2012 Report of the Arab Forum for Environment and Development

ARAB ENVIRONMENT·5
SURVIVAL OPTIONS
ECOLOGICAL FOOTPRINT OF ARAB COUNTRIES

EDITED BY: **NAJIB SAAB**

المنتدى العربي للبيئة والتنمية
ARAB FORUM FOR
ENVIRONMENT AND DEVELOPMENT
AFED

Incorporating
ARAB ATLAS OF FOOTPRINT AND BIOCAPACITY
by Global Footprint Network

Dedicated to

Mohamad Kassas
1921-2012

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Published with Technical Publications and *Environment & Development* magazine
P.O.Box 113-5474, Beirut, Lebanon

info@afedonline.org
http://www.afedonline.org

Editor: Najib Saab
Associate Editor: Bashar Zeitoon
Senior Advisers: Mohamad Kassas, Mostafa K. Tolba, Mohamed El-Ashry

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Graphics and Production Manager: Charbel Mahfoud
Assistant Copy-Editor and Researcher: Rosalyn Saab
Execution: Jamal Awada
Printing: Chemaly & Chemaly, Beirut
Photos: *Environment & Development* magazine archive - iStock photos

ISBN: 978-9953-437-43-9

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Preface

Survival Options is the fifth in the series of annual reports produced by the Arab Forum for Environment and Development (AFED) on the state of the Arab environment. It examines sustainability choices in Arab countries, based on a survey of people's demand for natural capital and available supply.

The primary aim of the AFED annual reports is to foster the use of science in policy and decision-making in Arab countries. This is a manifestation of AFED's mission to advocate prudent environmental policies and actions based on science and awareness. Since 2008, AFED has produced four reports in the series: *Arab Environment: Future Challenges* (2008), *Impact of Climate Change on Arab Countries* (2009), *Water: Sustainable Management of a Scarce Resource* (2010) and *Green Economy: Sustainable Transition in a Changing Arab World* (2011).

The present report comes as a logical addition to the sequence, since it discusses possible paths to sustainability based on ecological constraints. As a basis for the analysis, AFED has commissioned the Global Footprint Network, the world leader in this field, to produce an Arab Ecological Footprint and Biocapacity Atlas using the most recent data available. The Atlas covers the 22 members of the League of Arab States, as a region, sub-regions and individual countries.

The findings indicate that Arab countries' demand for nature's products and services amounts to more than twice what ecosystems in these countries can supply. This imbalance between domestic supply and demand for ecological services places a limit on future growth and wellbeing.

A group of experts has analyzed the findings of the Atlas, combined with the conclusions of previous AFED reports, in an attempt to go beyond pointing to the signs of deterioration, towards providing alternative paths to development in a positive spirit. The analysis focuses on the challenges posed by the state of food security, water and energy, while considering main drivers such as population and patterns of production and consumption.

The report prescribes regional cooperation and sound management of resources as the main options for survival in a region characterized by stark variations in Ecological Footprint, natural resources and income. In order to pursue sustainable wellbeing for all residents in the region, attention should be directed to achieving more regional economic integration and to the promotion of inter-Arab trade free of barriers, where the free flow of goods, capital, and people works to the benefit of all countries.

This report is dedicated to Mohamed Kassas, a pioneer ecologist and visionary who passed away in March 2012. He was a staunch believer in regional cooperation among Arab countries based on comparative advantages, and the role of scientific research in achieving real progress. Kassas, as he liked to be called, was behind the idea of producing a report examining sustainability options in the Arab region. We worked out the plan together, and held various meetings at his office in Cairo University to evaluate progress. Seeing the figures collected for the Footprint Atlas in December 2011, he thought that what the Arab region was facing amounted to not less than a struggle for survival. Thus, it was decided to change the title of the AFED report from *Sustainability Options to Survival Options*.

When we proposed regional cooperation as an 'option', Kassas affirmed that it was rather an obligation. To demonstrate his point, he asked the librarian to bring the Club of Rome's second report *Mankind at the Turning Point*, which proposed to divide the world into ten growth regions, and advocated cooperation within each region and among each other. Kassas opened page 44 to show that, in 1974, the report specified the group of Arab countries as one of the ten growth regions.

Kassas was a founding member of AFED's Board of Trustees, who supported the organization from the inception of the idea. The last time he traveled outside Egypt was to attend AFED's Board of Trustees meeting and its first Annual Conference in Manama in 2008. He contributed to all AFED reports, either as a scientific adviser or author. Mohamed Kassas was a world established scientist. To many of us, he was a mentor and a friend. But above all, he will always be remembered and missed for his kindness and unlimited capacity to give.

AFED wishes to thank all those who made this report possible, especially our partners at the Global Footprint Network, alongside the authors and experts who contributed to the contents and appraised the drafts. AFED's special thanks go to the Environment Agency-Abu Dhabi, the official sponsor, the OPEC Fund for International Development, the Kuwait Foundation for the Advancement of Sciences, and all corporate and media partners who supported this endeavor.

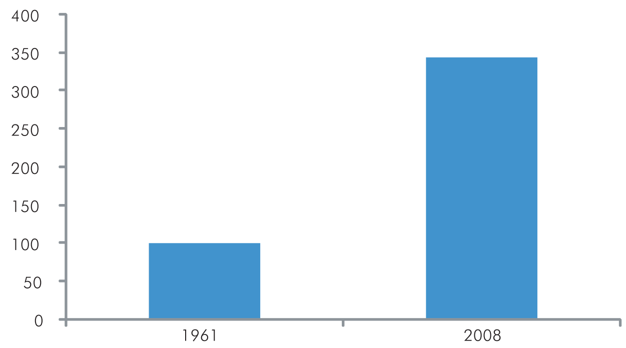
It is hoped that this report will help promote the integration of ecological accounting into the decision-making process in the Arab region, to secure sustainable growth.

November 2012

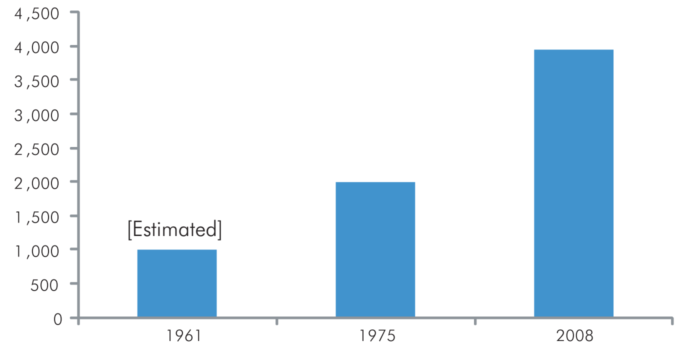
Najib Saab
Secretary General
Arab Forum for Environment and Development (AFED)

State of the Arab Region at a glance: 1961-2008

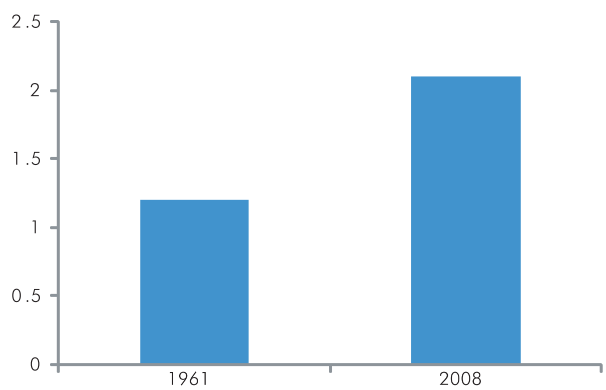
Population
[millions]



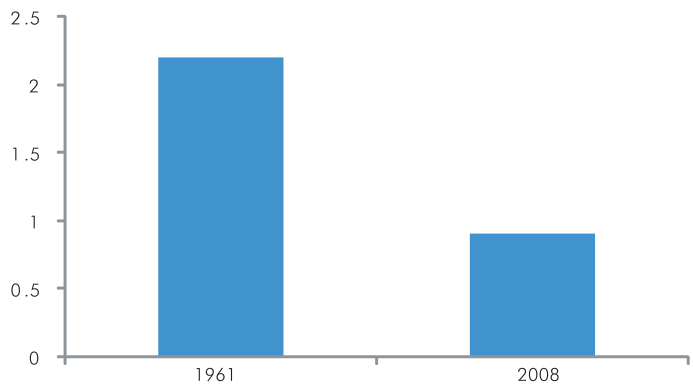
GDP
[constant $US 2000 per capita]



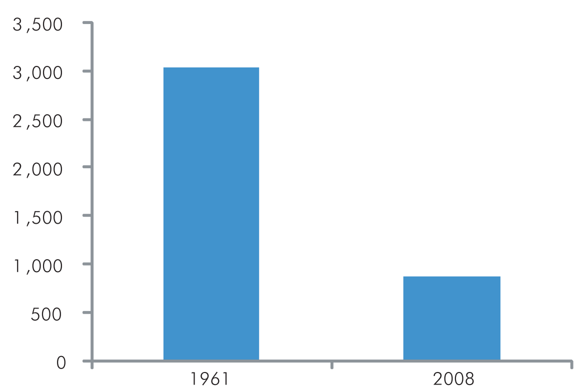
Ecological Footprint
[gha per capita]



Biocapacity
[gha per capita]



Freshwater availability
[m^3 per capita]



EXECUTIVE SUMMARY

ARAB ENVIRONMENT •5
SURVIVAL OPTIONS

2012 Report of the Arab Forum for Environment and Development (AFED)

Measured by the increase in Gross Domestic Product (GDP) over the last 50 years, Arab countries have performed well, with average GDP per capita quadrupling in this time. But while this has often resulted in higher standards of living, it has not always translated into a better quality of life nor has it enhanced the chances of sustainable living. Over the same period, available natural resources in the region have fallen to less than half, and this, coupled with deterioration in environmental conditions, has put the region on the brink of ecosystem bankruptcy. Not only does this situation impose limits on future growth and wellbeing, but it also threatens survival prospects in the region, according to the 2012 Annual Report of the Arab Forum for Environment and Development (AFED).

The Arab region entered into a state of steady ecosystem deficit in 1979 and the consumption levels of life-supporting goods and services are today more than twice what local ecosystems can provide. This has been accompanied with a doubling in the regional Ecological Footprint and a decrease in freshwater availability by nearly four times.

These are some of the key findings of the Arab Footprint and Biocapacity Atlas, prepared by researchers at the Global Footprint Network, as part of AFED's Annual Report on survival options in Arab countries. The Atlas analyzes the demand for resources (footprint) and available supply (biocapacity), expressed in global hectares (gha), to shed light on the resource constraints in Arab countries from the perspective of the regenerative capacity of nature.

ECOLOGICAL FOOTPRINT AND ENVIRONMENTAL DEGRADATION

Today most Arab countries suffer an ecological debt. Compared to 1961, the average Ecological Footprint of the region has increased by 78 percent, from 1.2 to 2.1 global hectares per capita. There are two main drivers which have led to this sharp jump: The first is a 3.5-fold increase in population size, leading to higher overall consumption; the second is a sharp rise in the amount of resources and services consumed per person as a result of higher incomes and changing lifestyle patterns.

The available average biocapacity per capita in Arab countries decreased by 60 percent over these 50 years, from 2.2 to 0.9 gha. This sharp decline is mainly attributed to the vast increase in population size and the decline in the productive capacity of the region's ecological systems due to pollution, habitat destruction, and overall inadequate resource management.

The vast deficit in the region's ecological resources is largely bridged by imports and an over-exploitation of finite local resources. This is an unsustainable strategy, the AFED report warns, as in the long term, overuse will lead to an even greater depletion of natural resources and degradation of the environment.

On the one hand, the dependence on global trade imports introduces concerns of economic insecurity, often driven by soaring food prices, disruptions in global supply chains, and trade restrictions. For oil-importing countries, carrying debt to finance imports imposes burdens on their economies and places a limit on future wellbeing.

And on the other hand, inadequate resource management has dire consequences on the environment. The AFED annual reports on the state of Arab environment have repeatedly warned that overexploitation of resources, the impact of climate change, high population growth rates, uncontrolled economic growth and urbanization amplify the region's environmental challenges and constrain its ability to manage them. Significant among those challenges are water scarcity, land degradation, inadequate waste management, coastal and marine environment degradation, and air and water pollution. AFED reports have estimated the cost of environmental degradation in the Arab region as a whole at 5 percent of total GDP, while budgetary allocations for environmental purposes do not even come close to 1 percent of GDP in any Arab country.

According to data in the Footprint Atlas, Arab countries' individual Ecological Footprints exhibit vast variations. The average resident of Qatar has the highest Ecological Footprint in the world (11.7 gha per capita), exceeding by nine times the Ecological Footprint of the average Moroccan. Kuwait and the United Arab Emirates have the second and third highest footprint per capita in the world, respectively.

To put this into perspective, if all humans lived like the average Arab resident, 1.2 planets would be required. If they lived like an average resident of Qatar, 6.6 planets would be required to satisfy their level of consumption and emissions of carbon dioxide. By contrast, if everyone lived like an average person in Morocco, humans would demand only three-quarters of the planet Earth.

Disparity is also reflected in many other forms, such as freshwater availability per capita - which varies between 8 cubic meters in Kuwait and 3,460 cubic meters in Mauritania - and GDP which currently varies between about US$ 1,000 in Sudan and Yemen to above US$ 92,000 in Qatar.

For some Arab countries, such as Yemen, the average inhabitant's footprint is small compared to the world average, and even too small to meet basic food, shelter, health, and sanitation needs. Therefore, the deficit cannot be bridged by simply reducing the demand for resources. To improve the quality of life, the actual per capita share of renewable natural resources must become more balanced and equitable across countries. Innovative resource management is needed to achieve this.

The Atlas also indicates that the carbon footprint component has been the only one to increase significantly since 1961, with energy consumption growing faster in the Arab region than in any other part of the world. This reflects the proliferation of energy-intensive industries and the increasing demand for electricity and transport from a growing population, often characterized by waste and inefficiency.

CHANGING COURSE

In light of the resource constraints in Arab countries, this AFED report is concerned with achieving economic prosperity while simultaneously ensuring ecological health. It seeks to investigate what level of resource consumption is most appropriate for Arab economies, given the available natural capital.

Addressing these questions demands a shift in economic policy formulation by accounting for national ecological endowments. Decision makers in Arab countries will need to look beyond GDP as the sole measure of performance, and must seek to complement traditional economic analysis with data on resources consumption and availability.

Setting development targets is naturally considered a sovereign national right, but economic growth must take into account ecological limits and the capacity of nature to sustainably support life. Given the low efficiency with which resources are turned into final products, Arab countries must improve the resource productivity of their economies by prioritizing energy and water efficiency.

While the AFED report warns of increasing food deficits, it also reveals that if the major Arab cereal producers raise their productivity and enhance irrigation efficiency only to match the world average, they will be able to meet demand. However, achieving food security requires regional cooperation, as often it cannot be realized at isolated country levels without causing grave environmental effects. An additional concern for Arab countries in this regard is the depletion of strategic reserves of scarce groundwater.

Regional programs in scientific research are key to achieving sustainable and equitable growth for all. One crucial step is to make good use of the present income from the region's finite oil resources to build a strong science and technology base, as a step to securing survival and the best possible quality of life in the post-oil era.

CONCLUDING REMARKS

Arab countries are facing an urgent challenge: how to provide sustainable wellbeing for all inhabitants and not simply seeking growth for the sake of growth at any cost.

The AFED 2012 report has found that no Arab country can survive as an isolated entity. However, the diversity of natural and human resources in the Arab region offers a foundation for survival and renewal. But this demands regional economic cooperation and Arab trade free of barriers, where the open flow of goods, capital, and people would work to the benefit of all countries in the region. Arab countries need to function as interdependent entities. This is particularly true in an era when the world is steadily moving towards regional trading blocs, based on practical common interests.

