands))	Ecological Footprint (Global hectares per person)	Biocapacity (Global hectares per person)
Ethiopia	77,431,000	104,678	77,755	1.35	1.00
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	12.3	581

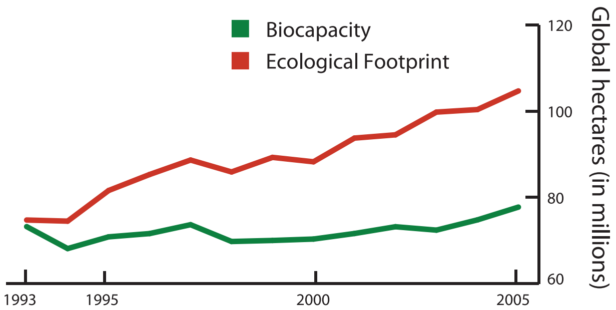
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	39.4	21.5	16.8	13.2	9.1

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Ethiopia	Female	Male
Human Development Index Value (0=min. 1=max.)	0.406	–	–
Adult Literacy Rate (percent adults over 18)	35.9	22.8	50.0
Gross Enrollment Ratio (percent eligible students enrolled)	41.6	36	47
Irrigated Cropland (percent of total, 2000)	2.7	–	–
Access to Improved Water (percent of population, 2002)	22	–	–
Domestic Electrification (percent of population, 2000)	15	–	–
Undernourishment (percent of population, 2000)	33	–	–
Life Expectancy (years)	51.8	53.1	50.5

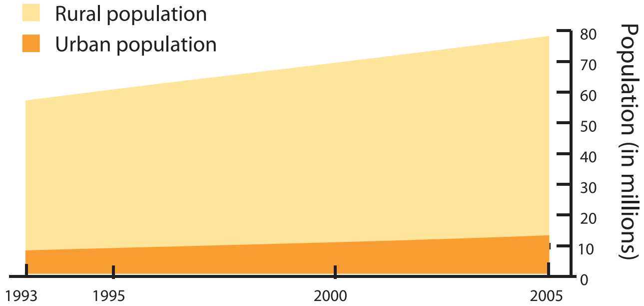
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 10.1. Ethiopia total Ecological Footprint and biocapacity,1993-2005



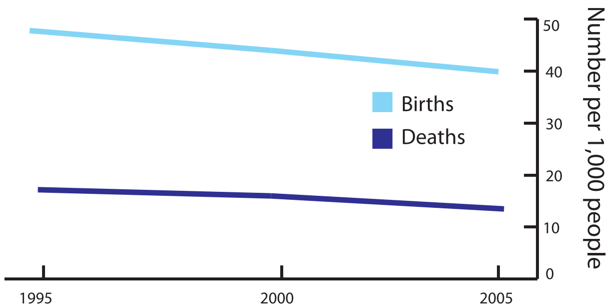
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 10.2. Ethiopia population, 1993-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 10.3. Ethiopia birth and death rate (annual est.),1995-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 10.4. Ethiopia Ecological Footprint per person, 1993-2005

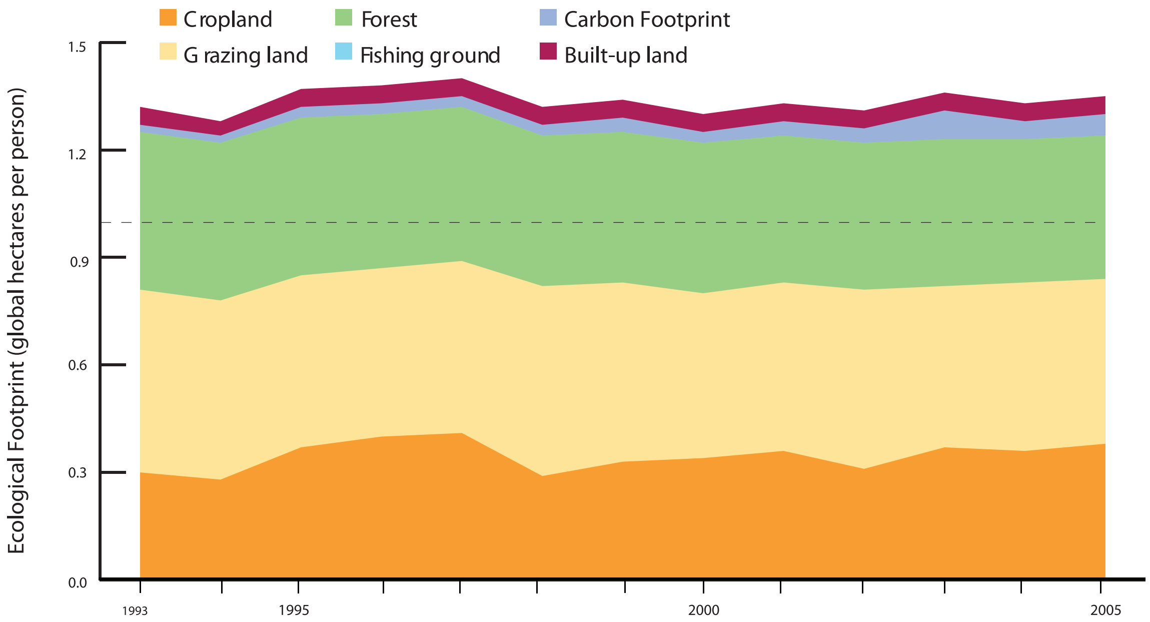


Table 10.2. Ethiopia Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	–	–	–	–	–	–	–
1965	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–
1980	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–
1995	0.37	0.48	0.44	0.03	0.00	0.05	1.36
2000	0.34	0.46	0.42	0.03	0.00	0.05	1.29
2005	0.38	0.46	0.40	0.06	0.00	0.05	1.35

Figure 10.5. Ethiopia biocapacity per person, 1993-2005

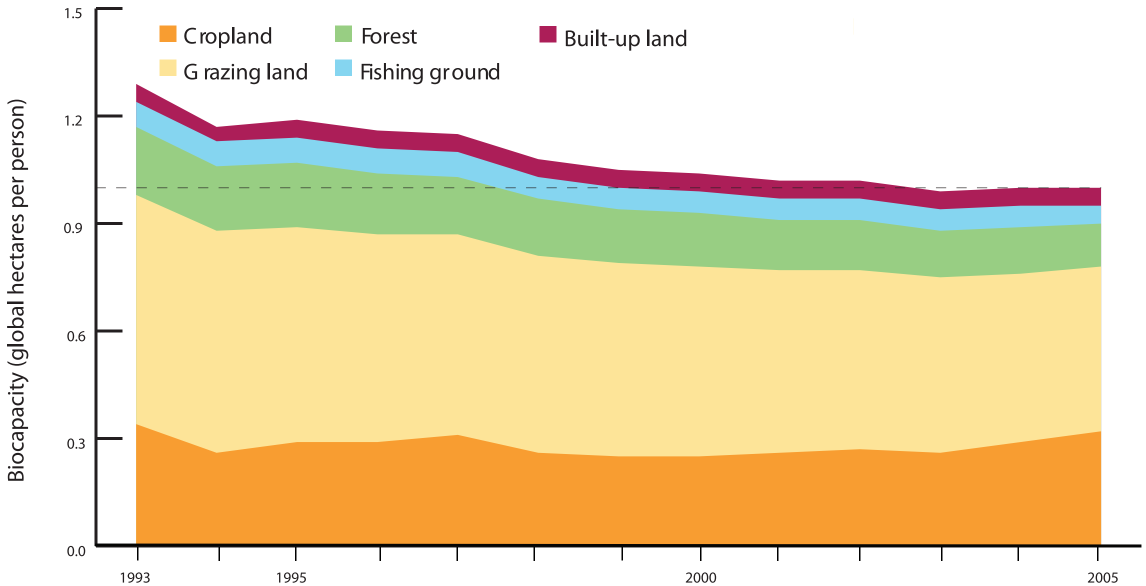


Table 10.3. Ethiopia biocapacity, 1961-2005

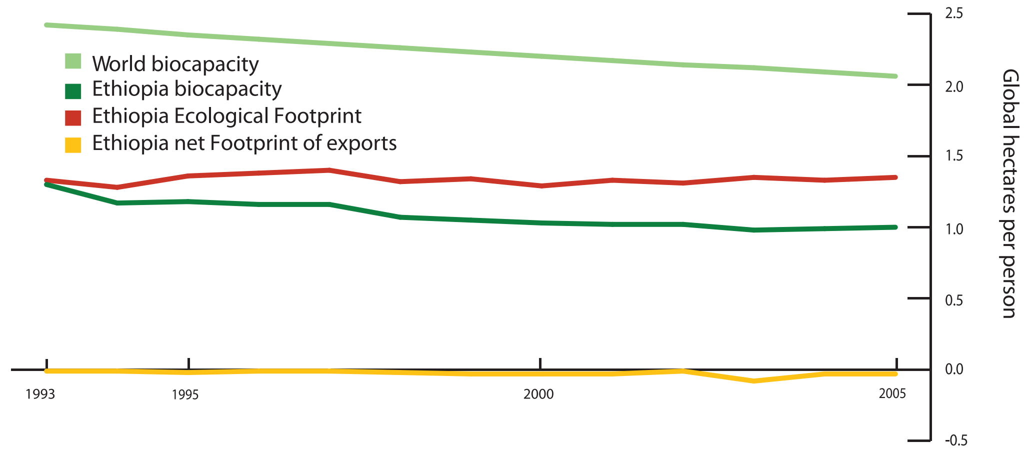
(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	–	–	–		–	–	–
1965	–	–	–		–	–	–
1970	–	–	–		–	–	–
1975	–	–	–		–	–	–
1980	–	–	–		–	–	–
1985	–	–	–		–	–	–
1990	–	–	–		–	–	–
1995	0.29	0.60	0.18		0.07	0.05	1.18
2000	0.25	0.53	0.15		0.06	0.05	1.03
2005	0.32	0.46	0.12		0.05	0.05	1.00

Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

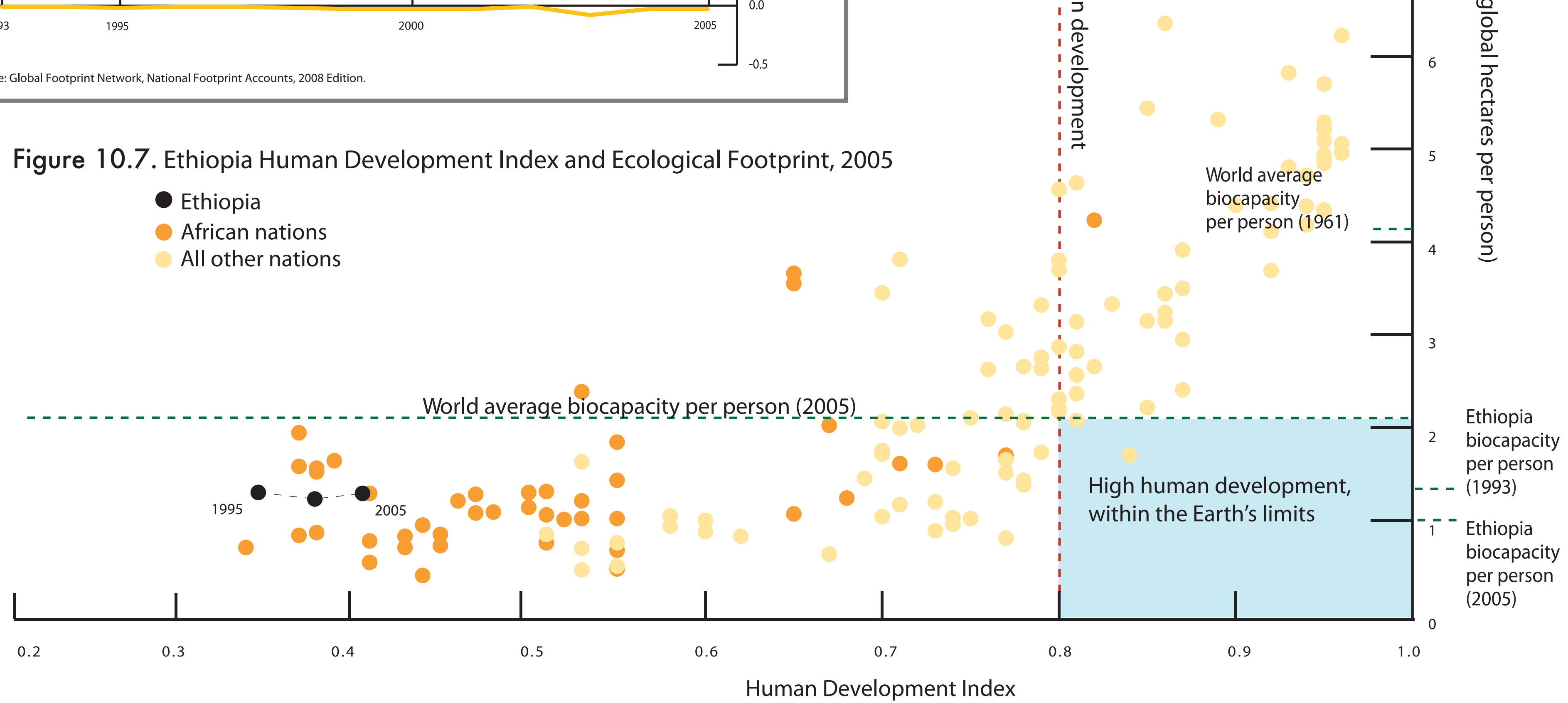
Figure 10.6. Ethiopia Ecological Footprint, net exports and biocapacity per person, 1993-2005

Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 10.7. Ethiopia Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Another Perspective on Ethiopia's Largest Dam: Gilgel Gibe III

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Hydroelectric power is an ideal method for satisfying Ethiopia's energy demand. The country's potential for exploitable hydroelectric power is enormous, estimated at 650 Tera Watt hours per year (CESEN-ANSALDO, 1986). Although economically viable and exploitable, only 31 percent of Ethiopia's potential hydroelectric power is currently consumed (Bekele 2009).

Similar to many other countries on the African continent, Ethiopia's prominent source of energy is biomass. Biomass sources, mostly wood, charcoal, animal waste and agricultural residue make up 95 percent of the total energy consumed in Ethiopia (Developing Renewables 2006; GTZ 2009). The practice of using biomass for energy in Africa often causes deforestation, soil degradation and can even lead to climate change through increased greenhouse gas emissions. Furthermore, it is increasingly clear that traditional energy sources are not sufficient to meet Ethiopia's rising energy needs. Hydroelectric power appears to be a promising alternative.

The Ethiopian Government is constructing the third phase of the Gilgel Gibe Dam on Ethiopia's Omo River. Gilgel Gibe III is expected to be the largest hydroelectric power plant in Africa, intended to satisfy the country's growing energy needs and provide an alternative to biomass-based energy. The dam is hoped to maximize national revenue through electricity trade with neighbouring countries of Sudan, Djibouti and Kenya (High, 2009). Lastly, by regulating water release the dam will help control the hazardous flooding from Omo River, such as that which killed 370 people and displaced over 100,000 in 2006 (EEPCo 2009).

Environmentalists, anthropologists, and economists have monitored and tried to evaluate this extensive development project in order to identify possible hazards and negative impacts. The Gilgel Gibe III hydroelectric project has become a cause of debate among these stakeholders and the Ethiopian Government.

Critics of the project highlight that the Environmental Impact Assessment (EIA) for the dam was executed two years after the project began. In subsequent investigations, anthropologists and other stakeholders conveyed further drawbacks: a loss of the indigenous flood cultivation by tribes that live downstream of the dam; the reduction in size of Lake Turkana, which gets 80 percent of its total water from the Omo River; and the threat posed by diminished water levels to the fragile riparian forests that serve as critical biodiversity habitat in the lower Omo River (Pietrangeli and Pallavicini 2007). In addition, the dam is expected to produce high sedimentation, which could cause landslides (Devi et al. 2008).

These potential hazards were not indicated in the government-sponsored Environmental Impact Reports, nor have the authorities adjusted the project to address these threats. Ethiopian Prime Minister Meles Zenawi announced in a news conference that "the impact of the project on the livelihood, traditional lifestyles, and natural habitats is negligible" (*Addis Fortune* 2009). The government-owned electric power organization, EEPCo, claimed the call by environmentalists to halt the project was unaffordable advice that would let Ethiopia live long in darkness (EEPCo 2009).

It is my opinion that an external review should indicate how these potential hazards could be minimized, and determine how to adapt the project so that it will be successful in all respects. Even though the dam will affect the water balance of the Omo River and Lake Turkana, the contribution of large downstream catchments should not be overlooked. If the project has negative impacts on vulnerable communities or regions near the dam, these impacts should be mitigated through social or economic compensation. The Ethiopian government must be open to suggestions that would make the project beneficial to both the environment and society. This would enable development that is valuable to Ethiopia's urban and rural residents, as well as to the country's national government.

Kenya occupies 58.0 million hectares. Of those, 3.5 million hectares are covered by forest, 5.7 million by cropland and 56.2 million by grazing land, with 1.0 million hectares supporting its built infrastructure. Located in the Great Rift Valley along the Indian Ocean, with Lake Victoria to its west and Lake Turkana to its north, Kenya borders 0.8 million hectares of continental shelf and has 1.1 million hectares of inland water.

Adjusting for its cropland and forest yields, which are lower than corresponding global averages, and its grazing land and fishery yields, which are higher than the global averages, Kenya has a biocapacity of 41.0 million global hectares (gha). This is more than its total Ecological Footprint of 34.2 million gha.

Kenya's average Ecological Footprint per person is 1.1 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. This is comparable to the 1.2 gha of biocapacity available per person within Kenya. As its population grew from 8.4 million to 34.3 million between 1961 and 2005, biocapacity per person in Kenya decreased by 74 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 11.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Kenya	34,256,000	36,545	40,978	1.07	1.20
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	18.8	1,375

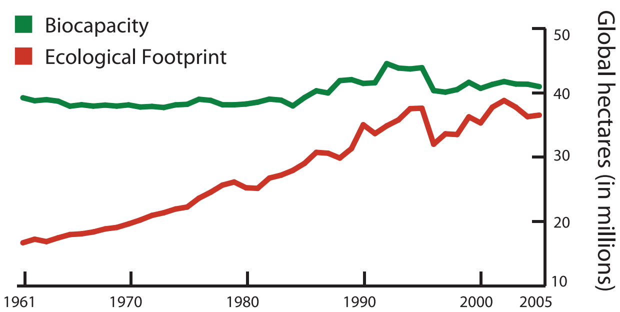
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	49.1	20.8	14.3	9.8	6.0

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Kenya	Female	Male
Human Development Index Value (0=min. 1=max.)	0.521	–	–
Adult Literacy Rate (percent adults over 18)	73.6	70.2	77.7
Gross Enrollment Ratio (percent eligible students enrolled)	59.4	58	61
Irrigated Cropland (percent of total, 2000)	1.8	–	–
Access to Improved Water (percent of population, 2002)	61	–	–
Domestic Electrification (percent of population, 2000)	14	–	–
Undernourishment (percent of population, 2000)	10	–	–
Life Expectancy (years)	52.1	53.1	51.1

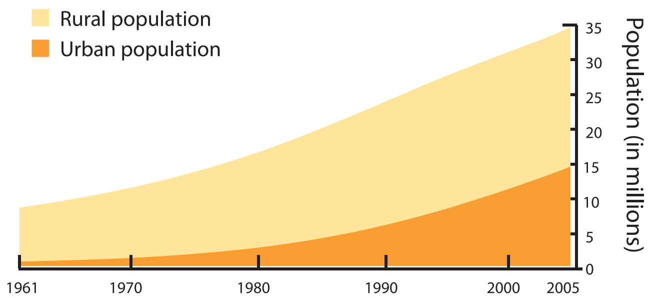
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 11.1. Kenya total Ecological Footprint and biocapacity, 1961-2005



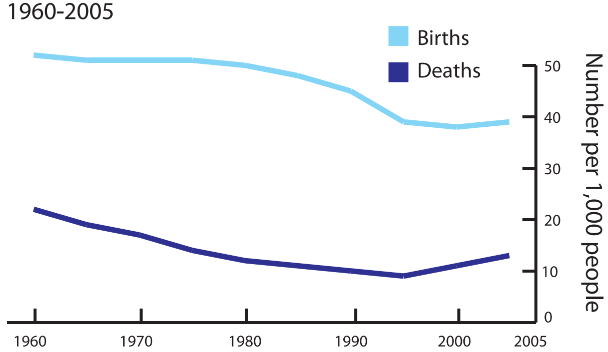
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 11.2. Kenya population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 11.3. Kenya birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 11.4. Kenya Ecological Footprint per person, 1961-2005

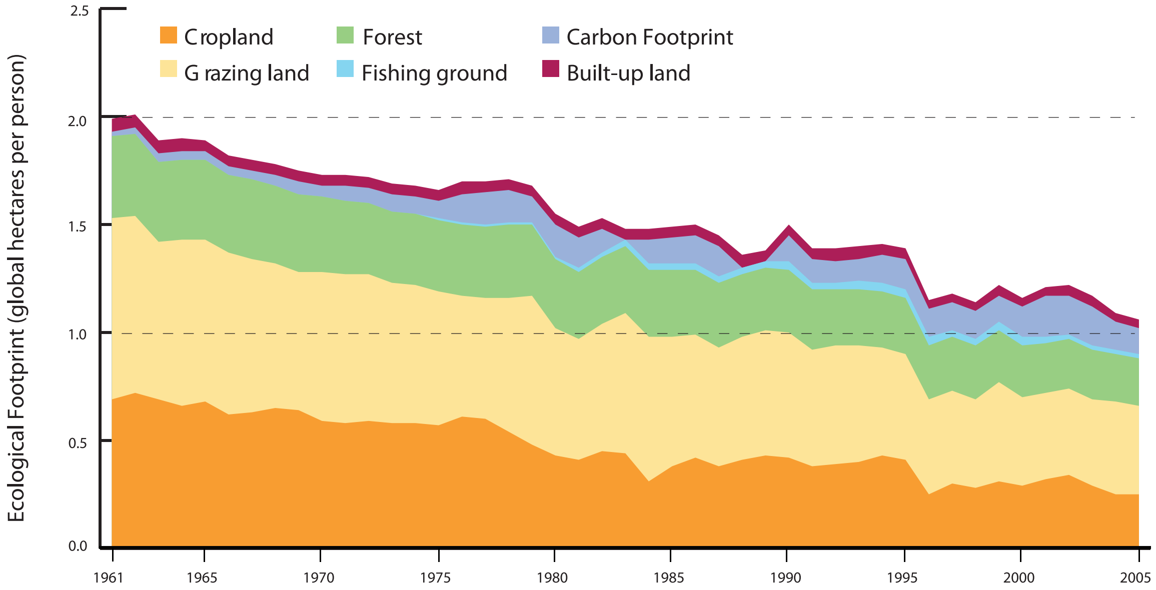


Table 11.2. Kenya Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.69	0.84	0.38	0.02	0.00	0.06	2.00
1965	0.68	0.75	0.37	0.04	0.00	0.05	1.89
1970	0.59	0.69	0.35	0.05	0.00	0.05	1.74
1975	0.57	0.62	0.33	0.08	0.01	0.05	1.65
1980	0.43	0.59	0.32	0.15	0.01	0.05	1.55
1985	0.38	0.60	0.31	0.12	0.03	0.05	1.48
1990	0.42	0.58	0.29	0.12	0.04	0.05	1.50
1995	0.41	0.49	0.26	0.14	0.04	0.05	1.38
2000	0.29	0.41	0.24	0.14	0.04	0.04	1.15
2005	0.25	0.41	0.22	0.12	0.02	0.04	1.07

Figure 11.5. Kenya biocapacity per person, 1961-2005

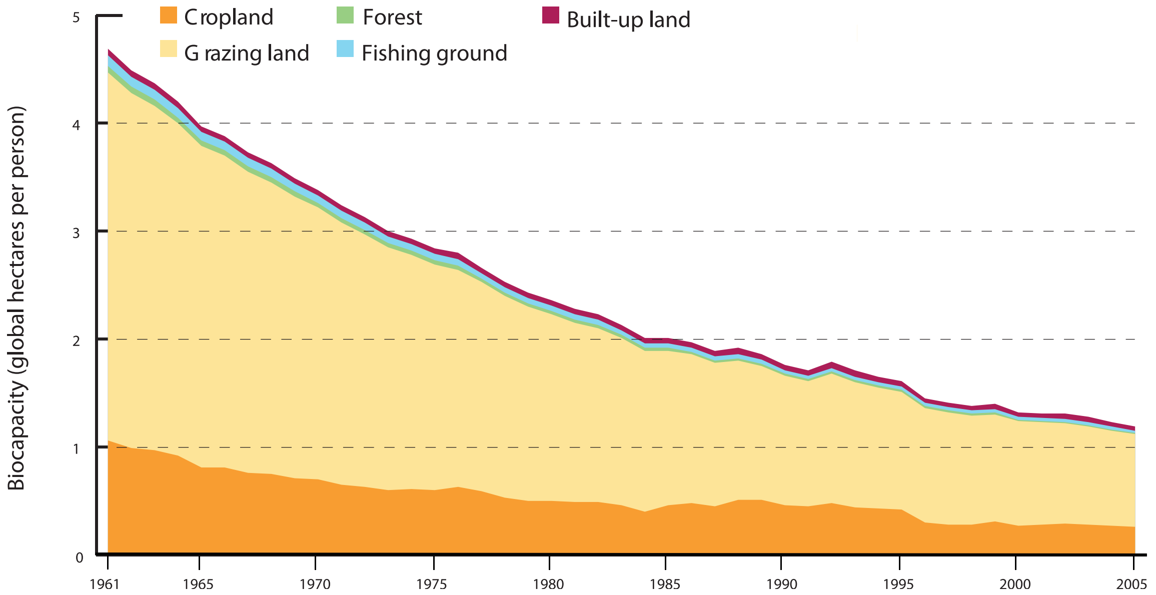


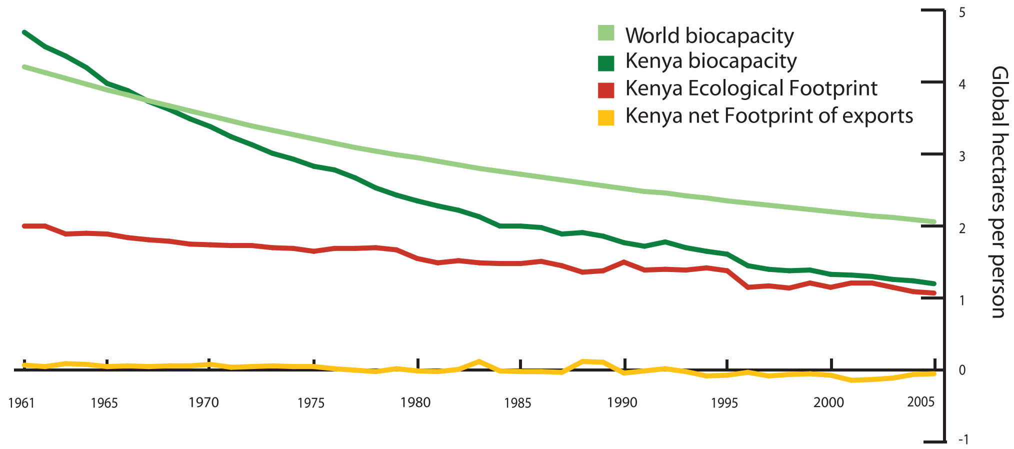
Table 11.3. Kenya biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.06	3.41	0.06		0.10	0.06	4.69
1965	0.81	2.98	0.05		0.08	0.05	3.98
1970	0.70	2.52	0.04		0.07	0.05	3.38
1975	0.60	2.09	0.04		0.06	0.05	2.83
1980	0.50	1.73	0.03		0.05	0.05	2.35
1985	0.46	1.43	0.03		0.04	0.05	2.00
1990	0.46	1.20	0.02		0.03	0.05	1.77
1995	0.42	1.09	0.02		0.03	0.05	1.61
2000	0.27	0.97	0.01		0.03	0.04	1.33
2005	0.26	0.86	0.01		0.02	0.04	1.20

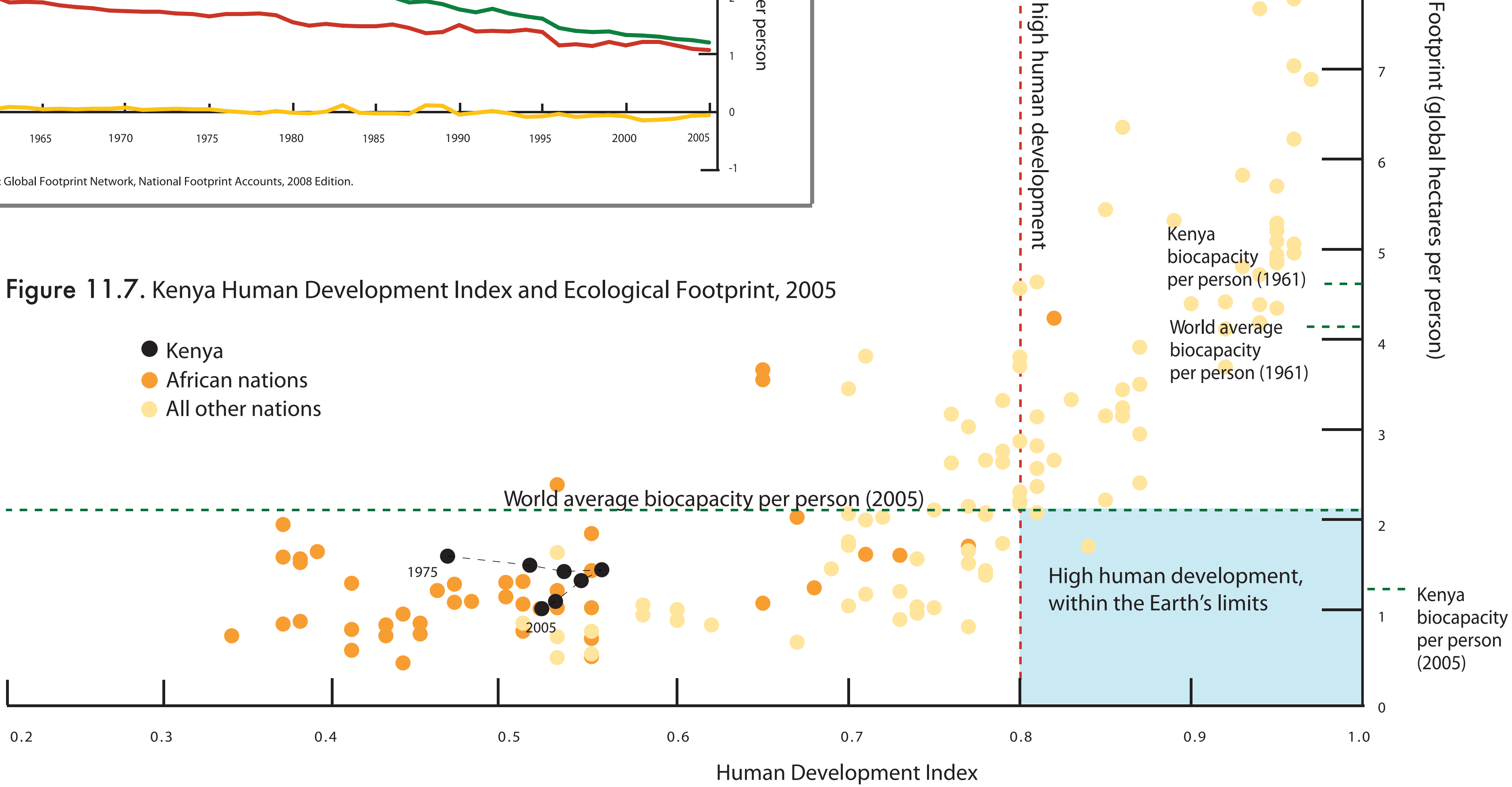
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 11.6. Kenya Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 11.7. Kenya Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Kenya: Increasing Food Security with Low-Impact Irrigation

Regina Kamau

Development Officer
KickStart International

Nairobi, Kenya

Kenya is home to 37 million people, and approximately 70 percent of them depend for their livelihood on small pieces of land between one and five acres. These smallholder families typically cultivate crops such as maize, sorghum, cassava, sweet potatoes, and beans, which are both consumed domestically and sold for income generation. These families are highly dependent on rainfall in Kenya: the long rains which occur annually in March and April and the short rains which occur in October and November. Due to changes in climate, Kenya's annual rains are increasingly less predictable in timing and duration. Both prolonged drought and extensive flooding can cause significant crop loss.

On the increasingly rare occasions when the rains are kind to the farmers, smallholder farms face the additional challenge of a glutted market. All of the farmers in one region will be harvesting their staple crops and trying to sell them at the same time. This depresses the price the farmer will receive for his/her harvest, limiting the potential household income.

In 2006, the FAO estimated that 31 percent, or 9.7 million Kenyans, were malnourished between 2001 and 2003 (FAO). Since then the country has experienced chronic crop failure and low market pricing for staple crops. As of 2003 it is estimated that at least 11 million Kenyans are undernourished (FAO).

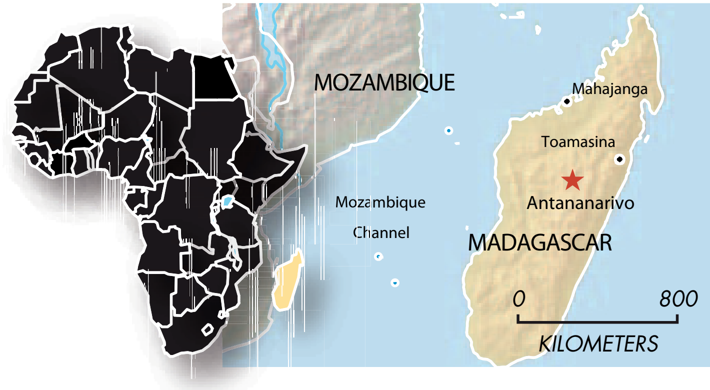
One solution to rainfall irregularities is to utilize groundwater for irrigation, drawing water from shallow-water aquifers that replenish during rainy seasons. Kenya still has significant unexploited irrigation potential. From an estimated 540,000 hectares of irrigable land, less than 90,000 hectares are currently being irrigated (Republic of Kenya 2004). If Kenya were to fully exploit irrigation, it would boost farm productivity and agricultural yields by an estimated 100 to 400 percent (FAO 2002).

Although there are many kinds of irrigation technologies, human powered treadle pumps have proved to be a remarkably effective solution. They are affordable for smallholder farmers, easy to operate from renewable, human power.

KickStart is a social enterprise with a mission of giving millions of people the means to get out of poverty through design and promotion of various technologies. KickStart has developed the MoneyMaker series of human powered micro-irrigation water pumps. To date, over 48,000 pumps have been sold in Kenya, helping establish over 38,000 small agricultural enterprises. This has created new wealth and employment helping 190,000 people move out of poverty (KickStart Impact Report).

On average each pump can irrigate 0.56 acres, and generates a new net annual household income of 1,200 USD (Kihia 1999). This tenfold increase in smallholder farm income as a result of using MoneyMaker irrigation pumps has made farming a dependable business for thousands of families in the rural areas of Kenya.

KickStart's pumps offer twice the return on investment when compared to motorized pumps. They provide the most affordable solution per square meter irragated (Grimm and Richter 2006). Use of human powered irrigation pumps not only boosts food production but also increases the family's household income.



Madagascar occupies 58.7 million hectares. Of those, 12.8 million hectares are covered by forest, 3.6 million by cropland and 37.3 million by grazing land, with 0.7 million hectares supporting its built infrastructure. Located off the eastern coast of southern Africa in the Indian Ocean, Madagascar borders 9.7 million hectares of continental shelf and has 0.6 million hectares of inland water.

Adjusting for its cropland, forest and fishery yields, which are lower than corresponding global averages, and its grazing land yield, which is higher than the global average,

Madagascar has a biocapacity of 69.7 million global hectares (gha). This is more than its total Ecological Footprint of 20.1 million gha.

Madagascar's average Ecological Footprint per person is 1.1 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 3.7 gha of biocapacity available per person within Madagascar. As its population grew from 5.5 million to 18.6 million between 1961 and 2005, biocapacity per person in Madagascar decreased by 70 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 12.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Madagascar	18,606,000	20,118	69,656	1.08	3.74
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	5.0	834

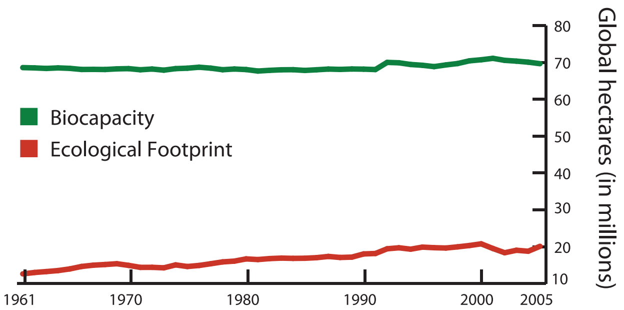
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	53.5	20.4	12.7	8.5	4.9

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Madagascar	Female	Male
Human Development Index Value (0=min. 1=max.)	0.533	–	–
Adult Literacy Rate (percent adults over 18)	70.7	65.3	76.5
Gross Enrollment Ratio (percent eligible students enrolled)	58.8	57	60
Irrigated Cropland (percent of total, 2000)	30.6	–	–
Access to Improved Water (percent of population, 2002)	50	–	–
Domestic Electrification (percent of population, 2000)	15	–	–
Undernourishment (percent of population, 2000)	7	–	–
Life Expectancy (years)	58.4	60.1	56.7

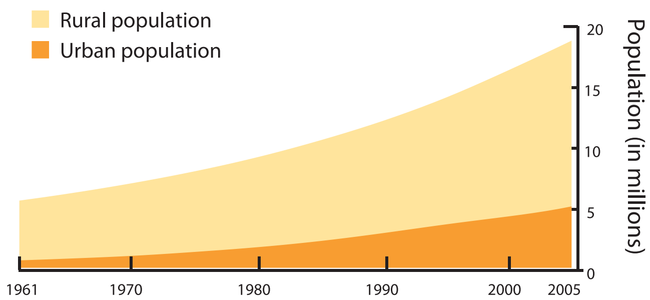
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 12.1. Madagascar total Ecological Footprint and biocapacity, 1961-2005



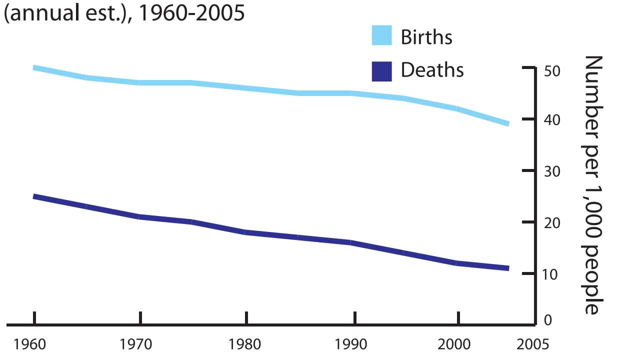
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 12.2. Madagascar population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 12.3. Madagascar birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 12.4. Madagascar Ecological Footprint per person, 1961-2005

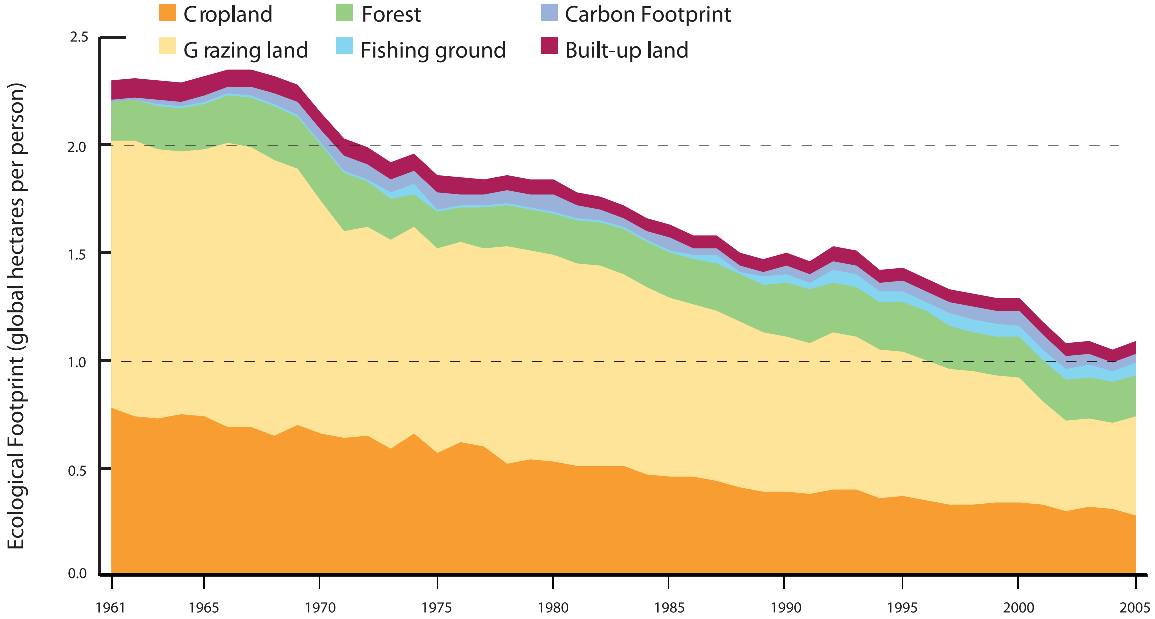


Table 12.2. Madagascar Ecological Footprint, 1961-2005 (global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.78	1.24	0.18	0.01	0.00	0.09	2.30
1965	0.74	1.24	0.21	0.03	0.01	0.09	2.30
1970	0.66	1.08	0.26	0.06	0.01	0.08	2.16
1975	0.57	0.95	0.17	0.08	0.01	0.08	1.85
1980	0.53	0.96	0.19	0.08	0.01	0.07	1.84
1985	0.46	0.83	0.21	0.06	0.01	0.06	1.62
1990	0.39	0.72	0.25	0.04	0.04	0.06	1.50
1995	0.37	0.67	0.23	0.05	0.05	0.06	1.43
2000	0.34	0.58	0.19	0.07	0.05	0.06	1.28
2005	0.28	0.46	0.19	0.04	0.06	0.06	1.08

Figure 12.5. Madagascar biocapacity per person, 1961-2005

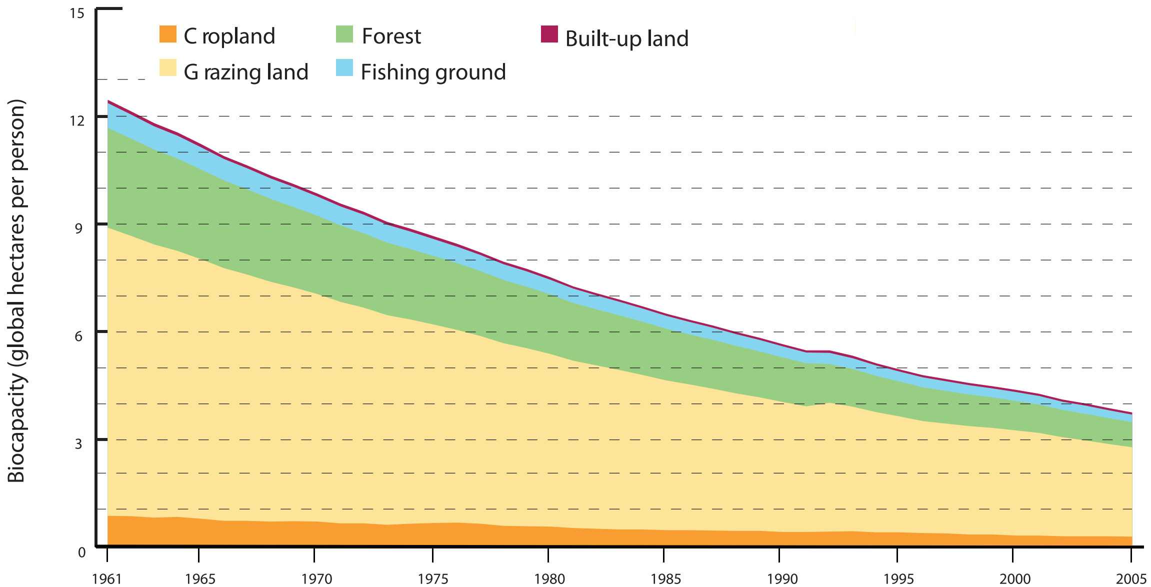
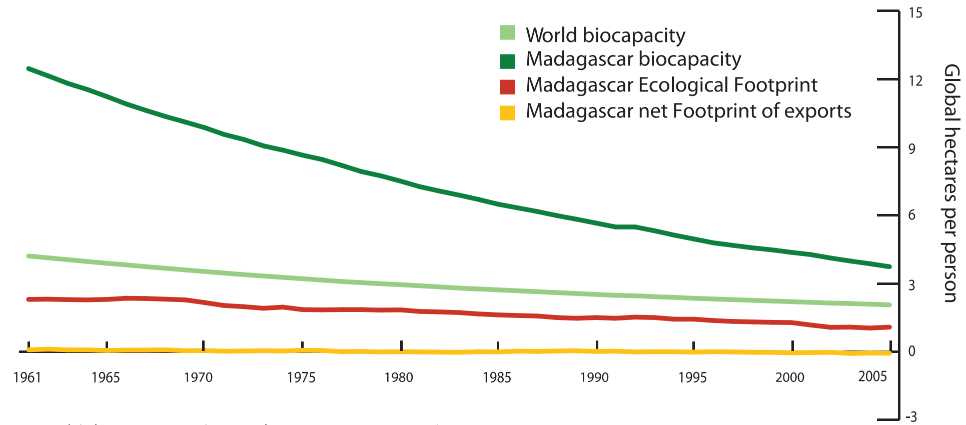


Table 12.3. Madagascar biocapacity, 1961-2005 (global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.87	8.03	2.78		0.69	0.09	12.46
1965	0.79	7.23	2.50		0.62	0.09	11.23
1970	0.71	6.34	2.18		0.54	0.08	9.86
1975	0.67	5.53	1.91		0.47	0.08	8.65
1980	0.57	4.81	1.66		0.41	0.07	7.51
1985	0.47	4.17	1.44		0.36	0.06	6.49
1990	0.42	3.62	1.24		0.31	0.06	5.66
1995	0.41	3.23	0.97		0.28	0.06	4.96
2000	0.32	2.93	0.82		0.25	0.06	4.37
2005	0.29	2.49	0.70		0.21	0.06	3.74

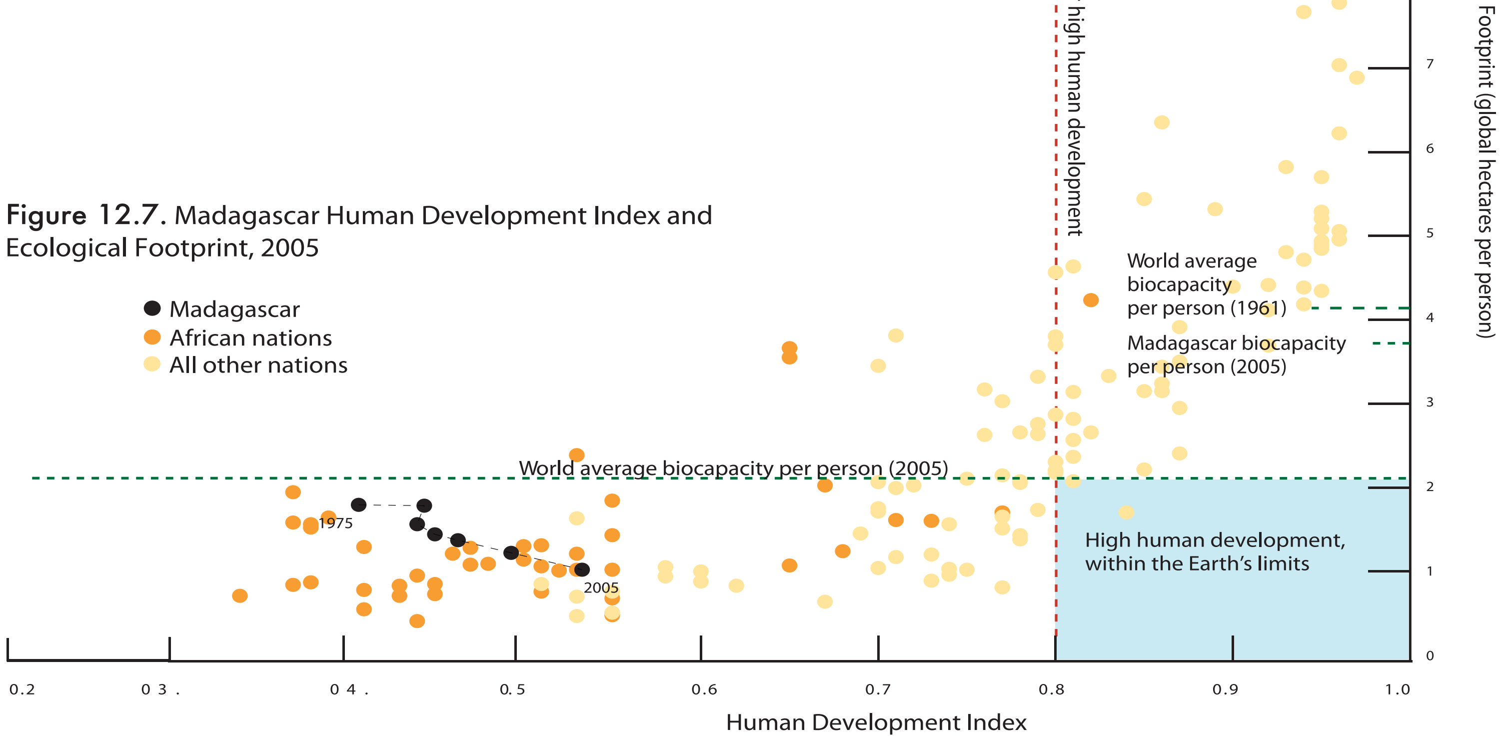
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 12.6. Madagascar Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 12.7. Madagascar Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development

The Impact of Slash and Burn Cultivation in Madagascar

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Madagascar is a tropical country with rich forest ecosystems. These forests contain vast biological resources, and as a result they are of economic value to the country. Despite efforts made by the Malagasy government and forest conservation projects, forest area in Madagascar continues to decrease. Slash and burn cultivation and forest fires are the main reasons for this deforestation. It is estimated that 200,000 hectares of natural forests are destroyed every year due to the practice of slash and burn cultivation known as "tavy" (Andriatsarafara 2000, 8-11, 94).

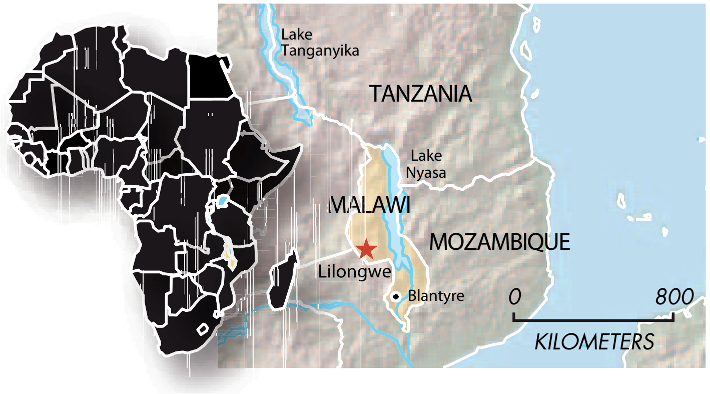
Slash and burn cultivation is an extensive agricultural practice that clears vegetation on a piece of land through incineration. Burning removes the vegetation and releases a large amount of nutrients into the soil, increasing the pH level in the soil and driving away pests for a short period of time. Technically, with slash and burn cultivation, land can only be cultivated once because the soil quickly loses its fertility, and the impacts of fire drastically reduces its agricultural production capacity. Normally, the soil should be lain fallow in order to allow natural fertility regeneration (Savaivo 2004).

However, due to the high population growth rate in Madagascar, this necessary step of crop-fallow rotation is not always adhered to. The demand for agricultural land in Madagascar increases at a rate of 2.5 percent annually (Lehavana 2002). As demand increases, we also see an increase in the area of primary and secondary forests destroyed by slash and burn cultivation techniques. And when previously burned cropland is not allowed adequate time to regenerate nutrients (as needed within traditional crop-fallow cycles), we see a decrease in agriculture outputs (Messerli 2002).

Slash and burn cultivation also increases erosion because the native vegetation used to hold the soil in place has been destroyed. In Madagascar, it is estimated that 14,600 kilograms/hectares of arable soil are lost each year due to "tavy" practices (Dupuy 1998).

As agricultural land becomes more inaccessible and less fertile due to slash and burn cultivation, local populations must travel further into the forests in order to find adequate land for farming. This forces them to lead a nomadic lifestyle, abandoning their established community, security and development (Andriatsarafara 2000).

Slash and burn practices create a very acute environmental problem for Madagascar. The continued shrinkage of remaining primary ecosystems in Madagascar will lead to a very significant loss of biodiversity if there is no intervention. Although deforestation is mostly caused by the increasing demand of new arable land using slash and burn cultivation, those who apply this agricultural practice are not solely responsible for deforestation. Deforestation is also a result of the wide socioeconomic division within the whole population: the extension of the most prosperous groups and the marginalization of the poorest ones. On the one hand, the way of life led by the most prosperous only increases their global needs (goods, crops and food, energy, built-up area). On the other hand, the poor do not have available equipment and can't invest in modern techniques or new lands, so they continue exploiting natural resources such as forests for themselves, while also supplying the needs of the rich.



Malawi occupies 11.8 million hectares. Of those, 3.4 million hectares are covered by forest, 2.7 million by cropland and 1.9 million by grazing land, with 0.4 million hectares supporting its built infrastructure. A landlocked country, Malawi has 2.4 million hectares of inland water, including Lake Malawi, which encompasses approximately a fifth of Malawi's area.

Adjusting for its cropland, forest and fishery yields which are lower than corresponding global averages, and its grazing land yield which is higher than the global average, Malawi has a biocapacity of 6.0 million global hectares (gha), slightly less than its total Ecological Footprint of 6.1 million gha. Although Malawi's ecological deficit is small, the country has been operating with this ecological deficit since 1965.

Malawi's average Ecological Footprint per person is 0.5 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. This is comparable to the 0.5 gha of biocapacity available per person within Malawi. As its population grew from 3.6 million to 12.9 million between 1961 and 2005, biocapacity per person in Malawi decreased by 64 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 13.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Malawi	12,884,000	6,072	6,035	0.47	0.47
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	2.9	648

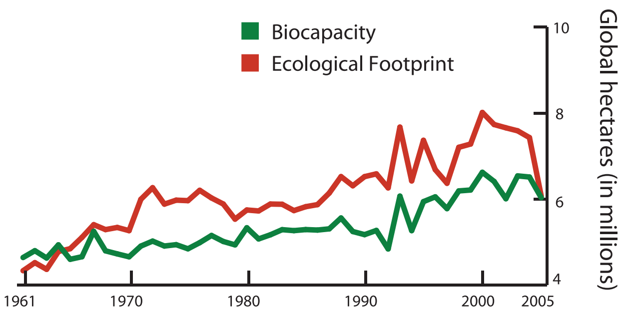
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	46.6	20.7	14.8	10.8	7.0

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Malawi	Female	Male
Human Development Index Value (0=min. 1=max.)	0.437	–	–
Adult Literacy Rate (percent adults over 18)	64.1	54.0	74.9
Gross Enrollment Ratio (percent eligible students enrolled)	61.8	61	62
Irrigated Cropland (percent of total, 2000)	2.3	–	–
Access to Improved Water (percent of population, 2002)	73	–	–
Domestic Electrification (percent of population, 2000)	7	–	–
Undernourishment (percent of population, 2000)	4	–	–
Life Expectancy (years)	46.3	46.7	46.0

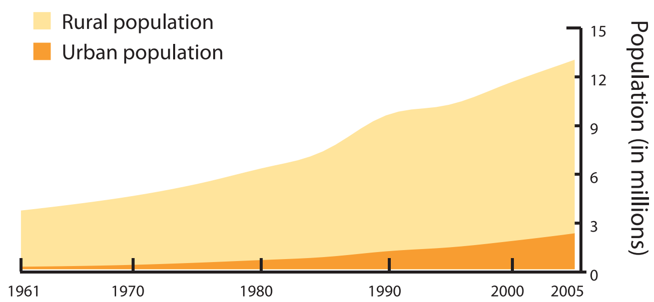
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 13.1. Malawi total Ecological Footprint and biocapacity, 1961-2005



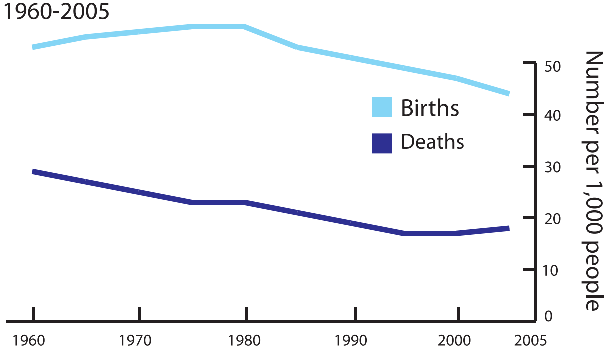
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 13.2. Malawi population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 13.3. Malawi birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 13.4. Malawi Ecological Footprint per person, 1961-2005

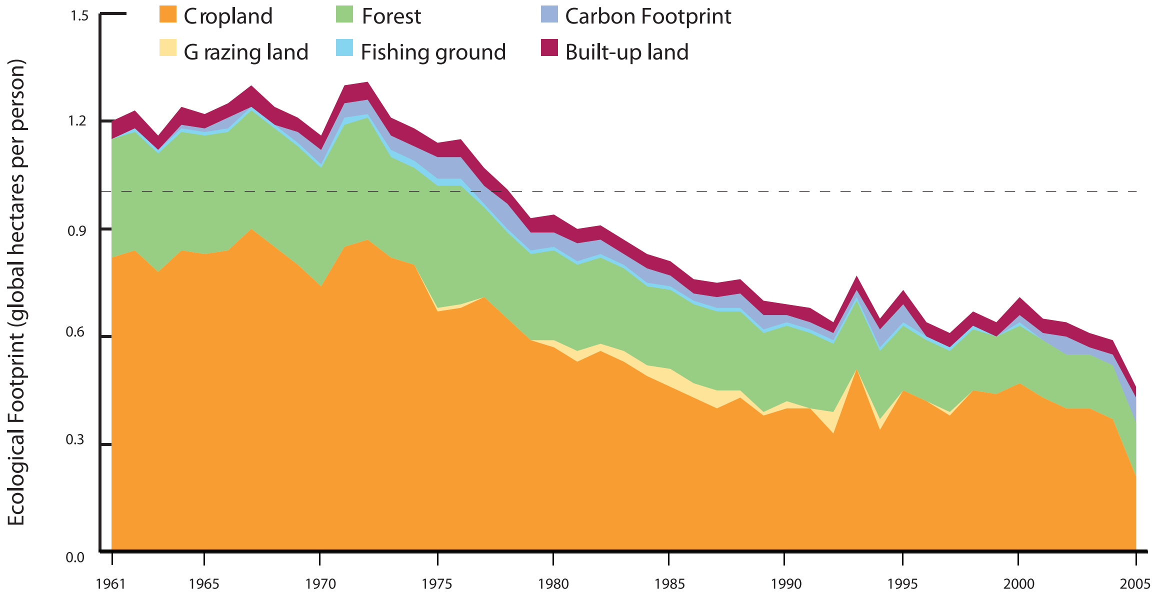


Figure 13.5. Malawi biocapacity per person, 1961-2005

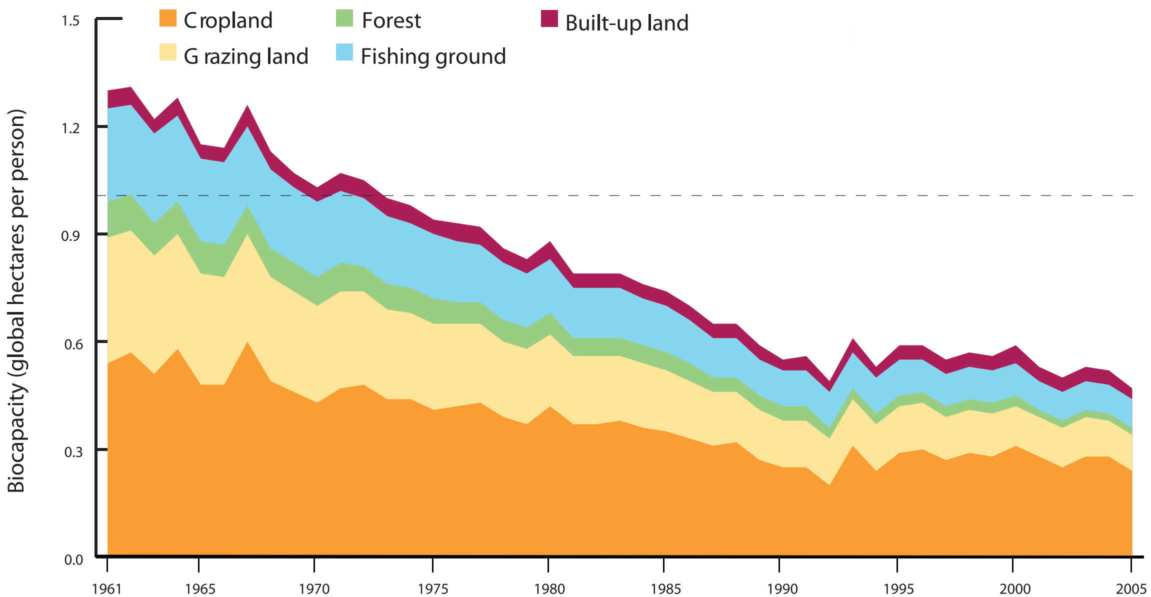


Table 13.2. Malawi Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.82	0.00	0.33	0.00	0.00	0.05	1.20
1965	0.83	0.00	0.33	0.01	0.01	0.04	1.22
1970	0.74	0.00	0.33	0.04	0.01	0.04	1.17
1975	0.67	0.01	0.34	0.06	0.02	0.04	1.14
1980	0.57	0.02	0.25	0.04	0.01	0.05	0.93
1985	0.46	0.05	0.22	0.03	0.01	0.04	0.80
1990	0.40	0.02	0.21	0.02	0.01	0.03	0.69
1995	0.45	0.00	0.18	0.05	0.01	0.04	0.73
2000	0.47	0.00	0.16	0.02	0.01	0.05	0.70
2005	0.21	0.00	0.15	0.07	0.00	0.03	0.47

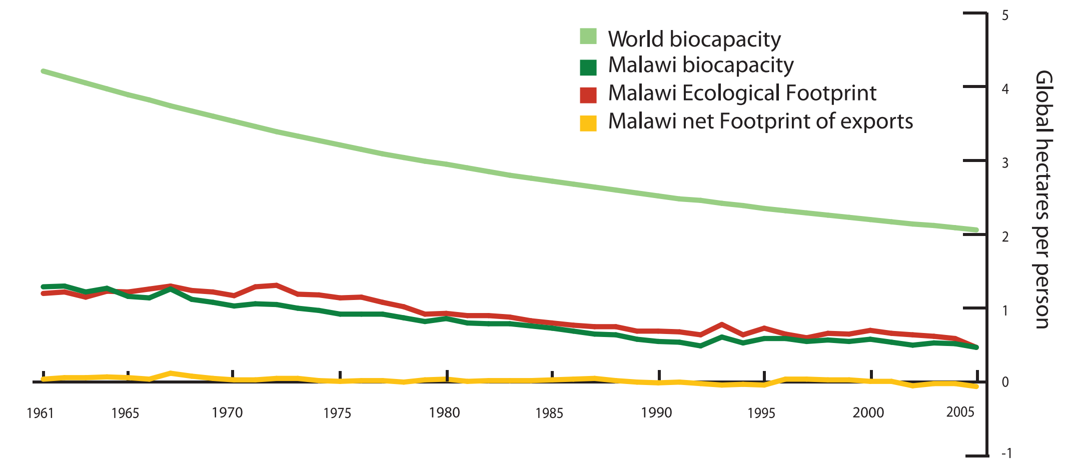
Table 13.3. Malawi biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.54	0.35	0.10		0.26	0.05	1.29
1965	0.48	0.31	0.09		0.23	0.04	1.16
1970	0.43	0.27	0.08		0.21	0.04	1.03
1975	0.41	0.24	0.07		0.18	0.04	0.92
1980	0.42	0.20	0.06		0.15	0.05	0.86
1985	0.35	0.17	0.05		0.13	0.04	0.73
1990	0.25	0.13	0.04		0.10	0.03	0.55
1995	0.29	0.13	0.03		0.10	0.04	0.59
2000	0.31	0.11	0.03		0.09	0.05	0.58
2005	0.24	0.10	0.02		0.08	0.03	0.47

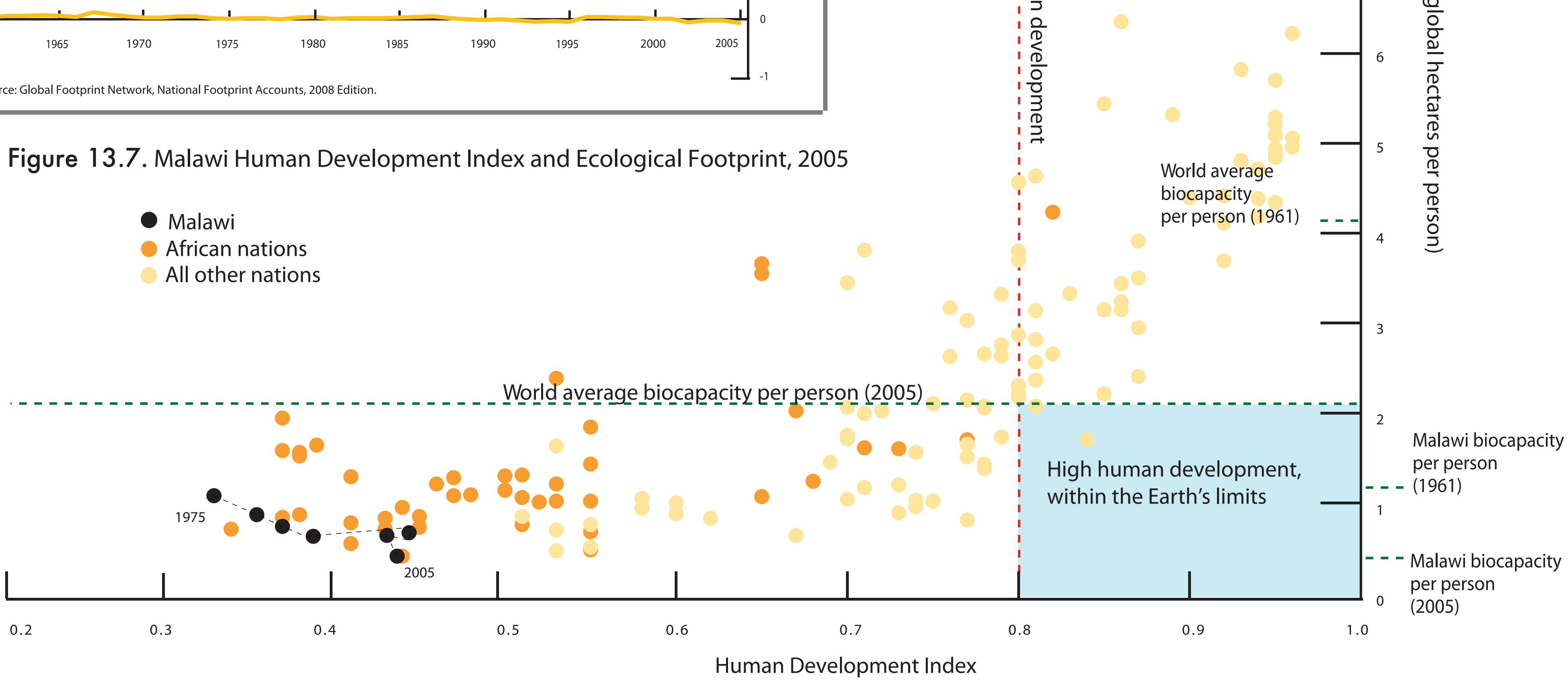
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 13.6. Malawi Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 13.7. Malawi Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Fisheries, Livelihoods and Environmental Degradation in Malawi

Malawi is endowed with extensive water resources covering approximately 20 percent of the country's 120,000 km^2 area (EAD 1998). The country's major lakes are Lake Malawi, Malombe, Chiuta and Chilwa. These lakes provide a diversity of ecosystem services, such as food and water for domestic, agricultural and industrial purposes. They also support populations of wildlife, birds and fish.

Daniel Jamu

East and Southern Africa Regional Director

The WorldFish Center

Zomba, Malawi

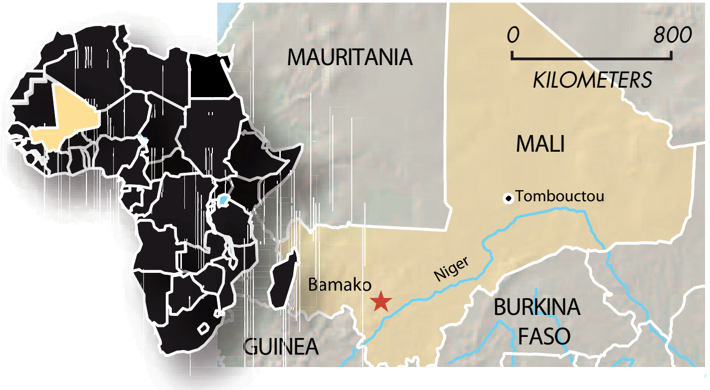
Fishing is the most important economic activity in Malawi's lakes. The lakes produce approximately 65,000 tons of fish per year. The fisheries sector provides direct employment opportunities to 56,000 people and indirectly to over 300,000 people in fish processing, distribution and associated trades (EAD 1998). This sector supports more than 14 percent of the Malawian population that resides along the lakeshores. The sector is also a major source of food, supplying approximately 60 percent of animal protein and 40 percent of total protein intake to Malawians (Banda et al. 2005). These nutrients include vital vitamins A, B2 and B6, minerals (iron, zinc, calcium, potassium), poly-unsaturated fatty acids and micro-nutrients - all essential nutrients for the health of Malawi's rural poor.

Fish catches in 2005 were valued at 4.8 billion Malawian Kwacha per annum (34.2 million USD) and constitute 4 percent of Malawi's total gross domestic production. Commercially, the most important fish species include tilapiine cichlids (*Oreochromis sp.*), haplochromine cichlids (*Copadicrhomis sp.*), catfish (*Bagrus meridionalis* and *Bathyclarias sp.*), and cyprinids (*Engraulicypris sardella*). The aforementioned species make up 80 percent of total catch, or 50,000 tons, annually (Ngochera 2001).

Malawi's fisheries are under considerable stress largely due to poverty and lack of arable land for agriculture to support an expanding population. These factors have led to increased deforestation and over-exploitation of fisheries resources. Low soil fertility has also contributed to increasing forest and land degradation as farmers seek to increase production through land expansion rather than intensification of land use (Mkanda 2001). This has led farmers to cultivate fertile river banks and steep slopes. These practices exponentially increase catchment soil erosion rates, which in turn, increases siltation within lakes. Increased siltation negatively affects both water quality and the production of cyprinids, the largest family of freshwater fish that depend on influent rivers for breeding. The siltation of weed beds around river mouths disrupts the spawning activity of tilapiine cichlids (locally known as ”chambo”) in Lake Malawi. The sand substrates required for breeding chambo in the lake are increasingly being silted, and the breeding area reduced. In Lake Malawi catchment, soil erosion as a result of the cultivation of river banks has also been associated with declining catches of mpasa (*Opsaridium microlepis*) also known as the lake salmon (Cohen et al. 1993).

Increasing turbidity as a result of soil erosion and increased silt load in rivers also reduce the visibility of males seeking breeding females to mate with. *Labeo mesops*, a cyprinid which is dependent on clear water and a high level of river discharge for river-spawning migration is reportedly absent in influent rivers with degraded catchment areas (Delaney et al. 2007).

Loss of fish production through increased siltation, reduced river discharge, altered water quality and overexploitation due to rising fish demand all impact the quality of life for Malawians. It becomes increasingly difficult for fisheries-dependent communities to maintain a sustainable livelihood when the habitat they depend on is in decline. As this resource becomes scarcer, the health and well-being of Malawi's residents will remain in jeopardy.



Mali occupies 124.0 million hectares. Of those, 12.6 million hectares are covered by forest, 4.8 million by cropland and 51.2 million by grazing land, with 0.6 million hectares supporting its built infrastructure. A landlocked country, Mali has 2.0 million hectares of inland water.

Adjusting for its cropland, grazing land, forest and fishery yields, which are lower than corresponding global averages, Mali has a biocapacity of 34.7 million global hectares (gha). This is more than its total Ecological Footprint of 21.9 million gha.

Mali's average Ecological Footprint per person is 1.6 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 2.6 gha of biocapacity available per person within Mali. As its population grew from 4.4 million to 13.5 million between 1961 and 2005, biocapacity per person in Mali decreased by 60 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 14.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Mali	13,518,000	21,896	34,714	1.62	2.57
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	5.3	1,004

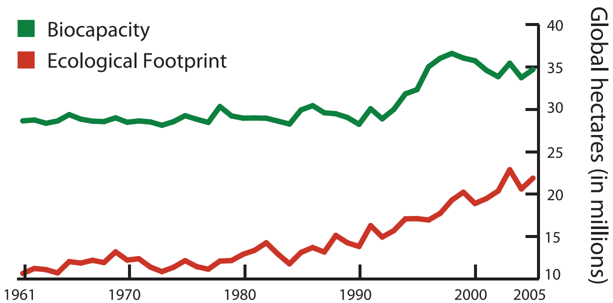
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	46.6	22.2	14.7	10.2	6.1

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Mali	Female	Male
Human Development Index Value (0=min. 1=max.)	0.380	–	–
Adult Literacy Rate (percent adults over 18)	24.0	15.9	32.7
Gross Enrollment Ratio (percent eligible students enrolled)	42.6	36	50
Irrigated Cropland (percent of total, 2000)	5.0	–	–
Access to Improved Water (percent of population, 2002)	50	–	–
Domestic Electrification (percent of population, 2000)	–	–	–
Undernourishment (percent of population, 2000)	4	–	–
Life Expectancy (years)	53.1	55.3	50.8

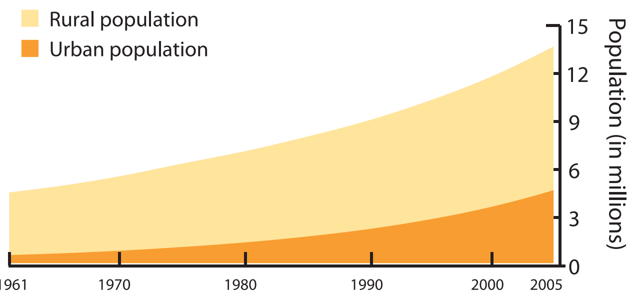
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 14.1. Mali total Ecological Footprint and biocapacity, 1961-2005



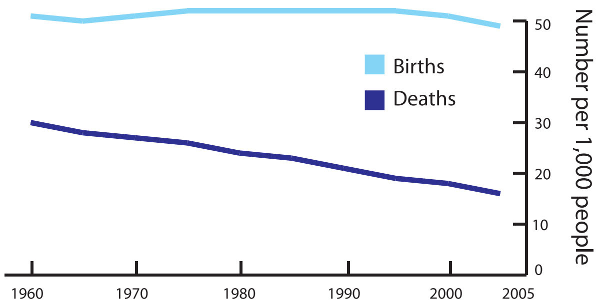
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 14.2. Mali population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2005; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 14.3. Mali birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 14.4. Mali Ecological Footprint per person, 1961-2005

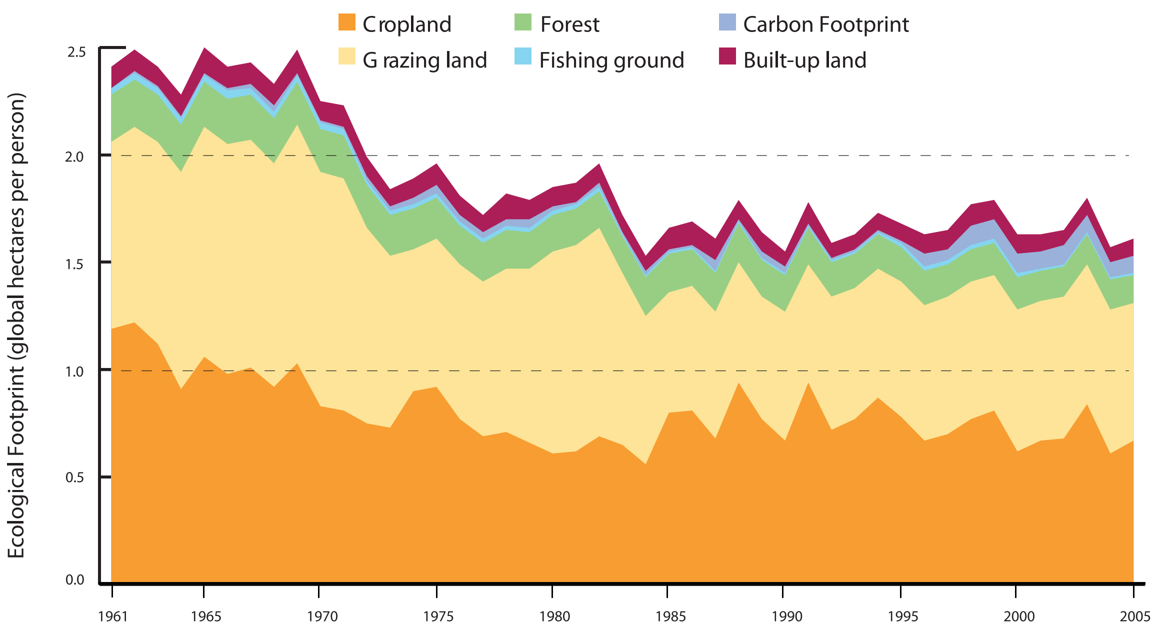


Table 14.2. Mali Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.19	0.87	0.22	0.00	0.03	0.10	2.41
1965	1.06	1.07	0.21	0.01	0.03	0.12	2.51
1970	0.83	1.09	0.20	0.01	0.03	0.09	2.25
1975	0.92	0.69	0.19	0.04	0.02	0.10	1.96
1980	0.61	0.94	0.17	0.02	0.02	0.09	1.85
1985	0.80	0.56	0.18	0.01	0.01	0.10	1.67
1990	0.67	0.60	0.17	0.03	0.01	0.07	1.56
1995	0.78	0.63	0.16	0.01	0.02	0.08	1.69
2000	0.62	0.66	0.15	0.09	0.02	0.09	1.62
2005	0.67	0.64	0.13	0.08	0.01	0.08	1.62