As gloomy as its findings might sound, this report does not seek to plant fear or despair about resource deficits. Rather, it seeks to stress the need to change course based on a hopeful vision for the Arab region. In this regard, the AFED report tracks glimpses of hope, with some Arab countries starting to genuinely respond to the warnings. The UAE, for example, which boasts the third largest footprint in the world, has launched a pioneering national footprint initiative intended to manage the country's ecosystem deficit and facilitate the adoption of science-based policies to advance sustainable development. The Masdar Institute of Science and Technology in Abu Dhabi and the King Abdullah University of Science and Technology in Jeddah are recent examples of regional initiatives to advance sustainable development by promoting research in clean and renewable energy, along with food and water security.

The AFED report on survival options is a call to Arab countries to embrace collective action to advance a new sustainable economic and ecological vision. Regional cooperation, resource efficiency, and balanced consumption are the options for survival. Action is needed now.

INTRODUCTION

ECOLOGICAL FOOTPRINT AND SURVIVAL OPTIONS IN ARAB COUNTRIES

2012 Report of the Arab Forum for Environment and Development (AFED)

OVERVIEW

Arab countries' demand on nature amounts to more than twice what the ecosystems in these countries can actually support. This disparity, particularly significant in terms of food, is largely bridged by imports and the over-exploitation of local resources.

Such an operating model is not sustainable. It is also economically dangerous, considering the increasing costs of imports, the impact on local and global environments, and the eventual depletion of non-renewable energy resources.

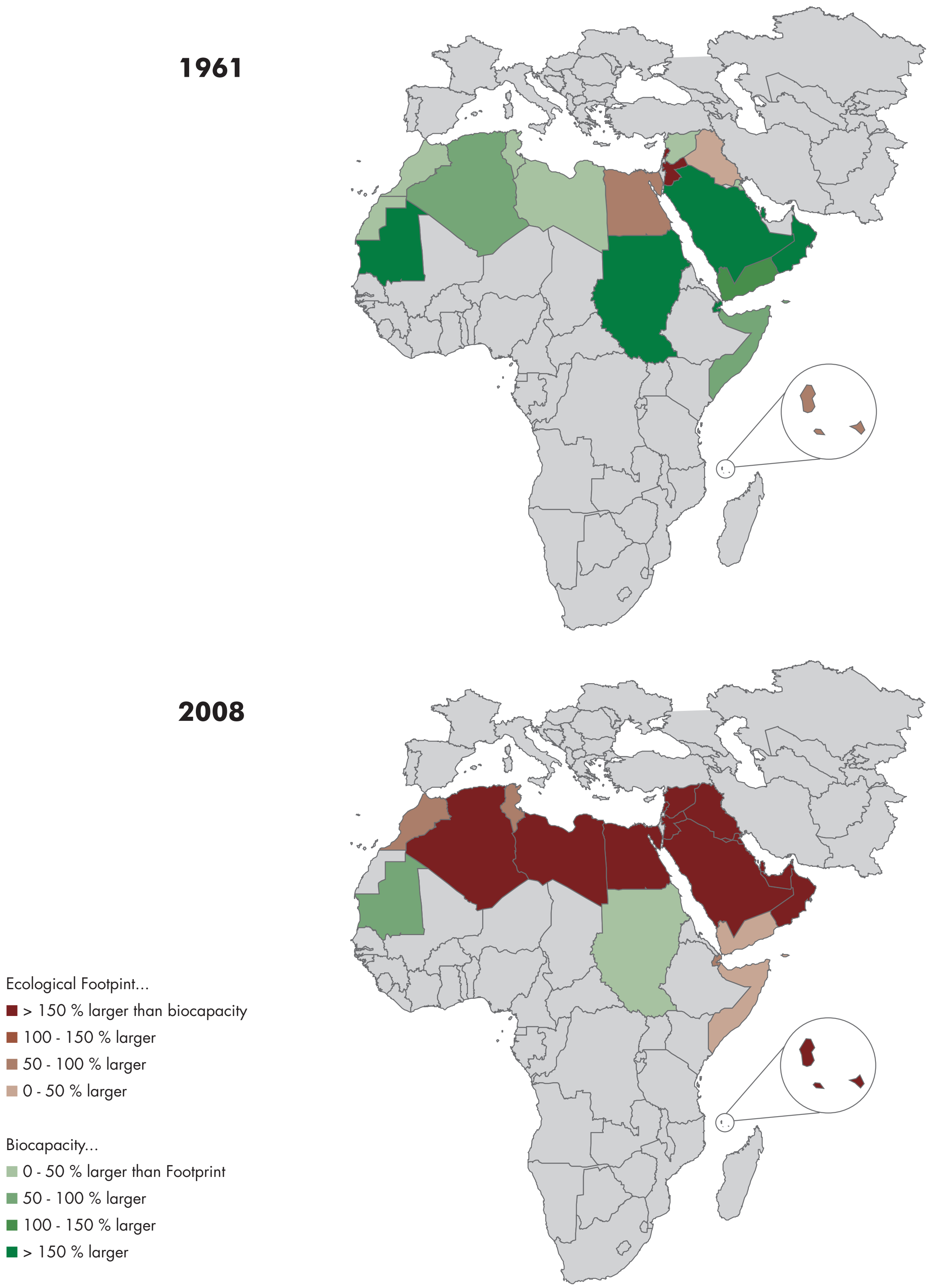
The AFED 2012 annual report discusses survival options in Arab countries based on analysis of the demand on nature (footprint) and available supply (biocapacity). It provides a detailed account of resource consumption and recommends sound resource management and regional cooperation, not only as a means to achieving sustainability, a stable economy, and a good quality of life, but also for survival itself.

This report seeks to state the facts, since ignoring signs of deterioration will not solve the resource deficit problem the Arab world faces. But AFED does not seek to promote a doomsday prophecy. On the contrary, the current situation can be reversed, if it receives the attention it merits. Therefore, this report calls for recognizing the challenges and finding alternative paths for development in a positive and constructive spirit.

The report asks central questions about resource management in the Arab region, and seeks to provide options for action. What might be the implications for Arab economies as they become increasingly dependent on resources they do not have? How can the region achieve energy sustainability, while reducing its air pollution and carbon footprint? How can the region achieve a proper balance between resource availability and the need for development, given current demographic transitions? What are the limits of using irreplaceable natural resources at rates that cannot be sustained? How can Arab countries replace policies that promote growth for growth's sake by ones that promote growth for the sustainable wellbeing of people? How can resource development, resource efficiency, and alternative paths to sustainability help achieve these transformations? How can Arab countries substitute food and water self-sufficiency, which entails the impossible task of relying completely on a country's internal resources, with the more practical alternative of resource security, which can be achieved by establishing mutually beneficial regional trade and investment cooperation, to boost their sustainability

FIGURE 1

CREDITOR-DEBTOR STATUS FOR ARAB COUNTRIES IN 1961 AND 2008 SHOWS SHARP ECOLOGICAL DETERIORATION. RED SHADING INDICATES THAT THE FOOTPRINT IS GREATER THAN BIOCAPACITY (DEBTOR STATUS), WHILE GREEN SHADING INDICATES THAT BIOCAPACITY IS GREATER THAN THE FOOTPRINT (CREDITOR STATUS).



options as a bloc? Beyond questions of political economy, what ethical values are needed to govern thinking about consumption and lifestyle?

Addressing these questions requires going beyond traditional economic thinking. Making more effective policy decisions demands a shift in the accounting of national ecological endowments. Therefore it is necessary to incorporate ecological accounting in economic policy formulation. In other words, policy makers and leaders in Arab countries will need to look beyond Gross Domestic Product (GDP) as the cornerstone measure of performance, and seek to complement traditional economic analysis with information on renewable resource consumption and availability. In this new era of economic insecurity, tracking the demand for natural capital is essential to meeting the basic needs of food and water security, and ultimately to ensuring economic competitiveness while strengthening ecological health.

As a basis for this analysis, AFED has cooperated with the Global Footprint Network (GFN) to produce an Ecological Footprint and Biocapacity Atlas, exploring ecological constraints in Arab countries.

The system of ecological footprint accounting, developed by GFN, measures human demand on nature. It does so by linking all human demand for food, fiber, urban space, and waste absorption -- such as CO_2 -- to biologically productive areas needed to provide these services. This demand is people's ecological footprint. Ecological accounting also tracks how much of this productive area is available in the world or in a particular country. By keeping books of demand for and supply of nature, this accounting system provides an ecological balance statement, evaluating the endowment of ecological services compared to what people consume.

Both footprint and biocapacity are expressed in global hectares (gha). By standardizing hectares and scaling them proportionally to the regenerative capacity on that hectare, this unit allows analysts to compare demand and supply across the world.

Based on this accounting methodology, the Arab Atlas documents trends over the period from 1961 to 2008, the last year data is available. It covers the 22 members of the League of Arab States as individual countries, sub-regions, and as a whole region. At a glance, the Atlas shows rapidly developing constraints in natural capital: All countries of the region exhibit vast ecological deficits today, except for Sudan and Mauritania, although the region as a whole was an ecological creditor in 1961, as illustrated in Figure 1.

The Atlas reveals figures that are critical for understanding the region's competitive advantages and disadvantages, among which are:

- Since 1979 the region as a whole has been experiencing a biocapacity deficit, with its demand for ecological services exceeding local supply by more than double. In order to bridge this gap, ecological services have had to be imported from outside the region.
- The average resident in Arab countries demands more than twice what is available locally.
- The average ecological footprint per capita in Arab countries increased by 78 percent from 1.2 to 2.1 global hectares per capita over the past 50 years.
- The available average biocapacity per capita in Arab countries decreased by 60 percent over the time period 1961-2008.
- Population has increased by 250 percent over the same time period; the

overall regional ecological footprint has therefore increased by more than 500 percent.

- Only four countries make up more than 50 percent of the Arab region's Ecological Footprint: Egypt (19 percent), Saudi Arabia (15 percent), the United Arab Emirates (UAE) (10 percent), and Sudan (9 percent).
- Only two countries provide approximately 50 percent of the biocapacity in the Arab region in 2008: Sudan (32 percent) and Egypt (17 percent).
- If all humans lived like the average Arab citizen, 1.2 planets would be required to satisfy human's resource needs. If they lived like an average resident of Qatar, 6.6 planets would be required to satisfy this level of consumption and emissions of carbon dioxide. By contrast, if everyone lived like an average Yemeni, humans would demand only half of planet Earth, however this would not adequately meet basic human needs.

These findings indicate that the region has already approached an imbalance between domestic supply and demand for ecological services, putting at risk future economic expansion and stability, and, simultaneously, human wellbeing.

While almost all Arab countries are in a state of biocapacity deficit, the demand on resources, or footprint per capita, varies vastly among individual countries and regions. Other than the GCC countries, which record some of the highest footprint figures in the world, the average inhabitant's footprint in other parts of the region is small compared to the world average, and in many cases it is too small to meet basic food, shelter, health, and sanitation needs. Therefore, the deficit cannot simply be bridged by reducing the demand for resources. For vital quality of life improvements, large segments of the region's population must instead have greater access to renewable natural resources. Meeting this need will involve multiple strategies: large improvements in resource efficiency to achieve more output while also utilizing lower input and generating less waste, and the expansion of biocapacity without resource-intensive production.

Arab countries should be concerned because ecological deficits constrain development and threaten economic and social security. There are multiple sources that bring about these constraints. One source stems from over-dependence on imports to meet the demand for primary products. This makes Arab countries vulnerable to disruptions in global supply chains, trade restrictions, and price volatilities. The financing of these imports presents another source of economic constraint. For oil-exporting Arab countries, fossil fuel resources are inherently finite and crude oil price levels are highly subject to global economic cycles, all of which heighten the risks of an extractive, one-source economy. For low-income Arab countries, which finance their imports with external borrowing and foreign assistance, debts and interest payments diminish their prospects for economic security. Economically, ecological deficits cannot be addressed by relying on imports indefinitely.

To close the resource deficit gap and boost biocapacity, Arab countries have intensively exploited local renewable and non-renewable resources, causing degradation to economically important environmental assets. The annual AFED reports of 2008 through 2011 on the state of the Arab environment have documented the effects of overexploitation and resource mismanagement.

As a result of agricultural intensification and overgrazing, land degradation in Arab countries has now affected 34 percent of all irrigated farmlands, 67 percent of rain-fed farmlands, and 83 percent of grazing lands. In doing so, many Arab countries have also over-extracted groundwater resources at rates higher than the ability to recharge. This is coupled by low rates of irrigation efficiency at less than 40 percent. The increased demand for water has reduced per capita supply to one quarter of the level it was in 1960. Within a decade, it is expected that the average annual freshwater availability in Arab countries will be below 500 m^3, which is just 10 percent of the world average, and falls below the severe water scarcity mark. Currently, 13 Arab countries are among the world's most water-scarce countries, and per capita water availability in eight of them is below 200 m^3 per year. In spite of this, the amount of water consumed for personal domestic use in some of the most water-scarce Arab countries is among the highest in the world -- mostly coming from expensive desalination of sea water. Only 40 percent of wastewater is treated, and less than one-third of the treated water is re-used. These conditions limit human development and are a threat to life.

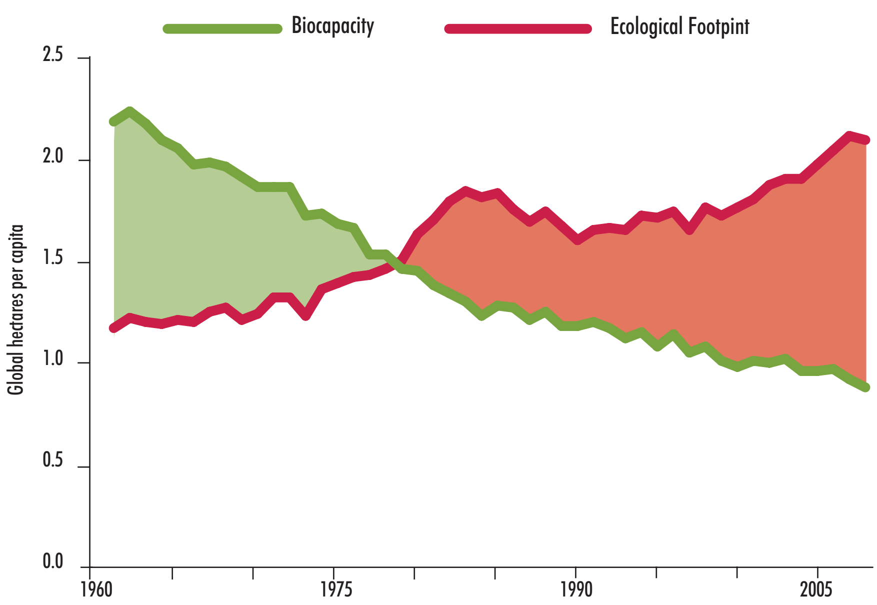
In Arab countries, the carbon footprint portion accounts for 45 percent of the total Ecological Footprint. This indicates high rates of energy consumption to meet urban demand and fast growing key economic sectors including construction, transportation, mining, industrialization, and tourism. The environmental impact of the largely inefficient fossil-fuel burning on the quality of air has been significant. In 2011, Kuwait, Saudi Arabia, and the UAE were among the 10 countries with the worst air pollution in the world. Rising asthma rates among children is linked to the deterioration of air quality. The annual health care costs of air pollution in 16 Arab countries have been estimated to be US$ 10.9 billion in 2008, equivalent to 1.2 percent of their combined GDP.

Anthropogenic climate change, caused by global CO_2 emissions, is predicted to cause rainfall to decrease by 25 percent and evaporation rates to increase by 25 percent in Arab countries by the end of the 21st century, which would cause average yields of rain-fed agriculture to decline by 20 percent overall, aggravating the risks of food and water shortages. In addition, 18,000 km of inhabited coastal areas will become vulnerable to rising sea levels. Other environmental damage afflicting coastal and marine areas includes overfishing, as well as pollution by municipal waste, industrial discharge, and agricultural run-offs brought about by the large number of coastal petrochemical and energy installations, uncontrolled tourism, and extensive urban development.

Escalating ecological footprints in Arab countries indicate higher consumption rates by institutions and households and consequently rapidly increasing rates of waste generation, including municipal solid waste (MSW), demolition waste, and electronic waste. The quantity of MSW alone generated annually in Arab countries today has reached 150 million tons and is estimated to exceed 200 million tons per year by 2020. At a per capita solid waste generation of over 1.5 kg per day on average, some GCC countries rank among the highest waste generators globally. And still, the rate of recycling is currently below 5 percent of the total waste generated. It is estimated that the annual damage cost from inadequate waste management exceeds 0.6 percent of combined Arab GDP.

In summary, ecological deficits in Arab countries have led to an overexploitation of renewable resources and in turn to deterioration in the quality of air, water, and soil. The average annual cost of environmental degradation in Arab countries has been estimated at $95 billion, equivalent to 5 percent of their combined 2010 GDP.

FIGURE 2 AVERAGE ECOLOGICAL FOOTPRINT AND BIOCAPACITY PER CAPITA IN ARAB COUNTRIES, 1961-2008



ECOLOGICAL FOOTPRINT ACCOUNTING IN ARAB COUNTRIES

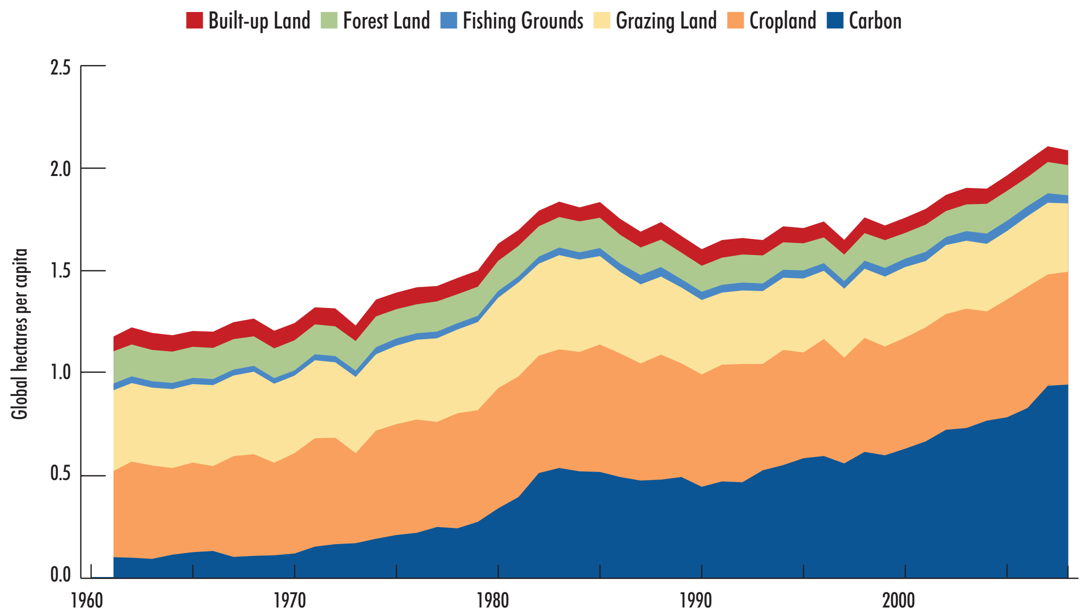
The deficit in resources in Arab countries started in 1979 and has been increasing ever since, as indicated in Figure 2. From an economic security perspective, the existence of this ecological deficit indicates a higher than desired degree of dependence on imports of primary products. The deficit also entails over-use of domestic renewable resources, leading to a reduction in local stocks of, for example fisheries, and a decrease in the capacity of sinks to absorb CO_2 emissions.

Relative to 1961, the per capita Ecological Footprint of Arab countries in 2008 has increased by 78 percent, as illustrated in Figure 3. Two contributing drivers have led to this significant increase. The first is a 3.5-fold increase in population over the time period 1961-2008, leading to higher overall consumption. The second driver is a sharp rise in the amount of resources and services consumed per person as a result of higher incomes and changing lifestyle patterns.

Population growth over the period 1961-2008 has also caused the average biocapacity per person to decline in Arab countries, as illustrated in Figure 4, despite an increase in total biocapacity across the Arab region by 40 percent. The 3.5-fold increase in population has simply overwhelmed expansion in the region's supply of resources. In other words, the finite amount of renewable resources is now shared by more people, despite growth in the size of productive areas providing these resources.

The only exception to this trend in the Arab region was Egypt, which experienced an increase in biocapacity per person from 1961 to 2008 of about 20 percent, despite a nearly three-fold increase in the population of the country over the same period. This can be attributed primarily to increased agricultural productivity and

FIGURE 3 ECOLOGICAL FOOTPRINT BY LAND USE TYPE IN ARAB COUNTRIES, 1961-2008



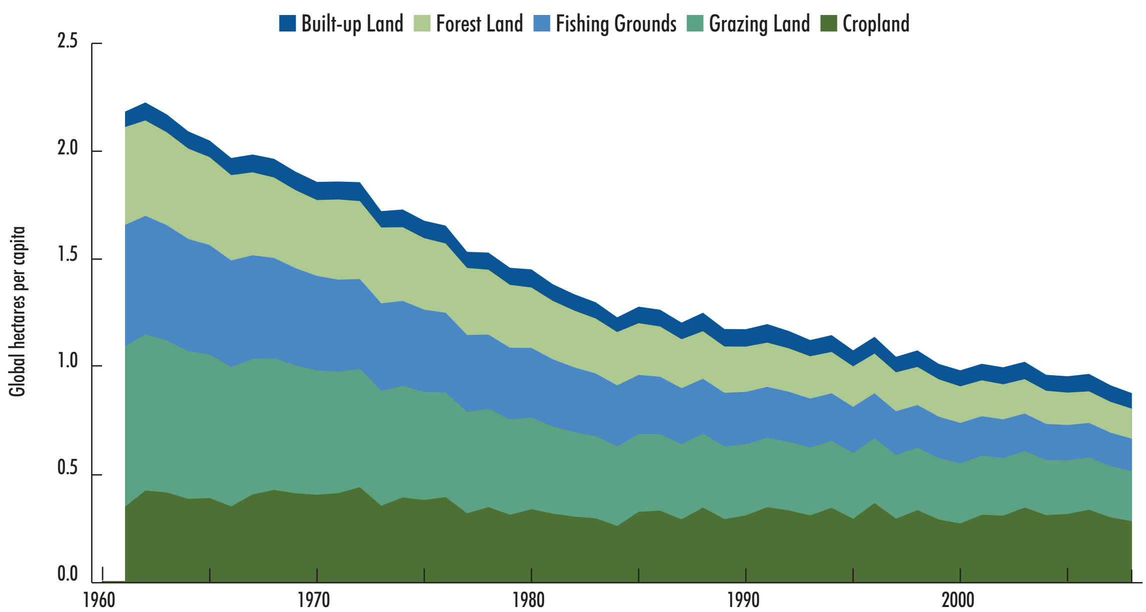
the addition of more cropland areas, achieved through increased irrigation and the application of intensive industrial farming methods. However, this has resulted in groundwater depletion in some cases and in a higher ecological footprint, which produced a greater biocapacity deficit in 2008 relative to 1961.

The Arab region as a whole has been experiencing a biocapacity deficit since 1979. However, regional averages mask great internal disparities, in both Ecological Footprint and biocapacity by land use type on a per capita basis, as illustrated in Figures 5 and 6, respectively, for selected Arab countries.

A snapshot of the Ecological Footprint by land use type indicates that the carbon footprint portion of the total footprint dominates in most Arab oil-exporting countries that also have some of the highest per capita ecological footprints in the world. Even in many Arab oil-importing countries, the carbon footprint makes up more than a third of the total footprint. In fact, the carbon footprint component on a per capita basis has been the only one to increase significantly since 1961, as illustrated in Figure 3. A nation with a high carbon footprint is indicative of an energy inefficient economy, and of consumption and lifestyle patterns characterized by high rates of per capita energy use. This suggests that improving energy productivity or efficiency combined with the adoption of more moderate consumption habits can significantly reduce Arab countries' Ecological Footprint.

Figure 5 suggests that many populous Arab countries have ecological footprints well below the global average on a per capita basis. However, this is more a reflection of the failure of these countries to meet basic food, water, shelter, health, and sanitation needs for their populations than a model of more sustainable patterns of economic development. In fact, these countries face the double challenge of high rates of poverty and biocapacity deficits.

FIGURE 4 **BIOCAPACITY BY LAND USE TYPE IN ARAB COUNTRIES, 1961-2008**



The available biocapacity by country indicates that fishing grounds is a significant component of the total biocapacity in Bahrain, Kuwait, Oman, Qatar, and the UAE, as illustrated in Figure 6. This reflects the dearth of cropland, grazing land, and forest areas in these countries. Thus the demand on these land use types exceeds biocapacity by a much greater amount than is at first apparent. This also places additional pressures on maintaining and protecting the marine environment in the Gulf region, particularly as over-fishing, pollution, and habitat destruction continue to destroy the prospects for sustaining fishing stocks.

Relative to the global average, the available biocapacity in most Arab countries is significantly lower on a per capita basis, as indicated in Figure 6. However, the low levels of available biocapacity in the region should not be used to justify the large ecological deficit. Instead, the scarcity of natural commodities should provide an impetus for the adoption of more rational and efficient use of renewable resources and to encourage a culture of not consuming more than necessary.

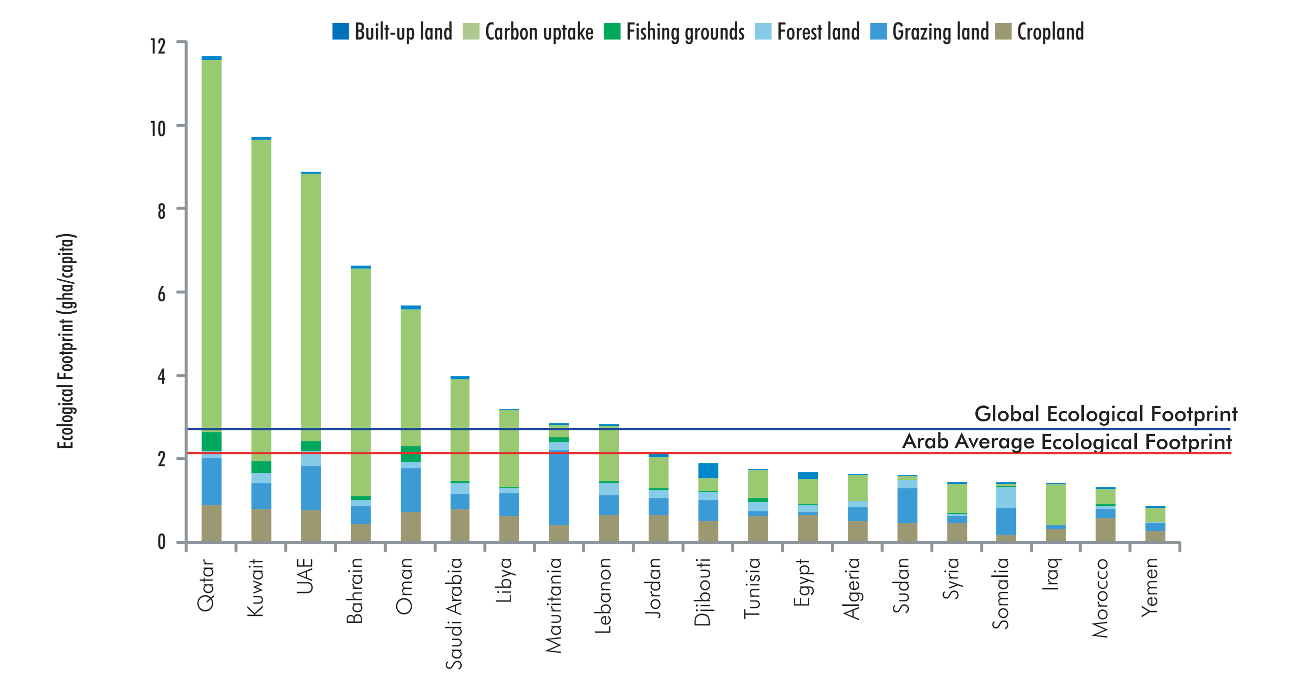
ECOLOGICAL FOOTPRINT AND THREATS TO ECONOMIC SECURITY

It is feared that the ecological deficit is creating a logic whereby the prospects for economic security are becoming threatened. Evidence of economic and social vulnerability is already manifested in biophysical constraints as well as in other forms, as described below.

Oil market volatility

Fossil fuel resources are inherently finite and crude oil price levels are highly subject to global economic cycles. For example, fears over the Eurozone debt crisis and a decrease in Chinese oil demand have all contributed to a plunge in crude

FIGURE 5 **ECOLOGICAL FOOTPRINT (GHA/CAPITA) BY LAND USE TYPE IN SELECTED ARAB COUNTRIES, 2008**



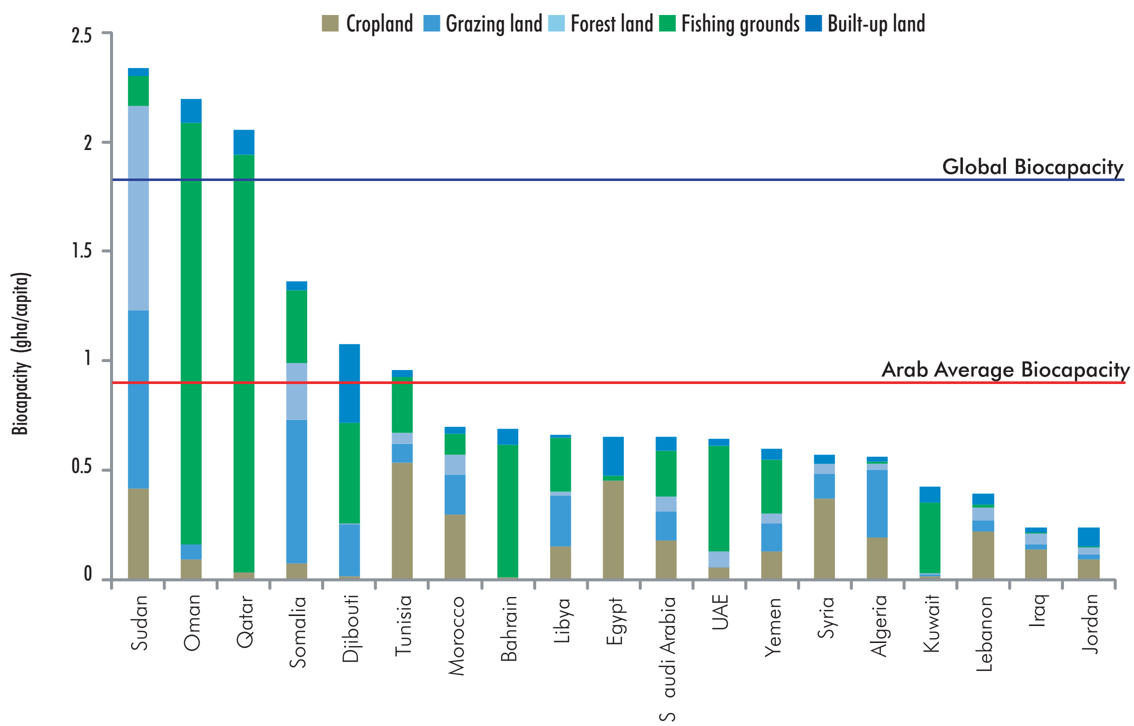
oil price from an average of US$ 120 in the first quarter of 2012 to US$ 95 per barrel in June 2012. Recurrence of such price swings leads oil-exporting countries of the Gulf Cooperation Council (GCC) to risk losing the ability to balance their budgets with implications on current spending levels and GDP. Global oil price volatility has exposed the GCC countries to boom and bust cycles since the 1970s, often leading to unbalanced budgets, government borrowing, negative growth, and delays in infrastructure development. From a long-term perspective, oil volatility presents policy makers and investors with serious challenges and makes sound economic planning difficult. Given the grand scale of the 2030 vision plans by GCC countries and the substantial amount of spending already allocated, there is an ever greater constraint on the ability to adapt quickly enough in response to these future conditions.