Figure 14.5. Mali biocapacity per person, 1961-2005

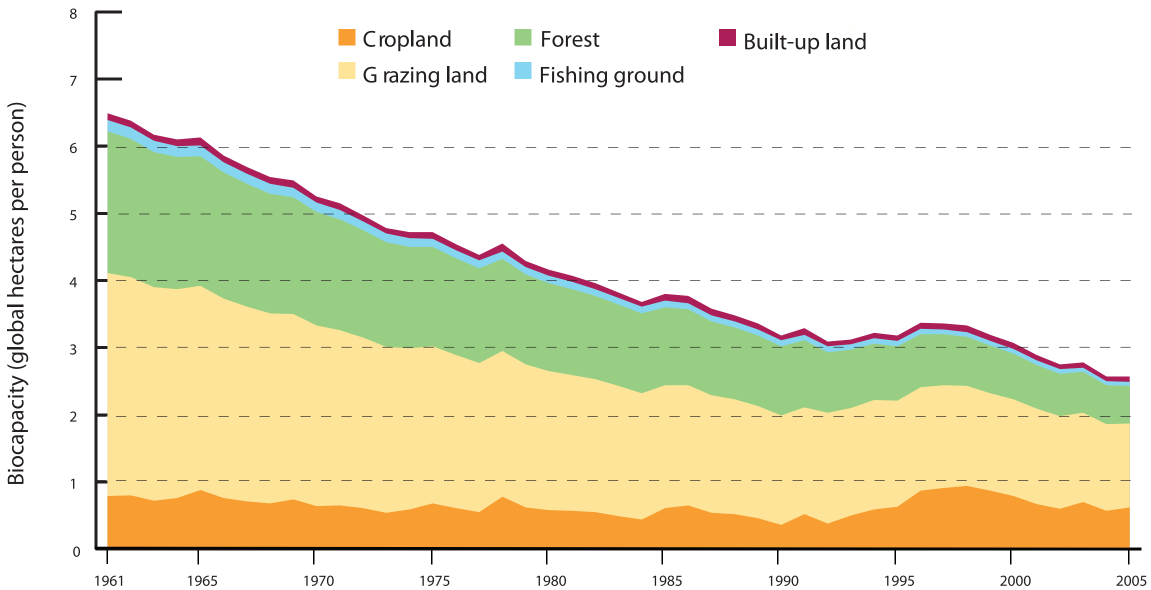


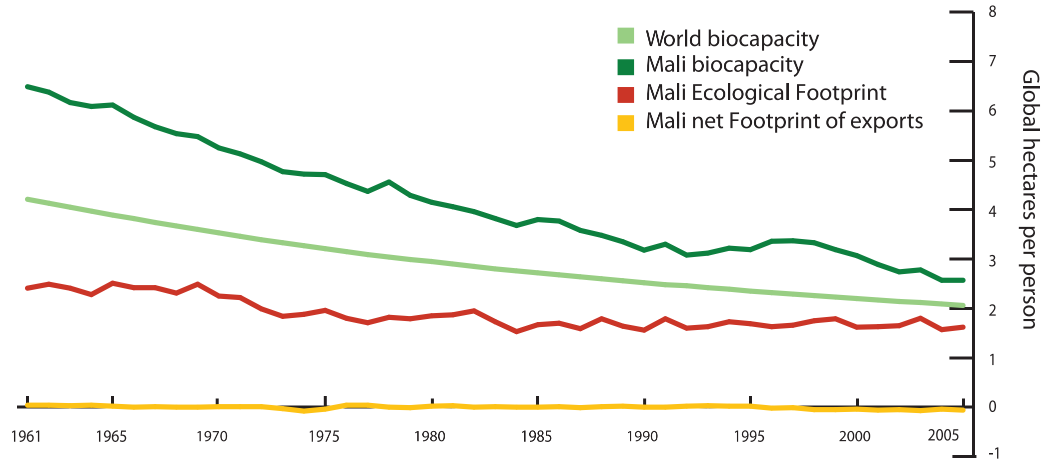
Table 14.3. Mali biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.79	3.32	2.11		0.17	0.10	6.49
1965	0.88	3.04	1.93		0.16	0.12	6.12
1970	0.64	2.69	1.69		0.14	0.09	5.25
1975	0.68	2.34	1.48		0.12	0.10	4.71
1980	0.58	2.07	1.31		0.11	0.09	4.15
1985	0.61	1.83	1.16		0.10	0.10	3.80
1990	0.36	1.63	1.03		0.09	0.07	3.18
1995	0.63	1.58	0.81		0.08	0.08	3.19
2000	0.79	1.44	0.68		0.07	0.09	3.07
2005	0.62	1.25	0.56		0.06	0.08	2.57

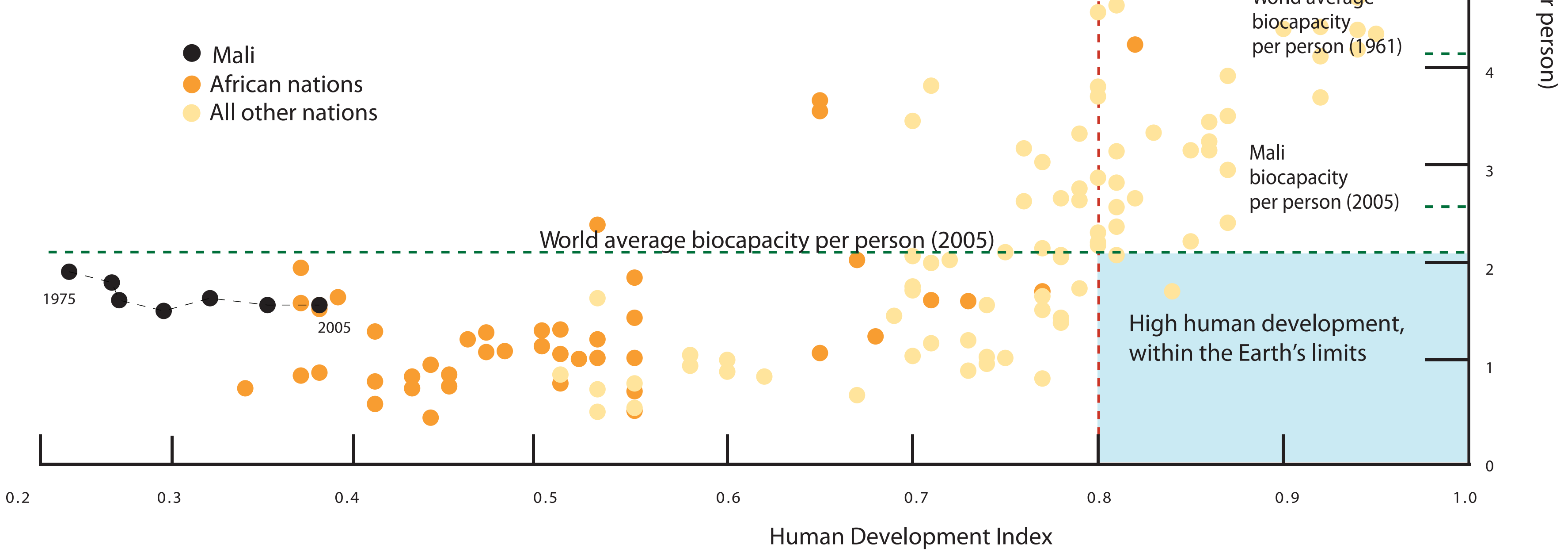
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 14.6. Mali Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 14.7. Mali Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Climate Change and Resource Depletion in a Fragile Ecosystem

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Mali is a semi-arid, landlocked country with a wide range of ecosystems, from the Sudano-Guinean zone in the south to the pre-desert and desert zones in the north. Home to a rich diversity of plant and animal species, the country's economic base has long been rooted in agriculture and animal husbandry. With 80 percent of the Malian population (mainly the rural poor) gaining its livelihood from natural resources, the well-being of the country's people and its social and economic stability is deeply connected to the productivity of the land, and the factors – from drought, to deforestation, to soil degradation – that affect that productivity.

Fifteen years ago, the contribution of the broader agriculture sector to the National Domestic Product was 45 percent; today it has decreased to 34 percent (PRS implementation report 2007). A number of ecosystems are rapidly degrading. The forest area in Mali is being reduced by 0.8 percent per year (Rapport sur létat de l'Environnement au Mali 2005), one of the highest deforestation rates in West Africa. Agricultural production has always been at the mercy of an erratic climate, such as the drought that plagued the country almost continually from 1968 to 1985. Now climate change threatens permanent disruptions.

In the pre-desert zone in the north, the repeated cycles of drought have caused a degradation of the soil and vegetation cover that has reduced crop yields and pastoral productivity. The drought cycles have also brought major social transformations, sometimes leading to uprisings against the Central Authority, such as the Touareg rebellion from 1990 to 1996, and the one that began in 2006 and continues today.

One way to address drought disruption is irrigation. Irrigated lands account for less than 10 percent of cultivated areas, some 400,000 hectares. The potential for irrigated land, however, is estimated to be more than five times that, at 2.2 million hectares (Document Stratégie Nationale de Sécurité Alimentaire du Mali 1998).

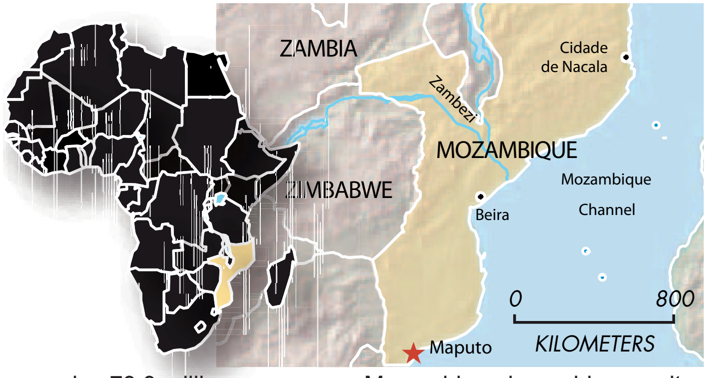
The state of Mali has taken a number of concrete policy and strategic actions to address climate change and its induced impacts. These include active involvement in the Kyoto Protocol and development of international policy around climate change, as well as the adoption, in 2007, of a National Climate Change Adaptation Action Plan with 19 priority projects.

Malian farmers, long used to living a context of great environmental variability and uncertainty, have developed a number of adaptation and coping systems. Farmers have developed diverse, adapted and dynamic genetic materials using their experimental knowledge of soils, climate, plants, selections, breeding, exchange of information and germ-plasm storability. They are also altering crop rotations; for example, the short cycle sorghum inter-cropped with cow-peas has replaced the late varieties of sorghum maturing normally in late October.

Other coping mechanisms include:

- Social solidarity frameworks based on gifts, seed exchange systems and various exchanges of other goods in kind
- Pastoral coping systems through seasonal migration of herders and animals based on the observation of the rainy season's trends in opposition to conventional planning, which in such a context becomes problematic and non-functional
- Agro-pastoralism through agro-forestry
- Population exodus (out-migration, nationally and internationally)

Nevertheless, climate change and its negative impacts remain an immediate threat to people in Mali. The effectiveness of adaptation and mitigation options and the strategies to be designed and implemented will determine the future of Mali and its communities. Holistic and participatory approaches (State, civil society members, private sector actors and local communes) are key options. The most effective climate change adaptation and mitigation measures will be carried out through a systematic long-term research and development drive.



Mozambique occupies 79.9 million hectares. Of those, 19.3 million hectares are covered by forest, 4.6 million by cropland and 44.0 million by grazing land, with 0.9 million hectares supporting its built infrastructure. Located along the Indian Ocean to the east and Lake Malawi to the northwest, Mozambique borders 7.3 million hectares of continental shelf and has 1.3 million hectares of inland water.

Adjusting for its cropland and forest yields, which are lower than corresponding global averages, and its grazing land and fishery yields, which are higher than the global averages, Mozambique has a biocapacity of 67.8 million global hectares (gha). This is more than its total Ecological Footprint of 18.5 million gha.

Mozambique's average Ecological Footprint per person is 0.9 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 3.4 gha of biocapacity available per person within Mozambique. As its population grew from 7.8 million to 19.8 million between 1961 and 2005, biocapacity per person in Mozambique decreased by 58 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 15.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Mozambique	19,792,000	18,451	67,796	0.93	3.43
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	6.6	677

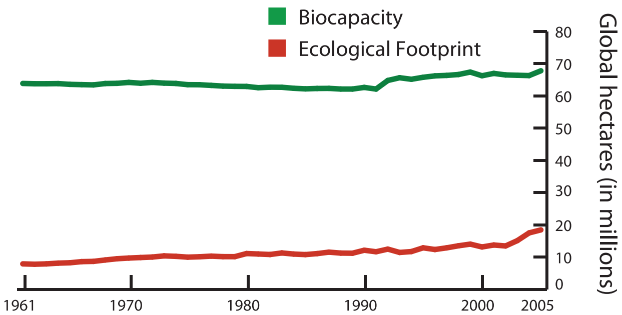
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	53.6	18.7	13.0	9.3	5.4

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Mozambique	Female	Male
Human Development Index Value (0=min. 1=max.)	0.384	–	–
Adult Literacy Rate (percent adults over 18)	38.7	25.0	54.8
Gross Enrollment Ratio (percent eligible students enrolled)	52.7	48	58
Irrigated Cropland (percent of total, 2000)	2.7	–	–
Access to Improved Water (percent of population, 2002)	43	–	–
Domestic Electrification (percent of population, 2000)	6	–	–
Undernourishment (percent of population, 2000)	8	–	–
Life Expectancy (years)	42.8	43.6	42.0

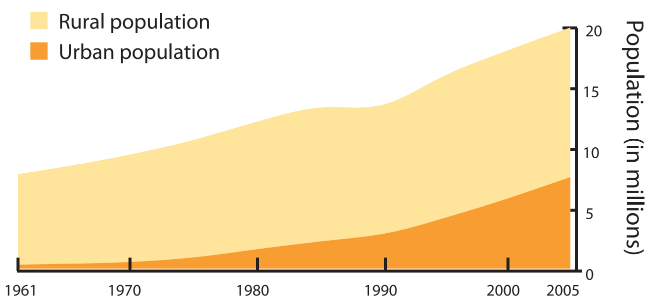
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 15.1. Mozambique total Ecological Footprint and biocapacity, 1961-2005



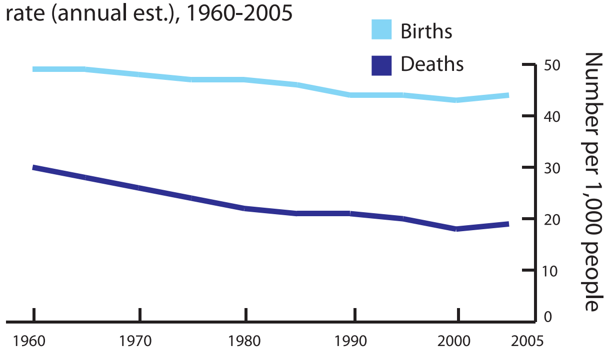
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 15.2. Mozambique population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 15.3. Mozambique birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 15.4. Mozambique Ecological Footprint per person, 1961-2005

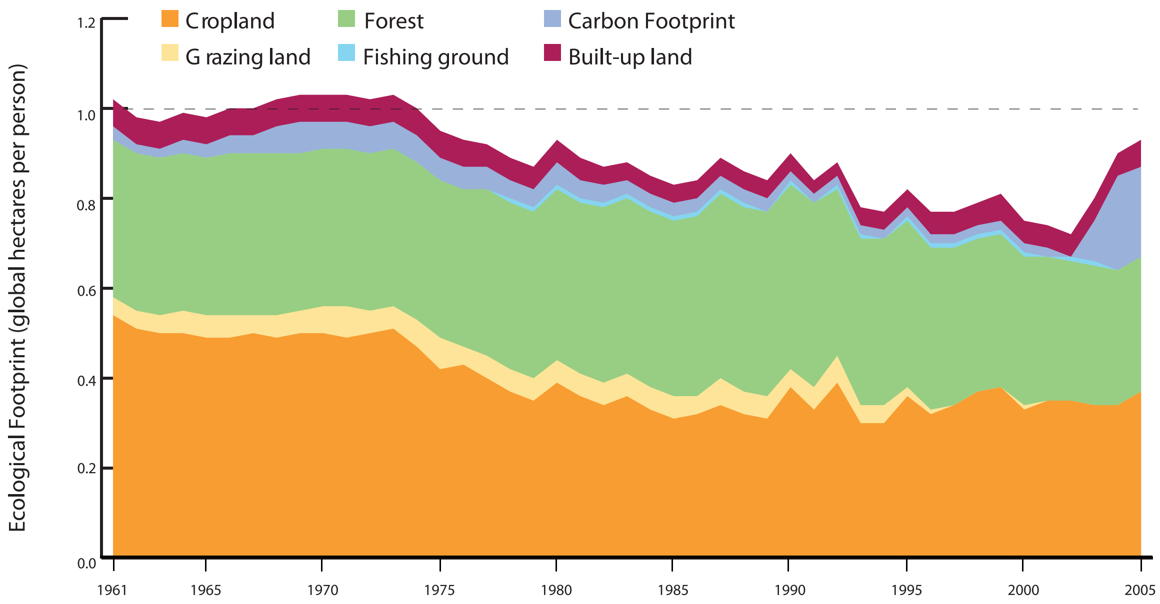


Table 15.2. Mozambique Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.54	0.04	0.35	0.03	0.00	0.06	1.02
1965	0.49	0.05	0.35	0.03	0.00	0.06	0.98
1970	0.50	0.06	0.35	0.06	0.00	0.06	1.04
1975	0.42	0.07	0.35	0.05	0.00	0.06	0.95
1980	0.39	0.05	0.38	0.05	0.01	0.05	0.92
1985	0.31	0.05	0.39	0.03	0.01	0.04	0.82
1990	0.38	0.04	0.41	0.02	0.01	0.04	0.90
1995	0.36	0.02	0.37	0.02	0.01	0.04	0.81
2000	0.33	0.01	0.33	0.02	0.01	0.05	0.74
2005	0.37	0.00	0.30	0.20	0.00	0.06	0.93

Figure 15.5. Mozambique biocapacity per person, 1961-2005

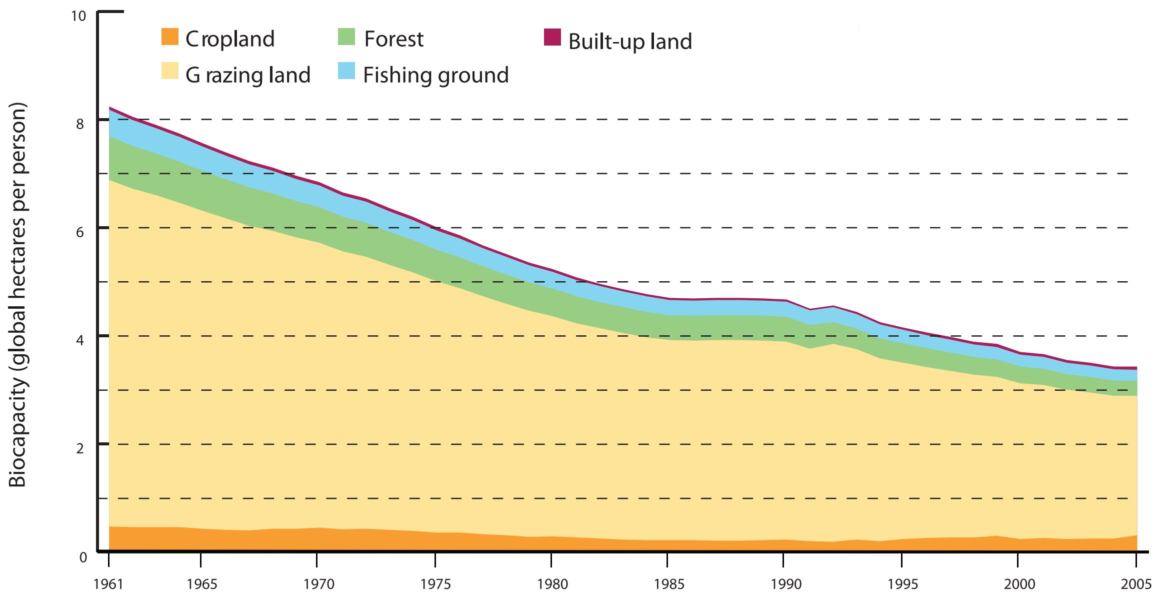


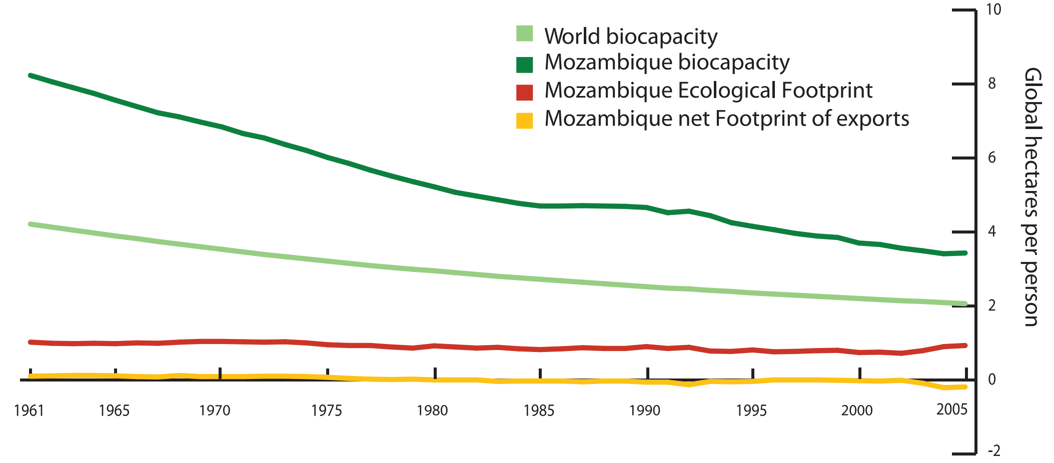
Table 15.3. Mozambique biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.47	6.41	0.81		0.49	0.06	8.23
1965	0.43	5.88	0.74		0.45	0.06	7.56
1970	0.45	5.27	0.66		0.40	0.06	6.84
1975	0.36	4.65	0.58		0.36	0.06	6.01
1980	0.29	4.07	0.51		0.31	0.05	5.22
1985	0.22	3.70	0.46		0.28	0.04	4.70
1990	0.23	3.66	0.46		0.28	0.04	4.66
1995	0.24	3.26	0.36		0.25	0.04	4.15
2000	0.24	2.88	0.31		0.22	0.05	3.70
2005	0.31	2.58	0.28		0.20	0.06	3.43

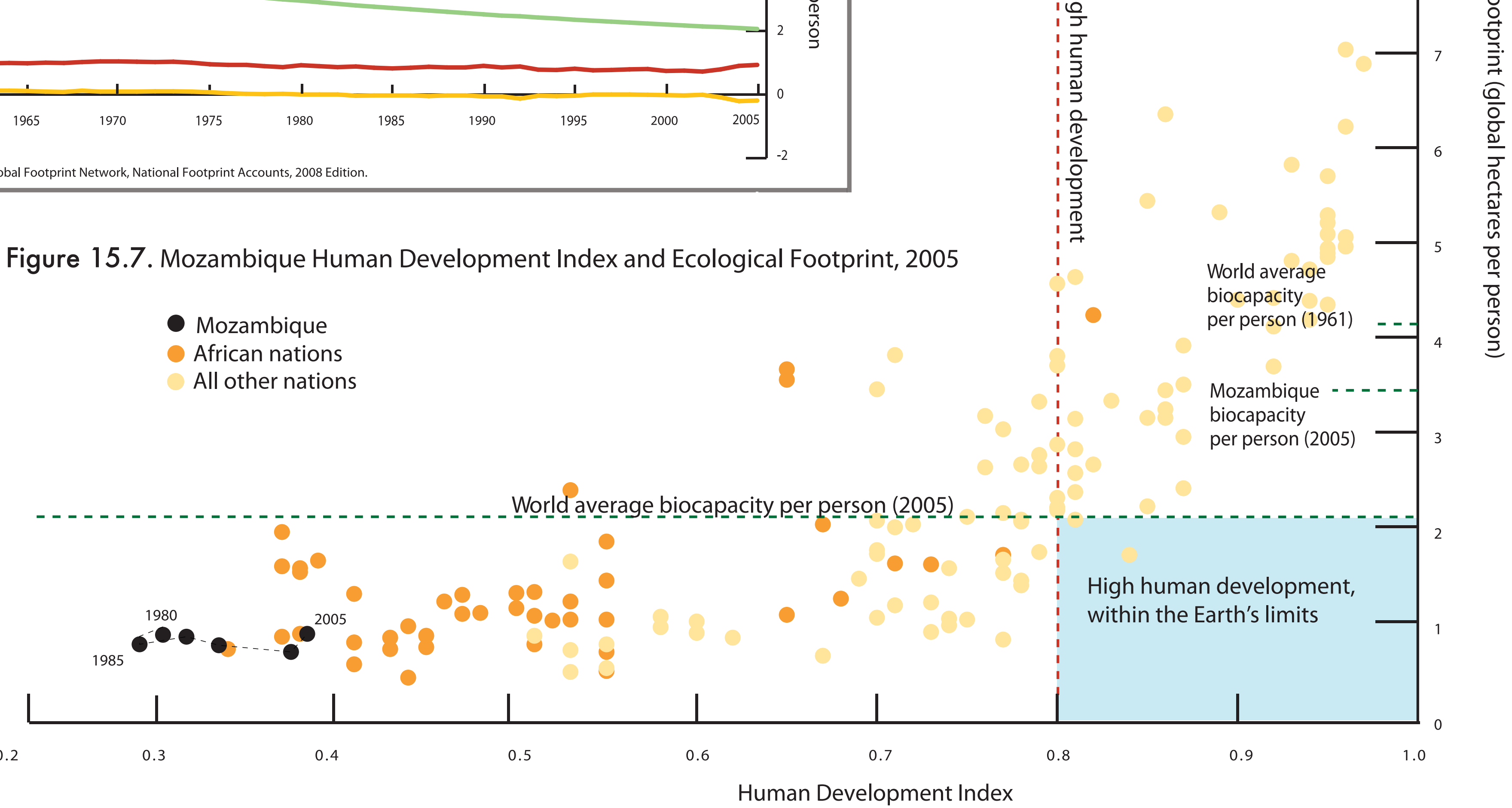
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 15.6. Mozambique Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 15.7. Mozambique Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

The Human Impact of Mangrove Depletion

More than 40 percent of Mozambicans live in communities that lie along the 2,700 kilometers of seashore on the Indian Ocean (Soto 2007). For the majority of these communities, fishing is more vital than agriculture for income generation and subsistence. In many of these areas, communities are far away from the common forests where firewood, the traditional and the major energy source in Mozambique, would be collected to meet household energy needs. Mozambique's coastline is home to approximately 400,000 hectares of coastal vegetation known as mangroves (Soto 2007). These mangrove forests are the most targeted resource for firewood collection by Mozambique's coastal communities. Studies estimate that Mozambique has lost 12,000 hectares of mangrove forest between 1972 and 1990 (Soto 2007).

Mangrove ecosystems play an important role in the region's biodiversity. They are essential because they provide habitat for many species that serve as the precursor to the marine food chain. Not only do mangroves provide breeding habitat, but they also play an indispensable role in water quality. The long outstanding roots of mangrove trees act as water filters retaining sediments and floating solids. The roots also protect the shoreline from soil erosion (Riley 2009). Because Mozambican mangroves are subject to the hot streams of water coming from the Cape of Agulhas, they provide essential habitat to local biodiversity including marine turtles, migratory birds and crustaceans

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during their gestation period. These mangroves are rich in vegetation species, such as *Rhizophora mucronata* (Asiatic mangrove), *Bruguiera gymnorrhiza* (Black mangrove), *Avicennia marina* (Gray mangrove), *Ceriops tagal* (Yellow mangrove), *Sonneratia alba* (Mangrove apple) and Xylocarpus granatul (Cannonball mangrove) (Tique and Tique 2006). Lastly, the mangroves serve as the main source of firewood for domestic energy needs. This use has a counter impact on local day-to-day life, because the devastation of mangroves for fuelwood creates a scarcity of crustaceans, including prawns. Prawns are essential for income generation of coastal communities, and they serve as a primary source of protein in the local diet. The shortage of fuelwood within the proximity of these communities results in women and girls spending time walking long distances to collect the wood in order to complete household tasks. Fuelwood is needed for cooking and heating water in order to wash, bathe and drink. The increased time needed to find fuelwood can prevent girls from attending school since they are normally obliged to care for the house, while their mothers are responsible for growing food crops to feed the family.

From an environmental perspective, forest clearing has negative impacts on local weather regimes by disrupting the exchange of atmospheric gases through water absorption and transpiration in the form of rain. Deforestation degrades soil fertility and speeds up soil erosion, which impacts agriculture productivity, income generation and, ultimately, the well-being of rural communities. This multi-facited problem is traditionally viewed in isolation – either as an environmental disgrace by conservationists or as an unmanaged energy supply by energy specialists. It is seldom addressed in its much broader scale as an integrated social-environmental-economic problem.

We must begin to understand the full scale of perspectives and impacts derived from mangrove tree-cutting. We need to not only raise awareness about the status of this valuable resource, but also consider how to manage this resource as a cross-sector problem.

Rwanda occupies 2.6 million hectares. Of those, 480,000 hectares are covered by forest, 1.5 million by cropland and 0.5 million by grazing land, with 0.2 million hectares supporting its built infrastructure. A landlocked country, Rwanda has 0.2 million hectares of inland water, including Lake Tivu on the western border.

Adjusting for its cropland, forest and fishery yields, which are lower than corresponding global averages, and its grazing land yield, which is higher than the global average, Rwanda has a biocapacity of 4.3 million global hectares (gha). This is less than its total Ecological Footprint of 7.2 million gha. Rwanda has been operating with an ecological deficit since prior to 1961.

Rwanda's average Ecological Footprint per person is 0.8 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still larger than the 0.5 gha of biocapacity available per person within Rwanda. As its population grew from 3 million to 9 million between 1961 and 2005, biocapacity per person in Rwanda decreased by 58 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 16.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Rwanda	9,038,000	7,168	4,291	0.79	0.47
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	2.4	696

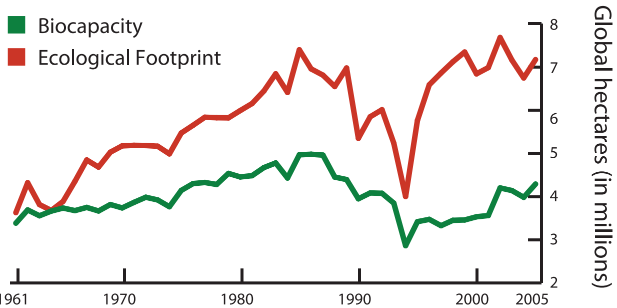
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	53.0	19.4	13.2	9.1	5.3

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Rwanda	Female	Male
Human Development Index Value (0=min. 1=max.)	0.452	–	–
Adult Literacy Rate (percent adults over 18)	64.9	59.8	71.4
Gross Enrollment Ratio (percent eligible students enrolled)	52.2	52	52
Irrigated Cropland (percent of total, 2000)	0.6	–	–
Access to Improved Water (percent of population, 2002)	74	–	–
Domestic Electrification (percent of population, 2000)	–	–	–
Undernourishment (percent of population, 2000)	3	–	–
Life Expectancy (years)	45.2	46.7	43.6

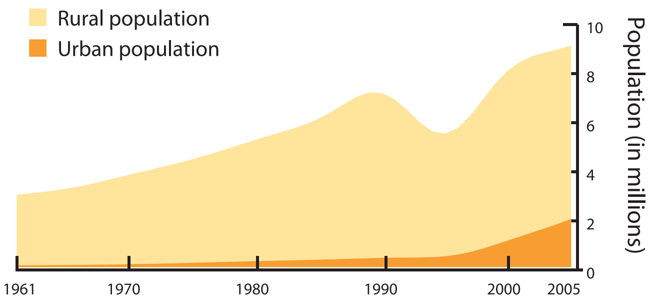
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 16.1. Rwanda total Ecological Footprint and biocapacity, 1961-2005



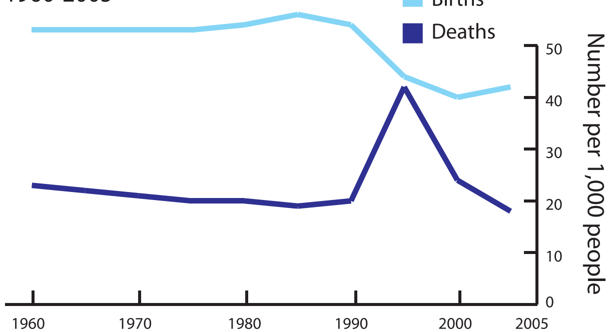
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 16.2. Rwanda population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 16.3. Rwanda birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 16.4. Rwanda Ecological Footprint per person, 1961-2005

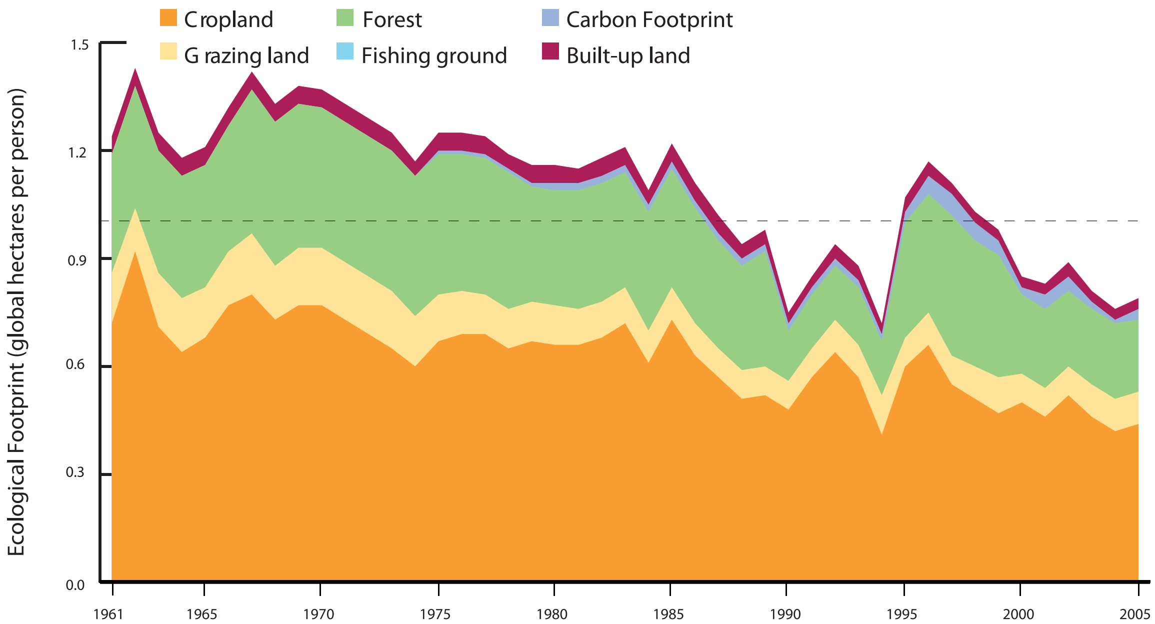


Table 16.2. Rwanda Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.72	0.14	0.33	0.00	0.00	0.05	1.23
1965	0.68	0.14	0.34	0.00	0.00	0.05	1.22
1970	0.77	0.16	0.39	0.00	0.00	0.05	1.37
1975	0.67	0.13	0.39	0.01	0.00	0.05	1.24
1980	0.66	0.11	0.32	0.02	0.00	0.05	1.15
1985	0.73	0.09	0.33	0.02	0.00	0.05	1.22
1990	0.48	0.08	0.14	0.02	0.00	0.03	0.75
1995	0.60	0.08	0.32	0.03	0.00	0.04	1.06
2000	0.50	0.08	0.22	0.02	0.00	0.03	0.85
2005	0.44	0.09	0.20	0.03	0.00	0.03	0.79

Figure 16.5. Rwanda biocapacity per person, 1961-2005

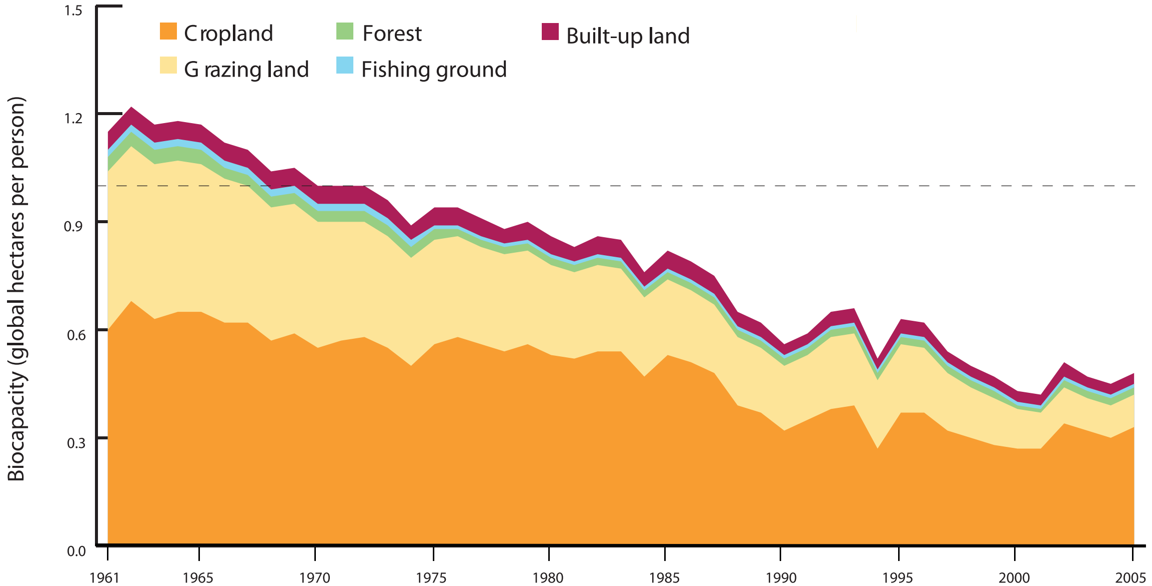


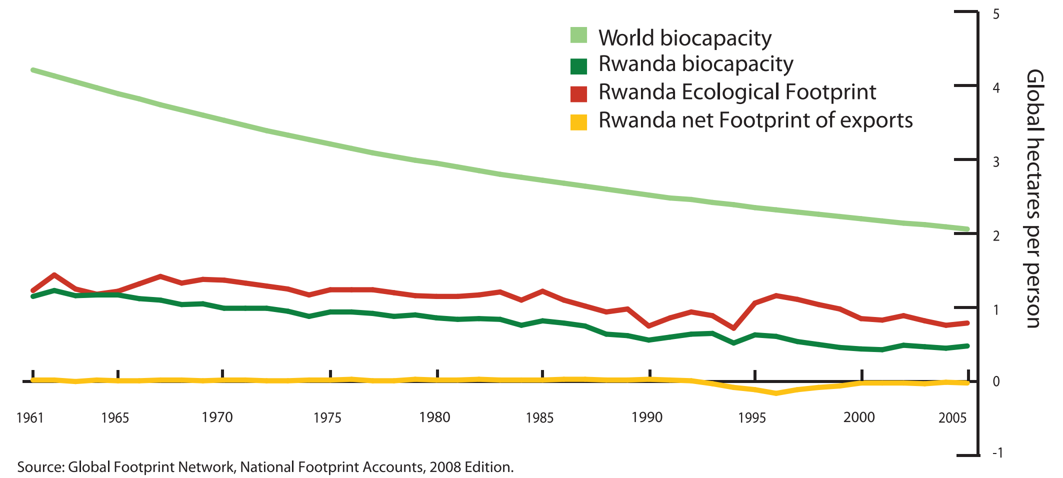
Table 16.3. Rwanda biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.60	0.44	0.04		0.02	0.05	1.15
1965	0.65	0.41	0.04		0.02	0.05	1.17
1970	0.55	0.35	0.03		0.02	0.05	0.99
1975	0.56	0.29	0.03		0.01	0.05	0.94
1980	0.53	0.25	0.02		0.01	0.05	0.86
1985	0.53	0.21	0.02		0.01	0.05	0.82
1990	0.32	0.18	0.02		0.01	0.03	0.56
1995	0.37	0.19	0.02		0.01	0.04	0.63
2000	0.27	0.11	0.01		0.01	0.03	0.44
2005	0.33	0.09	0.02		0.01	0.03	0.48

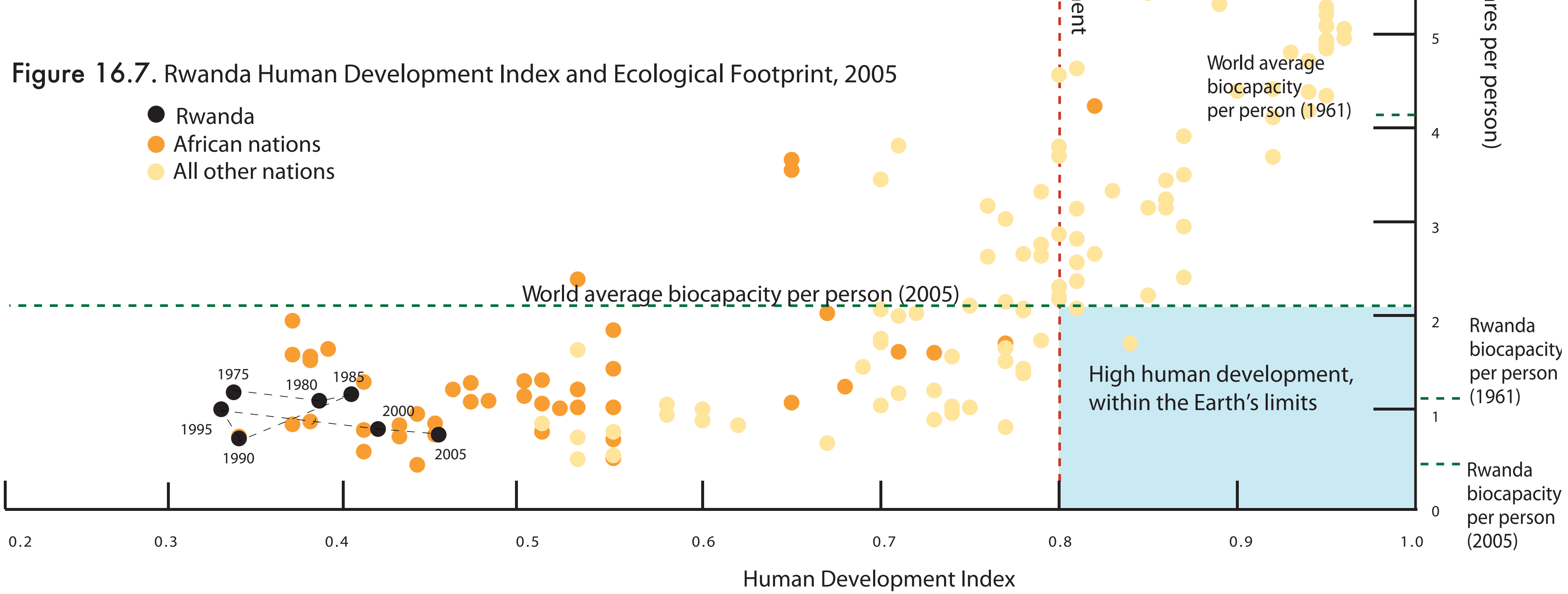
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 16.6. Rwanda Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 16.7. Rwanda Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Changes in Land Cover and Population in Rwanda

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Rwanda is a landlocked country located in the eastern part of Central Africa. The country has a population of 8.5 million people who live on a land area of 26,368 km², making Rwanda one of the most densely populated countries in Africa. Rwanda's population density of 322 per km² is drastically higher than the average population density in sub-Saharan Africa of 26 per km². At the current growth rate of 2.9 percent per annum, the population is expected to reach 11.4 million by the year 2010. Rwanda's urban population is expected to double by 2010, while its rural population is expected to reach 9.8 million (MINECOFIN, 2002). With such a growing population and limited amount of land, future agriculture expansion will clearly be constrained by the country's fixed supply of land.

Similar to many sub-Saharan African countries, Rwanda is dependent on its agriculture production. The agriculture sector serves as the country's main source of economic growth, accounting for 91.1 percent of the employment for the active population, and 40 percent of Rwanda's total gross domestic product (MINECOFIN 2002). Intensive crop cultivation to meet the needs of the growing population has led to land degradation and shortages over time. In many areas of the country, family farms have been subdivided multiple times as they pass from one generation to another. It is common for an inherited farm lot to average less than one hectare, an area of land too small to support a family. The partitioning and transfer of family land holdings over generations has created pressure on Rwanda's agriculture land. This ultimately leads to the expansion of cultivated land into marginal land areas and natural forests. Due to this and other factors such as wildlife poaching, illegal cutting, collection of firewood and grass, and mining, the size of natural forests in Rwanda has reduced substantially during the last decades. Since Independence in 1962, the country's total area of Protected Forest (PA) has been cut in half: from 4115 km² to 2073 km². More than 1,600 km² of protected forest have been lost within the last 10 years; almost all of this from Akagera National Park. The Volcanoes National Park has lost nearly half of its habitat since 1962 (310 to 160 km²), while Nyungwe National Park has lost more than 13 percent (from 1175 to 1013 km²) (Weber et al. 2005).

Troubling as this situation is for Rwanda's National Parks, deforestation trends are also catastrophic in the forest reserve areas outside the Protected Forest (PA) network. Of 280 km² of natural habitat within the Gishwati Forest Reserve in 1980, only 7 km² remain; of the 50 km² within the Mukura Forest Reserve, no more than 8 km² of degraded habitat remain (Weber et al. 2005). High population growth, regional immigration and growing poverty are creating pressure to clear and occupy land for human settlement and agricultural exploitation. These pressures often overcome the country's institutional capacity to enforce established conservation mandates.

There has been a cascade of events that followed these natural habitat losses as a result of flooding and sedimentation, including shortage of electricity and water for human consumption and frequent flooding in some regions of the country. Unfortunately, the case of Gishwati forest loss helps us to illustrate this issue. The production of electricity and potable water have been markedly affected through the increase of sediment load in the Sebeya River, as well as from the effects of flooding. The effects have been twofold in that not only have production costs increased due to additional cleaning and maintenance of equipment, but productive capacity has reduced because of the need for additional down-time to clean and repair machinery and other apparatus. In addition, floodings attributed to the then-rapid forest clearance caused one of the two hydroelectric power plants on the river to close completely, and the second to work at less than 50 percent capacity for a period of 12 months (Bush 2004). Unless actions are taken to reduce population growth through family planning, Rwanda is in danger of liquidating its natural resources. The continued depletion of natural assets will be a major obstacle in achieving Rwanda's vision of modernizing agriculture and improving the quality of life of its population.

SIERRA LEONE

Sierra Leone occupies 7.2 million hectares. Of those, 2.8 million hectares are covered by forest, 0.7 million by cropland and 2.6 million by grazing land, with 0.2 million hectares supporting its built infrastructure. Located along the Atlantic Coast of Africa, Sierra Leone borders 2.3 million hectares of continental shelf and has 12,000 hectares of inland water.

Adjusting for its cropland and forest yields, which are lower than corresponding global averages, and its grazing land and fishery yields, which are higher than the global averages, Sierra Leone has a biocapacity of 5.6 million global hectares (gha). This is more than its total Ecological Footprint of 4.3 million gha.

Sierra Leone's average Ecological Footprint per person is 0.8 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also smaller than the 1.0 gha of biocapacity available per person within Sierra Leone. As the populaiton grew from 2.3 million to 5.5 million between 1961 and 2005, biocapacity per person in Sierra Leone decreased by 61 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 17.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Sierra Leone	5,525,000	4,265	5,573	0.77	1.01
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	1.2	584

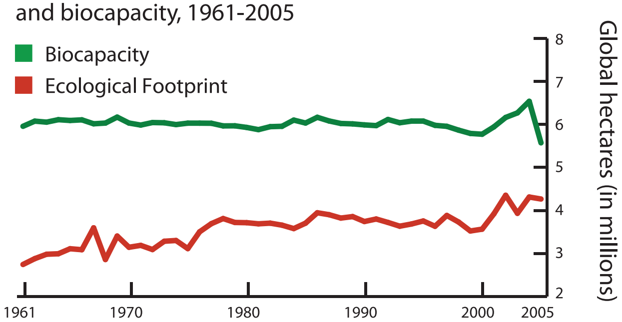
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	63.4	23.7	9.8	2.0	1.1

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Sierra Leone	Female	Male
Human Development Index Value (0=min. 1=max.)	0.336	–	–
Adult Literacy Rate (percent adults over 18)	34.8	24.2	46.7
Gross Enrollment Ratio (percent eligible students enrolled)	44.6	38	52
Irrigated Cropland (percent of total, 2000)	5.4	–	–
Access to Improved Water (percent of population, 2002)	57	–	–
Domestic Electrification (percent of population, 2000)	–	–	–
Undernourishment (percent of population, 2000)	3	–	–
Life Expectancy (years)	41.8	43.4	40.2

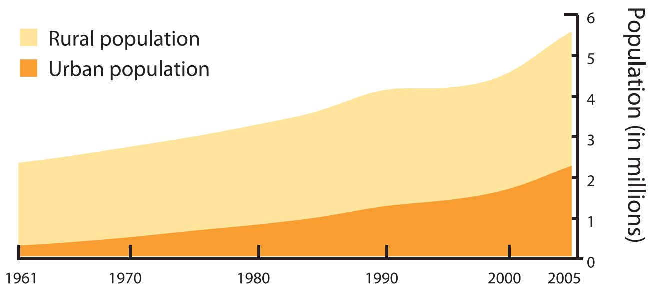
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 17.1. Sierra Leone total Ecological Footprint and biocapacity, 1961-2005



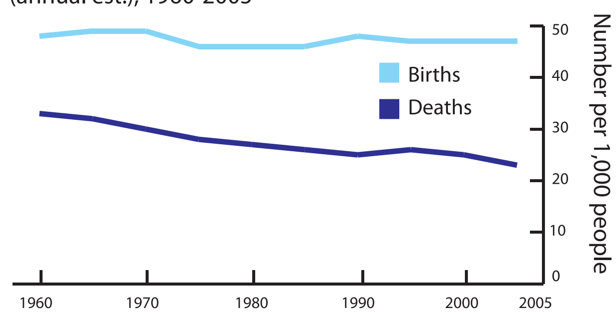
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 17.2. Sierra Leone population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008;
The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 17.3. Sierra Leone birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 17.4. Sierra Leone Ecological Footprint per person, 1961-2005

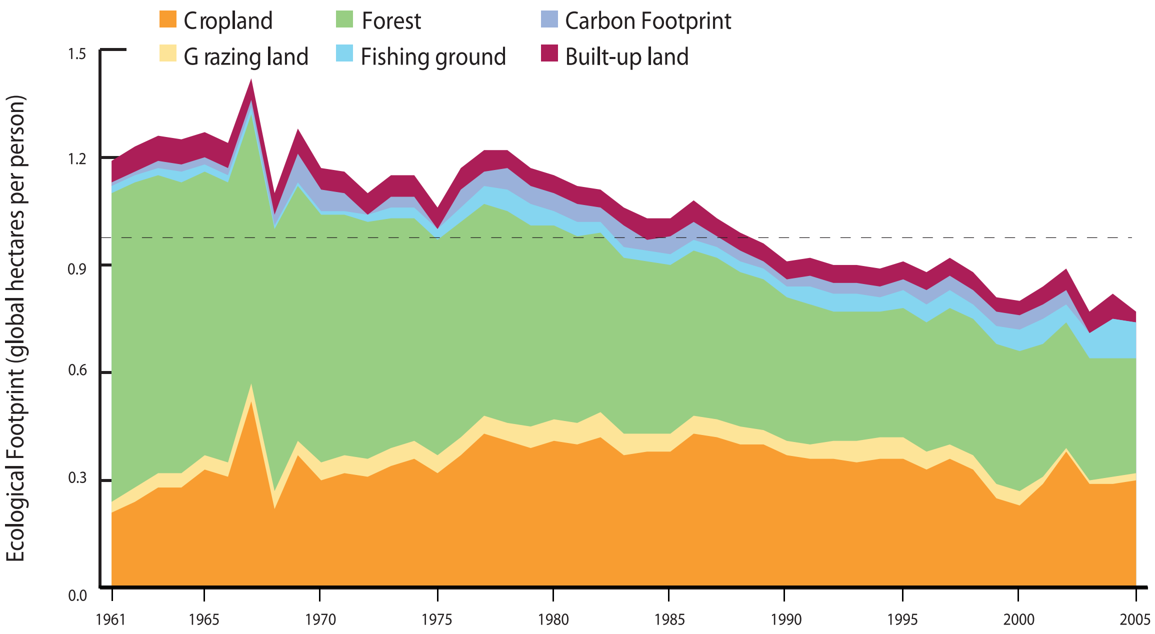


Table 17.2. Sierra Leone Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.21	0.03	0.86	0.01	0.02	0.06	1.20
1965	0.33	0.04	0.79	0.02	0.02	0.07	1.27
1970	0.30	0.05	0.69	0.06	0.01	0.06	1.17
1975	0.32	0.05	0.60	0.00	0.03	0.06	1.06
1980	0.41	0.06	0.54	0.05	0.04	0.05	1.15
1985	0.38	0.05	0.47	0.05	0.03	0.05	1.04
1990	0.37	0.04	0.40	0.02	0.03	0.05	0.92
1995	0.36	0.06	0.36	0.03	0.05	0.05	0.91
2000	0.23	0.04	0.39	0.04	0.06	0.04	0.79
2005	0.30	0.02	0.32	0.00	0.10	0.03	0.77

Figure 17.5. Sierra Leone biocapacity per person, 1961-2005

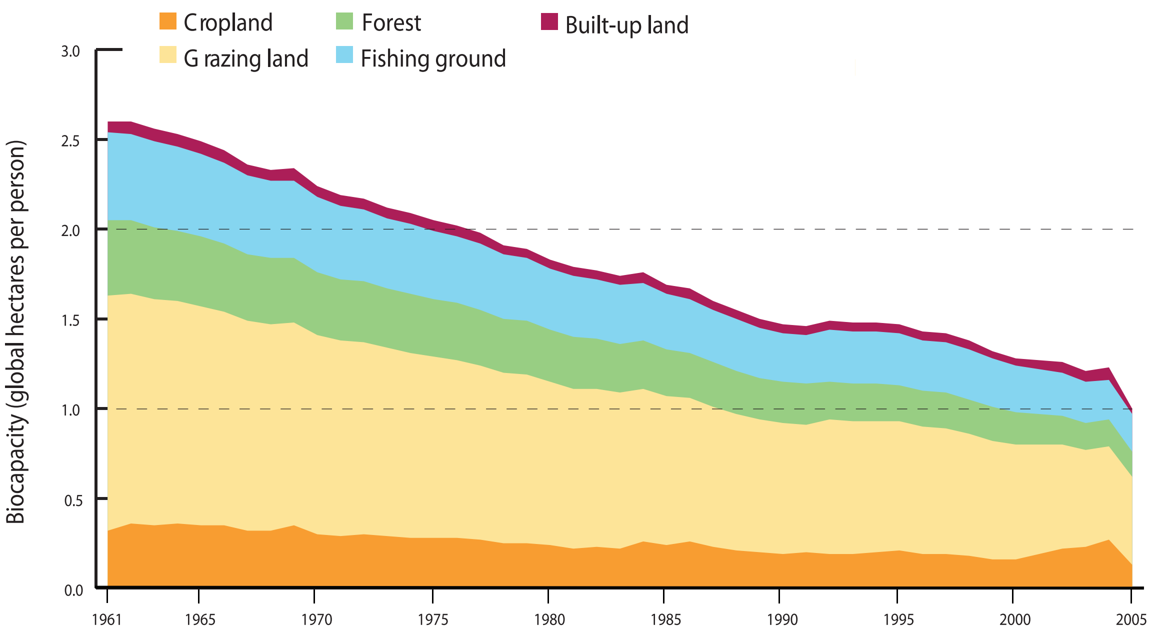


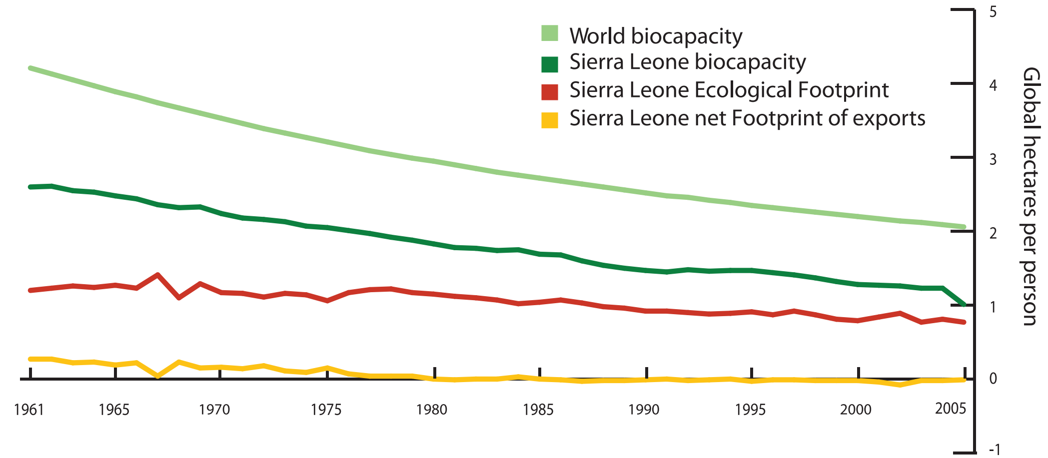
Table 17.3. Sierra Leone biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.32	1.31	0.42		0.49	0.06	2.60
1965	0.35	1.22	0.39		0.46	0.07	2.48
1970	0.30	1.11	0.35		0.42	0.06	2.24
1975	0.28	1.01	0.32		0.38	0.06	2.05
1980	0.24	0.91	0.29		0.34	0.05	1.83
1985	0.24	0.83	0.26		0.31	0.05	1.69
1990	0.19	0.73	0.23		0.27	0.05	1.47
1995	0.21	0.72	0.20		0.29	0.05	1.47
2000	0.16	0.64	0.18		0.26	0.04	1.28
2005	0.13	0.49	0.14		0.21	0.03	1.01

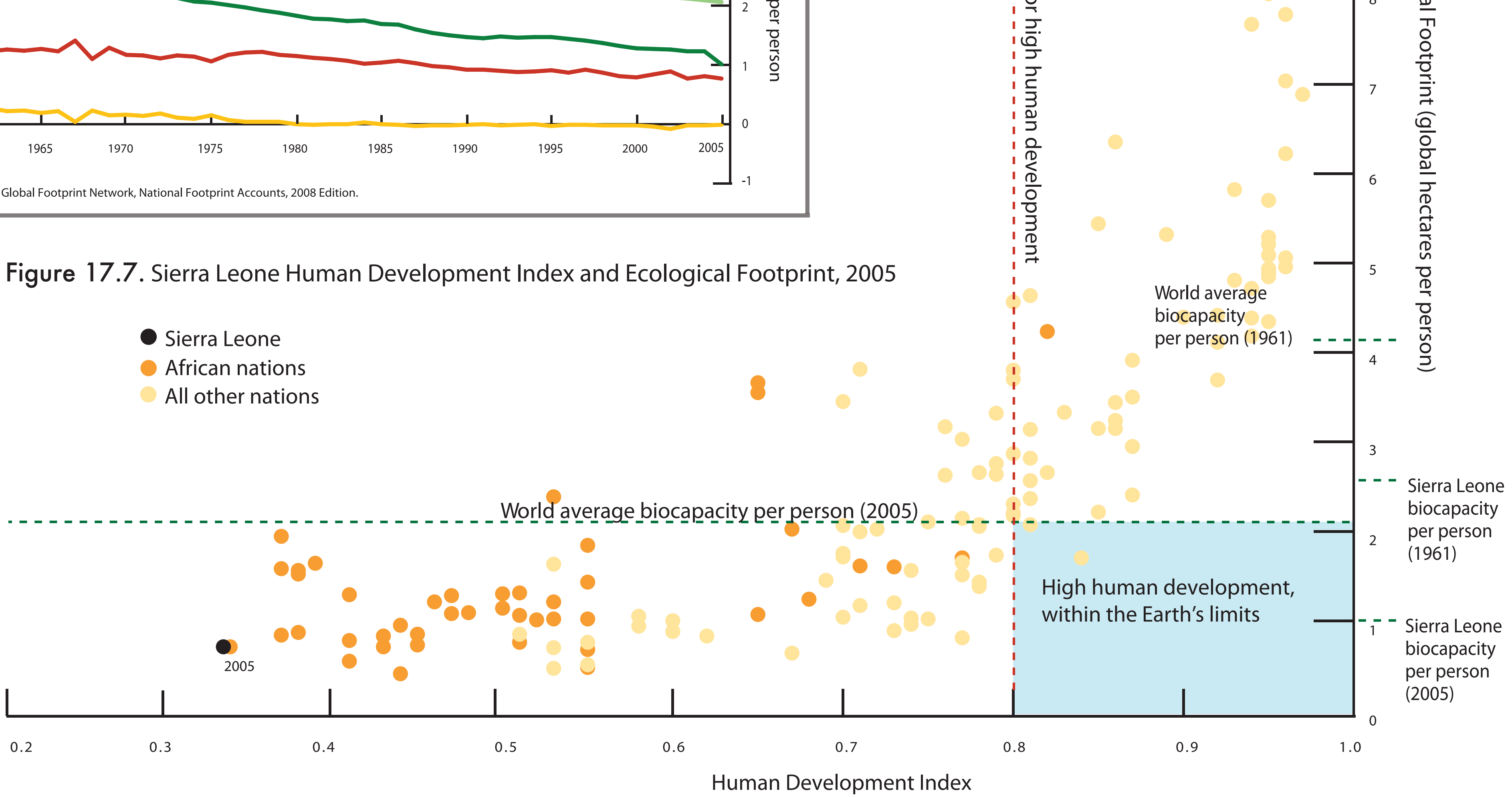
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 17.6. Sierra Leone Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 17.7. Sierra Leone Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Energy, Deforestation and Climate Change: How is Sierra Leone Faring?

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Head of Technical Programs

Conservation Society
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Freetown, Sierra Leone

Energy needs for 85 percent of Sierra Leone's population are met via direct exploitation of ecological resources, especially forest resources (UNDP 2000; NBSAP 2003). In the last two and a half decades, energy in the form of electricity has been either erratic at best, or completely absent. In the absence of a reliable energy supply, the population and, to a large extent, cottage industries are heavily reliant on fuel wood, including charcoal, for domestic energy needs.

Similarly, 80 percent of the population is exclusively dependent on farming for livelihood (NBSAP 2003). Farming in Sierra Leone relies heavily on traditional slash-and-burn shifting cultivation practices. This requires frequent movement of the farmer from one plot of forested land to another. Over the years this practice has left vast expanses of Sierra Leone's physical landscape deforested. In the last 30 years, it is estimated that 600,000 hectares of forested lands, almost 8 percent of the total arable land in Sierra Leone, has been cleared for farming (FAO/IFAD 2006; Vision 2025).

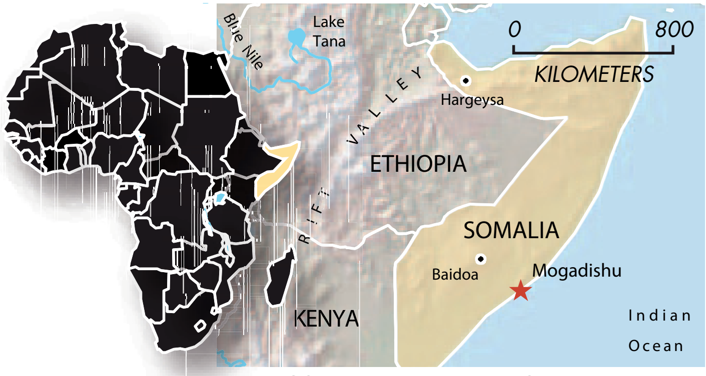
There is a direct relationship between deforestation and energy-related consumption patterns in Sierra Leone. Fuel wood extraction follows a disturbing pattern; forests are no longer cut necessarily for growing rice and other crops. Instead, forests are targeted primarily for wood to supply the ever burgeoning fuel wood and charcoal markets throughout the country. Prior to Sierra Leone's civil war, domestic charcoal use was largely restricted to Freetown and other urban centres. Today however, domestic use of charcoal occurs nationwide. It is quite common to see truckloads of fuel wood or charcoal being taken to Freetown on a daily basis. This ongoing activity poses a great threat to the well-being of Sierra Leone's social economy, culture, politics and environment. It is doubtful that Sierra Leone's ecosystems can withstand continued pressure from the growing population. At a time when climate change adaptation requires an urgent reality check, there is increasing debate around the ability of government to maximize opportunity for carbon credits. At current deforestation rates there is serious danger that Sierra Leone might lose all of her remaining forests. To prevent this, energy consumption, land use and forestry legislation must be re-evaluated.

The following suggestions are hoped to support positive and sustainable energy use and development:

- Review of energy laws to address issues of greenhouse gas emissions and sustainable eco-agricultural practices;

- Incentivizing development of alternative energy enterprise via tax exemption or reduction;

- Establishment of an institute for alternative energy research and development to support long term knowledge-based planning and program implementation.



Somalia occupies 63.8 million hectares. Of those, 7.1 million hectares are covered by forest, 1.4 million by cropland and 43.0 million by grazing land, with 0.6 million hectares supporting its built infrastructure. Located along the Indian Ocean in the Horn of Africa, Somalia borders 4.1 million hectares of continental shelf and has 1.0 million hectares of inland water.

Adjusting for its cropland, grazing land and forest yields, which are lower than corresponding global averages, and its fishery yield, which is higher than the global average, Somalia has a biocapacity of 11.7 million global hectares (gha). This is more than its total Ecological Footprint of 11.5 million gha.

Somalia's average Ecological Footprint per person is 1.4 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is comparable to the 1.4 gha of biocapacity available per person within Somalia. As its population grew from 2.9 million to 8.2 million between 1961 and 2005, biocapacity per person in Somalia decreased by 63 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 18.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Somalia	8,228,000	11,520	11,671	–	–
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	–	

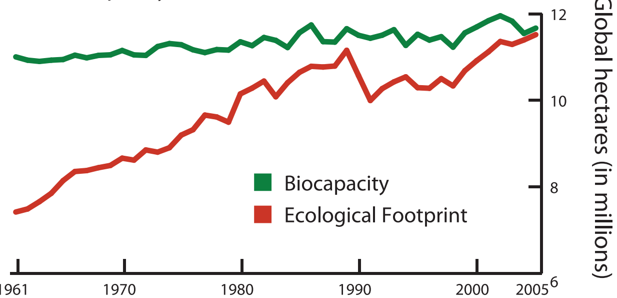
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	–	–	–	–	–

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Somalia	Female	Male
Human Development Index Value (0=min. 1=max.)	–	–	–
Adult Literacy Rate (percent adults over 18)	–	–	–
Gross Enrollment Ratio (percent eligible students enrolled)	–	–	–
Irrigated Cropland (percent of total, 2000)	14.5	–	–
Access to Improved Water (percent of population, 2002)	–	–	–
Domestic Electrification (percent of population, 2000)	–	–	–
Undernourishment (percent of population, 2000)	–	–	–
Life Expectancy (years)	–	–	–

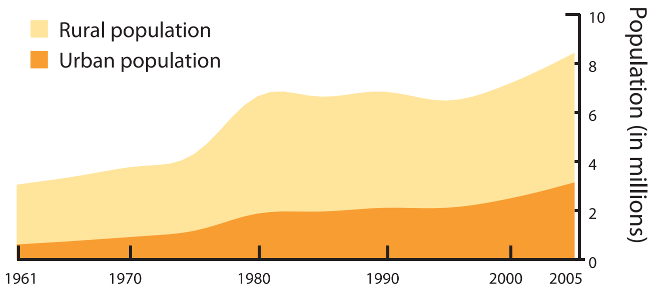
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 18.1. Somalia total Ecological Footprint and biocapacity, 1961-2005



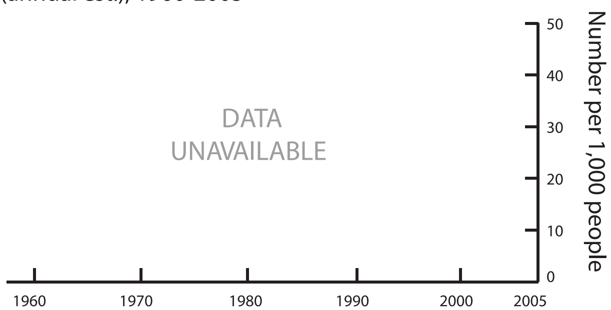
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 18.2. Somalia population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 18.3. Somalia birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 18.4. Somalia Ecological Footprint per person, 1961-2005

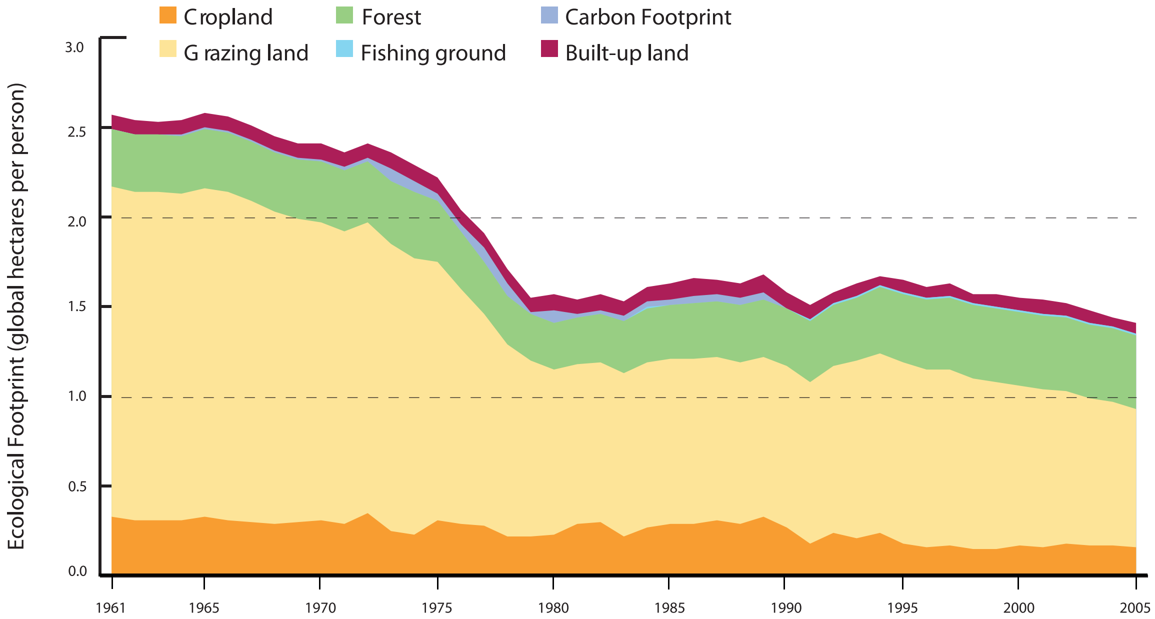


Figure 18.5. Somalia biocapacity per person, 1961-2005

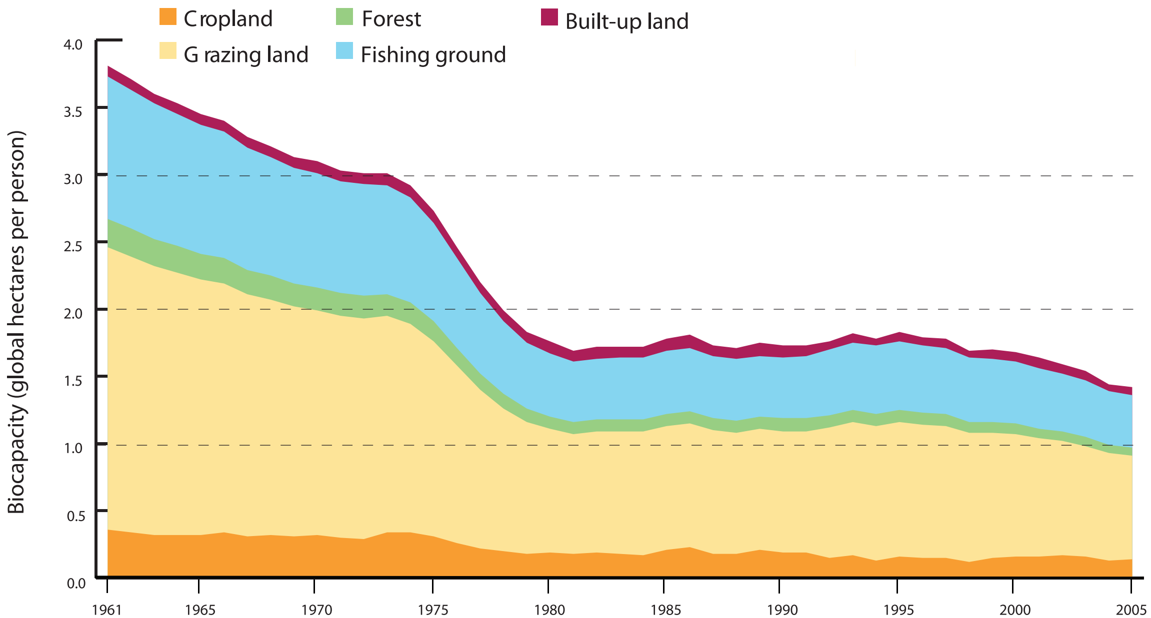


Table 18.2. Somalia Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.33	1.84	0.32	0.00	0.00	0.08	2.57
1965	0.33	1.83	0.33	0.01	0.00	0.08	2.57
1970	0.31	1.66	0.34	0.01	0.00	0.09	2.41
1975	0.31	1.44	0.34	0.04	0.00	0.09	2.23
1980	0.23	0.92	0.26	0.07	0.00	0.09	1.57
1985	0.29	0.92	0.30	0.03	0.00	0.09	1.65
1990	0.27	0.90	0.32	0.00	0.00	0.09	1.58
1995	0.18	1.01	0.38	0.00	0.01	0.07	1.63
2000	0.17	0.89	0.41	0.00	0.01	0.07	1.56
2005	0.16	0.77	0.41	0.00	0.01	0.06	1.40

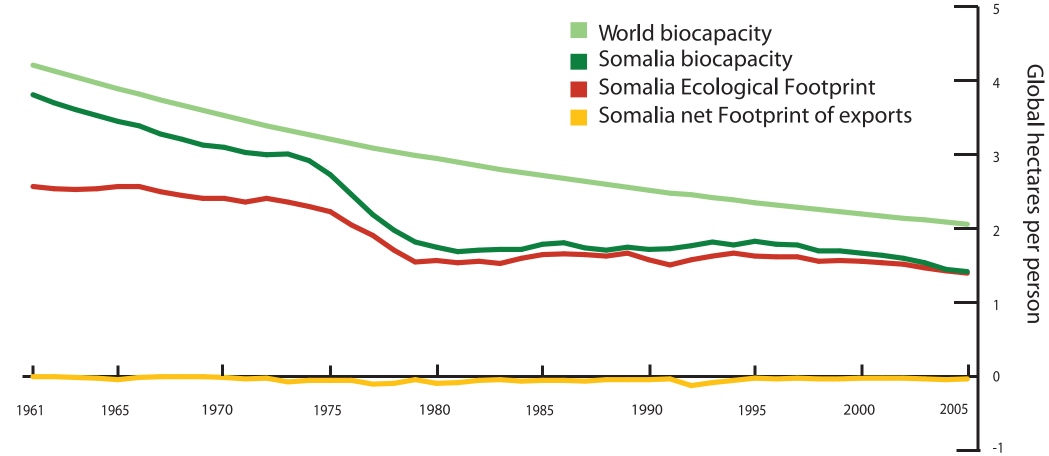
Table 18.3. Somalia biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.36	2.10	0.21		1.06	0.08	3.81
1965	0.32	1.90	0.19		0.96	0.08	3.45
1970	0.32	1.67	0.17		0.85	0.09	3.10
1975	0.31	1.45	0.15		0.73	0.09	2.73
1980	0.19	0.92	0.09		0.47	0.09	1.75
1985	0.21	0.92	0.09		0.47	0.09	1.79
1990	0.19	0.90	0.10		0.45	0.09	1.72
1995	0.16	1.00	0.09		0.51	0.07	1.83
2000	0.16	0.91	0.08		0.46	0.07	1.67
2005	0.14	0.77	0.06		0.39	0.06	1.42

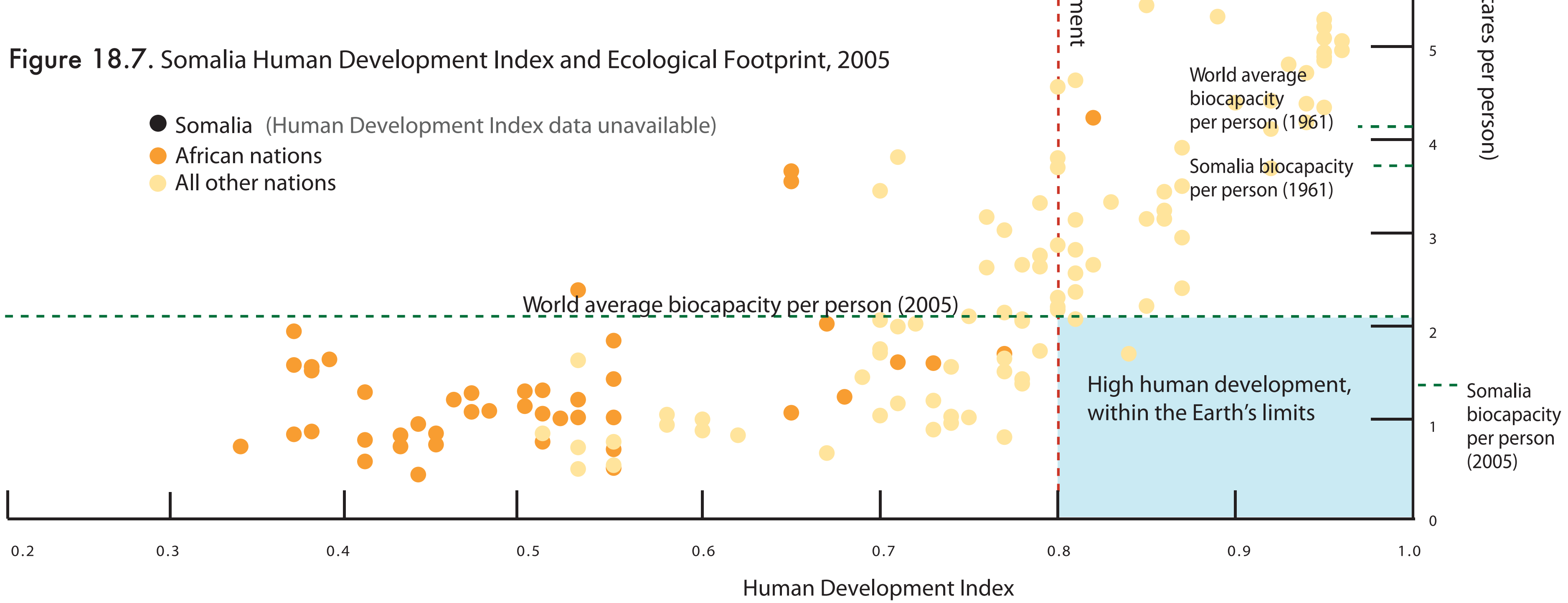
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 18.6. Somalia Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 18.7. Somalia Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Charcoal Production from Acacia in Somalia

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At least 80 percent of the Somali population continues to depend on traditional biomass fuels, mainly charcoal and firewood for its energy needs. The charcoal trade has a devastating effect on Somalia's forests, specifically *Acacia bussie* and *Acacia senegal*. It is also likely to increase the occurrence of desertification in Somalia, depriving pastoralists of grazing land and farmers of cultivatable areas. The charcoal trade in Somalia takes a heavy toll on the Acacia forests of southern Somalia, as traders clear-cut entire swaths of forest for shipment to Gulf states.

Most of the charcoal is made in southern Somalia, between Brava and Kismayo, an area that is typically sparse savannah with few forested areas, and is apart from the Sakow area, which has large trees. But Jilib near Kismayo and Brava has areas of thick vegetation, some too dense for livestock to pass. More than 80 percent of the trees used for charcoal are types of Acacia. In 2000, total charcoal production was estimated to be 112,000 metric tons, and was estimated to rise to 150,000 metric tons by 2005 (IRIN 2006). Approximately 80 percent of this charcoal is destined for stoves in the Gulf states, while only 20 percent is for domestic consumption.

The loss of ground cover and root systems leads to increased erosion in the riverine areas, and decreases the amount of land useable for agriculture or even grazing. As a result, locals are forced to move out of these areas as they become uninhabitable. Pastoralists and agriculturalists rely on the Acacia forests to play their part in maintaining the delicate balance that makes life in arid Somalia possible. Pastoralists graze their cattle in the grass that flourishes while the Acacia groves' root systems hold in ground water and prevent erosion. Agriculturalists grow staple crops in neighboring lands, but as erosion increases without the Acacia groves holding in top soil, their lands are becoming fallow. With forests destroyed, these groups must move to other areas in order to survive, or engage in the charcoal trade themselves, which only deepens the cycle of destruction.

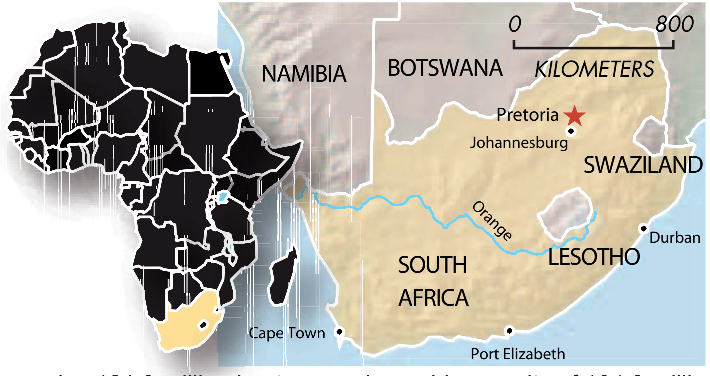
Somalia is a largely arid nation of sparse savannah, with pastoralism still a primary source of income, contributing 70 percent of GDP (IRIN 2006). The vegetation in Somalia is predominantly dry deciduous bushland and thicket, with semi-desert grasslands and deciduous shrubland in the north and along much of the coast. In general, the vegetation becomes more dense towards the south – much of the northeastern part of the country is devoid of trees.