Supply chain disruptions

The large deficit in the region's ecological resources and services raises serious concerns about food security. To make up for this deficit, Arab countries rely on global trade and resource flows, thus making them vulnerable to disruptions in global supply chains, trade restrictions, and price volatilities. It is not unimaginable that the real prices of key crops could rise by 50 or even 100 percent over the next few decades.

In addition to the strain of high commodity prices on public finances, Arab countries will remain vulnerable to export bans by other countries, due to extreme weather conditions in many parts of the world. For example, Egypt was left scrambling to replace more than 500,000 tons in wheat purchases after Russia imposed a nearly 11-month grain export ban in August 2010, as a drought decimated its crops. These unpredictable disruptions in trade flows indicate that ecological deficits cannot be addressed by relying on imports indefinitely. As the

FIGURE 6 **BIOCAPACITY (GHA/CAPITA) BY LAND USE TYPE IN SELECTED ARAB COUNTRIES, 2008**



2008 global food crisis has demonstrated, the implications transcend economic insecurity to include food unrest and political instability driven by food shortages and soaring prices.

Furthermore, in a world characterized by a growing ecological overshoot, there is increasing competition for biological resources which may make it ever more risky and potentially costly to bridge biocapacity deficits through imports alone.

Public health implications

Unrestricted economic growth is often a precursor to environmental degradation of air, land, and water, which in turn is a precursor to serious adverse public health consequences. Uncontrolled urbanization accompanied by irresponsible patterns of development in construction, industrialization, and tourism has proven to be environmentally calamitous in all Arab countries. Already, public health concerns about air pollution are being raised locally by a number of Arab governments. In a reference to air quality management in Qatar, a government planning document warns of the rise of asthma and respiratory diseases in the country as a result of air pollution. A 2011 World Health Organization (WHO) report placed Kuwait, Saudi Arabia, and the UAE in the top 10 countries with the worst air pollution in the world. An article from the same year in Construction Week about the deterioration of air quality in GCC countries and the rise in asthma among children blames the region's US$ 2 trillion construction industry.

Expressing concerns about the links between air pollution and human health, the Qatari government has found that almost a fifth of schoolchildren in the country suffer from asthma. These findings are corroborated by official government studies. For example, a study commissioned by Environment Agency - Abu Dhabi (EAD) has concluded that anthropogenic pollution in the atmosphere in the form of particulate matter (PM) is responsible for premature deaths, among other considerable negative public health outcomes in the UAE.

This deterioration in public health places a considerable and long-term burden on the economy and degrades people's quality of life and wellbeing, the very objectives which economic growth is supposed to achieve.

Biophysical constraints

A study in Qatar found that construction and industrialization are having damaging effects on fragile coastal habitats and marine life, with several fish species feared to be depleted. Marine fisheries account for 57 percent of all available biocapacity in the GCC countries. Pollution, habitat destruction, climate change, and overfishing are threatening the long-term productivity of marine resources there. In a sign of deteriorating fisheries, some GCC States, such as Kuwait, have already turned to aquaculture to maintain fish supplies, while others, such as Qatar, are creating a local aquaculture industry to meet future demand. The extensive use of chemicals, processed feed, and accelerated fattening techniques in aquaculture bring their own set of serious environmental and health consequences.

The most well-known biophysical constraint to growth is the limited absorptive capacity of the atmosphere (as well as the ocean) to greenhouse gases, whose concentrations are already causing disruption to Earth's climate and oceans. The adverse economic and social effects of climate change on Arab countries have already been well documented in the 2009 AFED report Impact of Climate Change on Arab Countries. The report identifies negative effects on food and water availability, coastal development, local ecosystems, and human health, and concludes that disruptions to infrastructure could conceivably negate their economic benefits.

FOOD SECURITY OPTIONS

The huge gap between biocapacity and footprint is mostly reflected in food deficits, and subsequently food security. Some of the blame rests with the geography of the region, characterized by arid and semi-arid conditions. The Arab region has limited cultivable land, and is the world's poorest in freshwater resources in absolute and in per capita terms. But as Arab agriculture in general is characterized by some of the lowest yields and worst irrigation efficiency levels in the world, the blame cannot be solely placed on harsh environment and limited resources. Decades of negligence and misdirected investments have driven agriculture in the Arab region to its current precarious state. Also, foreign aid has largely benefited large landholders, estate agents, and multinationals, further marginalizing small and poor farmers.

The Arab region's cropland biocapacity remained nearly undiminished at around 0.30 gha per person during the period 1961-2008, despite a population increase of nearly 250 percent over the same period. This is explained by an increase of biocapacity on an absolute basis, as a result of land expansion and increased productivity. Increased productivity over that time period would not have been possible in a generally dry region without increased irrigation. In fact, over-

OPINION

ARAB FUTURE OUTLOOK

Mohamed Kassas

During the twentieth century, particularly its second half, there have been numerous international attempts for the formulation of a new world order that guarantees human beings their legitimate rights, while preserving resources and protecting the environment for a better life. To which extent has the Arab world taken part in such efforts? In fact, involvement of the Arab countries in this entire endeavor has mostly been in the capacity of spectators on the sidelines, and rarely as actors. It seems that what is still lacking is a genuine motive that spurs a joint Arab action and turns this region into a real actor on the world stage. Being at the beginning of the twenty-first century, Arabs should consider this as a mission.

The world is preoccupied with the future global climate change challenges resulting from increased greenhouse gases (GHG) in the atmosphere, due to human industrial and agricultural activities. In the 1980s several international bodies, led by the World Meteorological Organization (WMO), organized an international program for climate studies. They held international conferences, as of the 1980s, to pursue scientific progress in this domain. Several states established national programs for climate studies that involved advanced scientific research capable of anticipating changes in the Earth's climate in the second half of the twenty-first century, in view of preparing plans for adaptation and mitigation. Unfortunately, the contribution of the Arab states to this massive international effort was modest, despite being located in the most severe drought belt, having extended coastlines vulnerable to sea level rise, and thus exposed to high risks of climate change and its consequences mainly on the food production and coastal areas. Current mathematical models in the programs of the states involved in addressing this issue can project the overall global changes such as global warming and increased temperatures, but are unable to foresee the territorial changes such as in rainfall and wind directions. Various regions, including the Arab region, need to establish joint programs for climate studies and research on future changes in order to be well positioned to act, prevent risks and build on successful attempts.

The Arab world, stretching from the Pacific Ocean to the Gulf, comprises an expanse of land (13.8 million km^2), and regional seas (Exclusive EconomicZones-EEZ as set by the United Nations Convention on the Law of the sea-UNCLOS, covering 200 nautical miles). The land area is an asset because it can accommodate settlements, industrial centers, power stations, tourist villages and recreational facilities. In addition, it abounds in mineral resources and locations suitable for renewable energy plants (mainly wind and solar). On the other hand, the maritime zone is replete with known sources of wealth (fisheries) and other explorable sources. For example, most of Egypt's natural gas resources are produced from

extraction of ground water for irrigation has depleted such water resources in some Arab countries, a practice which cannot be sustainable.

In view of the current precarious state of agriculture, the increasing scarcity of water, and the likely impact of climate change, Arab countries face daunting challenges. This demands a new green revolution, capable of establishing and maintaining a balance between agricultural biocapacity and footprint.

Prospects for increasing cereal production depend largely on improving productivity of both irrigated and rain-fed agriculture. If the six major cereal producers in the Arab region (Algeria, Egypt, Iraq, Morocco, Sudan, and Syria) wells more than 100 kilometers off the northern coast, and the Red Sea seabed is rife with mineral resources estimated to be worth billions of dollars and are jointly shared by Sudan and Saudi Arabia. The development of such land and marine resources requires scientific surveys and studies that are not able to be properly conducted in the Arab world.

One of the major challenges facing the Arab region is the shortage of freshwater resources. Cropland comprises 3.4 percent, rangeland area is 18.8 percent and forest land 10 percent. Overall productive land is 4.1 million km^2, or about 30 percent of total land, while the remaining 70 percent are drylands and deserts. Therefore, Arab scientific work should be directed toward collaboration and integration to address water resources issues at three main levels: 1) How to increase freshwater resources; 2) How to raise the efficiency of available freshwater; 3) How to maintain the quality of available freshwater.

Countries of the Arab region have the potential to advance research and studies. Universities and research centers should be able to contribute very effectively if they work within a common, integrated framework to help the Arab region find solutions to the issues of resources and achieve development and modernity.

The twenty-first century will witness further regional trans-boundary cooperation. Examples include the work towards more integration within the European Union through developing its institutions, the preliminary steps for establishing the North American Union (NAU), comprising Canada, the United States and Mexico, and the anticipated efforts for forming Latin American and Asian unions. Such attempts are driven by the fact that only large entities, and not small single ones, can survive in the twenty-first century; an era of economic competition that requires economic, scientific and technological powers.

Since the creation of the League of Arab States (LAS), there have been reports about an Arab economic union and an Arab common market, but no serious action has been taken. Effective Arab cooperation in this regard needs a great effort, but it is inevitable. Arab intellectuals, politicians, leaders and heads of state are all urged to support such cooperation if the Arab region wishes to exist on the twenty-first century world map and avoid being marginalized.

The risks that threaten the future of the entire Arab region call for a rationalized approach that mobilizes Arab efforts and potentials to maximize the Region's role in global economy, activate an Arab positive contribution to the progress of science and technology, and support a better political position and stable national security. Consequently, natural and human resources may be rationally and sustainably developed, maintaining a safe environment for our present and future generations and giving the Arab Region an active role in the conservation of the Earth's biosphere.

Arab countries cannot individually realize these future aspirations, but they can if they act collectively.

Dr. Mohamed Kassas, who died in March 2012 at the age of 91, was a founding member of the Board of Trustees of the Arab Forum for Environment and Development (AFED). He participated in editing all AFED's annual reports, and took part in developing the plan of action for the 2012 report, notably regarding the need for regional cooperation to attain effective and rational management of resources, in view of enhancing survival opportunities and realizing sustainable development.

could raise their combined cereal productivity to match the world average, their combined production would amount to about 87 million tons. In addition, by raising their irrigation efficiency from 40 to 70 percent they could save enough water to produce an additional 35 million tons of cereal. Thus, increasing cereal productivity, coupled with improved irrigation efficiency, raises the quantity of cereal available for consumption to 122 million tons, sufficient to meet the six countries' demand for cereal in 2030 of about 101 million tons, and would cover about 21 percent of the Arab region's unmet demand in the same year.

Research is an indispensable core activity for arriving at the optimal mix of inputs and discovering drought-resistant cultivars and salt-tolerant crops. New eco-agricultural methods, protective of soils, land, and water, such as organic and conservation farming should be promoted and supported.

Globally, the market for organic produce has grown from US$ 15 billion in 1999 to US$ 55 billion in 2009. Organic agriculture provides over 30 percent more jobs per hectare than traditional forms of agriculture. Promoting sustainable agriculture in Arab countries will generate new incomes for rural populations, while creating 10 million new jobs.

The AFED 2011 report on Green Economy found that shifting to sustainable agricultural practices is expected to result in savings to Arab countries of between 5-6 percent of GDP as a result of increased water productivity, improved public health, and protected environmental resources. In addition, revitalizing the agricultural sector through adequate investments and research and development should result in at least a 30 percent reduction in imports over the next five years, with savings amounting to US$ 45 billion.

Food security, however, does not necessarily equate to food self-sufficiency, especially in countries where any chance of achieving self-sufficiency will be at the cost of depleting renewable and non-renewable resources. In view of the disparities in land and water resources across Arab countries, virtual water trade affords them opportunities for cooperation on food security matters. Therefore, regional trade among Arab countries and with non-Arab countries in food commodities needs to be facilitated and strengthened. This will require strategies to build long-term, sustainable relationships with trade partners, where all parties benefit in an equitable manner. Agricultural investments by Arab states in countries which are rich in land and water resources, through land acquisition or other means, must address hunger and food security in these other countries in which investments are being made. Food security threats should not be shifted from Arab countries to non-Arab countries.

ENERGY SUSTAINABILITY OPTIONS

Against a backdrop of a rising demand for electricity, increased oil price volatility, gradual depletion of fossil fuel resources, and growing climate change concerns, policymakers in Arab countries must address the lack of energy diversification, disparity in per capita energy use within countries and across the region, and the region's high carbon footprint, associated with high energy inefficiency.

In some Arab countries, such as Morocco, Algeria, Sudan, Yemen and Palestine, access to energy poses a major development challenge. More than 40 percent of the Arab population in rural and poor urban areas does not have adequate access to modern energy services. It is also noted that almost one-fifth of the Arab population relies on non-commercial fuels, such as biomass, for cooking and heating.

Wide disparities exist in the levels of energy consumption among Arab countries. The average Qatari consumes energy nearly 53 times more than an average Yemeni and 10 times the global average. The same wide disparity exists in average electricity consumption per capita with a range from between 115 kWh/year in Sudan and 17,300 kWh/year in the UAE, equivalent to 150 times more. Residents of the UAE consume on average nearly six times the global per capita use of electricity.

Since the early 1980s, the consumption of energy has grown faster in the Arab region than in any other region in the world, reflecting the proliferation of energy-intensive industries, and the growing demand for electricity and transport by growing populations. Energy intensity—the ratio of energy use to GDP—has dropped dramatically nearly everywhere in the world. Only in Arab countries has energy intensity increased; energy consumption has been rising in concert with or faster than GDP. The region's energy intensity in 2009 was some 50 percent higher than the world average.

Thus, the need for shifting away from an economy based on finite fossil fuel extraction to one based on investments in diversified energy sources is more urgent than ever. Any consideration of meeting the region's growing demand for energy must include a focus on energy efficiency and renewable energy. Arab countries have a great potential for renewable energy, including solar and wind, as well as hydro and geothermal in specific locations, all of which are underutilized.

Already, nine Arab countries have set renewable energy targets to scale up penetration of renewable energy into their national energy mix. Some countries have introduced feed-in-tariffs to spur investment and adoption of renewable power. Egypt has become a leading example in the region in the commercial use of wind power, including local manufacturing of turbine components. More recently, some Arab countries have unveiled massive renewable energy programs. Morocco is investing $9 billion to develop solar power projects in the country. Saudi Arabia has recently announced an ambitious plan to install 41 gigawatts (GW) of solar energy by 2032, with 25 GW of power generated using concentrated solar power (CSP) and photovoltaic technology supplying the remaining 16 GW. Other investments in solar energy include the $600 million 100 MW Shams-1 CSP plant in Abu Dhabi, a 60 MW integrated solar combined cycle in Kuwait, and a 200 MW CSP plant in Oman.To increase economic value even further, Arab countries are urged to develop local manufacturing capacities of solar and wind systems.

For Arab oil-importing countries, the shift to green energy sources, coupled with improved energy efficiency, would foster desperately needed energy security and economic sustainability. In addition, renewable energy technologies could contribute to providing improved energy services for the rural poor, thereby alleviating poverty while improving environmental quality and mitigating climate change. However, widespread diffusion of such systems would involve overcoming large institutional, technical, and financial barriers.