Emissions from the production of charcoal are more significant than those from charcoal burning. Charcoal consumption leads to considerable deforestation, which is now one of the most pressing environmental problems faced by Somalia. Along with land degradation, charcoal production also leads to a reduction of natural resources on which the poor depend, contributing to the downward spiral of poverty. Deforestation not only has negative implications for the local environment, but the global environment as well (acceleration of climate change, threatened biodiversity). The reduction of forest cover also reduces the existing capacity to sequester carbon, and releases the already fixed carbon.

The charcoal trade from Somalia to the Gulf has caused open conflict between clans within Somalia, resulting in shootouts and mine-laying. This is especially true with pastoralists who must defend grazing areas from charcoal traders who cut the few Acacia trees that are very important for livestock.

The necessary trade and environmental policies needed to resolve or reduce this damage are:

- Policies governing charcoal production and export, in partnership with Gulf states;
- Improved efficiency of charcoal and fuel-wood use: for example through improved stoves and public education of technologies;
- Alternative sources of energy, especially those that are competitive in price, such as kerosene, coal, biogas, solar gas and other natural gases;
- Bans on charcoal production from specific tree species;
- Modalities to encourage reforestation of *Acacia bussie* and *Acacia senegal* to balance the use of charcoal for cooking energy and for export.



South Africa occupies 121.9 million hectares. Of those, 9.2 million hectares are covered by forest, 15.7 million by cropland and 83.9 million by grazing land, with 1.4 million hectares supporting its built infrastructure. Located along the southern tip of Africa where the Atlantic and Indian Oceans meet, South Africa borders 16.1 million hectares of continental shelf and has 0.5 million hectares of inland water.

Adjusting for its cropland, grazing land and forest yields, which are lower than corresponding global averages, and its fishery yield, which is higher than the global average, South Africa has a biocapacity of 104.8 million global hectares (gha). This is more than its total Ecological Footprint of 98.7 million gha.

South Africa's average Ecological Footprint per person is 2.1 gha, smaller than the world average Footprint and equal to the amount of biocapacity available per person on the planet. It is also slightly smaller than the 2.2 gha of biocapacity available per person within South Africa. As its population grew from 17.9 million to 47.4 million between 1961 and 2005, biocapacity per person in South Africa decreased by 56 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 19.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
South Africa	47,432,000	98,730	104,752	2.1	2.2
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	239.5	

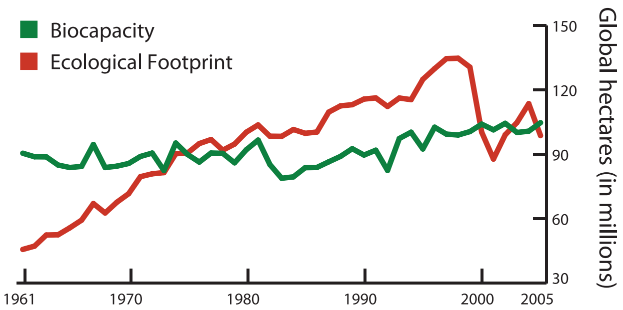
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	62.2	18.0	10.0	6.3	3.5

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	South Africa	Female	Male
Human Development Index Value (0=min. 1=max.)	0.67	–	–
Adult Literacy Rate (percent adults over 18)	82	81	84
Gross Enrollment Ratio (percent eligible students enrolled)	77	77	76
Irrigated Cropland (percent of total, 2000)	9.5	–	–
Access to Improved Water (percent of population, 2002)		–	–
Domestic Electrification (percent of population, 2000)	70	–	–
Undernourishment (percent of population, 2000)	–	–	–
Life Expectancy (years)	50.8	52.0	49.5

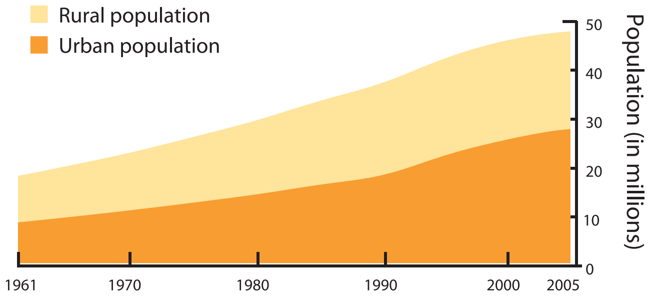
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 19.1. South Africa total Ecological Footprint and biocapacity, 1961-2005



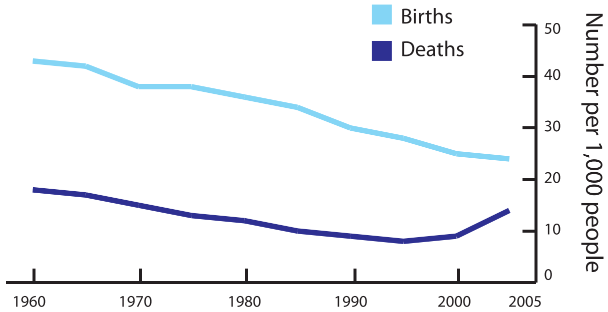
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 19.2. South Africa population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 19.3. South Africa birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 19.4. South Africa Ecological Footprint per person, 1961-2005

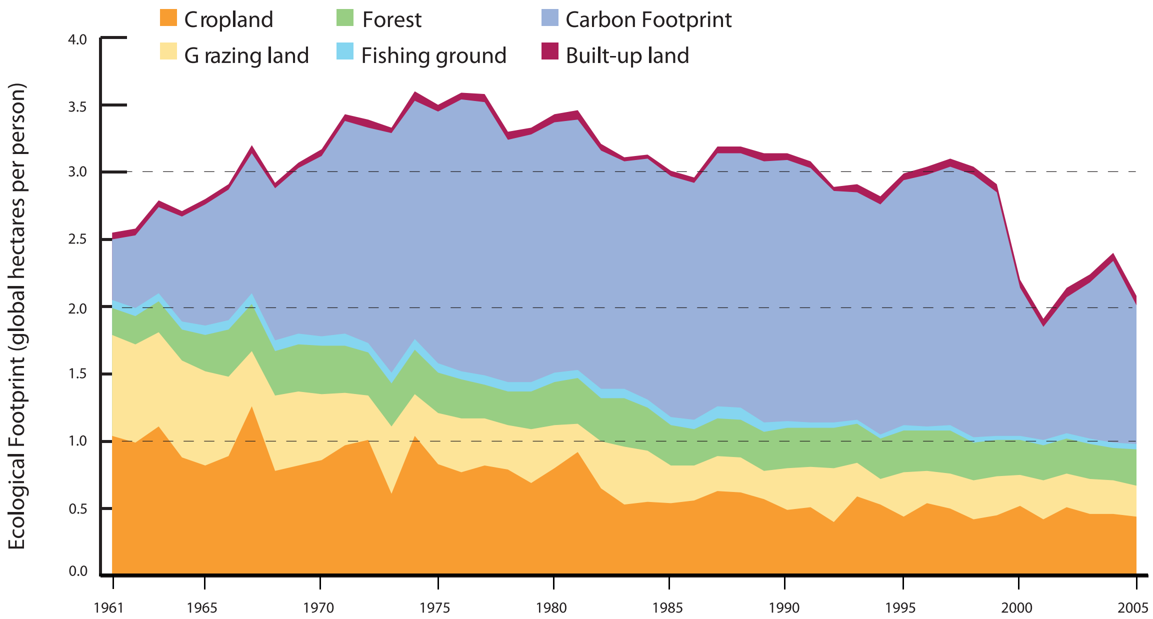


Table 19.2. South Africa Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.04	0.75	0.20	0.45	0.06	0.05	2.56
1965	0.82	0.70	0.27	0.90	0.07	0.04	2.80
1970	0.86	0.49	0.36	1.34	0.07	0.05	3.16
1975	0.83	0.38	0.30	1.87	0.07	0.05	3.51
1980	0.80	0.32	0.32	1.86	0.07	0.06	3.43
1985	0.54	0.28	0.30	1.79	0.06	0.04	3.01
1990	0.49	0.31	0.30	1.94	0.05	0.05	3.14
1995	0.44	0.33	0.31	1.82	0.04	0.05	2.98
2000	0.52	0.23	0.26	1.10	0.03	0.06	2.20
2005	0.44	0.23	0.27	1.03	0.04	0.07	2.08

Figure 19.5. South Africa biocapacity per person, 1961-2005

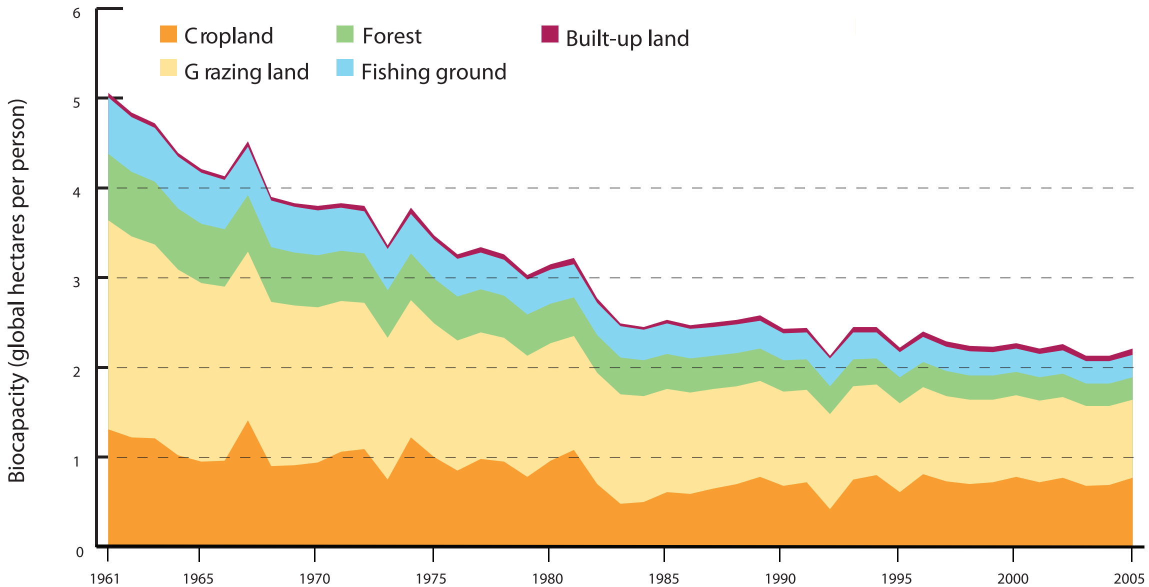


Table 19.3. South Africa biocapacity, 1961-2005

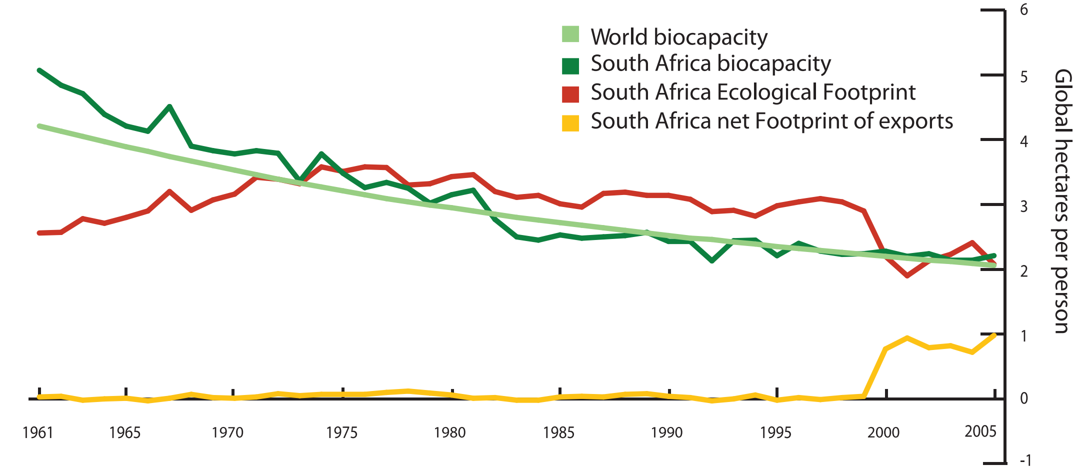
(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.31	2.33	0.74		0.63	0.05	5.07
1965	0.95	1.99	0.66		0.57	0.04	4.21
1970	0.94	1.73	0.58		0.50	0.05	3.78
1975	1.00	1.49	0.50		0.43	0.05	3.48
1980	0.96	1.31	0.44		0.38	0.06	3.15
1985	0.61	1.15	0.39		0.34	0.04	2.53
1990	0.68	1.05	0.35		0.30	0.05	2.43
1995	0.61	0.99	0.29		0.28	0.05	2.21
2000	0.78	0.91	0.26		0.26	0.06	2.28
2005	0.77	0.87	0.25		0.25	0.07	2.21

Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

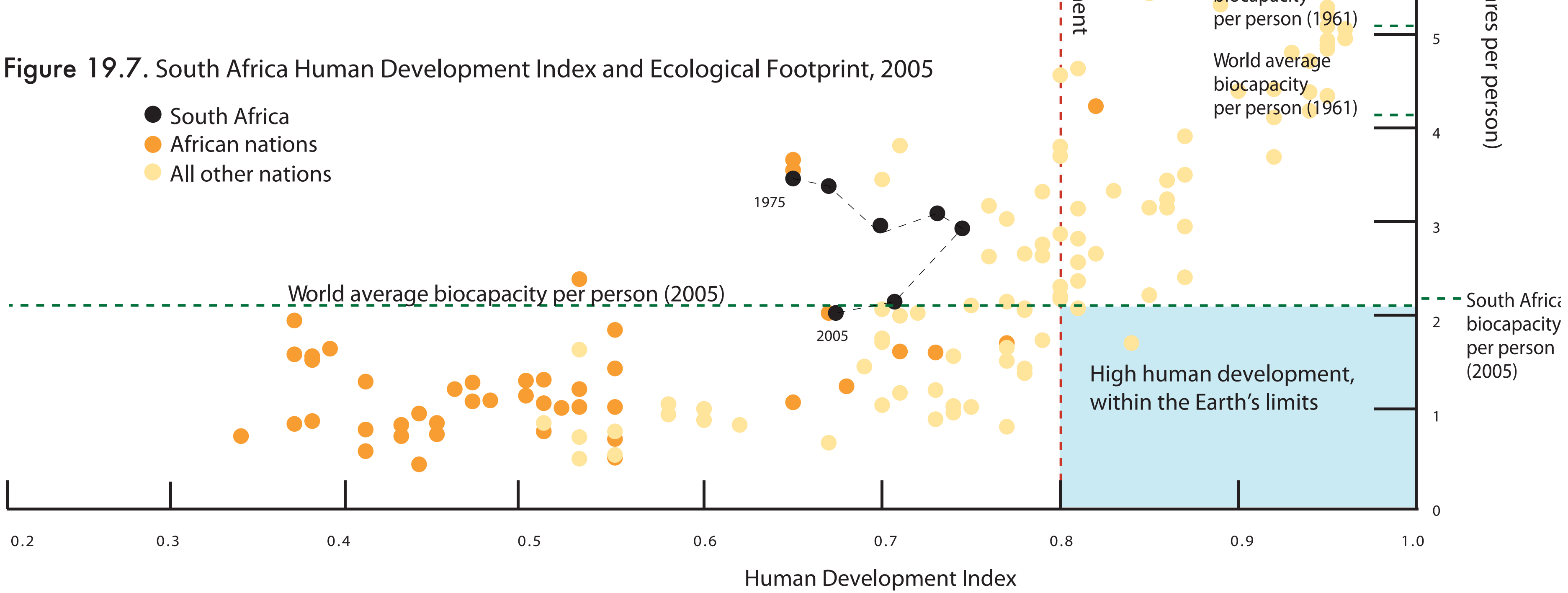
Figure 19.6. South Africa Ecological Footprint and biocapacity per person, 1961-2005

Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 19.7. South Africa Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Energy Use and Its Impact on Development

Emerging economies such as South Africa, Brazil, India and China face a challenge when it comes to meeting energy needs. While they want to meet their economic objectives, financial growth and the resulting increase in energy consumption often lead to further environmental degradation and poverty.

Growing energy consumption has disproportionately affected South Africa's poor. During the 1990s Eskom (South Africa's state energy production and supply company) moved to a policy of "user pays" cost recovery, meaning that the costs of infrastructure to supply energy needed to be covered by the end-user. This policy impacted many poor households, particularly the majority of black South Africans who had no access to electricity during the apartheid era – more than 80 percent of households in black townships did not have access to electricity.

Between 1991 and 2000 the government made over 3.2 million electricity connections to households, exceeding its goal of 2.5 million. But there were also a high level of disconnections because many people could not afford to pay for it. As a result, these households have reverted to using paraffin and biomass, particularly in rural areas, to meet their energy needs. So despite the fact that South Africa is the largest consumer of energy in the southern African region, a large proportion of the population is "energy-poor", as 30 percent does not have access to electricity (Greenberg 2006).

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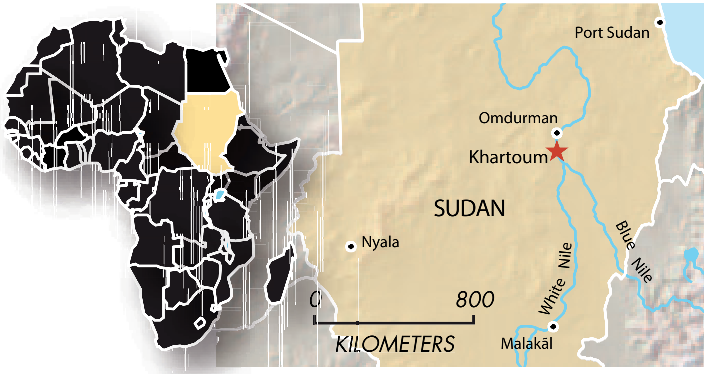
Historically, the state played a major role in the growth of manufacturing in South Africa. It set up a range of state corporations and entities primarily to support heavy industry for inputs into the mines and the beneficiation of mine outputs – known as the Minerals Energy Complex (MEC) (Greenberg 2006). This largely shaped South Africa's energy-intensive economy from the apartheid era (Greenberg 2006, Hallowes and Munnik 2007, Wakeford 2009). South Africa's "cheap" energy is based on the abundance of coal and presents a serious structural challenge to the government, which in principle adopted a goal of sustainable development in the Draft Energy Bill of 2004.

Approximately 90 percent of South Africa's electricity is generated in coal-fired power plants; the remaining 10 percent is divided between nuclear and hydroelectric dams. This reliance on coal has made South Africa the 11th largest carbon dioxide emitter in the world (Hallowes and Munnik 2007). Even though South Africa is a middle-income country, it has one of the highest levels of carbon dioxide emissions per capita (Wakeford 2009). Pollution from coal not only contributes to land degradation, acid rain and smog, but also imposes serious social costs in terms of health problems (Wakeford 2009).

For the economy, environment and health of South Africa's population, it will be vital to adopt alternative sources of energy, such as wind and solar power. The Department of Minerals and Energy set a meagre renewable energy target of 10,000 gigawatts to the final demand by the year 2013. A report by Groundworks suggests that if this is a "per-year" figure, renewable energy will amount to 1.5 percent of final consumption, extremely low compared to South Africa's energy consumption from coal, which is approximately 75 percent. Eskom has set itself a target of 1,600 megawatts capacity for renewable energy by 2025, and planned a 100 megawatt wind farm and is considering a 100 megawatt solar plant (Hallowes and Munnik 2007) .

South Africa must start planning for the transition towards a low-carbon society. The government should be investing in solar energy on a large scale, made viable by the country's abundant sunshine. This will not only create new jobs, but put the country on a path toward sustainable development.



Sudan occupies 250.6 million hectares. Of those, 67.6 million hectares are covered by forest, 19.7 million by cropland and 117.2 million by grazing land, with 1.6 million hectares supporting its built infrastructure. Located next to the Red Sea, with the Nile River flowing through its central parts, Sudan has 1.6 million hectares of continental shelf and 13.0 million hectares of inland water. The largest country in Africa, Sudan is covered by the Libyan and Nubian Deserts in the north.

Adjusting for its cropland, grazing land and forest yields, which are lower than corresponding global averages, and its fishery yield, which is higher than the global average, Sudan has a biocapacity of 101.1 million global hectares (gha). This is more than its total Ecological Footprint of 88.4 million gha.

Sudan's average Ecological Footprint per person is 2.4 gha, smaller than the world average Footprint and larger than the amount of biocapacity available per person on the planet. It is also smaller than the 2.8 gha of biocapacity available per person within Sudan. As its population grew from 11.8 million to 36.2 million between 1961 and 2005, biocapacity per person in Sudan decreased by 69 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 20.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Sudan	36,233,000	88,356	101,122	2.44	2.79
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	27.4	1,711

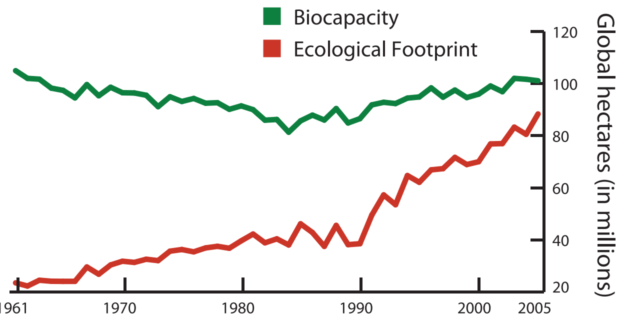
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	–	–	–	–	–

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Sudan	Female	Male
Human Development Index Value (0=min. 1=max.)	0.526	–	–
Adult Literacy Rate (percent adults over 18)	60.9	51.8	71.1
Gross Enrollment Ratio (percent eligible students enrolled)	35.7	34	38
Irrigated Cropland (percent of total, 2000)	11.2	–	–
Access to Improved Water (percent of population, 2002)	70	–	–
Domestic Electrification (percent of population, 2000)	30	–	–
Undernourishment (percent of population, 2000)	9	–	–
Life Expectancy (years)	57.4	58.9	56.0

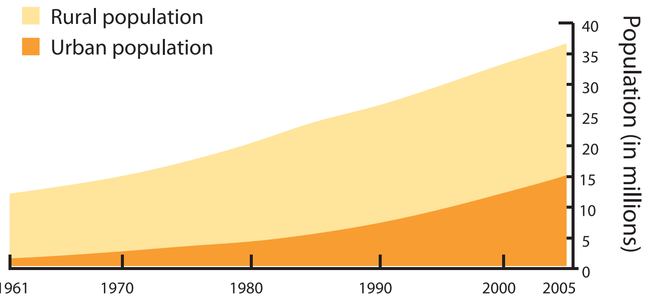
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 20.1. Sudan total Ecological Footprint and biocapacity, 1961-2005



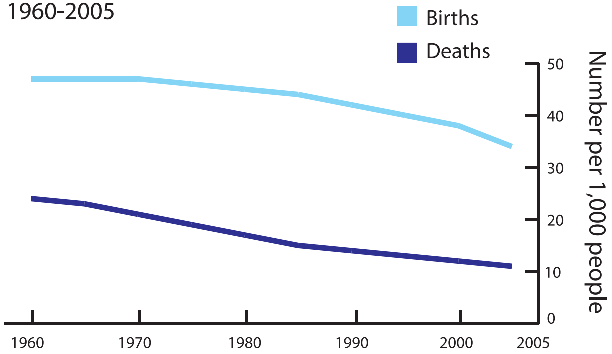
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 20.2. Sudan population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 20.3. Sudan birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 20.4. Sudan Ecological Footprint per person, 1961-2005

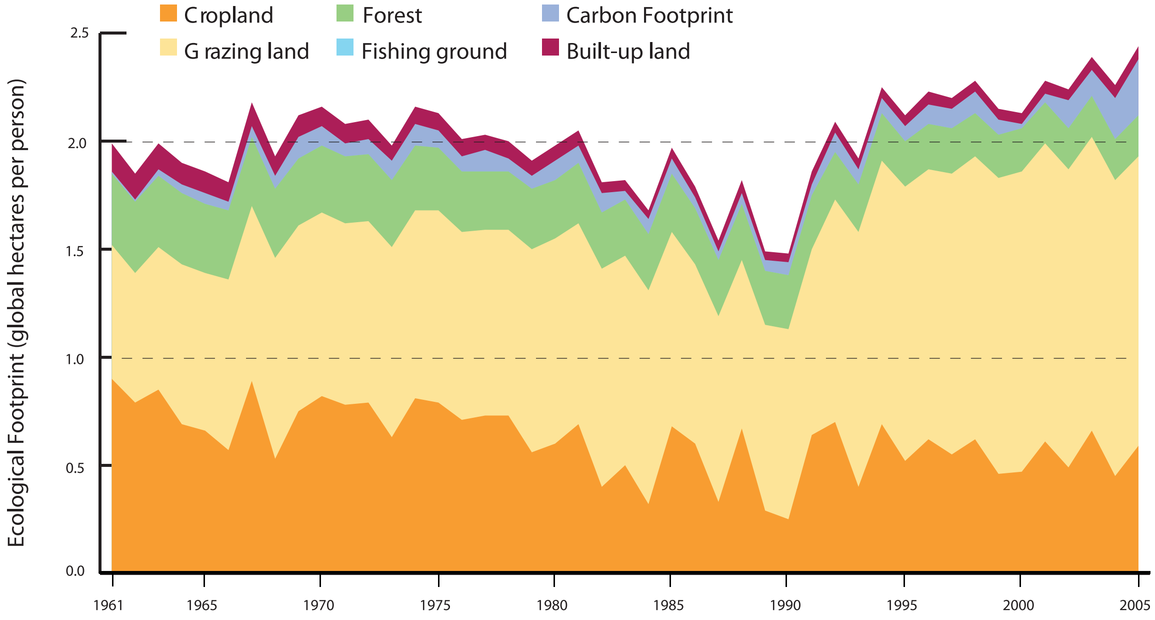


Table 20.2. Sudan Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.90	0.62	0.33	0.01	0.00	0.13	1.99
1965	0.66	0.73	0.32	0.05	0.00	0.10	1.86
1970	0.82	0.85	0.31	0.09	0.00	0.09	2.16
1975	0.79	0.89	0.29	0.08	0.00	0.08	2.13
1980	0.60	0.95	0.27	0.09	0.00	0.07	1.98
1985	0.68	0.90	0.27	0.07	0.00	0.05	1.97
1990	0.25	0.88	0.25	0.06	0.00	0.04	1.48
1995	0.52	1.27	0.21	0.07	0.00	0.05	2.12
2000	0.47	1.39	0.20	0.02	0.00	0.05	2.13
2005	0.59	1.34	0.19	0.26	0.00	0.06	2.44

Figure 20.5. Sudan biocapacity per person, 1961-2005

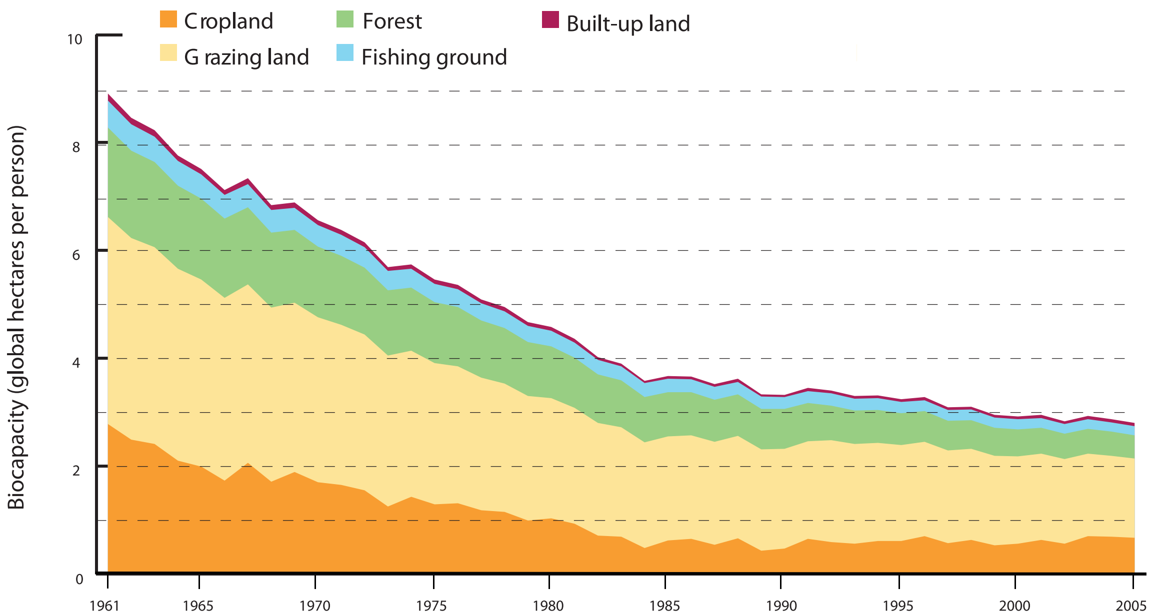


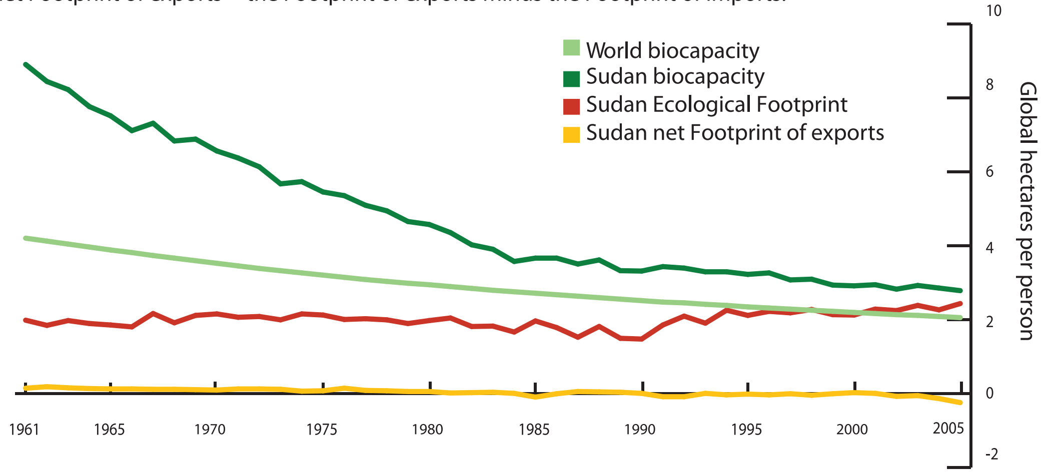
Table 20.3. Sudan biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	2.78	3.84	1.66		0.50	0.13	8.91
1965	1.99	3.47	1.50		0.45	0.10	7.52
1970	1.70	3.06	1.31		0.40	0.09	6.57
1975	1.29	2.62	1.13		0.34	0.08	5.46
1980	1.03	2.23	0.96		0.29	0.07	4.58
1985	0.62	1.93	0.82		0.25	0.05	3.67
1990	0.47	1.85	0.74		0.22	0.04	3.32
1995	0.61	1.78	0.59		0.21	0.05	3.23
2000	0.56	1.62	0.50		0.19	0.05	2.92
2005	0.67	1.47	0.43		0.17	0.06	2.79

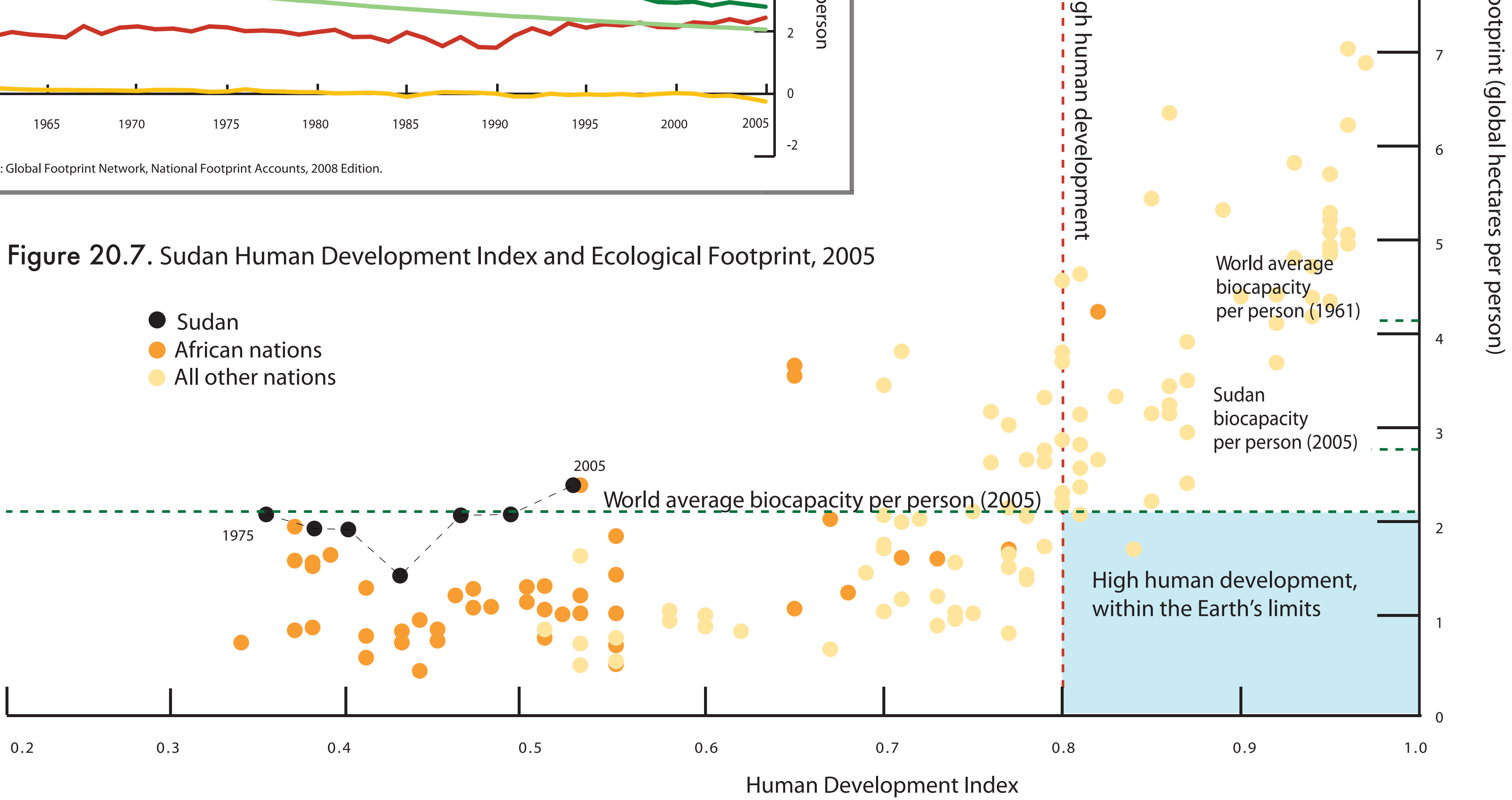
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 20.6. Sudan Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 20.7. Sudan Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Energy: A Critical Component in the Development of Sudan

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In order to understand how energy influences the development of people and society in Sudan, we must assess energy availability and distribution throughout the entire countryside and understand the relationship between energy and development.

Sudan suffers from having a scattered population. Although the country is home to 37 million people, Sudan has an overall population density of 13 inhabitants per square kilometer (Sudannet). Sudan's primary energy sources are limited; energy consumption is comprised of 69 percent biomass, 30 percent petroleum and one percent hydroelectricity (MEM 2006).

Sudanese have a low life expectancy of approximately 58 years (UNDP 2007). This is mainly due to the country's health care, which is hampered by a lack of energy services needed to run critical health systems. Only 61 percent of Sudanese are literate. This, too, is impacted by energy accessibility, especially in rural areas, where many school-age children must use their time to do domestic chores in place of studying (UNDP 2007). Sudan's low level of infrastructure enforces poor living standards. One-third of the population has no access to safe drinking water, and only 3,600 kilometres is paved in a country that has an area of 2,505,800 square kilometers. These conditions drive the urbanization in Sudan. In 1995, 28 percent of Sudan's population lived in urban areas. Today, the United Nations estimates that 40 percent of Sudanese live in cities (Sudannet; UNJLC).

Considering that only 30 percent of Sudan's population has access to electricity services, it is not surprising that domestically manufactured goods and industries make up only 28 percent of Sudan's GDP (UNDP 2007; Bank of Sudan). Much of Sudan's technology is imported including electronic devices, transmission cables, electric wires and components for domestic power plants (Bank of Sudan).

Almost 70 percent of Sudanese energy needs are met through biomass resources; predominantly fuelwood (MEM 2006; NEC 2004, 2009).

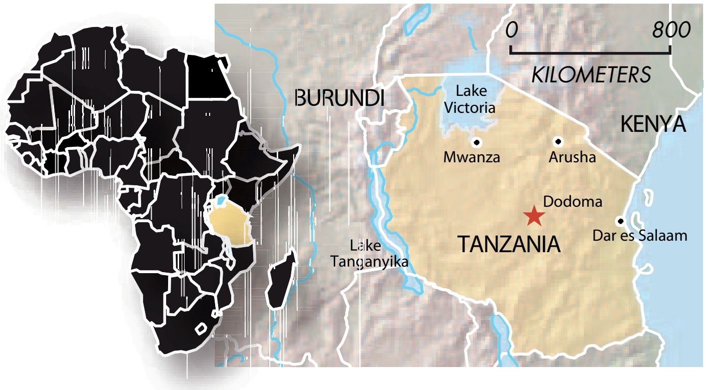
Sudan's urban areas are drivers for the country's economical development because they host the technical skills and resources needed to fuel the development process. Medium-size cities, such as Kassala, Halfa, Genina and Wau, are home to Sudan's middle class, higher education institutions, and industry, all of which help to push development. In order to support these areas, energy provision must be scaled up. Hydroelectric dams and thermal power plants, including nuclear-based power plants, are both potential solutions to Sudan's energy deficit.

Within Sudan's small cities, energy is needed for lighting, potable water, transportation and communication. One option is decentralized power plants; extending grid access from regional hydroelectric stations or erecting biomass combustion plants. For example, a sugar factory in the Kenana area uses sugar cane residues to generate steam and electricity for the factory, and the excess electricity is given to nearby communities for household use. Alternatives such as PV solar on rooftops could supplement this electricity provision.

Rural and nomadic populations must have reliable energy sources to provide food and shelter, and generate income. An increased investment in improving the efficiency of traditional appliances is suggested here, as well as adopting renewable energy techniques such as wind pumps for the irrigation of small plots.

Without sufficient energy, this rural population cannot make the steps needed to integrate into Sudanese society as it develops. As a result rural poverty will grow and we will see increasing urbanization as the rural poor migrate to cities.

Thorough infrastructure planning where residential and industry needs are considered is essential in planning future investments. Let us also consider a higher level of administration transparency that allows people and communities to participate in energy management. This will increase the trust between residents and the governing bodies that manage Sudan's natural resources.



The United Republic of Tanzania occupies 94.7 million hectares. Of those, 35.3 million hectares are covered by forest, 10.4 million by cropland and 28.8 million by grazing land, with 1.5 million hectares supporting its built infrastructure. Located along the Indian Ocean, with Lake Victoria to its north and Lake Taganyika to its west, Tanzania borders 1.8 million hectares of continental shelf and has 6.2 million hectares of inland water.

Adjusting for its cropland and forest yields, which are lower than corresponding global averages, and its grazing land and fishery yields, which are higher than the global averages, Tanzania has a biocapacity of 45.8 million global hectares (gha). This is more than its total Ecological Footprint of 43.9 million gha.