Since water is a production factor for biocapacity through its potential to increase the area of productive land, the interconnections between water, energy, food, and climate change become highly important and a source of concern. There is a need to ensure that the future use of water and energy production is closely considered, together with plans for climate change mitigation and adaptation. Furthermore, due to large disparities in water and energy endowments across Arab countries, regional cooperation is critical. For example, creating efficient regional power grid networks would increase the possibilities for individual countries to get access to power more cost-effectively.

DRIVERS OF ECOLOGICAL FOOTPRINT

Population

The two main drivers of ecological footprint are population and per capita consumption. In 2010, the Arab world's population reached 357 million persons, and UN agencies estimate that it will increase to 633 million by 2050, compared to below 100 million in 1960. Despite the fact that the Arab region has witnessed one of the highest rates of population increase over the past 50 years, the average annual rate of population change is projected to decline from 1.9 percent between 2010-2015 to 0.7 percent between 2045 and 2050.

Total fertility rates (TFR) in Arab countries have experienced a substantial and rapid decline, particularly between 1980 and 2010. However, because the onset of fertility decline was relatively recent, the Arab region is expected to witness rapid growth in its population over the next few decades, albeit at a declining rate.

Another key trend affecting Arab demographic change is the rising rate of urbanization. The proportion of urban population in Arab countries grew from 38 percent in 1970 to 55 percent in 2010. By 2050, 66 percent of the Arab population, or 423 million people, are expected to live in urban areas.

Therefore, the implications of the demographic transitions in population size, rate of growth, and urban density on the ecological footprint and the demand for resources are going to be significant over the next few decades. Planners and municipal officials in Arab countries will have to take the concept of sustainable urbanization seriously as a pre-requisite to improving the quality of life and meeting the rising demand for energy, water, transportation, housing, waste management services, and other urban amenities without causing environmental damage.

While it is acknowledged that larger populations place greater pressures on ecological resources and lead to a smaller share in per capita biocapacity, influences of social institutions such as markets, policies, and incentives cannot be ignored.

The situation in member countries of the GCC offers a distinct case study of the impacts of population and consumption on the ecological footprint of these countries, because of the large influx of labor migration over the past four decades. What is notable is the growth of the foreign population by nine-fold between 1975 and 1990, at an annual growth rate 4.5 times faster than national population growth. While the foreign population in GCC countries represented 9.7 percent of the total in 1975, by 1990 it had soared to 36.6 percent and reached 42.7 percent in 2010. In some countries it is around 90 percent.

Clearly, the policies of rapidly rising economic growth have fueled the demand for labor in the GCC states, causing a surge in the influx of expatriate workers. Available statistics should be worrying to economic planners in the GCC region, given its large biocapacity deficit. Rapid population growth, caused in this case by the rapid influx of expatriate workers, accelerates resource use and waste generation and quickens the pace of environmental degradation.

More challenging trends pertain to employment figures and rates of labor participation by national citizens in the region's economies. According to the most recent surveys (2001-2011), the unemployment rate in the GCC region was 4.6

percent, soaring to an alarming level of 23.3 percent among youth (those aged 15-24), which is double the world average of 11.9 percent. The high proportion of migrant workers has also reduced the share of national citizens in the workforce. For example, the proportion of Qatari national citizens in the labor force has declined from 14 percent in 2001 to 6 percent in 2009.

The demand for expatriate workers in GCC countries was a necessity in the early period of state and institutional building, especially with the advent of oil, when only low levels of education and skill were available locally. It can also be argued that a large expatriate workforce was needed to harness oil in a more efficient manner and to secure proper development, with the required infrastructure. Given that the GCC countries have already achieved comparatively high standards of living by undertaking infrastructure investments to support social and economic development, even achieving a higher per capita GDP in 2008 than the European Union countries as a group, it is now imperative to re-evaluate current economic development structures and to accord a higher priority to social and environmental goals.

GCC countries are taking serious steps towards economic diversification and transitioning to a knowledge economy. This requires preconditions such as the creation of a robust industrial base, a strong higher educational system, and a sound research and development infrastructure. However, the most critical prerequisite is a demonstrated willingness on the part of national citizens to embrace opportunities in all these spheres. Actions by all GCC governments to seriously invest in higher education and research are commended. As the number of national citizens enrolled in these universities increases over time, the path to a knowledge economy will become more plausible, leading to a more balanced workforce.

Per capita consumption

As population growth continues to slow down in Arab countries over the next few decades, the per capita consumption rate is quickly becoming a source of even more serious concern. Prior to the global financial crisis of 2008, most Arab countries experienced extraordinarily high rates of economic growth, as measured by a fast rising GDP.

Political leaders, policy makers, and economic planners in Arab countries must address what level of GDP growth is needed to attain a sufficient level of wellbeing. New research by economists has emerged which questions the relationship between economic growth and societal wellbeing, revealing that “economic growth, beyond a certain level, provides little improvement in societal wellbeing” (Brown, 2012). Pursuing growth for the sake of more growth without addressing ecological limits and social inclusion will not turn out to be in the best long-term national interest of Arab countries.

Nations can no longer achieve real prosperity by pursuing a development policy predicated on high per capita GDP growth with the concurrent high per capita consumption. By adopting policies of unquestioned and excessive economic growth, Arab countries will generate substantial GDP growth in the short-term but will incur long-term social and environmental costs, ultimately rendering them vulnerable to economic insecurity. The findings of this report reveal the fundamental fact that biophysical and economic limits are already being felt in Arab countries. Economist Herman Daly has described this scenario as 'uneconomic growth', where the costs of growth exceed the benefits.

While setting development targets is a national right, limits to growth have to be considered according to the constraints of natural resources, and the capacity of nature to sustainably support life in a certain geographical area. The challenge is to provide sustainable wellbeing for a country's citizens, not seek growth for the sake of growth itself. In other words, the goal should be to construct a building capable of best providing shelter to those who need it, rather than constructing buildings and then searching for people to occupy them. The goal should be to generate real wealth, not solely to increase income, since income with hidden costs leads to wealth loss.

CONCLUSION

Given the challenges facing Arab countries, this report has made it clear that short of transformative actions, survival options are limited. Such a transformation should be guided by economic restructuring which is committed to the principles of sustainability and fair distribution. A strong commitment should be made to match economic consumptive activities with resource availability. Arab countries need to give priority to restoring and nurturing the regenerative capacity of the region's ecological endowments, including topsoil, fisheries, and aquifers. Current patterns of urbanization and tourism should be replaced with models that are more ecological in design and more attuned to the region's climate and hydrological cycles.

The Arab region has one of the greatest variations in ecological footprint, biocapacity, and income of any region in the world. In order to pursue sustainable wellbeing for all residents in the region, attention should be given towards more regional economic cooperation and towards more Arab trade devoid of barriers, where the free flow of goods, capital, and people works to the benefit of all countries. Regional programs in scientific research geared for development are key to achieving sustainable and prosperous economies for all, based on sound resource management. One fundamental option is to make good use of the present income from the region's finite oil resources to build a strong science and technology base and a compelling research and development infrastructure, which can help to extract and use resources more efficiently and develop unconventional resources, as a strategy to securing survival and a decent quality of life.

The AFED 2012 report, which examines Ecological Footprint and survival options in Arab countries, has reached the conclusion that Arab countries suffer from deficits in natural resources at different levels. Diversity in resources in different parts of the region can bridge the deficit if Arab countries work together to develop their resources within regional and sub-regional groups. No Arab country can survive as an isolated independent entity, and neither can any be self-sufficient in life-supporting resources.

The world has been moving towards regional alliances and trading blocs based on practical interests. Arabs cannot afford to miss out on this process, remaining as fractured entities. Sustainable growth of Arab countries is only possible through cooperation mechanisms, anchored in common interests, and based on interdependence among different components. Achieving this requires a shift from the rhetoric about one Arab nation, which, over the years, failed to achieve any meaningful cooperation at the political, social, or economic levels, to practical measures based on the common struggle for survival and achieving wellbeing for the Arab populace.

The findings of this AFED report make it clear that the Arab region is rapidly approaching a situation where the imbalance between domestic supply and demand for ecological services places a limit on future growth and wellbeing. From an economic security perspective, ecological deficits cannot be addressed by relying on imports indefinitely. Over-exploitation of local renewable and non-renewable resources, as a strategy to boost biocapacity, causes depletion and unrecoverable losses in the economic value of natural capital assets.

This report thus seeks to promote the concept of Ecological Footprint and encourage government planners and decision-makers to incorporate ecological accounting when making policy decisions about economic development and investment, so that the region can achieve a competitive advantage well into the future.

We hope that political leaders in the Arab region will consider the messages of this report. Losing another 50 years on rhetoric is not an option that Arabs can afford. Regional cooperation, resource efficiency, and balanced consumption are the options for survival.

OPINION

ARAB REGIONAL COOPERATION FOR SUSTAINABLE DEVELOPMENT

Mostafa K.Tolba

The search for sustainability options in the Arab region requires serious consideration of two principal points: pursuing alternative patterns of development and advocating Arab regional cooperation to achieve sustainable development.

Alternative Patterns of Development and Lifestyles

The fundamental question the global community is confronted with is how to meet the basic human needs of all people without simultaneously destroying the resource base – the main component of the environment – from which those needs are met. The Arab region is not different in that respect.

Since Stockholm we have looked upon the environment as the stock of physical and social resources available at a given time for the satisfaction of human needs, and upon development as a process pursued by all societies with the aim of increasing human wellbeing. Thus, the ultimate purpose of both environment and development policies is the enhancement of the quality of life, beginning with the satisfaction of basic human needs.

Today, there are hundreds of millions of people without the basic human needs of adequate food, shelter, clothing and health; hundreds of millions more lack access to even a rudimentary education or regular employment. Almost half of the world's rain forests have been destroyed, and every year we are losing some six million hectares of arable land to desertification. Further, coastal areas and breeding grounds for over two thirds of the world's fisheries are being degraded or destroyed, and over 1,000 animal and some 25,000 plant species are threatened with extinction. Finally, large segments of the atmosphere, soil, rivers, and oceans are polluted.

The Arab world suffers from all these problems in one way or another.

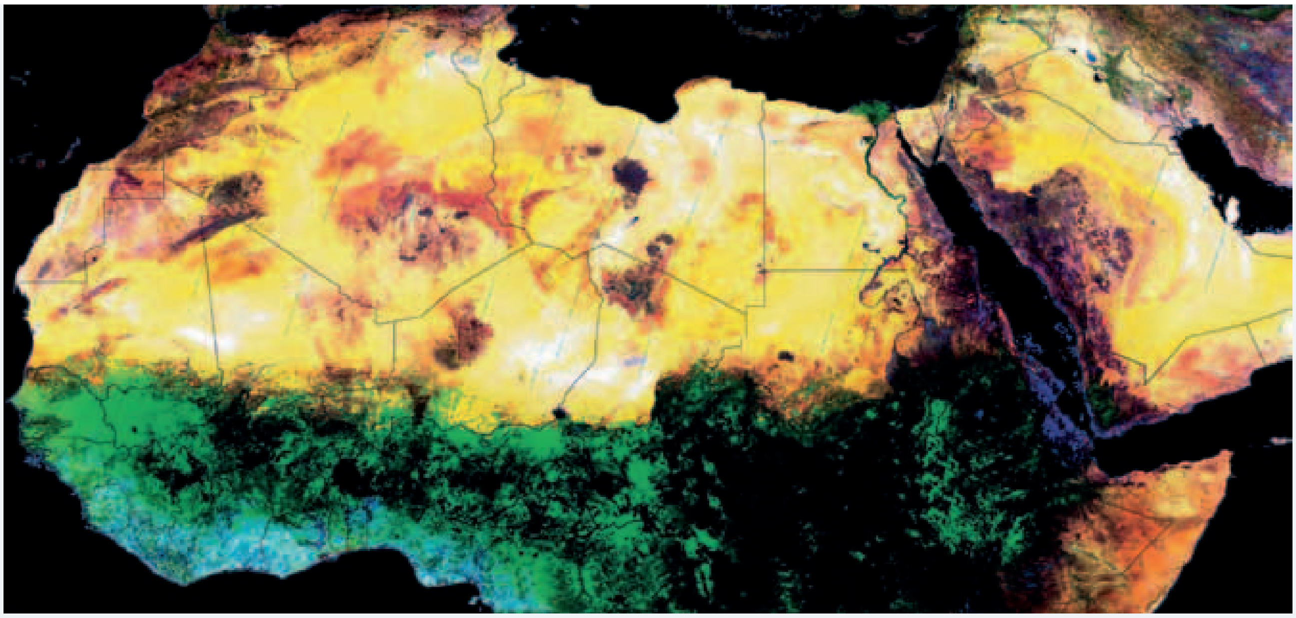
Agricultural runoffs, hazardous waste dumps, particulates emissions, toxic chemicals, CO_2 build-up in the atmosphere, and ozone depletion all plague our environment. If we add such dimensions as the energy-intensive nature of much of modern agriculture, the limited capacity of land to provide employment under certain development patterns, or the increased resistance of agricultural pests, the questions multiply.

Similar questions arise when discussing the resource base for industrial development. Were developing countries to succeed in consuming minerals at the rate prevailing in developed countries during the 1980s, known recoverable resources of copper would have been exhausted in 9 years, bauxite in 18 years, zinc in 6 months, lead in 4 years, petroleum in 7 years, and natural gas in 5 years.

To survive on Earth, humans must adopt alternative patterns of development and lifestyles. Humans must learn to become less arrogant in their wants for, and less wasteful in their use of, natural resources. Wastefulness is the particular form of irrationality in which a given level of fulfillment of human needs is achieved with the use of more resources than is necessary. Three examples capture this behavior: pollution of the environment by effluents from industry; destruction of nature by exceeding its capacity to reproduce itself; and the adoption of lifestyles based on conspicuous over-consumption. The latter is most glaring in a number of Arab countries.

Making development sustainable is our only real option, and the only way to do so is to dematerialize as fast as we grow.

The word dematerialization denotes acts that reduce the consumption of materials (energy, water, land, forests, minerals, etc.) for each unit of economic output. Dematerialization rate is measured by the rate of decrease



in material intensity, which in turn is defined as the quantity of consumed material (e.g. ton of oil equivalent in the case of energy) per unit of economic output (e.g. dollars).

This definition furnishes the criteria for meeting sustainable development goals, and spells out the size of our task. It even lets us monitor how close or distant we are from our target.

Dematerialization is not a new concept. A part of the evolution of our economic logic has always been to become more efficient, to use less energy and materials to produce more goods and services. Neither is this concept new to sustainable development.

Historically, each new generation of technologies has almost always been more efficient and less material intensive than the last. But if technology as such is good to the environment, how is it that the changes brought about have been detrimental overall? Technology by itself is not bad. The trouble is that it has always done a lot more for the growth side of the equation than for the dematerialization side.

A new kind of development is therefore needed because it is essential to relate development to the limitations and opportunities created by the natural resource base. An alternative model of development is required because past patterns of development in both developed and developing countries have been characterized by serious environmental damage. This is very true for the case of development in the Arab region.

Arab Regional Cooperation to Achieve Sustainable Development

The Arab world faces major shortages in natural resources, particularly arable land and water, and suffers from pollution of air, water, and soil. No development can be achieved without the rational use of these resources in agriculture, industry, and human settlements. Arab countries also face two major problems: fast growing populations driven in large part in some countries by labor migration, and wasteful over-consumption by the rich.

As the GFN-AFED study on the Ecological Footprint in the Arab countries demonstrates, with the exception of Mauritania and Sudan, who are creditor countries, all Arab countries have a debtor status; that is, they use much more of the Earth's biocapacity than is available to them. Arab countries, in general, have low levels of biocapacity and consume much more than what is locally available by importing significantly from other countries.

Regional cooperation can help reduce the Ecological Footprint of Arab countries. Arab countries are endowed with resources that are complementary, which can be harnessed through trade and regional integration to satisfy their needs and reduce ecological deficits. Some examples are provided.

1- Food self-sufficiency in Arab countries has been debated for decades, but has gained more steam following the 2007-2008 global rise in food prices. It has always been suggested that countries endowed with agricultural resources can benefit from investments from oil-producing countries to satisfy the basic food needs of all Arab countries. There is an urgent need today to re-examine the conditions conducive to making such cooperation possible. In another part of this AFED report, a study on the prospects of Arab countries becoming self-sufficient in cereals is presented. Supported by data on the availability of agricultural land, available water resources, and projected demand at the current rate of consumption and population growth, the study concludes that improving water irrigation efficiency and crop yields can enable Arab countries to produce a surplus in cereals by 2030 and 2050. By pooling resources from Arab countries endowed with financial resources with countries endowed with agricultural resources, such desperately needed investments in agricultural infrastructure and sustainable agricultural practices can become a reality. Any plan should also take into consideration the carrying capacities of the areas to be cultivated and the full rights of Arab farmers.

2- The second issue requiring regional cooperation in the Arab world is the management of scarce freshwater resources. Available water in our region is projected by 2050 to fall down to almost 300 m^3/capita/year; far below what the United Nations considers to be the level of water poverty of 1000 m^3/capita/year. In addition, two thirds of renewable water resources originate outside the Arab world, while most groundwater aquifers are shared by two or more states.

   Therefore, regional cooperation is required both politically and technically to set up joint management of these shared water resources. Arab countries should seek stable, sustained relationships with regional countries as a precursor to making better use of regional water resources. They should also create an industry base for the design, manufacturing, building, operation, and maintenance of water-desalination technologies.

3- Renewable energy (solar, wind, and bio-energy) is an open field for regional cooperation. The Arab world has the highest concentrations of solar energy, reasonable wind resources, and significant amounts of unexploited waste materials (e.g. agricultural waste). Although the region claims a wealth of talented scientists, they are either underutilized or work in isolation. The Arab world has an opportunity to combine their financial and human resources to create a regional research and development (R&D) infrastructure to meet technological needs in renewable energy, water desalination, and agriculture, to name a few.

Arab countries certainly need to concentrate on the local development and manufacturing of those technologies critical for the region's development. Specifically, teams of scientists, economists, and sociologists from Arab countries should conduct well-planned, well-financed, long-term R&D programs in:

a- Identifying and addressing the wasteful use of energy.
b- Establishing infrastructure for photovoltaic cell manufacturing locally.
c- Converting biomass waste materials into energy or bio-based products.
d- Manufacturing components of wind energy technology.

Otherwise, the prohibitive cost of purchasing these technologies from multi-national corporations will remain a drag on the region's economies. Arab countries have no option but to depend on their integrated national capacities – whatever it takes, time and money, to reach there.

4- The fourth major problem we face in the Arab world is the loss of biodiversity. We have lost and are still losing thousands of our endemic animals and plants, and we do not have any mechanism of regional cooperation to stop this.

These issues need to be carefully studied in technical, economic, and social terms by multi-sectoral groups from all Arab countries. To provide weight to such an endeavor, pan-Arab institutions should take the lead in initiating these joint efforts. Specifically, the League of Arab States (LAS) and regional organizations such as the Arab Forum for Environment and Development (AFED) are well-positioned to launch an Arab regional cooperation strategy. With AFED acting as a referral center, this would include the establishment of a database of who is doing what in these areas in each Arab country.

Above all, there needs to be sufficient political will. Therefore, the point of departure in regional cooperation in the Arab region is to study means of securing political will. And, here, I think, we have to rely upon the youth the owners of the future, to make this happen.

Dr. Mostapha Kamal Tolba is former Executive Director of the United Nation Environment Program (UNEP)

Food Security and Agricultural Sustainability

Abdul-Karim Sadik

I. INTRODUCTION

Food is indispensable to human life. For their food supply, humans depend on agriculture; an activity that exploits the planet's finite natural resources of land and water. Arab countries have long been pursuing food self-sufficiency, but the progress achieved neither kept pace with population growth, nor was sufficient to reduce the food deficit. The recent world food crisis in 2007-2008 has raised even deeper concerns over food security.

Land and water are the bounty of nature, which is the very source of people's lives and wellbeing. The Arab region, with its arid and semi-arid climate, has limited cultivable land and is the world's poorest in freshwater resources in absolute and in per capita terms. To sustain the services provided by these natural resources, users must ensure that land and water are used rationally and in measured terms that do not exceed natural replenishment limits or the capacity to assimilate discharged waste. In other words, the load imposed by a country's population on nature's resources, or its 'Ecological Footprint', must not exceed its limited 'ecological biocapacity' to deliver the desired resources.

Past agricultural policies and practices in Arab countries have greatly undermined the biocapacity of their agricultural resources, which are currently marked with inefficient use, low productivity, land degradation, soil erosion, depleted water aquifers, and polluted water resources. Pursuing a policy of food self-sufficiency on the basis of business-as-usual, with no regard to environmental values, is detrimental to the role of agriculture as a provider of food and as a contributor to socio-economic development.

In view of the current precarious state of agriculture, the increasing scarcity of water resources, and the likely impact of climate change, Arab countries face daunting challenges and constraints to their aspirations for food self-sufficiency at national, sub-regional, and regional levels. It is imperative that Arab countries develop a new green revolution based

on agricultural policies and practices capable of restoring and maintaining a balance between the demand for agricultural resources and agricultural biocapacity, while at the same time strengthening regional cooperation based on comparative advantage in agricultural resources.

Under this paradigm, several options for enhancing food self-sufficiency are available, including raising irrigation efficiency, boosting crop and water productivity, alleviating water scarcity through the use of non-conventional water resources, and developing rain-fed agriculture. In addition, the virtual water concept is a tool for policy-makers to consider alternatives for food security.

II. FOOD SECURITY

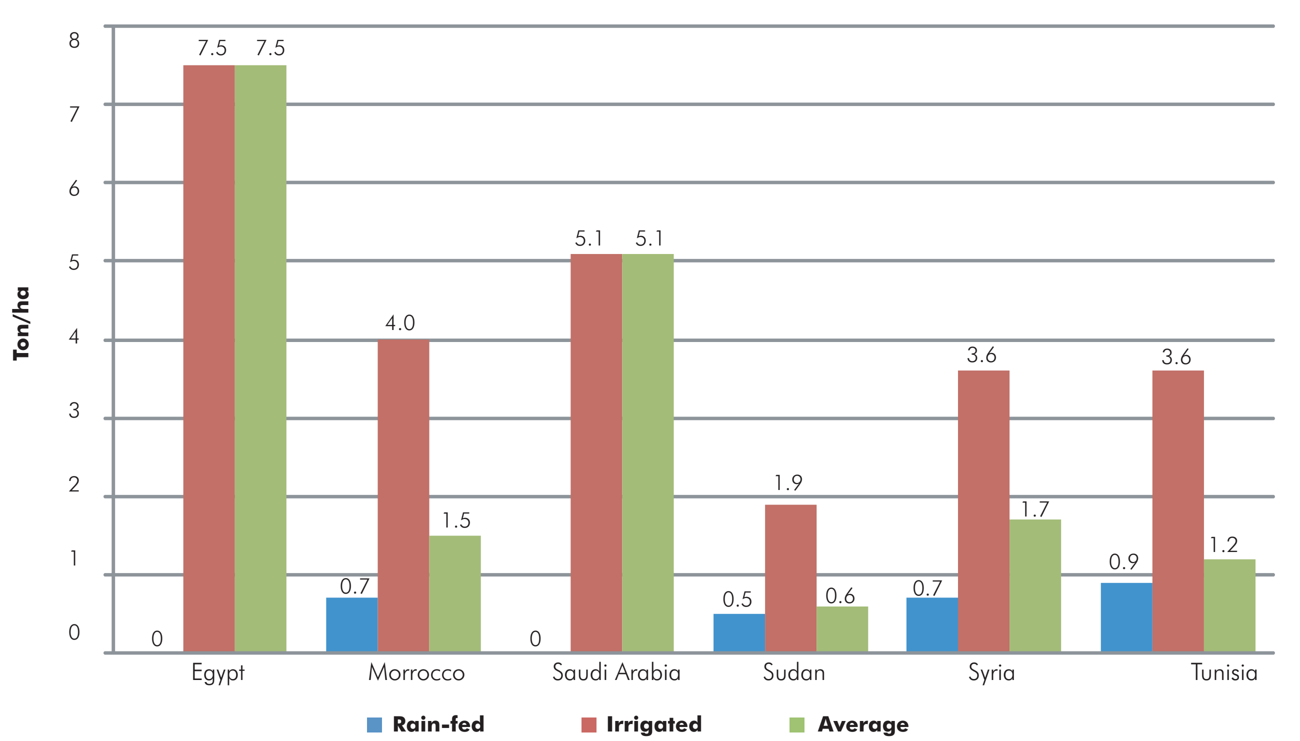
Arab countries procure their food supplies domestically and through imports from other countries. As a group, they are almost self-sufficient in fruits, vegetables, and red meat. In 2010, they were net importers of cereals, oils and fats, and sugar, with a self-sufficiency ratio of 48.2 percent, 25.8 percent, and 34.6 percent, respectively (AOAD, 2010a). Arab countries accord self-sufficiency in cereals high priority because they constitute the basic food staple and main food intake in the region. "Cereals are still by far the world's most important sources of food, both for direct human consumption and indirectly, as inputs to livestock production. What happens in the cereal sector is therefore crucial to world food supplies" (FAO, 2002). As the largest importers of these commodities, Arab countries are vulnerable to global food prices and supplies. The world food crisis in recent years has brought to the fore the risks encountered by countries dependent on staple food, such as Arab countries, and heightened their concern about food self sufficiency, but do Arab countries, individually or as a group, have the ecological biocapacity in terms of natural land and water assets to achieve food self-sufficiency? What options do they have towards achieving food security in the long-term?

In what follows, these questions are addressed by focusing on the available potential for attaining self-sufficiency, particularly in cereals, which are of highest concern to Arab countries in their pursuit for food security. The available biocapacity of land and water is a crucial determinant of the extent of domestic food supply.

A. Land

Despite a vast cultivable area in the Arab region of about 197 million hectares (ha) (GSLAS et al., 2011), the cropland area (arable land and permanent crops) increased by only 16.3 million ha – from 49.32 million ha in 1961 to 65.6 million ha in 2008 (FAO, FAOSTAT), or an increase of 0.61 percent annually. Seven countries (Algeria, Egypt, Iraq, Morocco, Sudan, Syria, and Tunisia) accounted for 87 percent of all cropland in 1961, and 85 percent in 2008. The overall contribution of these seven countries to Arab agricultural gross domestic product (GDP) amounted to 85 percent in 2008 (Sadik et al., 2011). They had a 91 percent

FIGURE 1 PRODUCTIVITY OF RAIN-FED AND IRRIGATED CEREAL IN SELECTED ARAB COUNTRIES



Source: GSLAS et al., 2011

share of land cultivated with cereals in 1990-92 and 2008-2010, as illustrated in Table 1.

Relative to the world average, cereal productivity is low in Arab countries. With a land area of 27.3 million ha dedicated to cereals, the Arab region uses twice the world's average land area (13.9 million ha) needed to produce the same amount of cereals. The source of growth in cereal production everywhere over the last two decades was not due to expansion in land area, but rather as a result of boosting yields. Despite a decline in the area cultivated with cereals, an increase in the production of these crops in the world and in the Arab region over the period 1990-2010 was achieved through boosting yields. However, average cereal productivity in the Arab region remains at about only half that of the world average. While most Arab countries boosted their productivities, cereal productivity in Sudan, whose share of regional land under cereal cultivation amounted to 29 percent, stagnated at around 450 kg/ha, with a share of total cereal production in the region of only 7.2 percent. The annual quantity of cereal production fluctuates widely among countries of the region (Table 1), depending on weather conditions, irrigation variations, and disparity in the use of agricultural inputs such as fertilizers, pesticides, and machinery.

Irrigation is critical for maintaining and raising land productivity. In Arab countries, higher yields are generally associated with higher levels of irrigation. Higher yields in countries of the Gulf Cooperation Council (GCC) and in Egypt corresponded with an irrigation ratio of a 100 percent and 95 percent, respectively, of the cultivated area in 2007 (AOAD, 2007). In Sudan the irrigation ratio is low at only 10 percent of the cultivated area (AOAD, 2007), while fertilizer use has averaged about 8 kg/ha of arable land over the period 2007-09, compared with an average of 503 kg/ha in Egypt, 1,033 kg/ha in the United Arab Emirates, and 122.1 kg/ha in the world (World Bank, 2012a).

The rise in yields through irrigation accounted for the major increase in crop production. In 1997-99, only 20 percent of the total arable land in developing countries was irrigated, but it produced 40 percent of all crops and close to

60 percent of cereal production (FAO, 2002). Arab countries are heavily dependent on rain-fed agriculture, with only 27 percent of the cultivated area irrigated (AOAD, 2007).

At least 80 percent of cereal production is rain-fed in the Maghreb countries (Algeria, Libya, Mauritania, Morocco, and Tunisia), Sudan, and Yemen. In the Mashreq countries (Iraq, Jordan, Lebanon, and Syria), the proportion of rain-fed cereal production ranges from one-half to two-thirds (World Bank et al., 2009). The yield of rain-fed cereal production is low with 0.7 ton/ha in Morocco and Syria, 0.5 ton/ha in Sudan, and 0.9 ton/ha in Tunisia, as illustrated in Figure 1.

TABLE 1 **CEREAL PRODUCTION IN ARAB COUNTRIES**

Country/ Sub-Region	Area (1,000 ha)		Productivity (kg/ha)		Production (1,000 Ton)	
	1990-1992	2008-2010	1990	2010	1990	2010
Bahrain	0.0	0.0	0.0	0.0	0.0	0.0
Kuwait	0.3	1.1	3,653	3,415	1.10	3.76
Oman	2.8	3.1	2,160	18,987	6.05	58.86
Qatar	1.2	2.1	2,897	4,795	3.48	10.07
Saudi Arabia	1,121.9	317.4	4,245	5,631	4,762.47	1,787.28
United Arab Emirates	1.4	0.0	2,216	0.0	3.10	0.00
GCC	**1,127.6**	**323.7**	**4,236**	**5,746**	**4,776.20**	**1,859.97**
Yemen	730.0	927.3	908	1,092	662.84	1,012.61
GCC & Yemen	**1,857.6**	**1,251.0**	**2,928**	**2,296**	**5,439.41**	**2,872.58**
Iraq	3,919.5	2,555.5	1,061	1,687	4,158.59	4,311.13
Jordan	121.1	44.5	1,220	1,963	147.74	87.35
Lebanon	42.1	64.9	1,878	2,740	79.06	177.83
Syria	3,712.6	2,620.6	750	1,789	2,784.45	4,688.25
West Bank & Gaza	0.0	32.5	0	1,163	0.00	37.80
Levant	**7,795.3**	**5,318.0**	**920**	**1,749**	**7,169.84**	**9,302.36**
Egypt	2,477.1	2,967.1	5,703	6,541	14,126.90	19,407.80
Sudan	8,258.8	7,886.4	456	452	3,766.01	3,564.65
Nile Valley	**10,735.9**	**10,853.5**	**1,667**	**2,117**	**17,892.91**	**22,972.45**
Algeria	3,530.5	2,988.8	638	1,568	2,428.98	4,686.44
Libya	287.7	329.0	674	662	193.91	217.80
Mauritania	123.6	291.5	870	946	107.53	275.76
Morocco	5,019.6	5,059.7	1,120	1,548	5,621.95	7,832.42
Tunisia	1,469.9	651.8	1,145	1,702	1,683.04	1,109.36
North Africa	**10,430.8**	**9,320.8**	**962**	**1,515**	**10,035.41**	**14,121.78**
Comoros	0.00	0.00	0.00	0.00	0.00	0.00
Djibouti	0.00	0.00	0.00	0.00	0.00	0.00
Somalia	401.6	596.3	793	432	318.47	257.60
African Horn	**401.6**	**596.3**	**793**	**432**	**318.47**	**257.60**
Arab Countries	**31,221.2**	**27,339.6**	**1,309**	**1,812**	**40,856.04**	**49,526.77**
World	**699,721.0**	**681,889.9**	**2,756**	**3,568**	**1,928,430.00**	**2,432,980.00**

Source: World Bank, 2012a and author's calculations

Therefore, the prospects for increasing cereals production depend more on increasing the amount of irrigated land area, rather than expanding rain-fed land area, in the absence of developing drought-resistant and salt-tolerant crop varieties.