Tanzania's average Ecological Footprint per person is 1.1 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also slightly smaller than the 1.2 gha of biocapacity available per person within Tanzania. As its population grew from 10.3 million to 38.3 million between 1961 and 2005, biocapacity per person in Tanzania decreased by 75 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 21.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Tanzania	38,329,000	43,878	45,841	1.2	1.2
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	12.1	933

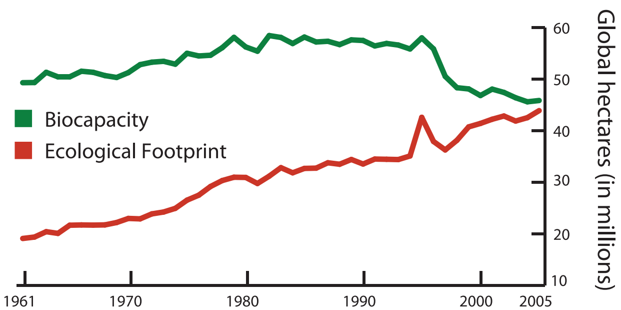
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	42.4	22.3	16.1	12.0	7.3

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Tanzania	Female	Male
Human Development Index Value (0=min. 1=max.)	0.47	–	–
Adult Literacy Rate (percent adults over 18)	69	62	78
Gross Enrollment Ratio (percent eligible students enrolled)	52	51	53
Irrigated Cropland (percent of total, 2000)	1.8	–	–
Access to Improved Water (percent of population, 2002)		–	–
Domestic Electrification (percent of population, 2000)	11	–	–
Undernourishment (percent of population, 2000)	16.4	–	–
Life Expectancy (years)	51.0	52.0	50.0

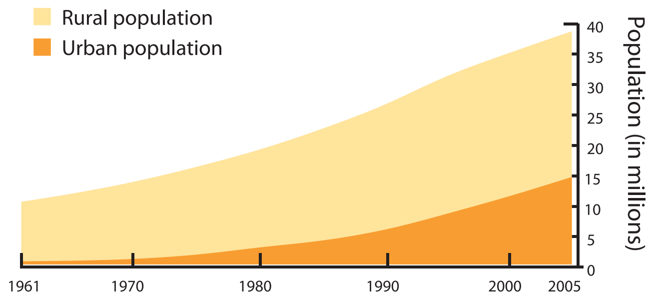
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 21.1. Tanzania total Ecological Footprint and biocapacity, 1961-2005



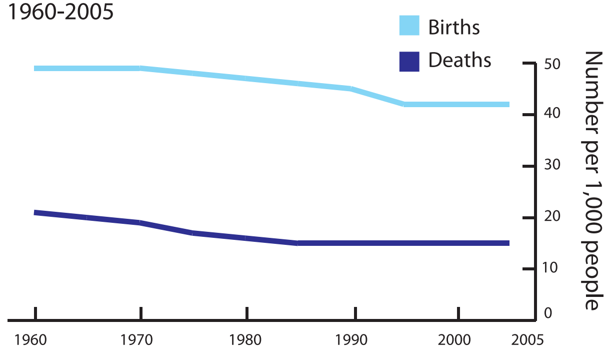
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 21.2. Tanzania population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 21.3. Tanzania birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 21.4. Tanzania Ecological Footprint per person, 1961-2005

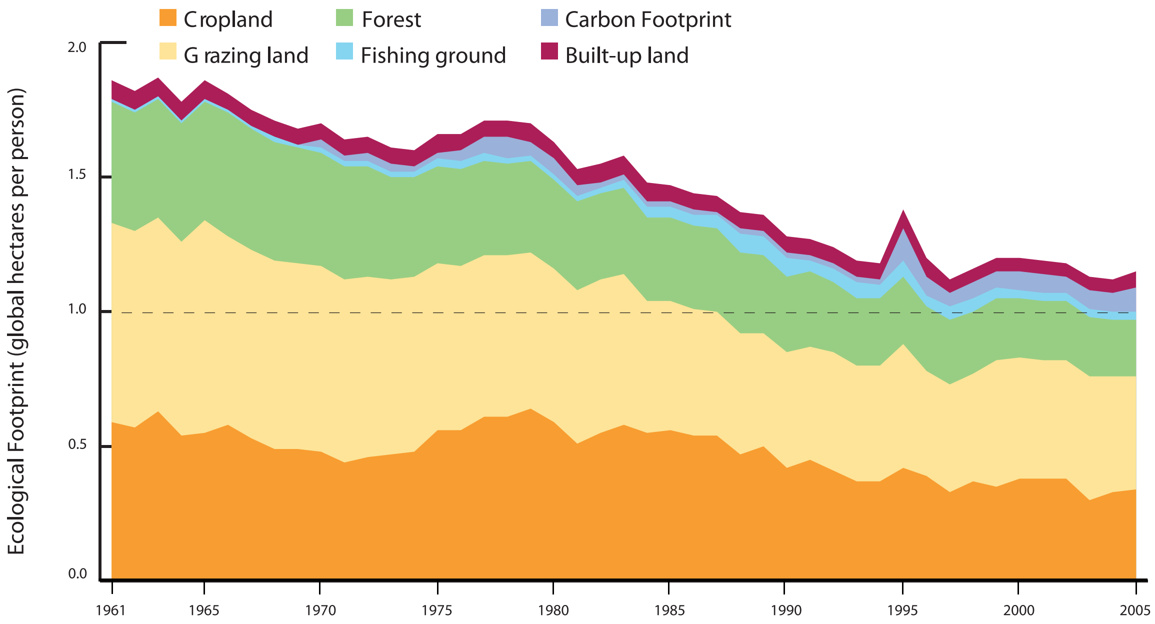


Figure 21.5. Tanzania biocapacity per person, 1961-2005

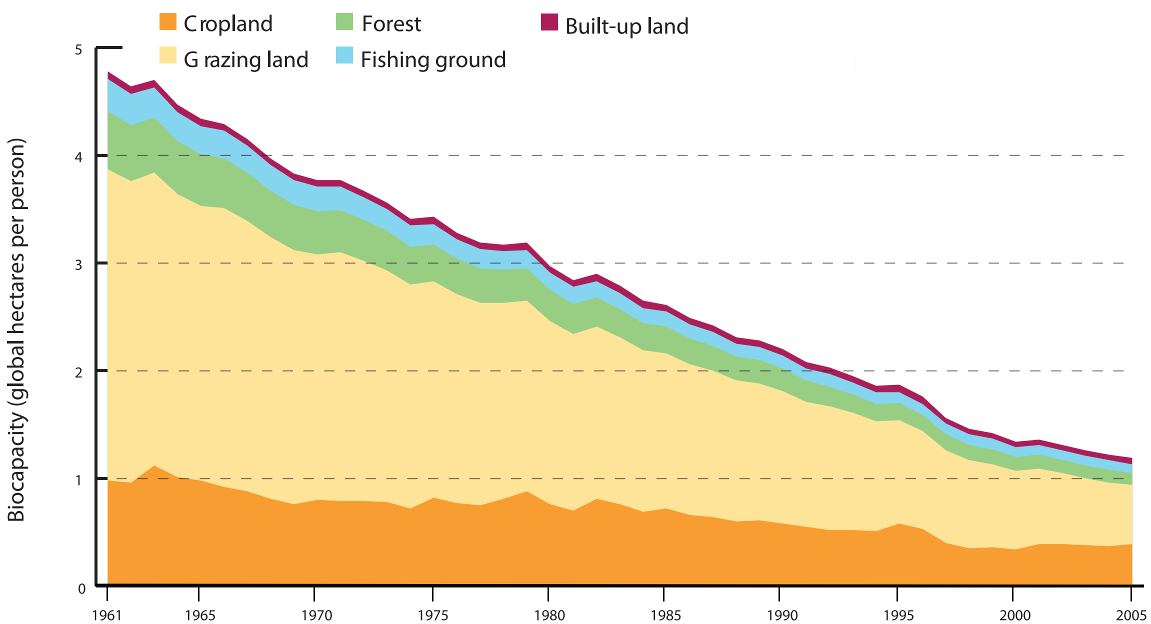


Table 21.2. Tanzania Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.59	0.74	0.45	0.00	0.01	0.07	1.85
1965	0.55	0.79	0.44	0.00	0.01	0.07	1.86
1970	0.48	0.69	0.42	0.03	0.02	0.06	1.69
1975	0.56	0.62	0.36	0.02	0.03	0.07	1.65
1980	0.59	0.57	0.33	0.06	0.02	0.06	1.64
1985	0.56	0.48	0.31	0.02	0.04	0.06	1.47
1990	0.42	0.43	0.28	0.02	0.07	0.06	1.28
1995	0.42	0.46	0.25	0.12	0.06	0.07	1.38
2000	0.38	0.45	0.22	0.07	0.03	0.05	1.19
2005	0.34	0.42	0.21	0.09	0.03	0.06	1.15

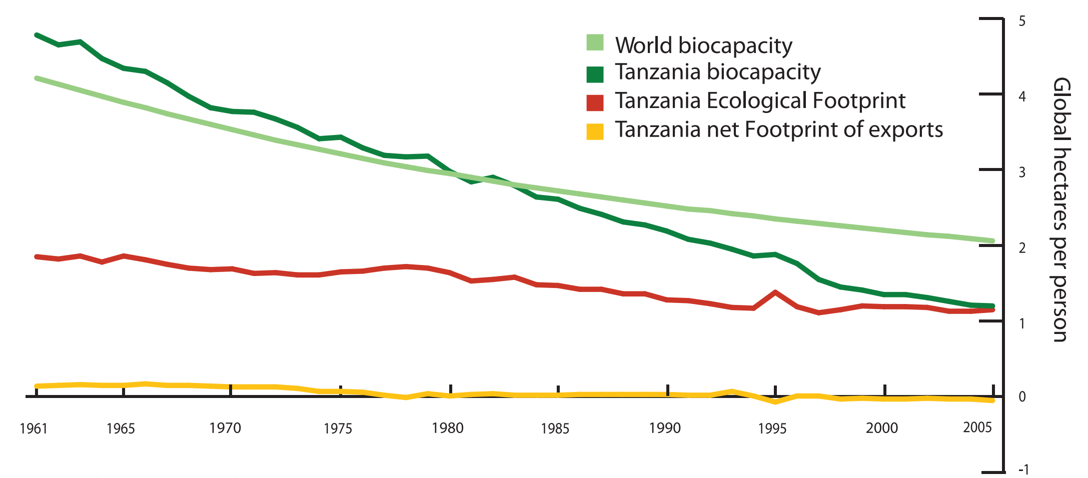
Table 21.3. Tanzania biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.98	2.89	0.54		0.30	0.07	4.78
1965	0.98	2.55	0.48		0.26	0.07	4.34
1970	0.80	2.28	0.40		0.23	0.06	3.77
1975	0.82	2.01	0.34		0.19	0.07	3.43
1980	0.76	1.70	0.29		0.16	0.06	2.98
1985	0.72	1.44	0.25		0.14	0.06	2.61
1990	0.58	1.23	0.21		0.12	0.06	2.19
1995	0.58	0.96	0.16		0.10	0.07	1.88
2000	0.34	0.73	0.13		0.09	0.05	1.35
2005	0.39	0.55	0.11		0.08	0.06	1.20

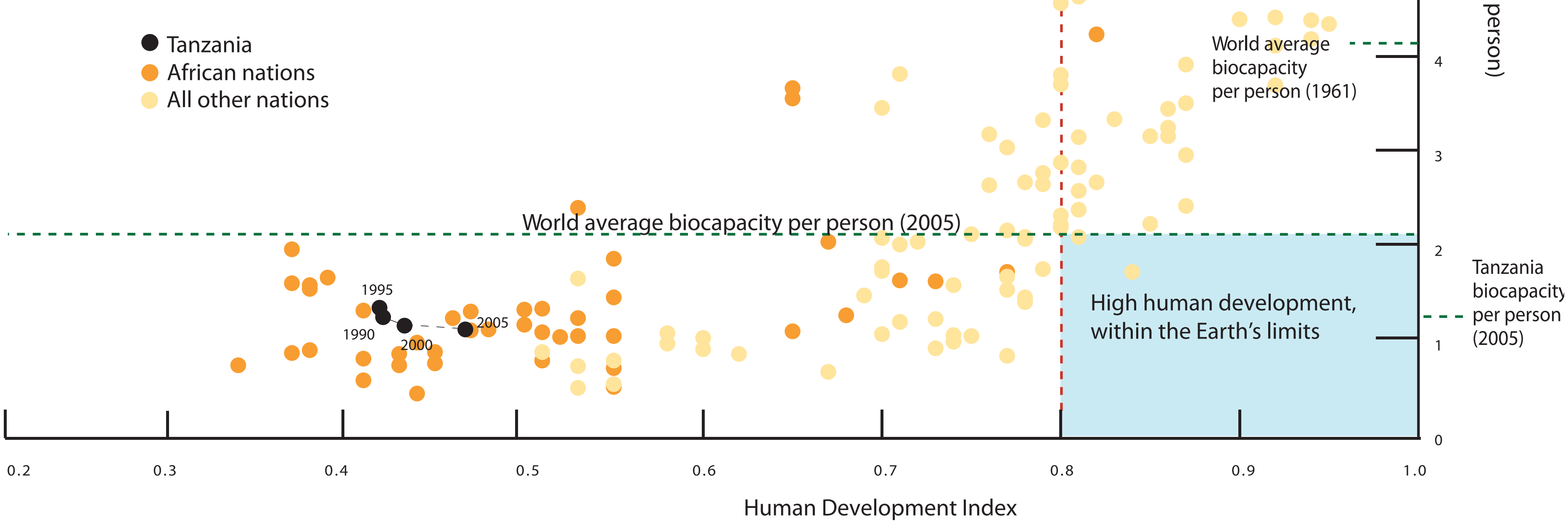
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 21.6. Tanzania Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 21.7. Tanzania Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

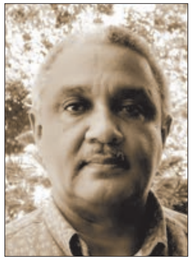
Agriculture: A Core Component of Tanzania's Economy

Tanzania covers 945,000 square kilometers. Its economy relies on agriculture, mining and tourism. Industry is limited to processing agricultural products and light consumer goods, such as textiles, food and beverages. Recent economic growth has been driven by tourism, a rise in industrial production and substantial increases in mineral outputs, led by gold, gemstones and diamonds. Offshore gas is also being extracted.

Tanzania's population living below the poverty line dropped to 33.3 percent in 2006 from 35.7 percent in 2001, but the number of people who live on less than a $1 a day has risen by one million to 12.7 million in the last six years, largely attributed to the country's 2.6 percent annual population growth. Tanzania's population growth has important implications for natural resource utilization.

Even with economic growth at 6-7 percent per annum, Tanzania is one of the poorest countries in the world (UNDP 2006). Progress in spreading Tanzania's economic benefits has been uneven. The problem lies in Tanzania's countryside, where 80 percent of Tanzanians live off of farms (NPES 1998). Agricultural development is hampered by a lack of investment in infrastructure, equipment, fertilizer and little access to markets or appropriate technology.

Agriculture accounts for half of the national income, 33 percent of merchandise exports,



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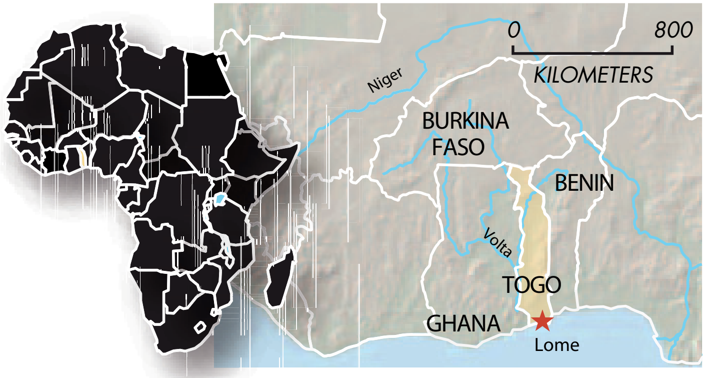
and employs an estimated 80 percent of the population. It supports the non-farm sector through agro-processing, consumption and export, and provides raw materials to industries as well as a market for manufactured goods.

Smallholder farmers dominate agriculture, which is approximately 85 percent food crops, and mostly rain-fed. About 70 percent of Tanzania's crop area is cultivated by hand hoe, 20 percent by ox plough and 10 percent by tractor. Non-traditional export crops include fruits, vegetables and flowers. Traditional crops including coffee, tea, cotton lint, sisal, tobacco, and raw cashew nuts are the main sources of Tanzania foreign exchange earnings, contributing up to 60 percent of total export volume. Domestic food crops are maize, rice, beans, sorghum, potatoes and cassava.

The agriculture sector suffers from low-efficiency technology and irregular weather patterns, especially droughts. Irrigation can stabilize production, improve food security, and produce higher value crops, such as vegetables and cut-flowers for export. Agricultural GDP has grown at 3.3 percent per year since 1985. This performance falls short of the overall GDP growth needed to reduce poverty by 2010, estimated at 6-7 percent (Econ Survey 2000). While global food prices are on the rise, efforts to take advantage of these rising prices are slow and vulnerability to climate change is increasing.

Irrigation for dry-season farming, mainly of rice and vegetables, is common but not widespread. Despite low use of irrigation there are already downstream problems such as reduced flows of rivers. The Great Ruaha River has ceased completely during the dry season for 10 consecutive years, while the Ruvu and the Pangani rivers have had erratic and reduced flows as a result of climatic variability (Econ Survey 2000).

Economic reforms have led to increased private investment in production and processing, input importation and distribution and agricultural marketing, while opening up new areas for agriculture, including biofuel production. In some areas competition between food crops and biofuel stocks may emerge.



Togo occupies 5.7 million hectares. Of those, 0.4 million hectares are covered by forest, 2.6 million by cropland and 2.2 million by grazing land, with 0.2 million hectares supporting its built infrastructure. Located along the Atlantic Coast in West Africa, Togo borders 62,940 hectares of continental shelf and has 0.2 million hectares of inland water.

Adjusting for its cropland yield, which is lower than the corresponding global average, and its grazing land, forest and fishery yields, which are higher than the global averages, Togo has a biocapacity of 6.6 million global hectares (gha). This is more than its total Ecological Footprint of 5.0 million gha.

Togo's average Ecological Footprint per person is 0.8 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also smaller than the 1.1 gha of biocapacity available per person within Togo. As its population grew from 1.6 million to 6.1 million between 1961 and 2005, biocapacity per person in Togo decreased by 75 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 22.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Togo	6,145,000	5,047	6,648	0.82	1.08
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	2.1	742

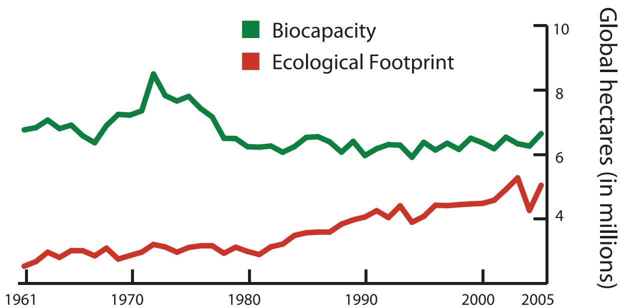
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	–	–	–	–	–

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Togo	Female	Male
Human Development Index Value (0=min. 1=max.)	0.512	–	–
Adult Literacy Rate (percent adults over 18)	53.2	38.5	68.7
Gross Enrollment Ratio (percent eligible students enrolled)	54.8	46	64
Irrigated Cropland (percent of total, 2000)	0.3	–	–
Access to Improved Water (percent of population, 2002)	52	–	–
Domestic Electrification (percent of population, 2000)	17	–	–
Undernourishment (percent of population, 2000)	1	–	–
Life Expectancy (years)	57.8	59.6	56.0

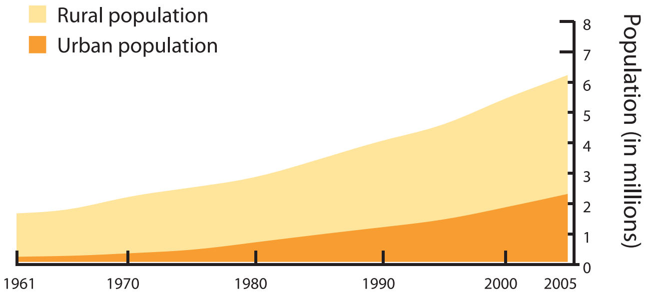
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 22.1. Togo total Ecological Footprint and biocapacity, 1961-2005



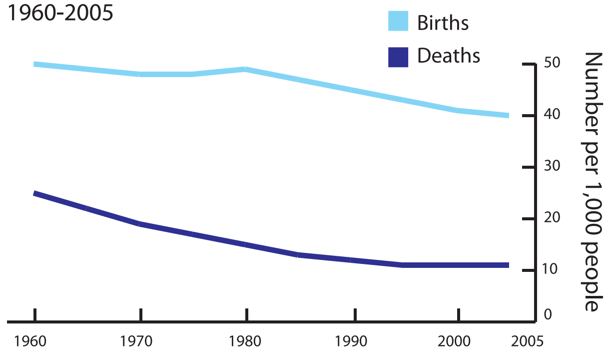
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 22.2. Togo population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 22.3. Togo birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 22.4. Togo Ecological Footprint per person, 1961-2005

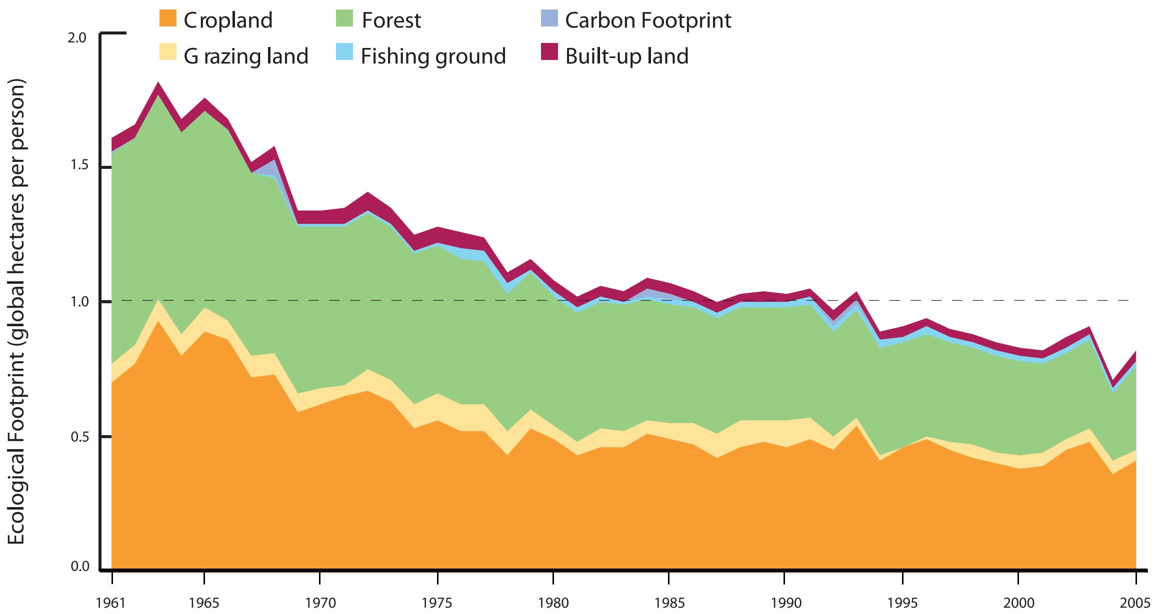


Table 22.2. Togo Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.70	0.07	0.78	0.01	0.00	0.05	1.59
1965	0.89	0.09	0.73	0.00	0.00	0.05	1.76
1970	0.62	0.06	0.60	0.00	0.01	0.05	1.34
1975	0.56	0.10	0.55	0.00	0.01	0.06	1.28
1980	0.49	0.05	0.48	0.00	0.02	0.04	1.08
1985	0.49	0.06	0.44	0.02	0.02	0.04	1.07
1990	0.46	0.10	0.42	0.00	0.02	0.03	1.03
1995	0.46	0.00	0.39	0.00	0.02	0.04	0.91
2000	0.38	0.05	0.35	0.00	0.02	0.03	0.84
2005	0.41	0.04	0.31	0.00	0.02	0.04	0.82

Figure 22.5. Togo biocapacity per person, 1961-2005

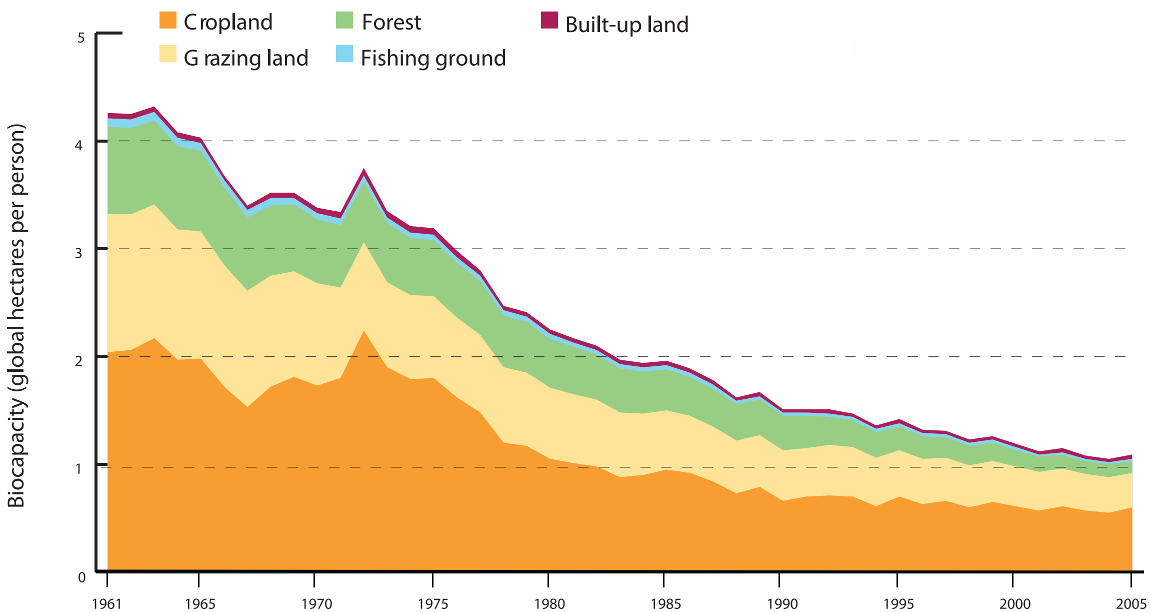


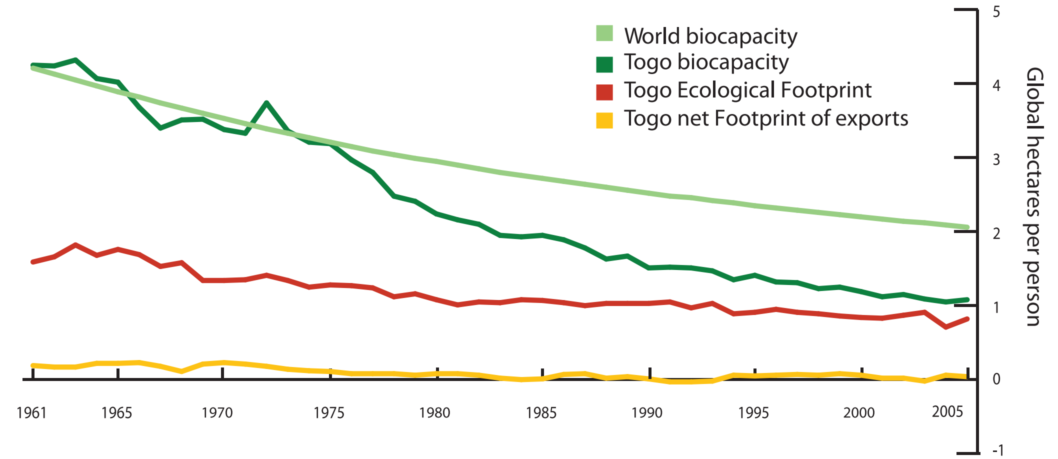
Table 22.3. Togo biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	2.04	1.28	0.81		0.08	0.05	4.25
1965	1.98	1.18	0.75		0.07	0.05	4.02
1970	1.73	0.95	0.59		0.06	0.05	3.38
1975	1.80	0.76	0.52		0.05	0.06	3.19
1980	1.05	0.66	0.45		0.05	0.04	2.24
1985	0.95	0.55	0.38		0.04	0.04	1.95
1990	0.66	0.47	0.32		0.03	0.03	1.51
1995	0.70	0.43	0.22		0.03	0.04	1.41
2000	0.61	0.37	0.15		0.03	0.03	1.19
2005	0.60	0.32	0.11		0.02	0.04	1.08

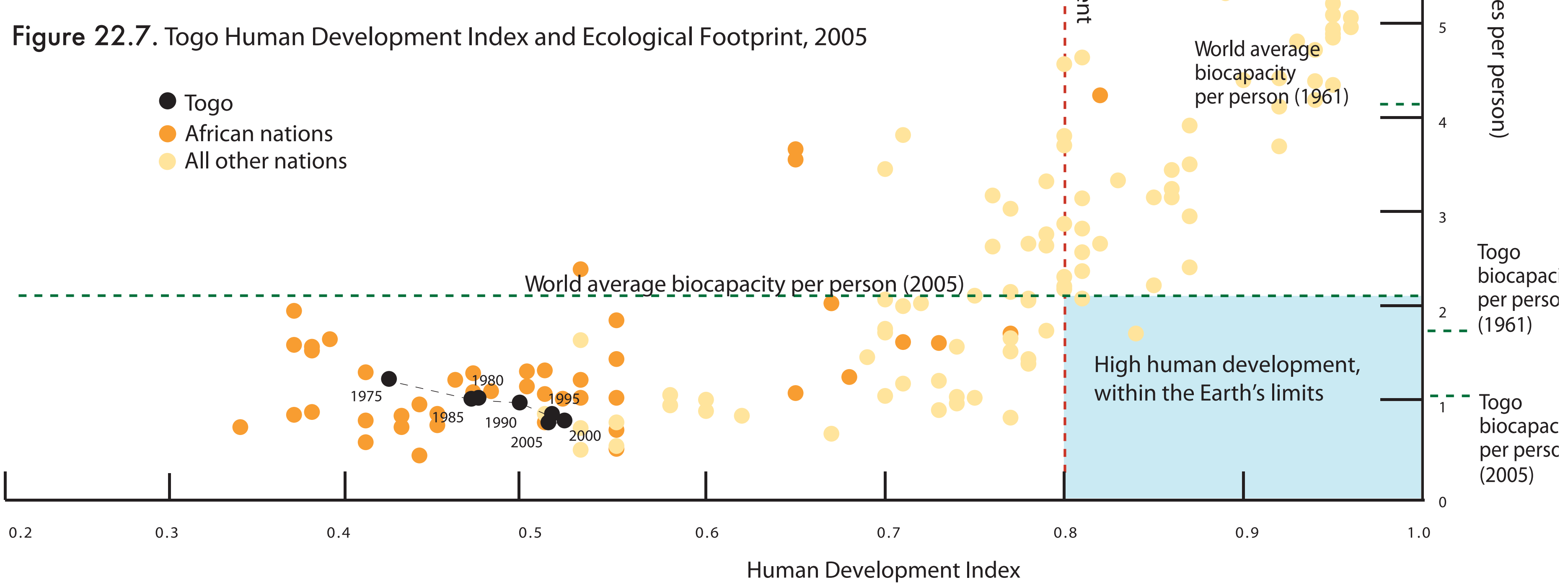
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 22.6. Togo Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 22.7. Togo Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Wood Exploitation as a Contributing Factor to Deforestation in Togo

Papi Kwami Ekuka Wussinu

Young Leaders Network

Department of Environment and Natural Habitat

Lomé, Togo

Forests are valuable, complex ecosystems used by human beings in many ways. As a renewable natural resource, forest utilization can be sustained if the resource is properly managed. Unfortunately, forests in many parts of the world are disappearing as a result of excessive use and mismanagement. Our country, Togo, is no exception.

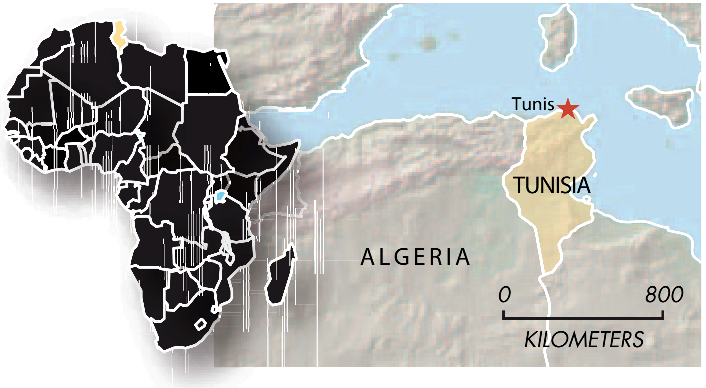
Trees are important for many reasons. They prevent desertification, protect land against erosion, preserve soil fertility, sequester carbon dioxide and produce oxygen. Wood is a critical raw material for industry and a source of energy.

The results of uncontrolled deforestation in Togo are devastating. Between 1990 and 2000, it is estimated that Togo lost an average of 19,900 hectares of forest per year. This 2.9 percent annual deforestation rate almost doubled between 2000 and 2005. In total, between 1990 and 2005, Togo lost 43.7 percent of its forest cover, or approximately 299,000 hectares. This 43.7 percent forest cover loss caused an estimated 16.4 percent decline in forest and woodland habitat between 1990 and 2005, habitat decline being defined as change in forest area plus change in woodland area minus net plantation expansion (Mongabay 2009).

In 1988, the Togolese government suspended exploitation of wood in natural forests in order to allow regeneration (FAO 2009). New trees were also planted to aid reforestation efforts. However, in some places the damage from deforestation was so great that the government's efforts were unsuccessful. In some other cases, reforestation efforts failed due to poor monitoring and management (Amous 1999).

Three factors are responsible for the problems linked to wood exploitation in Togo. Economically, the main interest for logging businesses is sustaining a high yield from wood extraction in any location. Once the harvests go down, companies abandon a forest to seek out another location with high extraction yields. Companies are not forced to replant trees at the same rate they extract them; on average, for every 29 trees felled commercially only one is replanted (Hrabar and Ciparis 1990). The decrease of coffee and cocoa prices on the international market during the 1990s encouraged timber harvesting to make up for lost export revenue.

In Togo, population growth and cultural traditions amplify pressure on forest resources. There are not enough schools that focus on the importance of forest ecosystems for the health of society. Politically, we must balance economic, social and environmental priorities. The difficulty of finding this compromise often leads to political inaction, which in the interim can be devastating to the environment.



Tunisia occupies 16.4 million hectares. Of those, 1.0 million hectares are covered by forest, 4.9 million by cropland and 5.1 million by grazing land, with 0.3 million hectares supporting its built infrastructure. Located along the Mediterranean Sea, Tunisia borders 6.5 million hectares of continental shelf and has 0.8 million hectares of inland water.

Adjusting for its cropland, grazing land, forest and fishery yields, which are lower than corresponding global averages, Tunisia has a biocapacity of 11.6 million global hectares (gha). This is less than its total Ecological Footprint of 17.8 million gha. Tunisia first began operating with an ecological deficit in 1979.