In addition to limited irrigation and inadequate quantity and quality of agricultural inputs, the relatively low cereal yields in most Arab countries could be attributed to land degradation. Sarraf and Jorio produced estimates of the impact of land degradation on crop productivity in terms of losses in cereal yields in Morocco, where most agricultural land is cultivated with cereals. The cost of cropland and rangeland degradation was US$134 million in 2000, the equivalent of 0.4 percent of GDP, with cropland degradation accounting for 88 percent of this cost. These cost estimates do not capture other effects, such as the impact of salinity on irrigated soil. Thus the average cost estimates referred to here most likely underestimate the total cost of land degradation (Sarraf and Jorio, 2010).

If Arab countries aspire to achieve self-sufficiency in cereals under business-as-usual, land availability will fall far short of the needed area. With the Arab population projected to reach 503 million and 633 million in 2030 and 2050 (UN, 2011), respectively, using an average consumption of cereals of 300 kg/capita in 2008 (AOAD, 2009) and a current cereal productivity of 1,812 kg/ha, the land area required to attain self sufficiency in cereals is estimated at 83 million ha and 105 million ha in 2030 and 2050, respectively. Despite the potential to increase the cultivated area in the Arab region by about one million ha annually, horizontal expansion is constrained by the limited area suitable for agriculture (GSLAS et al., 2011). It is obvious that expansion in cereal production is severely constrained by land availability, especially under current productivity levels. Prospects for enhancing food self-sufficiency will therefore have to depend primarily on increasing crop yields through irrigation. The next section will address whether the available water resources are sufficient to meet rising water demand for all uses.

B. Water Resources

Water is a very precious finite natural resource. It is vital for human survival as a commodity for direct consumption and as an essential intermediary in the production of food and other goods and services necessary to sustain life and achieve environmentally sustainable economic and social development. It is a resource unevenly distributed among regions and nations of the world depending on geographical location and climatic conditions.
The Arab region, with an arid and semi arid climate is the world's poorest in natural water resources in absolute and in per capita terms. The per capita average in the region of about 840 m^3 in 2010 is only about 12 percent of the world's per capita average of over 7,000 m^3. The regional per capita average of water availability calculated here covers the 22 member countries of the League of Arab States. The same per capita average calculated in the AFED (2010) Report Water: Sustainable Management of a Scarce Resource excluded the high per capita water availability countries of Comoros, Mauritania, and Somalia, resulting in even a lower regional per capita average figure. (AFED, 2010)

As Table 2 indicates, the average water share per capita declined in 2010 to below the water stress level of 500 m^3 in 12 Arab countries. The situation is projected to worsen with the region's population increasing at a projected growth rate of 1.7 percent over the period 2010-2030, and 1.1 percent over the period 2030-2050. Accordingly, 13 Arab countries are projected to suffer from water stress, and the number rises to 14 in 2050, in which year the average share of water per capita in the region will fall to 474 m^3. These projected water levels and their increasing scarcity over time indicate the serious challenges facing Arab countries not only in their endeavor to attain food self-sufficiency, but also in their aspirations for sustainable development. When considering food self-sufficiency, even in cereals alone, against the increasing scarcity of water and current agricultural practices, challenges need not be overemphasized.

Agriculture is the source of food, and cultivating crops requires water either in the form of rainfall, irrigation, or both. In the dry Arab region, irrigation is critical for food self-sufficiency, but the increasing scarcity of the available natural water resources and the competing demands by domestic and industrial sectors greatly constrain the potential for irrigation.

Agriculture in the Arab region annually consumes about 85 percent (218 billion m^3) of total water use, with six countries (Algeria, Egypt, Iraq, Morocco, Sudan, and Syria) consuming about 80 percent (176.5 billion m^3) of that amount, as illustrated in Table 3.

These same countries are endowed with about 85 percent of all natural water resources in the region. To satisfy their domestic and industrial demand and keep pace with population growth only, while

TABLE 2 **RENEWABLE WATER RESOURCES AND PER CAPITA SHARE**

Country/ Sub-Region	Natural Water Resources (million m³)	Average share (m³/capita)		
		2010	2030	2050
Bahrain	116	92	70	64
Kuwait	20	7	5	4
Oman	1,400	503	389	374
Qatar	58	33	24	22
Saudi Arabia	2,400	87	62	53
United Arab Emirates	150	20	14	12
GCC	**4,144**	**95**	**68**	**59**
Yemen	2,100	87	51	34
GCC and Yemen	**6,244**	**92**	**61**	**47**
Iraq	75,610	2,387	1,368	907
Jordan	937	151	111	95
Lebanon	4,503	1,065	958	963
Occupied Palestinian Territory	837	207	124	86
Syria	16,800	823	603	508
Levant	**98,687**	**1,483**	**958**	**701**
Egypt	57,300	706	538	464
Sudan	64,500	1,481	965	709
Nile Valley	**121,800**	**1,062**	**775**	**635**
Algeria	11,670	329	268	251
Libya	600	94	77	68
Mauritania	11,400	3,295	2,192	1,609
Morocco	29,000	908	773	740
Tunisia	4,595	438	376	363
North Africa	**57,265**	**653**	**539**	**501**
Comoros	1,200	1,663	1,034	706
Djibouti	300	337	238	185
Somalia	14,700	1,575	899	521
African Horn	**16,200**	**1,479**	**862**	**514**
Arab Countries	**300,196**	**840**	**597**	**474**

Source: FAO, AQUASTAT; UN, 2011; and author's calculations

keeping agricultural consumption constant with an irrigation efficiency of 40 percent, projections show a positive water balance of 33 billion m³ and 22 billion m³ in 2030 and 2050, respectively (Sadik et al., 2011). Even if all the water balances mentioned were allocated to cereal production, with an irrigation requirement of 1,500 m³ per ton, an additional quantity of only about 22 million tons and about 14 million tons of cereals could be produced by the years 2030 and 2050, respectively. These are small amounts relative to projected demand for cereals in these countries of 101 and 119 million tons in 2030 and 2050, respectively (Sadik et al., 2011).

TABLE 3 **WATER WITHDRAWAL AND USES OF NATURAL WATER RESOURCES (2009)**

Country/ Sub-Region	Withdrawal	Agriculture	Industry	Domestic
	million m³			
Bahrain	400	180	24	196
Kuwait	900	486	18	396
Oman	1300	1,144	26	130
Qatar	400	236	8	156
Saudi Arabia	23,700	20,856	711	2,133
United Arab Emirates	4,000	3,320	80	600
GCC	**30,700**	**26,222**	**867**	**3,615**
Yemen	3,600	3,276	72	252
GCC and Yemen	**34,300**	**29,498**	**939**	**3,863**
Iraq	66,000	52,140	9,900	3,960
Jordan	900	585	36	279
Lebanon	1,300	780	143	377
Syria	16,800	14,784	672	1,344
West Bank and Gaza	400	180	28	192
Levant	**85,400**	**68,469**	**10,779**	**6,152**
Egypt	68,300	58,738	4,098	5,464
Sudan	37,100	35,987	371	742
Nile Valley	**105,400**	**94,725**	**4,469**	**6,206**
Algeria	6,200	3,968	868	1,364
Libya	4,300	3,569	129	602
Mauritania	1,600	1,504	32	64
Morocco	12,600	10,962	378	1,260
Tunisia	2,900	2,204	319	377
North Africa	**27,600**	**22,207**	**1,726**	**3,667**
Comoros	-	-	-	-
Djibouti	-	-	-	-
Somalia	3,300	3,267	17	17
African Horn	3,000	3,267	17	17
Total Arab Countries	**256,000**	**218,166**	**17,930**	**19,905**
Percentage	100.0	85.2	7.0	7.8

Source: World Bank, 2012a and author's calculations

The above analysis, rough as it may be, is quite indicative that water scarcity in the region, coupled with low efficiency of water use, especially in irrigation, and generally a low average of crop yields, particularly for cereals, pose serious challenges for food self-sufficiency. The World Bank et al. (2009) refer to the particular challenges of agriculture in Arab countries due to water and land constraints. Arab countries use approximately 75 percent of exploitable renewable water resources compared to between 1 percent and 30 percent in other regions. In some areas, non-renewable sources such as fossil groundwater are depleted, with little or no potential for sustainable increase in water use in most Arab countries. Moreover, expansion of

arable land and permanent cropland, excluding Sudan, increased at a rate of 1.7 percent annually from 1995-2005 (6.7 percent in Sudan) compared to a worldwide increase of 2.3 percent. In addition to water and land constraints, cereal-yield growth in Arab countries lagged behind that of the rest of the world with an average increase of 14.5 percent from 1990-2007, compared to 21.5 percent worldwide (World Bank et al., 2009). The prospects for food self-sufficiency in the Arab region become even more constrained when accounting for the impact of a widening ecological or biocapacity deficit in cropland, notwithstanding the impact of climate change.

C. *Agricultural Footprint*

Agriculture can have a vast impact on natural resources, mainly land and water and their capacity to regenerate their services over time. At the global level, agriculture accounts for a major share of human use of land and water and has a profound effect on the wider environment through crop and livestock production, which are the main sources of water pollution, greenhouse gases, and biodiversity loss. In addition, agriculture threatens the basis of its sustainability through land degradation, salinization, water over-extraction, and reduction of genetic diversity in crops and livestock (FAO, 2002).

Agriculture in the Arab region has for decades been subjected to distortive policies, leading to its current precarious state. Disregard to the health of land and water resources and to the protection of ecosystems has often led to soil erosion, land degradation, salinization, depleted aquifers, and water pollution, constraining the capacity of land and water to regenerate their services over time.

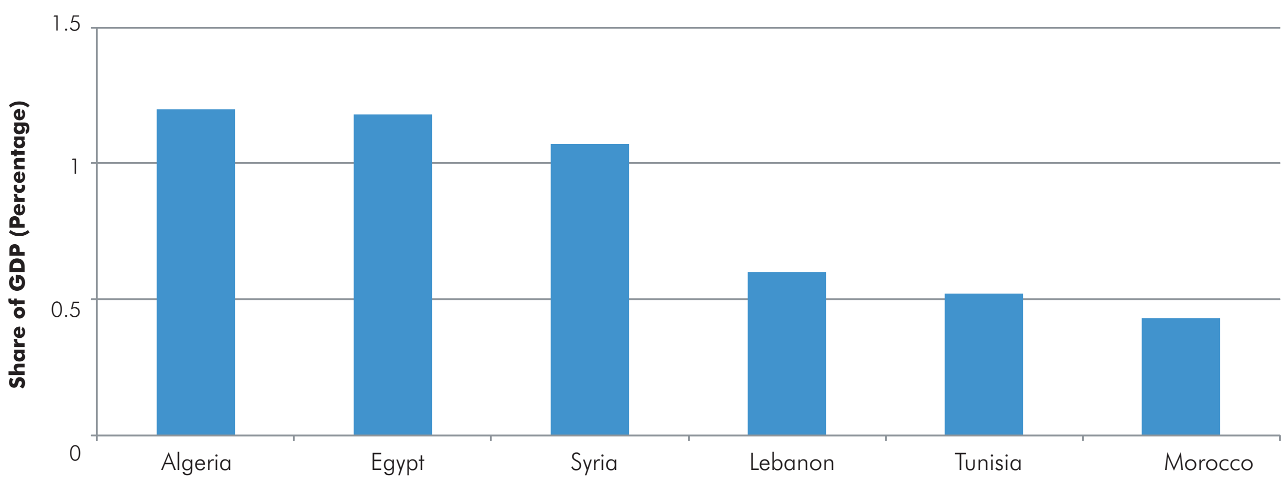
The inability to factor these costs in the agricultural gross domestic product (AGDP), led to overestimating the real potential of agriculture to contribute to the wellbeing of nations. For example, land degradation caused by inefficient irrigation, uncontrolled agriculture, overgrazing, logging for fuel, and mismanagement of water resources, depletes the bioproductive capacity of land. Notwithstanding the lack of precise data on the sources of degradation, Sarraf (2004) produced order of magnitude estimates of the annual costs of land degradation, which reveal the economic impact in six Arab countries, as indicated in Figure 2.

The wider impact of agriculture on the environment, including desertification, deforestation, depletion of water aquifers, water pollution, and loss of biodiversity imply additional costs beyond those estimated for land degradation. For example, the estimated environmental degradation costs constitute a sizeable portion of GDP, as illustrated in Figure 3. Continued neglect of the ecological effects of agriculture on the long-term productive capacity of land and the replenishment of renewable water resources will eventually exacerbate the already precarious status of agriculture in the Arab region.

i. Cropland Footprint

The survey prepared for the 2012 Annual Report of the Arab Forum for Environment and

FIGURE 2 **ANNUAL DAMAGE COSTS FROM LAND DEGRADATION**



Note: Dates for estimates are 1999 for Algeria, Egypt, and Tunisia, 2000 for Lebanon and Morocco, and 2001 for Syria
Source: Sarraf, 2004

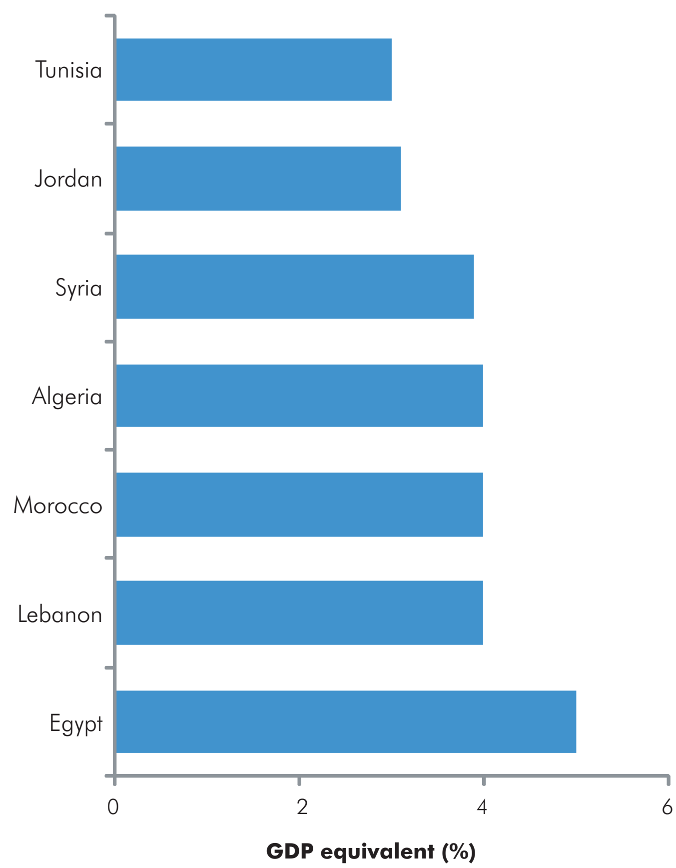
Development (AFED) by the Global Footprint Network (GFN) on the Ecological Footprint of Arab countries explored resource constraints in Arab countries from the perspective of the regenerative capacity of nature. Nature's capacity (biocapacity) and human demand on this capacity (footprint) are expressed in biologically productive land and sea areas with world average productivity expressed in a common unit of global hectares (gha), which allows comparisons among countries. Components of bioproductive areas include cropland, grazing land, forestland, marine and inland fishing grounds, carbon uptake land, and built-up areas (GFN/AFED, 2012).