Tunisia's average Ecological Footprint per person is 1.8 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still larger than the 1.2 gha of biocapacity available per person within Tunisia. As its population grew from 4.3 million to 10.1 million between 1961 and 2005, biocapacity per person in Tunisia decreased by 43 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 23.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Tunisia	10,102,000	17,808	11,613	1.76	1.15
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	29.0	6,382

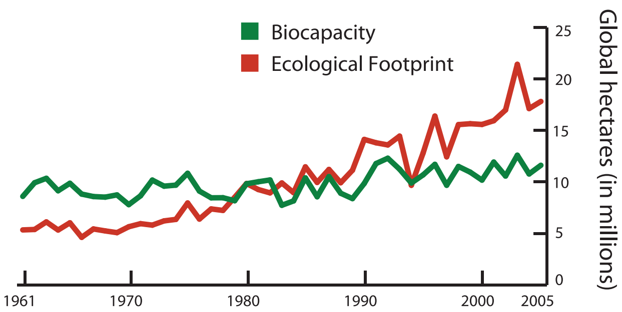
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	47.3	21.7	14.8	10.3	6.0

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Tunisia	Female	Male
Human Development Index Value (0=min. 1=max.)	0.766	–	–
Adult Literacy Rate (percent adults over 18)	74.3	65.3	83.4
Gross Enrollment Ratio (percent eligible students enrolled)	76.1	79	74
Irrigated Cropland (percent of total, 2000)	8.0	–	–
Access to Improved Water (percent of population, 2002)	93	–	–
Domestic Electrification (percent of population, 2000)	99	–	–
Undernourishment (percent of population, 2000)	–	–	–
Life Expectancy (years)	73.5	75.6	71.5

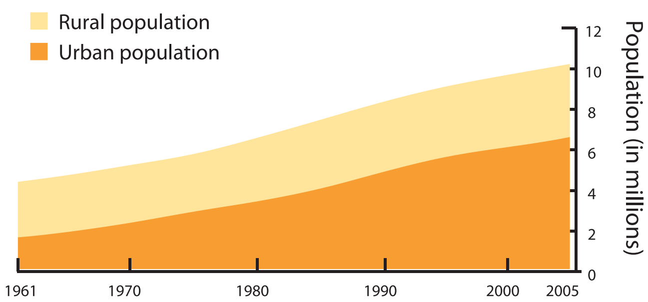
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 23.1. Tunisia total Ecological Footprint and biocapacity,1961-2005



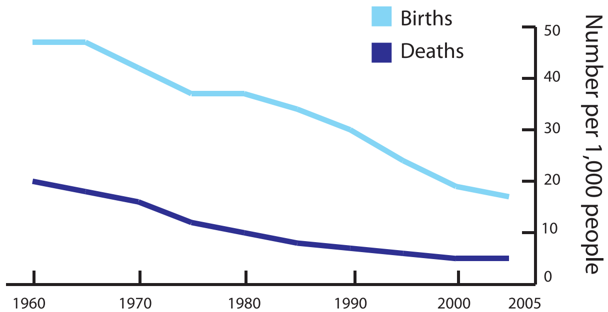
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 23.2. Tunisia population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 23.3. Tunisia birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 23.4. Tunisia Ecological Footprint per person, 1961-2005

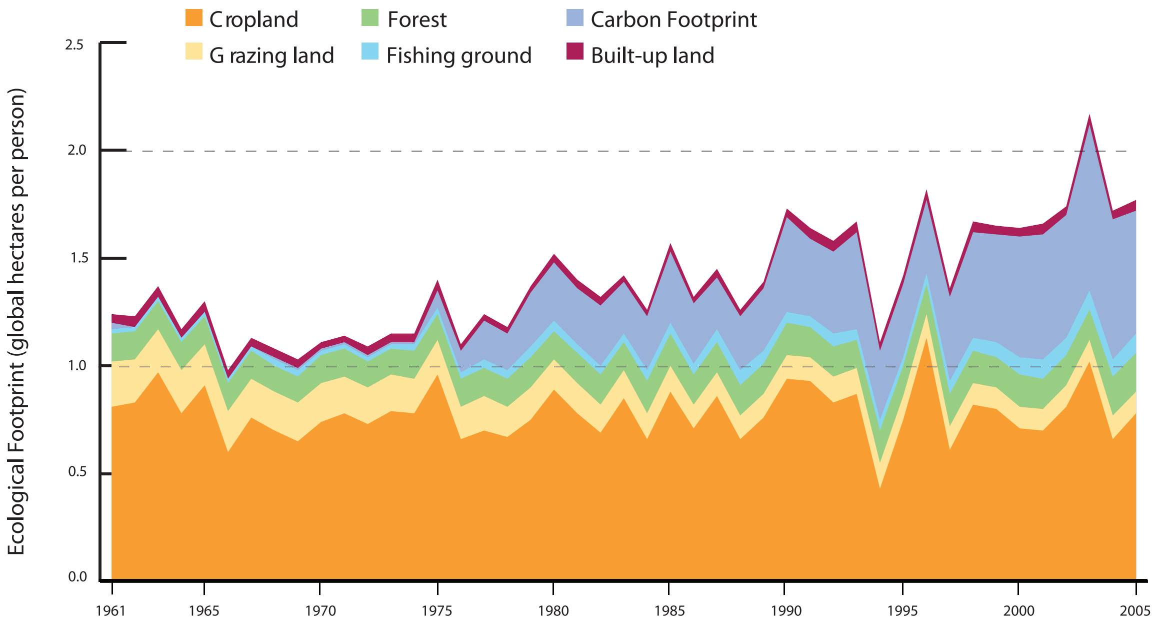


Table 23.2 Tunisia Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.81	0.21	0.13	0.03	0.02	0.04	1.24
1965	0.91	0.19	0.13	0.00	0.02	0.05	1.30
1970	0.74	0.18	0.13	0.01	0.02	0.03	1.10
1975	0.96	0.16	0.12	0.08	0.03	0.05	1.40
1980	0.89	0.14	0.13	0.27	0.05	0.04	1.53
1985	0.88	0.12	0.15	0.33	0.05	0.04	1.56
1990	0.94	0.11	0.15	0.44	0.05	0.04	1.72
1995	0.75	0.11	0.14	0.34	0.04	0.04	1.43
2000	0.71	0.10	0.15	0.56	0.08	0.04	1.63
2005	0.78	0.10	0.18	0.57	0.09	0.05	1.76

Figure 23.5. Tunisia biocapacity per person, 1961-2005

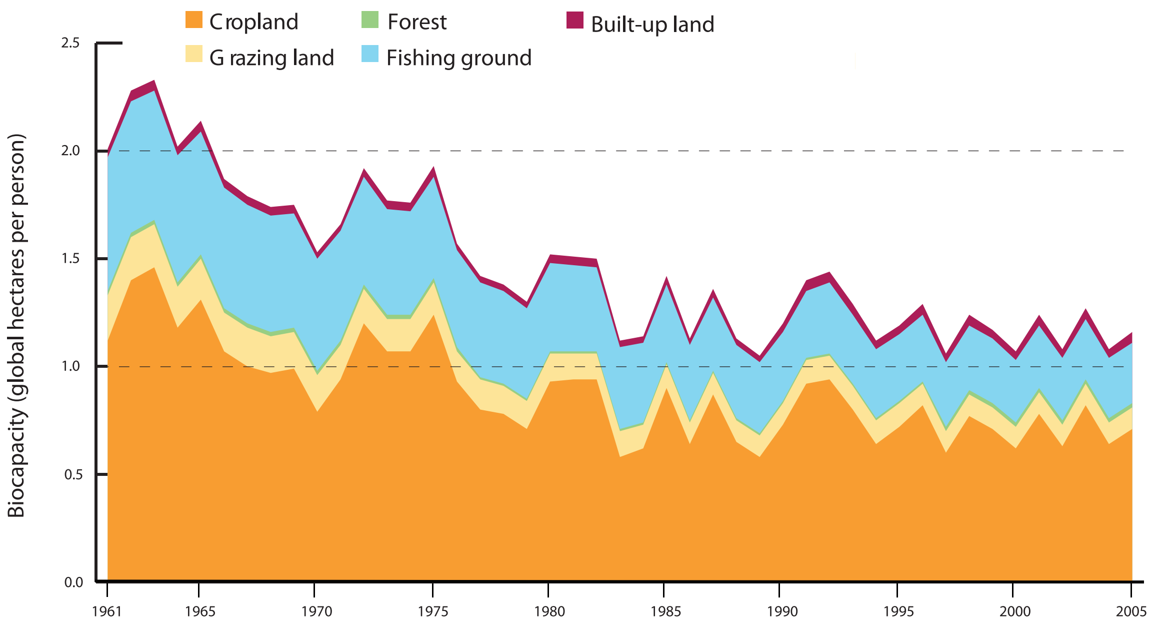


Table 23.3 Tunisia biocapacity, 1961-2005

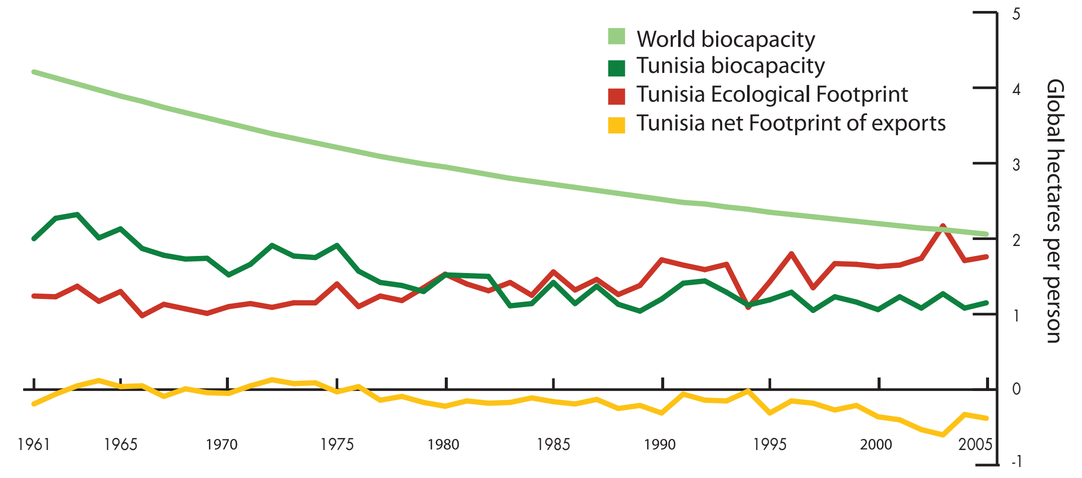
(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.12	0.21	0.02		0.62	0.04	2.00
1965	1.31	0.19	0.02		0.57	0.05	2.13
1970	0.79	0.17	0.02		0.52	0.03	1.52
1975	1.24	0.15	0.02		0.47	0.05	1.91
1980	0.93	0.13	0.01		0.41	0.04	1.52
1985	0.90	0.11	0.01		0.36	0.04	1.42
1990	0.73	0.10	0.01		0.32	0.04	1.20
1995	0.72	0.11	0.01		0.31	0.04	1.19
2000	0.62	0.10	0.02		0.29	0.04	1.06
2005	0.71	0.10	0.02		0.28	0.05	1.15

Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

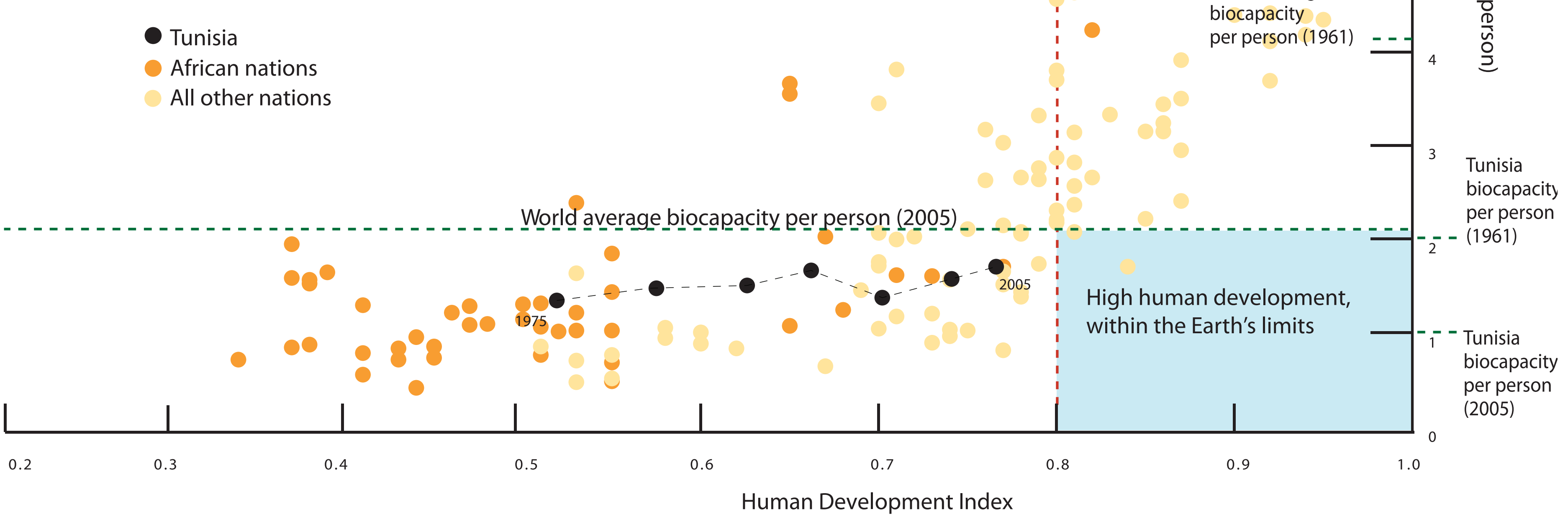
Figure 23.6. Tunisia Ecological Footprint and biocapacity per person, 1961-2005

Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



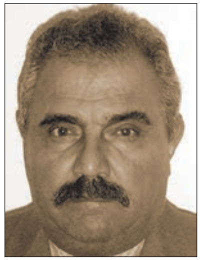
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 23.7. Tunisia Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Soil and Water Conservation in Tunisia: Assessment and Perspectives



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Situated at the frontiers of the Sahara, broadly open to the Mediterranean Sea, Tunisia remains nevertheless arid or semi-arid over three quarters of its territory. Agricultural lands are limited, and only a third of the total area of Tunisia is arable. The resources of accessible water are therefore allocated almost entirely to irrigation, with the remainder going to potable water and industry. The amount of water available annually per capita is extremely low, even in comparison to other water-poor countries.

Erosion is a scourge that affects more than 60 percent of the usable agricultural land of Tunisia, the result of which is that 10,000 hectares cease to be arable each year. Studies of the accumulation of silt at existing dams have made apparent the magnitude of annual erosion by flowing waters. Annual rates of accumulation of silt at the 26 largest dams are on the order of 30 million cubic meters, corresponding to a reduction of 6,000 hectares of irrigated surface per year.

Thanks to traditions rooted in time, as well as to increasing interest in agricultural development and more specifically to the conservation of water and soil in arid and semi-arid zones, Tunisia has been able to carry out a number of programmes and strategies devoted to the protection and mobilization of water and soil. Recent programmes have focused on efforts to integrate the management of river catchments, in cooperation with farmers in the area. The objectives targeted by these programmes are the management of erosion of agricultural land, the improvement of soil productivity, the protection of hydraulic infrastructure against premature silting, and the conveyance of surface waters on a small scale. The rural environment has thus benefited from the creation of a number of integrated agricultural development projects since 1990, costing on the order of one billion Tunisian Dinars in total.

During the period 1990-2008, concrete achievements in rural development and water and soil management have included:

- The protection of over 950,000 hectares of riverbanks and streambeds from erosion;
- A study of the history of the Jeffara, the southern region of Tunisia, which revealed that erosion of agricultural lands in Jessours between 1979 and 1999 had progressed by 180 percent in the mountains and 356 percent in the foothills;
- The construction of 800 small dams in mountain lakes, for the creation of an irrigated area of 7,500 hectares, enabling more than 4,000 farmers to remain on their farms, in zones of prevailing rural exodus;
- The creation of more than 3,700 projects for the recharging of overdrawn aquifers. The rates of augmentation of these resources are on the order of 20 percent.

Efforts deployed by the Tunisian government for the protection and sustainable use of the resources, water and soil, have had significant impact for the protection of lands from erosion by water, as have the enhancement and protection of the large dams. Nevertheless, the area threatened by water erosion remains extensive, and the accumulation of silt at the large dams in Tunisia remains significant.

Future success must be accomplished through the systematic protection of hydraulic infrastructure and through cooperative engagements between national and local programmes on the integrated management of surface and groundwater systems.

Uganda occupies 24.1 million hectares. Of those, 3.6 million hectares are covered by forest, 7.6 million by cropland and 6.3 million by grazing land, with 0.8 million hectares supporting its built infrastructure. Landlocked, but in the heart of the African Great Lakes region, Uganda has 4.4 million hectares of inland water.

Adjusting for its cropland, forest and fishery yields, which are lower than corresponding global averages, and its grazing land yields, which are higher than the global average, Uganda has a biocapacity of 27.2 million global hectares (gha). This is less than its total Ecological Footprint of 39.6 million gha. Uganda has operated with an ecological deficit since at least 1961.

Uganda's average Ecological Footprint per person is 1.4 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still considerably larger than the 0.9 gha of biocapacity available per person within Uganda. As its population grew from 6.8 million to 28.8 million between 1961 and 2005, biocapacity per person in Uganda decreased by 64 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 24.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Uganda	28,816,000	39,621	27,162	1.37	0.94
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	9.2	848

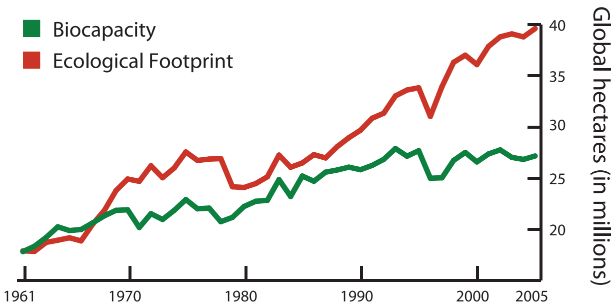
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	52.5	19.1	13.2	9.4	5.7

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Uganda	Female	Male
Human Development Index Value (0=min. 1=max.)	0.505	–	–
Adult Literacy Rate (percent adults over 18)	66.8	57.7	76.8
Gross Enrollment Ratio (percent eligible students enrolled)	62.5	62	63
Irrigated Cropland (percent of total, 2000)	0.1	–	–
Access to Improved Water (percent of population, 2002)	60	–	–
Domestic Electrification (percent of population, 2000)	9	–	–
Undernourishment (percent of population, 2000)	5	–	–
Life Expectancy (years)	49.7	50.2	49.1

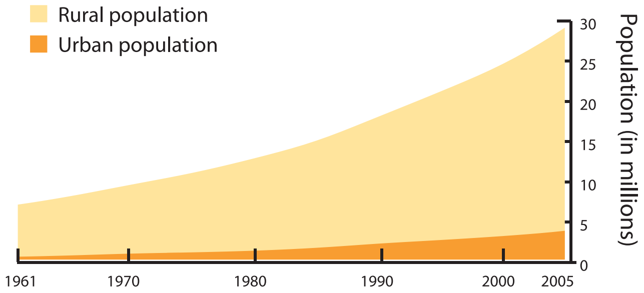
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 24.1. Uganda total Ecological Footprint and biocapacity, 1961-2005



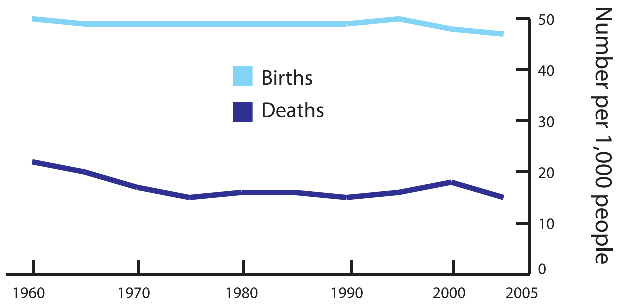
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 24.2. Uganda population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 24.3. Uganda birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 24.4. Uganda Ecological Footprint per person, 1961-2005

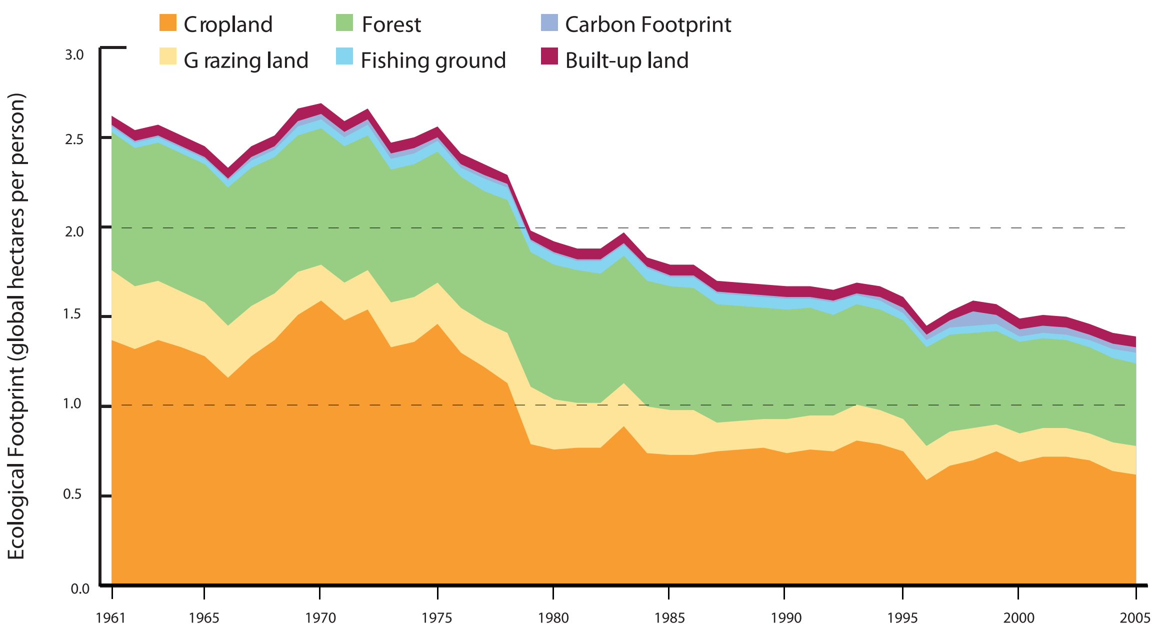


Table 24.2. Uganda Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.37	0.39	0.77	0.01	0.03	0.05	2.62
1965	1.28	0.30	0.77	0.01	0.03	0.06	2.45
1970	1.59	0.20	0.76	0.03	0.05	0.06	2.69
1975	1.46	0.23	0.73	0.02	0.06	0.06	2.56
1980	0.76	0.28	0.75	0.01	0.06	0.06	1.92
1985	0.73	0.25	0.69	0.01	0.05	0.06	1.79
1990	0.74	0.19	0.61	0.01	0.06	0.06	1.67
1995	0.75	0.18	0.55	0.03	0.04	0.06	1.62
2000	0.69	0.16	0.51	0.04	0.03	0.06	1.49
2005	0.62	0.16	0.46	0.03	0.06	0.06	1.38

Figure 24.5. Uganda biocapacity per person, 1961-2005

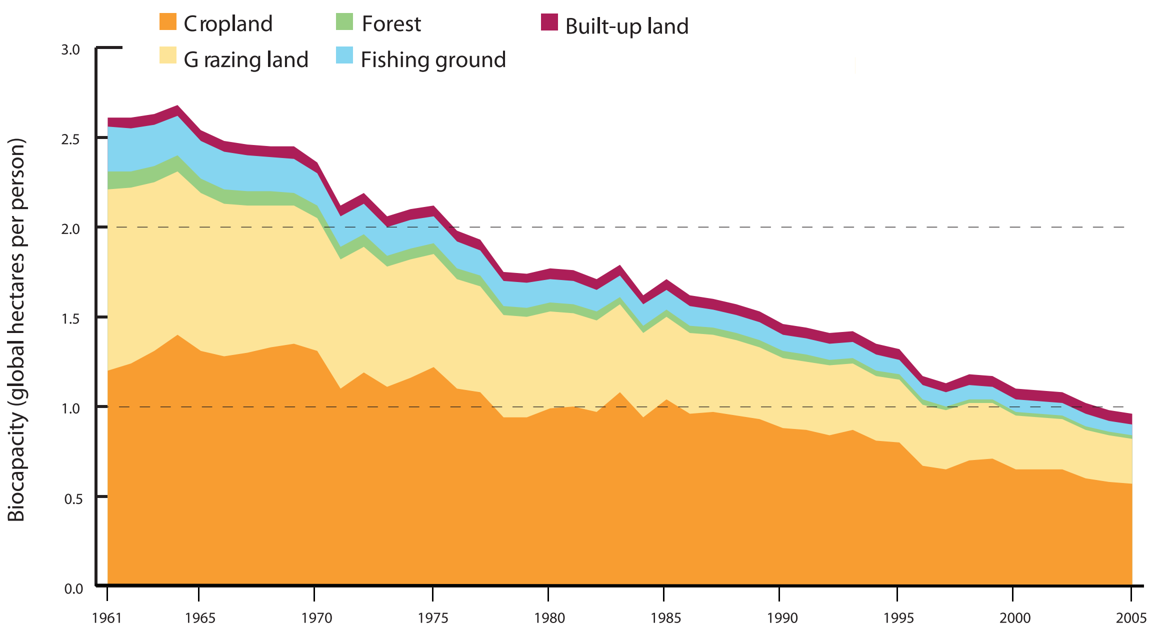


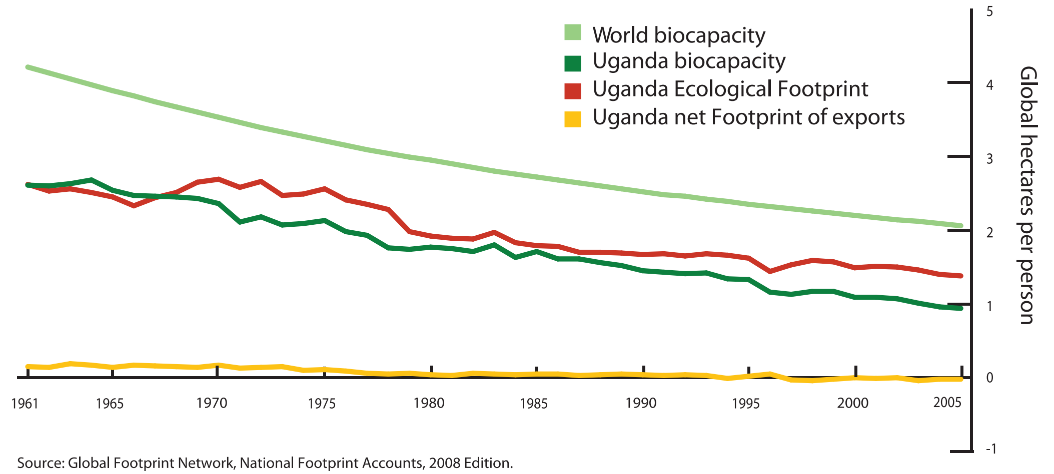
Table 24.3. Uganda biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.20	1.01	0.10		0.25	0.05	2.61
1965	1.31	0.88	0.08		0.21	0.06	2.54
1970	1.31	0.74	0.07		0.18	0.06	2.36
1975	1.22	0.63	0.06		0.15	0.06	2.13
1980	0.99	0.54	0.05		0.13	0.06	1.77
1985	1.04	0.46	0.04		0.11	0.06	1.71
1990	0.88	0.39	0.04		0.09	0.06	1.45
1995	0.80	0.35	0.03		0.08	0.06	1.33
2000	0.65	0.30	0.02		0.07	0.06	1.09
2005	0.57	0.25	0.02		0.06	0.06	0.94

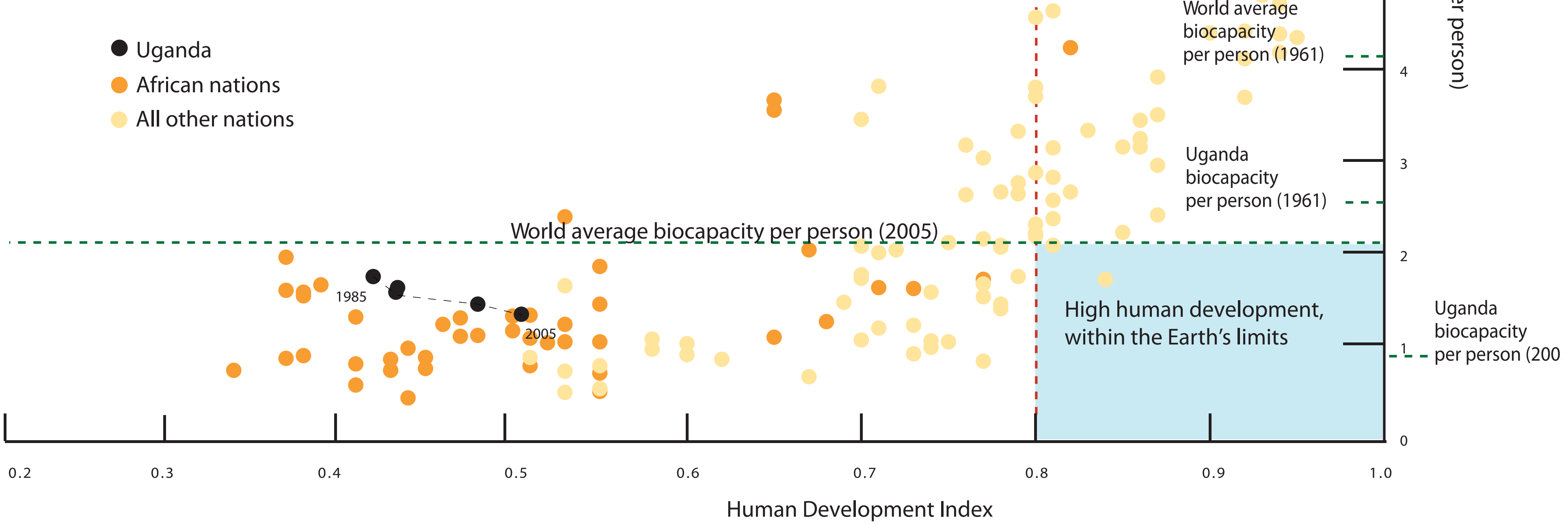
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 24.6. Uganda Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 24.7. Uganda Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Freshwater Resources in Uganda: the Lifeblood of Communities

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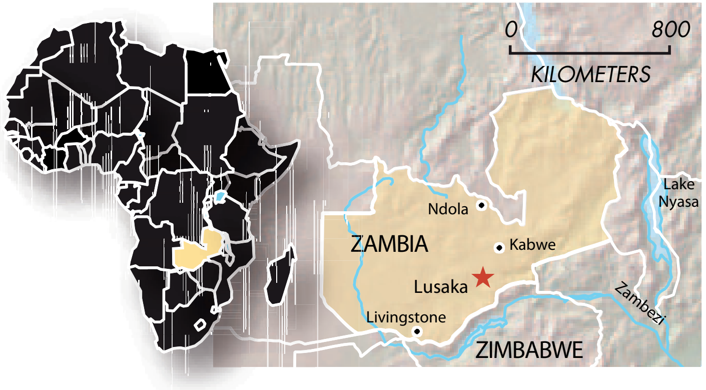
Freshwater is an abundant resource throughout most of the Ugandan countryside, with the exception of the northern arid regions. Despite this abundance, water quality has been severely compromised due to human activity. In urban areas, access to clean water is a luxury. The majority of Ugandans are poor and have no access to potable water, or if they do, they must pay for it. For many of these families, the cost of clean water exceeds the family's expendable income. In the Kampala area, years of wetland degradation around Lake Victoria has had a negative impact on the region's water quality. Wetlands, locally referred to as swamps, serve as a barrier between the urban land and Africa's largest lake. Wetland ecosystems play a critical role in water sanitation by regulating floods, removing pollutants from water and cleaning the water through phytofiltration. This process of using plants to remove contaminants from water occurs naturally in wetlands.

The impact of wetland degradation around Kampala is costly. According to the Minister of Water and Environment, the price of water treatment in Kampala has tripled between 2006 and 2008 (Tenywa 2009) due to the rampant degradation of the environment. Excess spending on the city's water treatment has constrained the expansion of piped water within the municipality. The communities that remain without access to piped and treated water are too often the poor communities living in peri-urban neighbourhoods. These households are forced to use untreated water, which leads to a high prevalence of waterborne diseases such as cholera and dysentery. This results in sicknesses and sometimes loss of life. In 2006, 1,099 cases of cholera were recorded in Kampala, and of infected cases there was a 3 percent death rate (IFRC 2008). Recently released, the Water and Sanitation Sector Performance Report 2008 indicates that the capacity of the National Water and Sewerage Corporation (NW&SC) to fully treat water was being held back due to lack of modern technology (Ngatya 2009).

In rural areas, environmental degradation as a result of deforestation, wetland degradation, pesticide use, poor grazing practices and pollution from road construction have negatively impacted the quality and quantity of water available in Uganda's streams, rivers, and lakes (Chapman et al. 2003; Kasangaki 2008). Today, most of Uganda's urban and rural rivers have highly turbid waters with very low transparency in comparison to the rivers located inside Uganda's nature reserves (Kasangaki et al. 2006, 2008). This was found to be the case within the Bwindi, Kibale and Rwenzori National Parks in Western Uganda. Rural communities generally do not have access to treated water, and their only sources of water are open rivers or unprotected wells. This impacts the health and productivity of Uganda's rural population with frequent cases of waterborne disease.

Water shortages and a decline in water quality also impact the country's economy. Over the years, there has been a noted decline in fish production, and fishing communities are reporting reduced catch. In 2005-2006, severe droughts coincided with a decline in water levels on Lake Victoria, which adversely affected hydroelectric power generation on Owen Falls Dam (Winterbottom and Eilu 2006). Many industries were forced to reduce production, households suffered from power outages for several hours a day and some employees lost their jobs.

Sustainable utilization of the freshwater resource in Uganda is being hampered by limited knowledge of freshwater quantity and quality as a natural resource. There are many government departments in place, including the National Environmental Management Authority, Department of Water Resources, and Wetlands Department, but their efforts are often not coordinated in water resource management. There is an urgent need for government departments to work together to conserve Uganda's freshwater resource. We must synergize our efforts and engage in collaborative research to better understand this critical issue. We must also monitor the availability and use of freshwater sources so that we can make informed management decisions at both local and national government levels.



Zambia occupies 75.3 million hectares. Of those, 42.5 million hectares are covered by forest, 5.3 million by cropland and 23.6 million by grazing land, with 0.5 million hectares supporting its built infrastructure. A landlocked country, Zambia has 0.9 million hectares of inland water.

Adjusting for its cropland, forest and fishery yields, which are lower than corresponding global averages, and its grazing land yield, which is higher than the global average, Zambia has a biocapacity of 33.4 million global hectares (gha). This is more than its total Ecological Footprint of 9.0 million gha.

Zambia's average Ecological Footprint per person is 0.8 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. It is also considerably smaller than the 2.9 gha of biocapacity available per person within Zambia. As its population grew from 3.2 million to 11.7 million between 1961 and 2005, biocapacity per person in Zambia decreased by 71 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 25.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint	Biocapacity	Ecological Footprint	Biocapacity
		Total global hectares (thousands)		Global hectares per person	
Zambia	11,668,000	8,987	33,409	0.77	2.86
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	7.3	1,171

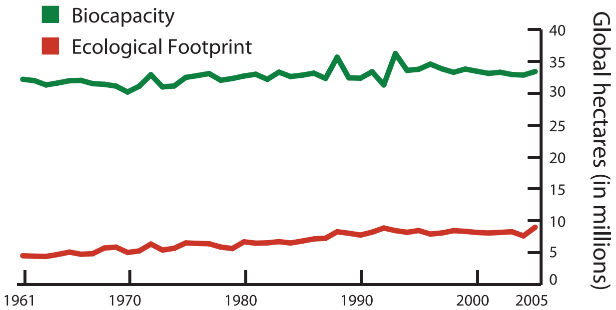
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	55.1	20.8	12.6	7.9	3.6

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Zambia	Female	Male
Human Development Index Value (0=min. 1=max.)	0.434	–	–
Adult Literacy Rate (percent adults over 18)	68.0	59.8	76.3
Gross Enrollment Ratio (percent eligible students enrolled)	63.3	61	66
Irrigated Cropland (percent of total, 2000)	2.9	–	–
Access to Improved Water (percent of population, 2002)	58	–	–
Domestic Electrification (percent of population, 2000)	19	–	–
Undernourishment (percent of population, 2000)	5	–	–
Life Expectancy (years)	40.5	40.6	40.3

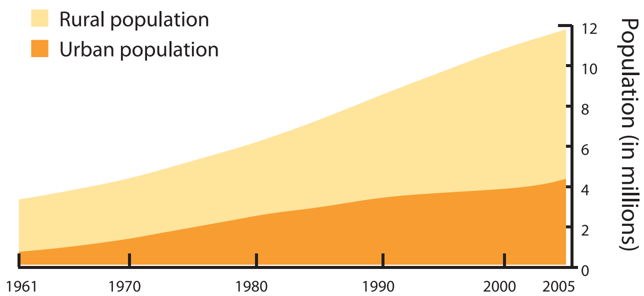
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 25.1. Zambia total Ecological Footprint and biocapacity,1961-2005



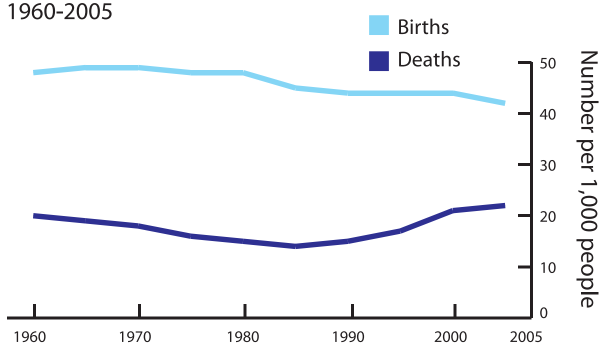
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 25.2. Zambia population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 25.3. Zambia birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 25.4. Zambia Ecological Footprint per person, 1961-2005

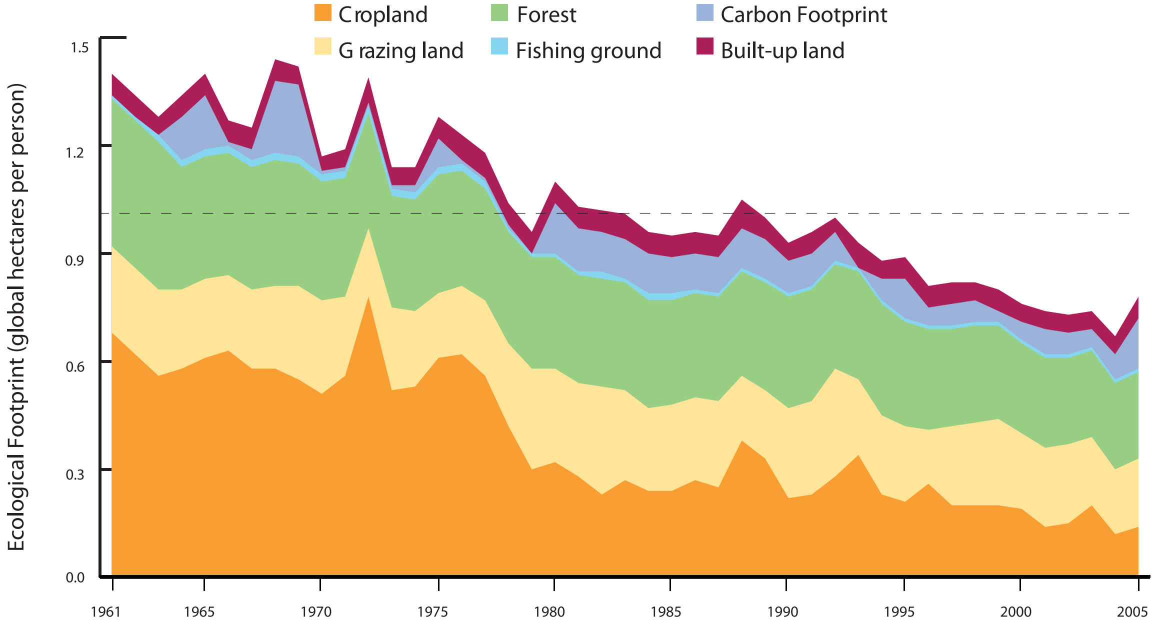


Table 25.2. Zambia Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.68	0.24	0.41	0.00	0.01	0.06	1.40
1965	0.61	0.22	0.34	0.15	0.02	0.06	1.39
1970	0.51	0.26	0.33	0.01	0.02	0.04	1.17
1975	0.61	0.18	0.33	0.08	0.02	0.06	1.27
1980	0.32	0.26	0.31	0.14	0.01	0.06	1.11
1985	0.24	0.24	0.29	0.10	0.02	0.06	0.96
1990	0.22	0.25	0.31	0.09	0.01	0.05	0.93
1995	0.21	0.21	0.29	0.11	0.01	0.06	0.89
2000	0.19	0.21	0.25	0.05	0.01	0.05	0.76
2005	0.14	0.19	0.24	0.14	0.01	0.06	0.77

Figure 25.5. Zambia biocapacity per person, 1961-2005

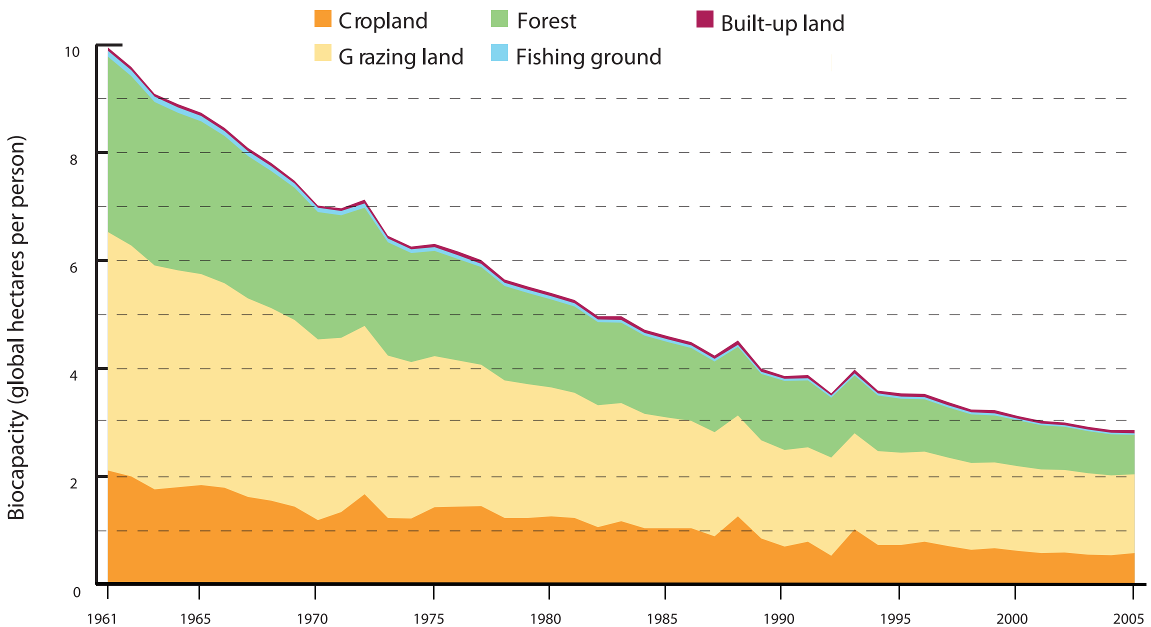


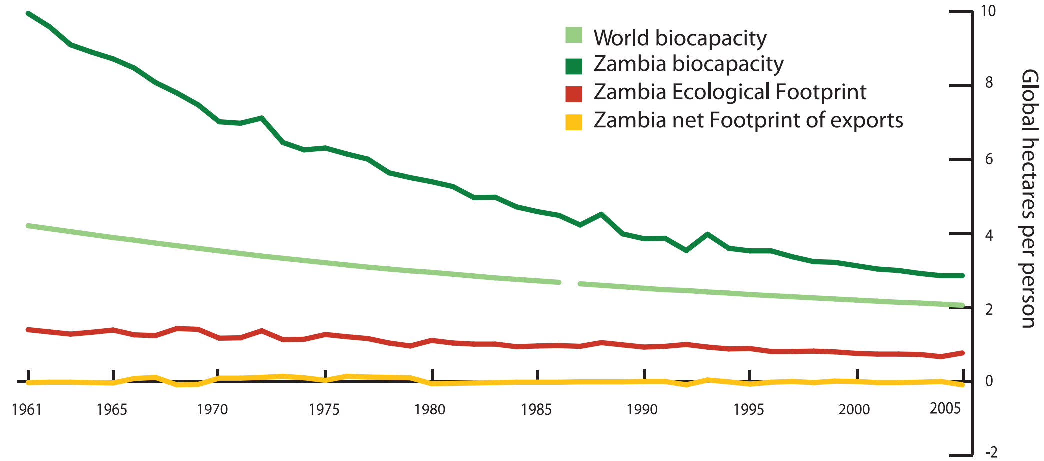
Table 25.3. Zambia biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	2.11	4.42	3.25		0.11	0.06	9.95
1965	1.84	3.91	2.83		0.10	0.06	8.72
1970	1.19	3.35	2.36		0.08	0.04	7.02
1975	1.43	2.80	1.95		0.07	0.06	6.31
1980	1.26	2.39	1.63		0.06	0.06	5.40
1985	1.04	2.05	1.40		0.05	0.06	4.59
1990	0.70	1.79	1.28		0.04	0.05	3.86
1995	0.73	1.71	1.00		0.04	0.06	3.53
2000	0.62	1.57	0.85		0.03	0.05	3.13
2005	0.58	1.46	0.73		0.03	0.06	2.86

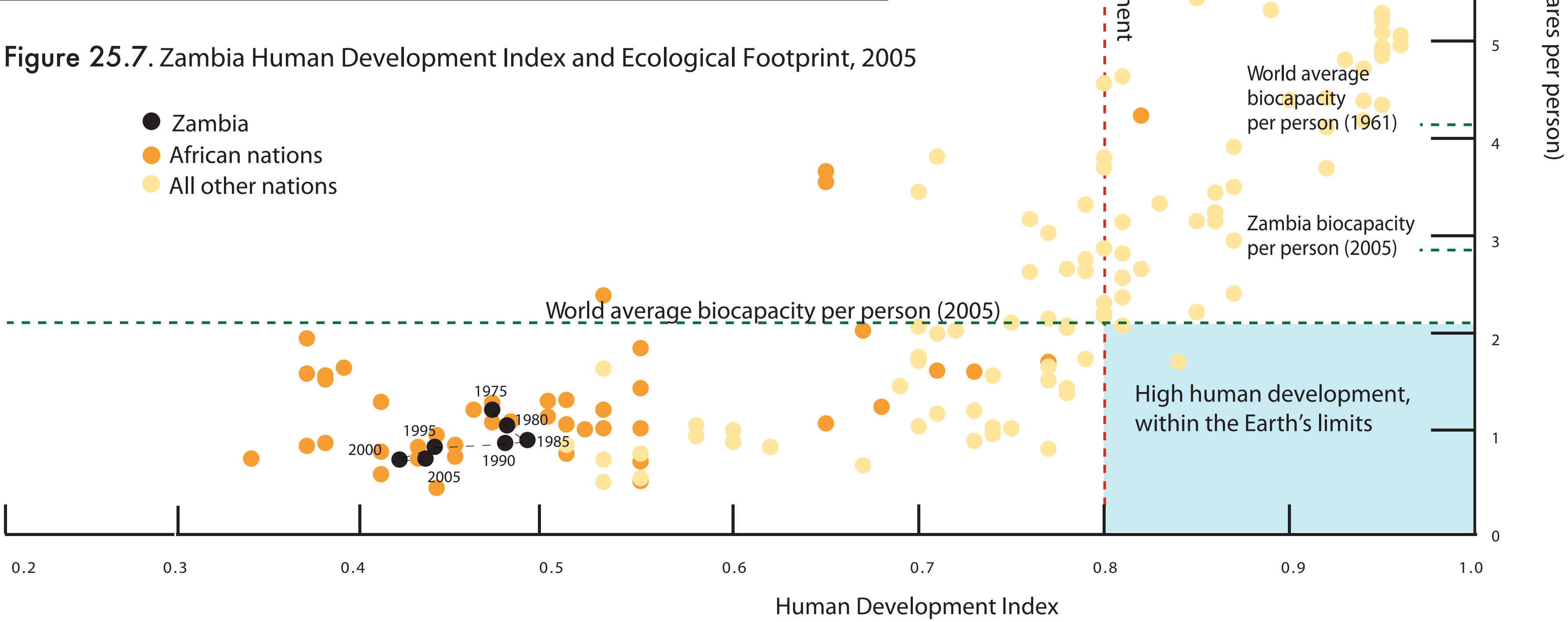
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 25.6. Zambia Ecological Footprint and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 25.7. Zambia Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Zambia: Economic Struggles amid Natural Riches

Zambia has a wealth of natural resources that have long been of interest to both conservationists and commercial enterprise alike. The country is located in the centre of Africa's two major river basins, the Zambezi and the Congo. It ranks fifth in the world in terms of copper production, and the northwest regions hold large deposits of cobalt, lead and zinc. Zambia is a leading producer of agricultural products including maize, cotton, tobacco, sorghum, rice, peanuts, sunflower seeds, sugarcane, beans and cassava. Zambia's rich soils yield more grain per hectare than is average for sub-Saharan Africa (WHO 2006).

Despite this natural wealth, a 2005 UN estimate shows that 63.8 percent of Zambia's population lives on less than one USD per day. In 2007 the country was ranked 124th out of 135 countries on the United Nations Poverty Index (UNDP 2008). This is partly due to migration from rural to urban areas. The majority of urban migrants are young men and women who go in search of employment – which in most cases they do not find – and who end up in overpopulated squatter settlements

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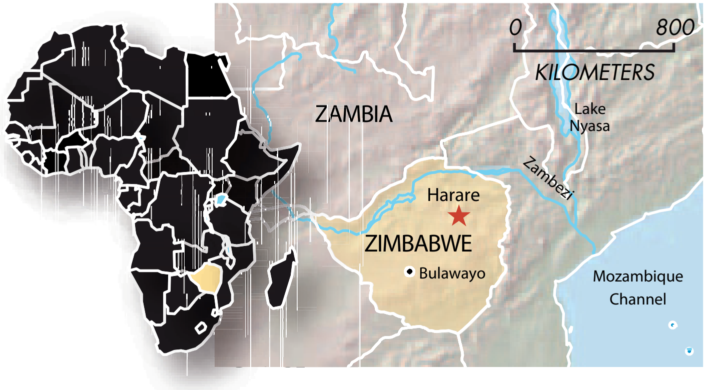
without adequate sanitation, water or energy services.

The Ecological Footprint of Zambians at 0.8 global hectares per capita is small compared to the world average of 2.7 global hectares per person (Global Footprint Network 2008a). This can be partially attributed to a low household income and a high annual population growth rate of 1.9 percent. Adding to the strain on Zambian families is the high prevalence of HIV/AIDS; in 2005, 15.8 percent of the total adult population in Zambia was infected with HIV (WHO 2006). This number is estimated to be even higher in urban areas and in the Copperbelt region which has high migrant labour populations. This epidemic is responsible for the majority of Zambia's 1.2 million orphans (UNICEF). For females, stark poverty or orphan status exposes them to abuse. The majority of these girls and women end up in prostitution.

Orphanhood has multiple negative effects for children in terms of education. It is often linked to poor academic performance, and is a major cause of the increased drop-out rate we see in schools. For girls, the situation is compounded by negative cultural practices whereby parents and guardians prefer to send boys to school at the expense of girls when faced with economic difficulty. Girls end up being married off in their teenage years or staying home to carry out domestic chores (Noorani 2005). The United Nations Millennium Development Goals of achieving universal primary education and eliminating gender disparity in primary and secondary education by 2015 would be particularly beneficial to Zambian society. It would result in increased participation of women in the public sphere, and would likely lead to a multitude of health benefits including reduced HIV incidence (Rihani 2006).



Zimbabwe occupies 39.1 million hectares. Of those, 17.5 million hectares are covered by forest, 3.4 million by cropland and 12.3 million by grazing land, with 0.5 million hectares supporting its built infrastructure. Landlocked between five countries, Zimbabwe has 0.4 million hectares of inland water.

Adjusting for its cropland, grazing land, forest and fishery yields, which are lower than corresponding global averages, Zimbabwe has a biocapacity of 9.7 million global hectares (gha). This is less than its total Ecological Footprint of 14.5 million gha.

Zimbabwe's average Ecological Footprint per person is 1.1 gha, smaller than both the world average Footprint and the amount of biocapacity available per person on the planet. However, it is still larger than the 0.8 gha of biocapacity available per person within Zimbabwe. As its population grew from 3.9 million to 13 million between 1961 and 2005, biocapacity per person in Zimbabwe decreased by 75 percent.

Sources: Food and Agriculture Organization of the United Nations (FAO). Statistical databases, 2008a,b,c; Global Agro- Ecological Zones, 2008; Global Land Cover, 2000.

Table 26.1. Ecological Footprint, Economy and Human Development (2005)

	Population	Ecological Footprint (Total global hectares (thousands))	Biocapacity (Total global hectares (thousands))	Ecological Footprint (Global hectares per person)	Biocapacity (Global hectares per person)
Zimbabwe	13,010,000	14,545	9,721	1.12	0.75
World	6,475,634,000	17,443,626	13,360,955	2.7	2.1

Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition; Food and Agriculture Organization (FAO). PopSTAT, 2005.

	Total (billions)	Per person (PPP)
GDP (USD)	3.4	2,038

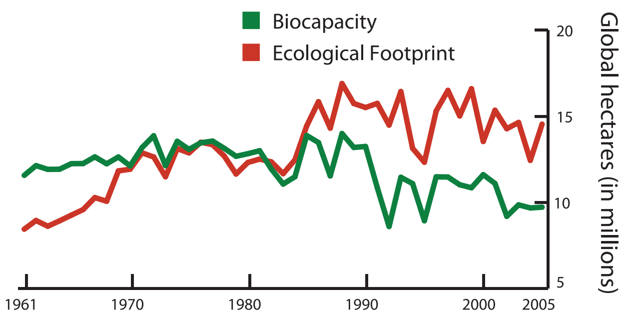
ECONOMIC QUINTILE (2001)	Highest	Fourth	Third	Second	Lowest
Percentage share of income	55.7	19.3	12.2	8.1	4.6

Sources: UNDP, 2005. Human Development Report, 2007; The World Bank; World Development Indicators database, 2007; United Nations Educational, Scientific and Cultural Organization. Beyond 20/20 Web Data Server, 2006.

	Zimbabwe	Female	Male
Human Development Index Value (0=min. 1=max.)	0.513	–	–
Adult Literacy Rate (percent adults over 18)	89.4	86.2	92.7
Gross Enrollment Ratio (percent eligible students enrolled)	52.4	51	54
Irrigated Cropland (percent of total, 2000)	5.2	–	–
Access to Improved Water (percent of population, 2002)	81	–	–
Domestic Electrification (percent of population, 2000)	34	–	–
Undernourishment (percent of population, 2000)	6	–	–
Life Expectancy (years)	40.9	40.2	41.4

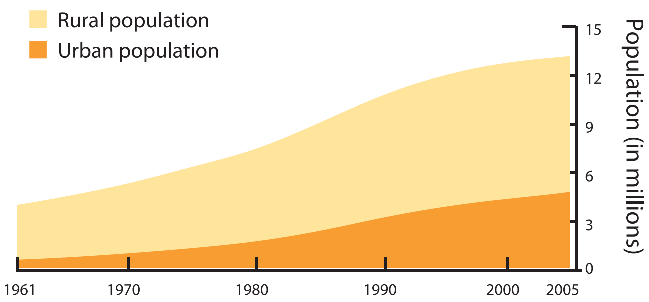
Sources: UNDP, 2005.Human Development Report, 2007; The World Bank. World Development Indicators database, 2007; International Energy Agency (IEA). 2002. World Energy Outlook.

Figure 26.1. Zimbabwe total Ecological Footprint and biocapacity, 1961-2005



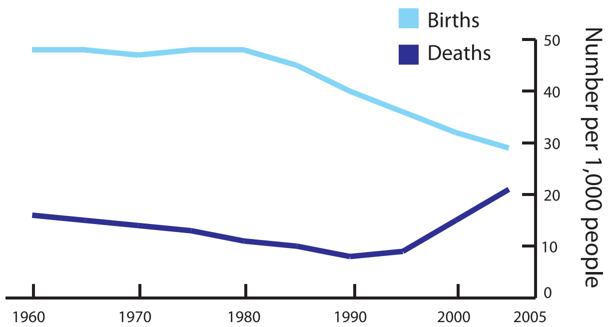
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 26.2. Zimbabwe population, 1961-2005



Sources: Food and Agriculture Organization (FAO). PopSTAT, 2008; The World Bank. Health, Nutrition and Population (HNP) Statistics, 2005.

Figure 26.3. Zimbabwe birth and death rate (annual est.), 1960-2005



Source: United Nations Population Division. World Population Prospects, 2007.

Figure 26.4. Zimbabwe Ecological Footprint per person, 1961-2005

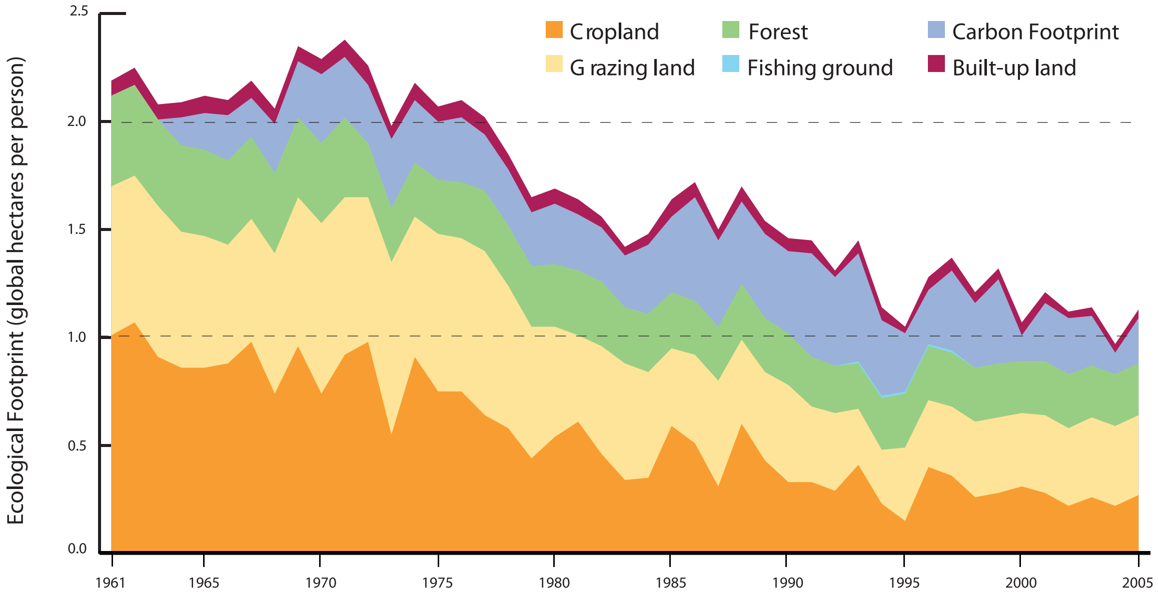


Figure 26.5. Zimbabwe biocapacity per person, 1961-2005

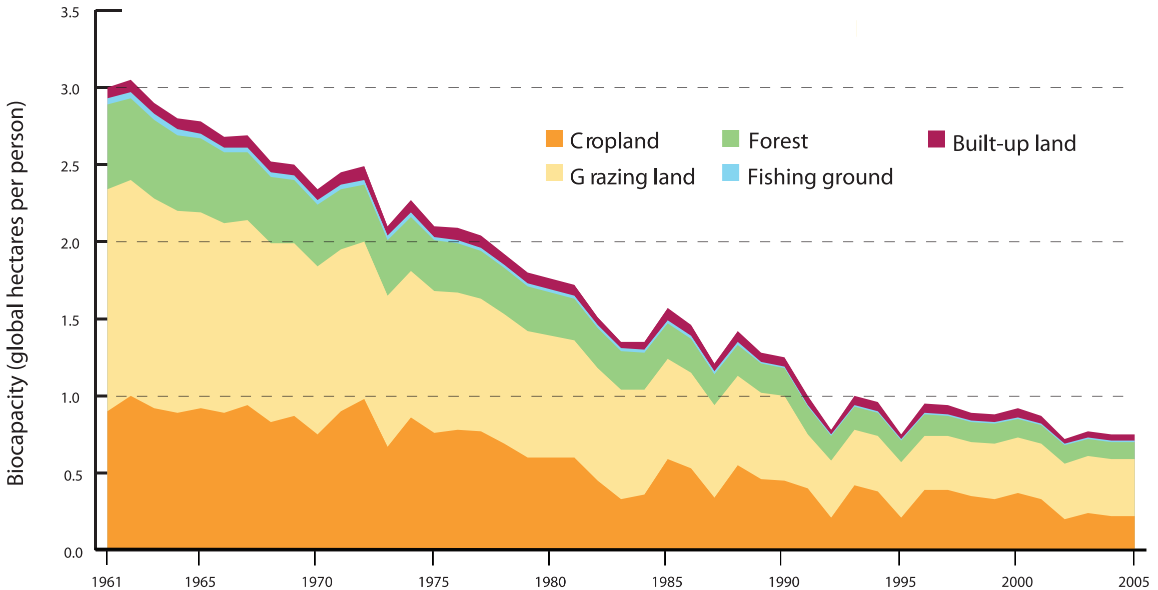


Table 26.2. Zimbabwe Ecological Footprint, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	1.01	0.69	0.42	0.00	0.00	0.07	2.19
1965	0.86	0.61	0.40	0.17	0.00	0.08	2.10
1970	0.74	0.79	0.37	0.32	0.00	0.07	2.29
1975	0.75	0.73	0.25	0.27	0.00	0.07	2.07
1980	0.54	0.51	0.29	0.28	0.00	0.07	1.69
1985	0.59	0.36	0.26	0.35	0.00	0.08	1.63
1990	0.33	0.45	0.24	0.38	0.00	0.06	1.47
1995	0.15	0.34	0.25	0.27	0.01	0.03	1.04
2000	0.31	0.34	0.24	0.12	0.00	0.06	1.08
2005	0.27	0.37	0.24	0.21	0.00	0.04	1.12

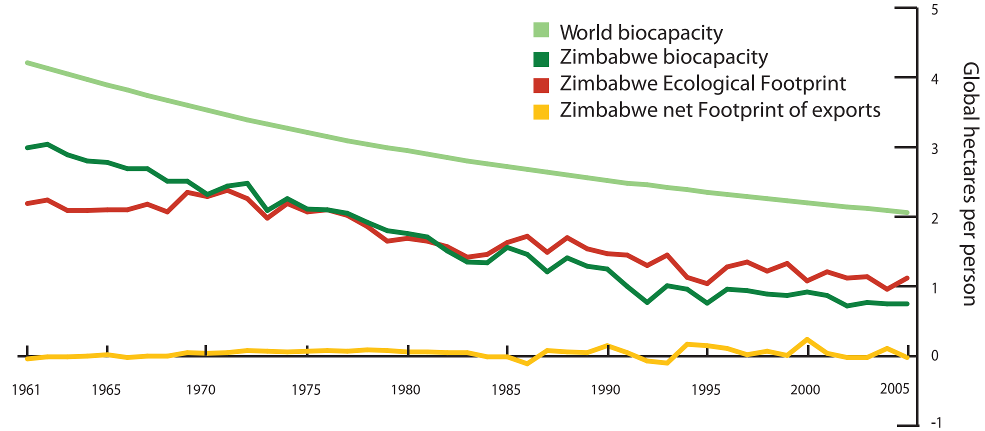
Table 26.3. Zimbabwe biocapacity, 1961-2005

(global hectares per person)

Year	Cropland	Grazing land	Forest	Carbon Footprint	Fishing ground	Built-up land	Total
1961	0.90	1.44		0.55	0.04	0.07	2.99
1965	0.92	1.27		0.48	0.03	0.08	2.78
1970	0.75	1.09		0.40	0.03	0.07	2.32
1975	0.76	0.92		0.33	0.02	0.07	2.11
1980	0.60	0.79		0.28	0.02	0.07	1.76
1985	0.59	0.65		0.23	0.02	0.08	1.56
1990	0.45	0.55		0.18	0.01	0.06	1.25
1995	0.21	0.36		0.14	0.01	0.03	0.76
2000	0.37	0.36		0.12	0.01	0.06	0.92
2005	0.22	0.37		0.11	0.01	0.04	0.75

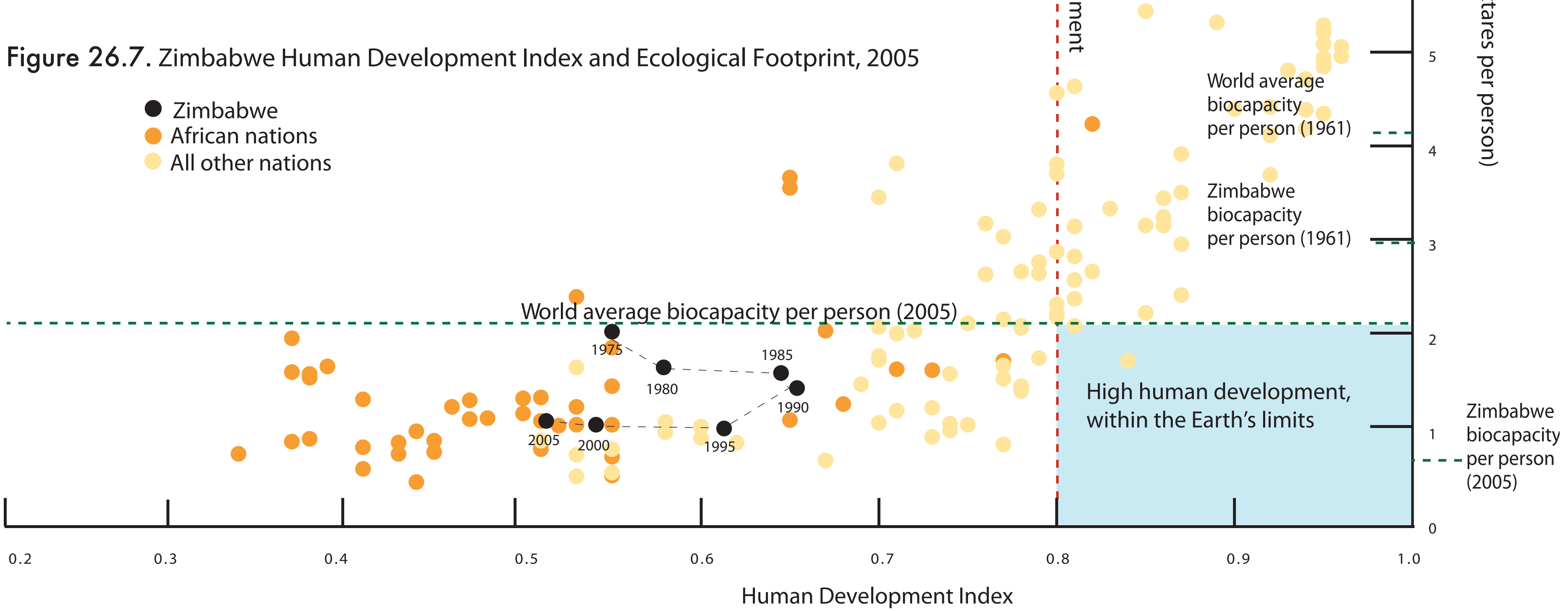
Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 26.6. Zimbabwe Ecological Footprint, net exports and biocapacity per person, 1961-2005
Net Footprint of exports = the Footprint of exports minus the Footprint of imports.



Source: Global Footprint Network, National Footprint Accounts, 2008 Edition.

Figure 26.7. Zimbabwe Human Development Index and Ecological Footprint, 2005



Sources: Global Footprint Network, National Footprint Accounts, 2008 Edition ; UNDP, 2005 Human Development Report, 2007.

Water Scarcity in Zimbabwe

Zimbabwe is a landlocked country located in southern Africa. Climatic conditions are largely sub-tropical with one rainy season that runs from approximately mid-November to early April. Zimbabwe is divided into five agro-ecological regions based mainly on rainfall patterns, soil quality and vegetation type. Rainfall quantity ranges from greater than 1,000 millimeters to less than 450 millimeters within Zimbabwe's agro-ecological regions. Only about 37 percent of the country receives adequate rainfall for agriculture, which is the cornerstone of the country's economy (FAO, 2007). Because Zimbabwe lies in a semi-arid zone, precipitation is frequently insufficient to maintain the cultivation needed to support its population and in many cases, evaporation exceeds precipitation.

In addition to these biological factors that limit water supply, land and water-use legislation enacted during Zimbabwe's colonial rule has contributed to the country's current water scarcity. Colonial legislation included the relocation of blacks to low rainfall regions (Zimbabwe's present day 'communal areas') and the allocation of fertile high rainfall land for privately owned 'white' farms (News Africa 2000; Okele 2000; Nicol et al. 2006). The communal areas were densely populated leading to serious land degradation from over-grazing and soil mining.

Though the present-day Zimbabwean government has passed legislation to redress these land and water inequities, their efforts have been met with opposition from human rights activists and hindered by the lack of money needed to compensate farmers (Okele 2000).

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Both Zimbabwe's economy and the livelihood of rural populations depend on agriculture. Agriculture contributes 11-14 percent of Zimbabwe's GDP, provides employment to 70 percent of the population, and provides 60 percent of all raw material inputs for the manufacturing industry (Zimbabwe Ministry of Foreign Affairs). Agriculture in Zimbabwe's communal areas is predominantly rain-fed, so precipitation levels play a critical role in agriculture production, economic performance and domestic food security.

Communal farmers in Zimbabwe are the most impacted by water scarcity. Eighty percent of communal farmers live in the driest regions of the country, and where rainfall is erratic farmers must rely on surface water from shallow rivers for irrigation (Nicol et al. 2006). These farmers primarily grow food crops such as maize, wheat, beans, tomatoes and vegetables (Nicol et al. 2006). For example, communal farmers who live around Beitbridge, Chiredzi and Gwanda in the Limpopo basin (regions IV and V) experience a short and intense rainy season. Rain-fed agriculture, livestock production, and remittances are the main sources of livelihood in these areas (ALM 2007). The regions' chronic water scarcity results in crop failure. The people in these regions largely depend on international food aid, while malnutrition and starvation are prevalent (Amaral and Sommerhalder 2004).

Water scarcity also impacts the welfare of livestock in Zimbabwe. Communal livestock in Zimbabwe depend on natural pasture for grazing; however, water scarcity has led to a browning of pastures with frequent dusty patches. Loss of livestock has been recorded because of lack of pasture and water (Reliefweb 2003).

Lastly, water scarcity in Zimbabwe has resulted in water-rights conflicts between farmers. For example, on the Nyanyadzi River in Chimanimani district, farmers downstream of the river frequently clash with upstream farmers over access to water (Farm Radio International 2000; Bolding and Nyagwande 1998). In the communal areas around Plumtree (area southwest of Zimbabwe), there have been conflicts with communities in the neighboring country, Botswana, over water for livestock and domestic purposes (Banda 2008).

Water is a critical resource that supports Zimbabwe's economy and enables the well being of Zimbabwe's population. Conflict and scarcity over water in Zimbabwe hinders the livelihood of people, while putting the country in economic jeopardy.

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 wastes they generate, given prevailing technology and resource management. This area is expressed in *global hectares*—hectares with world-average biological productivity. Footprint calculations use yield factors to take into account national differences in biological productivity (e.g., tonnes of wheat per UK hectare versus per Argentina hectare) and equivalence factors to take into account differences in World-average- productivity across land types (e.g., world average forest versus world-average cropland).

Ecological Footprint and biocapacity results for nations are calculated annually by Global Footprint Network. Footprint and biocapacity assessment for any given country and year relies on over 5,400 raw data points. This leaves much potential for missing or erroneous source data to contribute to implausible Footprint estimates or abrupt year-to year changes in a country's Footprint that do not reflect actual changes in consumption. In some cases the solution to this problem has been to systematically estimate missing data points based on data for surrounding years, as described below.

The primary procedure used to test the 2008 edition templates and identify potential template errors was to compare results from the 2008 and the 2006 editions of the Accounts for the same data years. In the initial screening, country rankings for biocapacity and Footprint were compared across the two editions. The second step was to compare time series for the six land-use types as well as for total biocapacity, Footprint of consumption and Footprint of production. This comparison was done for all 150 countries over the 1961-2005 time period, including the 48 African countries for which the United Nations collects data. In addition, abrupt inter-annual shifts in any of the Footprint or biocapacity components were identified. When large discrepancies were identified, tests were conducted to determine whether they originated from template errors, the underlying data set, or the methodological improvements in the later edition of the Accounts. These tests also helped identify methodological issues that will need to be explored through further research. The continuing methodological development of these National Footprint Accounts is overseen by a review committee. A detailed methodology paper and copies of sample calculation sheets can be obtained at: *http://www.footprintnetwork.org/atlas*.

What does a per-capita national Ecological Footprint actually mean?

A per-capita national Ecological Footprint measures the amount of bioproductive space that is required to support the average individual of a given country, at world average productivity in that year. For example, a five-global hectare per person Ecological Footprint means in the specified year an average individual in that country used all of the services produced by five hectares of world-average productive land in that year. This land does not need to be within the borders of the individual's country as biocapacity in other countries is used to provide imported goods and services.

How do you measure biocapacity and how do you determine how much is available?

Biocapacity available per person globally is calculated by taking the total amount of bioproductive land worldwide and dividing it by world population. It is a globally aggregated measure of the amount of land and water area available per person to produce crops (cropland), livestock (grazing land), timber products (forest) and fish (fishing grounds), and to support infrastructure (built-up land). A nation's biocapacity may include more global hectares than the nation has actual hectares if its land and sea area are highly productive. Biocapacity assessments reflect technological advancements that increase yields, as the conversion of hectares into global hectares takes into account productivity.

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

The Ecological Footprint is a measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices. It is comprised of six land use types: cropland, grazing land, fishing grounds, forest land, carbon uptake land, and built-up land. One resource that is not included in the Ecological Footprint is water; although the emissions of carbon dioxide from pumping and treating the water is part of the carbon Footprint. Water is a natural resource cycled through the biosphere, and related to many of the biosphere's critical goods and services. However, it is not itself a product made by biologically productive area, or a waste absorbed by the biosphere. It is suggested to include a water footprint analysis in addition to the Ecological Footprint analysis to obtain more insight on the resource use for a given population or activity.

How is international trade taken into account?

The national Ecological 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 consumption Footprints can be distorted, since the resources used and waste generated in making products for export are not fully documented. This can bias 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 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 quantity of goods and services an average person consumes, and the resource and waste intensity of these goods and services. If a population grows or declines (or if any of the other factors change), this will be reflected in future Footprint accounts. Footprint accounts 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 does the Ecological Footprint account for the use of fossil fuels?

Fossil fuels such as coal, oil, and natural gas are extracted from the Earth's crust rather than produced by current ecosystems. When burning this fuel, carbon dioxide is produced. In order to avoid carbon dioxide accumulation in the atmosphere – the goal of the UN Framework Convention on Climate Change – two options exist: a) human technological sequestration, such as deep well injection; or b) natural sequestration. The Footprint for fossil fuels corresponds to the biocapacity required to absorb and store the CO_2 emitted but not sequestered by humans, less the amount absorbed by the oceans. Currently, negligible amounts of CO_2 are sequestered through human technological processes.

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 2005 global hectare can absorb the CO_2 released by burning approximately 1525 litres of gasoline per year. The fossil fuel 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 the Footprint per tonne of CO_2 sequestration increases. Eventually, forests may even become net emitters of carbon.

Does the Ecological Footprint take into account other species?

The Ecological Footprint describes human demand on nature. Currently, there are 2.1 global hectares of biocapacity available per person on planet Earth, less if some of the biologically productive area is made available for use by wild species. The value society places on biodiversity will determine how much biocapacity should be reserved for the use of non-domesticated species. Efforts to increase biocapacity, such as through monocropping and the application of pesticides, may at the same time increase pressure on biodiversity; this means a larger biocapacity buffer may be required to achieve the same conservation results.

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 capita Footprint to consumption categories (e.g., food, shelter, mobility, goods and services). Regional or municipal average per capita 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 activities, see *www.footprintstandards.org.*

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 demand on ecosystems exceed the ability of ecosystems to meet this demand? 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 technological advances or other factors bring human demand within the capacity of the biosphere to meet this demand, Footprint accounts will show this as the elimination of global overshoot.

What is an equivalence factor?

The equivalence factor translates the productivity of a specific land use type (e.g. world average cropland) into units of world average biologically productive area: global hectares (gha). In 2005, for example, cropland had an equivalence factor of 2.64 gha/hectare, indicating that world-average cropland productivity was more than double the global average productivity of all bioproductive area. In comparison, grazing land had an equivalence factor of 0.50 gha/hectare, or half the average productivity of all bioproductive area. Equivalence factors are calculated using suitability indexes from the Global Agro-Ecological Zones model (FAO and IIASA) combined with data on actual land use (FAO ResourceSTAT).

How is the net Footprint of exports calculated?

The net Footprint of exports of a country is calculated as the Footprint of the country's exports minus the Footprint of its imports. A positive net Footprint of exports means that the Ecological Footprint of the goods and services a country exports is greater than the Footprint of the goods and services it imports. Tracking trade flows has become increasingly important as globalization has increased. In 1961, the Footprint of all goods traded between countries was equal to 8 percent of humanity's total Ecological Footprint. By 2005, this had risen to more than 40 percent. More information about Ecological Footprint methodology, data sources, assumptions, and definitions can be found in The Ecological Footprint Atlas 2008 and Calculation Methodology for the National Footprint Accounts, available at *http://www.footprintnetwork.org/methodology.*

Is the research question answered by the Ecological Footprint important?

Ecological Footprint accounts address, through empirical analysis and with ever increasing accuracy, one particular research question: How much of the planet's regenerative capacity, its ability to create resources from waste, is demanded to support human activities?

More precisely, the Ecological Footprint measures the amount of biologically productive land and water area required to produce all the resources an individual, population, or activity consumes, and to absorb the waste they generate, given prevailing technology and resource management practices. This area can then be compared with biocapacity, the amount of productive area that is available to generate these resources and to absorb the waste. If a land or water area provides more than one of these services it is only counted once, so as not to exaggerate the amount of productive area actually available.

In a time of increasing ecological constraints, this is perhaps the single most important research question for the 21st century, one that humanity cannot afford to ignore. Failing to live within the budget that nature provides will eventually lead to liquidation of resources and accumulation of waste, and eventually to ecological bankruptcy and collapse. Accurate, open and transparent accounts of humanity's demand on the biosphere and the capacity of the biosphere to meet this demand can help us avoid these tragic consequences by learning to live within the planet's ecological budget.

Are Ecological Footprint accounts scientifically reliable?

Global Footprint Network is an international NGO with a network of over 100 government, business and scientific organizations that use the Ecological Footprint in a wide variety of ways. It annually calculates the National Footprint Accounts for over 150 nations. Apart from overall results, the accounts also provide conversion factors that translate quantities of resources used or wastes emitted into the bioproductive land or sea area required to generate these resources or absorb these wastes. These conversion factors serve as the reference data for almost all Ecological Footprint applications worldwide, all scales. Results from the Nation Footprint Accounts can also be aggregated to provide results for humanity as a whole.

As the steward of the Accounts, Global Footprint Network constantly strives to improve their scientific basis, and to improve the accuracy and transparency of the calculation methodology. The most current description of the national calculation methodology is documented in three reports issued in 2008: an Atlas that includes global and national Ecological Footprint and biocapacity data, a method paper, and a detailed guidebook to the calculations in the National Footprint Accounts. All three of these reports can be downloaded from *http://footprintnetwork.org/atlas*. In addition to these and many other scientific publications, a popular introduction to the Ecological Footprint is available in the *2008 Living Planet Report*, which can be found at: *http://www.footprintnetwork.org/download.php?id=505*

The National Footprint Accounts are continuously improved and evolve in response to new scientific information, and updated editions are released on an annual basis. Several processes at Global Footprint Network and externally help ensure that the calculations are up-to-date and transparent for users.

First, internal and community reviews of the methodology are conducted through the activities of the National Accounts Committee. Comprised of representatives from Global Footprint Network government, business, academia, and NGO partner organizations, the Committee is responsible for suggesting methodological changes to the National Footprint Accounts. External parties are encouraged to submit recommendations for changes directly to Global Footprint Network for consideration by the Committee, and all changes to the calculation methodology are open for public comment before implementation, in accordance with the Committee's charter.

Second, while some criticisms raised in the literature have been based on misconceptions about Ecological Footprint methodology or the research question it is designed to address, many criticisms are valid, and are being addressed through an ongoing research agenda. Responses to many of these criticisms can be found on the Global Footprint Network website: *www.footprintnetwork.org.*

Working with national governments to collaboratively review the underlying data in their National Footprint Accounts for accuracy and completeness is a third way Global Footprint Network helps ensure that Footprint and biocapacity results for a country are valid and reliable. This process also increases the reliability and robustness of the Footprint methodology for all nations. The verified national results are then often put to use by the government for a wide variety of purposes.

How are applications of the Ecological Footprint being standardized?

In addition to its National Accounts Committee, Global Footprint Network has a complementary committee which oversees standards development for Footprint accounting at the subnational level—e.g., for regions, cities, products and organizations (*www.footprintstandards.org*). These standards are designed to ensure that the Footprint is applied and reported in a consistent and appropriate manner regardless of type of application or scale, and over time.

The Standards Committee drafts protocols and proposes standards which are then circulated for feedback. Pilot testing of protocols and standards helps refine them and confirms their applicability to real-world Footprint projects. In order to guarantee both transparency and the best possible standards, standards development follows the ISEAL guidelines, with opportunities for both partner and public comment during the development process. The first standards were published in 2006. Ecological Footprint Standards 2006 addresses the use of source data, derivation of conversion factors, establishment of study boundaries and communication of findings. It focuses on applications that analyze the Footprint of sub-national populations.

Development of the next edition of Ecological Footprint standards is currently underway. This work will expand the standards to more specifically address Footprint analysis of organizations, products, processes and services. Global Footprint Network partners agree to comply with the most recent Ecological Footprint Standards in their applications of the Footprint.

Protocols and standards are reviewed on a regular basis, and revised as necessary. The goal is to establish continuous improvement in the quality and consistency with which Ecological Footprint applications are conducted and findings communicated.

Completed government reviews of the Ecological Footprint methodology

Independent reviews of the Footprint by national governments and internal agencies are a fourth process that helps ensure the scientific robustness of the National Footprint Accounts. Global Footprint Network encourages any nation to seek a research collaboration with the Network to test and improve the accounts for the nation. The first of these was completed by the government of Switzerland. Four Swiss government agencies led the effort and the Swiss Statistical Offices published the review in 2006. The report (*http://www.bfs.admin.ch/bfs/portal/en/index/themen/21/03/blank/blank/01.html*)exists in English, French, German and Italian. They also published a more technical background report found at *http://www.bfs.admin.ch/bfs/portal/en/index/themen/21/03/blank/blank/01.parsys.0001.downloadList.00011.DownloadFile.tmp/ecologicalfootprinttechnicalreport.pdf* (available only in English). Switzerland features the Ecological Footprint among its sustainability indicators (MONET) since 2009.

The European Commission's DG Environment recently concluded its review of the Ecological Footprint with a 350-page report which is highly supportive of the measure and confirms Global Footprint Network's research agenda. The report can be downloaded at: *http://ec.europa.eu/environment/natres/studies.htm.*

Recently, the Service de l'Observation et des Statistiques (SOeS) of the French Ministry of Sustainable Development produced the study Une expertise de l'empreinte ecologique (May 2009, No 4), which examined the transparency and reproducibility of the National Footprint Accounts. The report documents that their research team was able to reproduce Ecological Footprint trends within 1-3 percent of the values published by Global Footprint Network. SOeS' initial report is available at *http://www.ifen.fr/uploads/media/etudes_documentsN4.pdf or see http://www.ifen.fr/publications/nos-publications/etudes-documents/2009/une-expertise-de-l-empreinte-ecologique-version-provisoire.html.*

Other reviews of the Ecological Footprint have been conducted by Eurostat, the statistical agency of the European Union (*http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-AU-06-001/EN/KS-AU-06-001-EN.PDF*), Germany (*http://www.umweltdaten.de/publikationen/fpdf-l/3489.pdf), Ireland (http://erc.epa.ie/safer/iso19115/displayISO19115.jsp?isoID=56#files*), and Belgium (*www.wwf.be/_media/04-lies-janssen-ecologische-voetafdrukrekeningen_236536.pdf*). The United Arab Emirates is currently completing a review of the Ecological Footprint, and Ecuador is preparing to begin a research collaboration reviewing the Ecological Footprint in late 2009.

How are countries using their national Footprint accounts?

Countries, especially but not only those that have engaged in research collaborations with Global Footprint Network, use their national Footprint accounts to better understand the demands they are placing on productive ecosystems, and the capacity they have internally or are accessing elsewhere to meet these demands. This can help them identify resource constraints and dependencies, as well as recognize resource opportunities. In addition, countries use their Ecological Footprint and biocapacity data for:

- Exploring policy creation, to:
  - Protect national interests and leverage existing opportunities;
  - Bring their economies in line with global limits, including planning for a low-carbon future;
  - Foster innovation that maintains or improves quality of life while reducing dependence on ecological capacity.
- Leveraging trade opportunities, to:
  - Create a strong trade position for exports by better understanding who has ecological reserves and who does not;
  - Minimize and prioritize external resource needs.
- Creating a baseline for setting goals and monitoring progress toward lasting and sustainable economic development; in particular, to guide investment in infrastructure that is both efficient in its use of resources, and resilient if supply disruptions materialize.
- Providing a complementary metric to GDP that can help lead to a better way of gauging human progress and development.

For more information, visit *www.footprintnetwork.org/reviews.*

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