Notwithstanding the shortcomings in assessing Ecological Footprint accounts such as the exclusion of water footprints, particularly in the context of cropland component, the GFN/AFED survey highlights the widening gap in Arab countries between population demand for ecological resources and available domestic biocapacity. According to 2008 data, the survey indicates that the Ecological Footprint of Arab countries, at an average of 2.1 gha per capita, is more than twice the biocapacity of 0.9 gha per capita. While the average biocapacity per capita has declined by 60 percent from 1961 to 2008, mostly because of a 3.5 fold increase in population, total biocapacity across the Arab region has increased by 42 percent over the same period, largely attributed to increased irrigation and intensification of agricultural inputs. The cropland component of biocapacity remained almost unchanged since 1961 at 0.3 gha per capita. This indicates that the biocapacity of cropland has kept pace with the rapid population growth in the region, a situation that is unlikely to be maintained in the future due to ever greater pressures placed on scarce water resources (GFN/AFED, 2012).

The availability of agricultural land is important for producing food crops, but more so is its productivity. Satisfying the demand for food domestically for a growing population at world competitive prices while maintaining land sustainability, requires that consumption of available resources be less than what nature can supply.

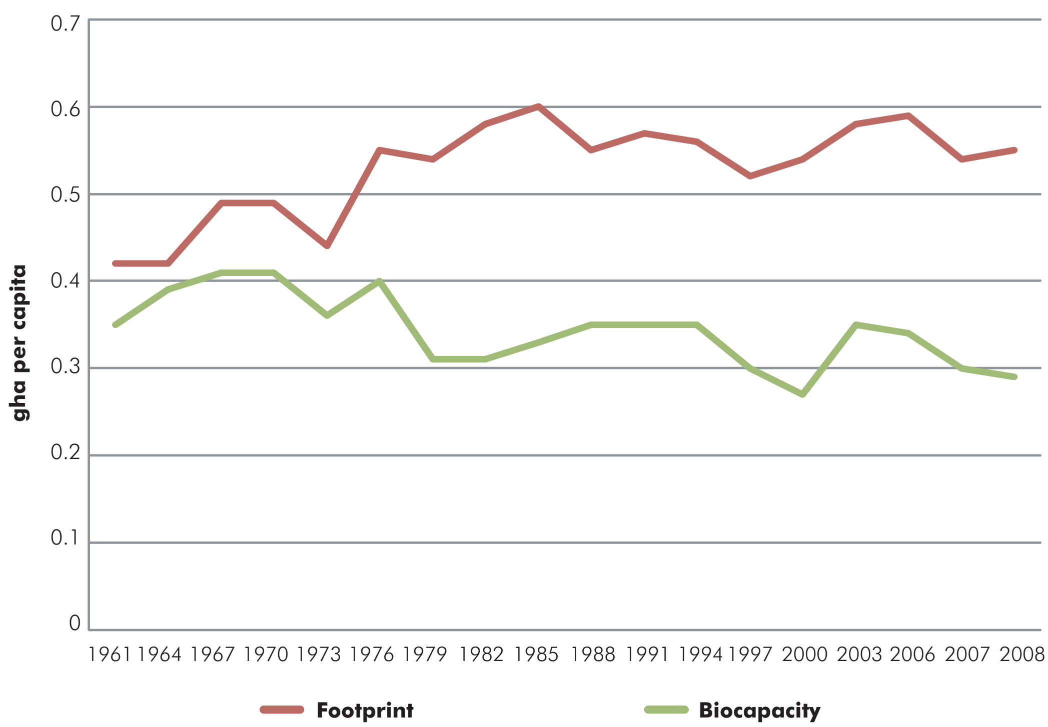
Cropland is one of six types of bioproductive areas considered by GFN in the survey on the Ecological Footprint of Arab countries (GFN/

FIGURE 3 COST OF ENVIRONMENTAL DEGRADATION EXPRESSED AS A PERCENTAGE OF GDP EQUIVALENT



Source: Adapted from World Bank, 2012b

FIGURE 4 CROPLAND ECOLOGICAL FOOTPRINT AND BIOCAPACITY IN ARAB COUNTRIES, 1961-2008



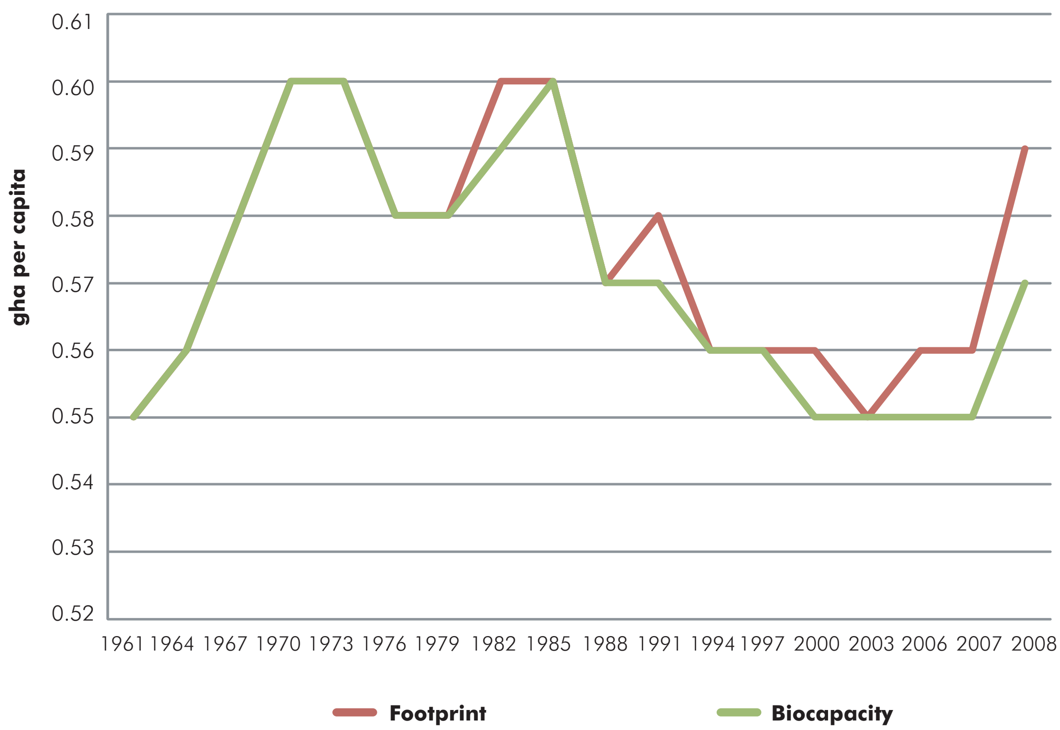
Source: Based on data provided by GFN

AFED, 2012). The cropland component of footprint and biocapacity in Arab countries in 1961 and 2008, as determined by the GFN/AFED survey, is indicated in Table 4.

It is apparent from Table 4 that since 1961 Arab countries have been consuming much more cropland resources than their biocapacity is capable of supplying. Arab countries differ greatly in their cropland biocapacity (BC) and Ecological Footprint (EF), but all face a wide gap between BC and EF as measured by globally productive land areas per capita. For example, in 2008, Bahrain, Djibouti, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates had a per capita EF several times greater than the per capita biocapacity. The Arab region's cropland biocapacity remained nearly undiminished at around 0.30 gha per person over the period 1961-2008, despite an increase of population of nearly 250 percent over the same period. This is explained by an increase of biocapacity, on an absolute basis, as a result of land expansion and increased productivity. Although the role of water resources withdrawn for irrigation, with a share of about 85 percent, cannot be assessed quantitatively, it would not have been possible to increase productivity in a generally dry region without increased irrigation. In fact, over-extraction of ground water for irrigation has depleted such water resources in some Arab countries.

The picture for cropland EF and BC at sub-regional level is not much different from that at country level. Wide variations still exist between sub-groups as shown in Table 4. The per capita deficit in cropland biocapacity in 2008 was greatest in the GCC countries at about 0.70 gha, reaching 0.22 gha in the Levant, 0.16 gha in the Nile Valley, 0.30 gha in North Africa, and 0.12 gha in the African Horn. While the biocapacity deficit in cropland in Arab countries increased substantially from about 0.14 gha per capita in 1961 to about 0.26 gha per capita in 2008, as illustrated in Figure 4, the world's cropland biocapacity and footprint remained in balance over the period 1961-2008, as indicated in Figure 5.

FIGURE 5 WORLD CROPLAND ECOLOGICAL FOOTPRINT AND BIOCAPACITY, 1961-2008



Source: Based on data provided by GFN

The share of the cropland component of biocapacity at 0.3 gha per capita was 32.2 percent of the total average biocapacity in the Arab region in 2008, compared with a world average of 31.7 percent. While the cropland component share of biocapacity in Arab countries is almost identical to that of the world, the cropland component of Ecological Footprint at the global level exceeded the cropland component of biocapacity by only 3.5 percent, whereas a similar increase amounted to about 90 percent in Arab countries (Table 4), indicating that the demand for cropland biocapacity in the Arab region is almost twice the available supply.

ii. Water Footprint

Water availability per capita varies widely among countries of the Arab region, with a low per capita average, mainly caused by the region's arid climate and the relatively high population growth. Agriculture consumes about 85 percent of total water use and about 73 percent of available natural water resources, as indicated in Table 5, and thus places a heavy load on the region's water resources. The water withdrawal data reveal the high stress on freshwater resources in most Arab countries as expressed by withdrawal percentages for all uses, which exceed 90 percent in 11 countries, with a regional average of about 86 percent.

The high percentage of freshwater withdrawal for agriculture in seven Arab countries (Table 5), exceeding by far their annual renewable water resources, indicates the heavy reliance on fossil groundwater and the rapid depletion of both renewable and non-renewable water resources. High water withdrawal rates in GCC countries and Libya have depleted their groundwater resources. In these countries, there are no prospects for increasing the area of irrigated land, let alone meeting the demand for irrigation in current areas. For example, stress on groundwater resources in Saudi Arabia in past years has led to the reduction of the area under cereal cultivation from about 1.12 million ha in

TABLE 4 **CROPLAND ECOLOGICAL FOOTPRINT (EF) AND CROPLAND BIOCAPACITY (BC), (GHA/CAPITA)**

Country/ Sub-Region	1961		2008	
	EF	BC	EF	BC
Bahrain	0.82	0.03	0.45	0.01
Kuwait	0.66	0.00	0.80	0.01
Oman	0.22	0.07	0.74	0.09
Qatar	2.01	0.03	0.91	0.03
Saudi Arabia	0.39	0.21	0.80	0.18
United Arab Emirates	2.26	0.04	0.77	0.05
GCC	**0.52**	**0.18**	**0.83**	**0.13**
Yemen	0.46	0.37	0.28	0.13
GCC and Yemen	**0.49**	**0.28**	**0.64**	**0.13**
Iraq	0.56	0.44	0.33	0.14
Jordan	1.00	0.60	0.66	0.09
Lebanon	0.54	0.18	0.66	0.22
Occupied Palestinian Territory	0.42	0.12	0.33	0.11
Syria	0.64	0.61	0.48	0.37
Levant	**0.70**	**0.50**	**0.43**	**0.21**
Egypt	0.38	0.34	0.66	0.45
Sudan	0.45	0.56	0.47	0.42
Nile Valley	**0.40**	**0.41**	**0.60**	**0.44**
Algeria	0.31	0.22	0.51	0.19
Libya	0.59	0.18	0.64	0.15
Mauritania	0.51	0.29	0.43	0.11
Morocco	0.32	0.26	0.60	0.30
Tunisia	0.41	0.30	0.65	0.53
North Africa	**0.35**	**0.25**	**0.57**	**0.27**
Comoros	0.40	0.32	0.34	0.23
Djibouti	0.37	0.02	0.52	0.02
Somalia	0.17	0.16	0.18	0.08
African Horn	**0.19**	**0.16**	**0.20**	**0.08**
Arab Countries	**0.44**	**0.30**	**0.55**	**0.29**
World Average	**0.55**	**0.55**	**0.59**	**0.57**

Source: GFN data, 2012

1990-92 to about 317.4 thousand ha in 2008-2010 (Table 1). Furthermore, the country has adopted a decree in 2008 that seeks to gradually phase out all water-intensive agricultural crops by 2016 (FAO, 2012).

The costs of water over-extraction could be substantial. The annual cost of groundwater depletion in four Arab countries, indicated in Figure 6, ranges between 1.2 percent of GDP in Tunisia to 2.1 percent in Jordan. In the short term, over-extraction of water may increase GDP, but over-pumping undermines a country's long-term natural capital or wealth (FutureWater, 2011), which is essential for a country's sustainable development and wellbeing.

In a study by the Water Footprint Network (WFN) about the global water footprints of national production and consumption by country, most Arab countries have been found to have an average water footprint of national consumption that is much higher than the world average of 1,385 m^3/capita/year. In Jordan, Kuwait, Lebanon, Libya, Saudi Arabia, and United Arab Emirates, the external component of each country's water footprint exceeds 50 percent, reaching 65 percent in Libya and 90 percent in Kuwait (Mekonnen and Hoekstra, 2011), indicating a high level of dependence on imports of water-intensive commodities or virtual water.

Irrigation and net food imports play a major role in water footprint levels in Arab countries. Low levels of irrigation efficiency (40 percent) and water productivity (35 percent) (AOAD, 2007), combined with high levels of cereal imports are major contributors to the high water footprint in Arab countries.

The rise in cropland and water footprints in Arab countries driven by population growth and past agricultural policies and practices endangers the capacity of land and water ecosystems to regenerate and meet future demand. It is quite evident that Arab countries urgently need to address land and water issues and pursue options conducive to the sustainability of agriculture.

III. AGRICULTURAL SUSTAINABILITY OPTIONS

The agricultural sector in Arab countries has reached a precarious state caused by past policies and practices inattentive to maintaining a balance between nature's supply of land and water and current consumption levels of these resources. Unless this trend is reversed, the long-term consequences will be dreadful. A new approach to agricultural production based on policies and practices that sustain the integrity of agricultural resources is needed, while pursuing options for enhancing food self-sufficiency. A number of policy and action options are discussed hereunder.

A. Nature's Biocapacity

Policy and decision makers need to increase their awareness about the sustainability limits to Earth's biocapacity or natural endowments, which are distributed unevenly among regions and countries of the world. In this respect, the Arab region is the least endowed with renewable water resources of vital importance to human survival and wellbeing. A better understanding of the consequences of overuse of water resources on the environment and on the regenerative capacity of land and water ecosystems needs to be translated

TABLE 5 **WITHDRAWAL IN ARAB COUNTRIES AS A PERCENTAGE OF ANNUAL FRESHWATER RESOURCES (2009)**

Country/ Sub-Region	All uses (percent)	Agricultural use (percent)
Bahrain	344.8	155
Kuwait	4,500.0	2,500
Oman	92.3	82
Qatar	689.6	407
Saudi Arabia	987.5	869
United Arab Emirates	2,666.6	2,213
GCC	**740.0**	**633**
Yemen	171.9	156
GCC and Yemen	**549.3**	**472**
Iraq	87	69
Jordan	96.1	62
Lebanon	28.9	17
Syria	100.0	88
West Bank & Gaza	47.8	22
Levant	**87.0**	**69**
Egypt	119.0	103
Sudan	57.5	56
Nile Valley	**86.5**	**78**
Algeria	53.1	34
Libya	716.7	595
Mauritania	14.0	13
Morocco	43.4	38
Tunisia	63.3	48
North Africa	**48.2**	**39**
Comoros	-	-
Djibouti	-	-
Somalia	23	23
Horn of Africa	**23**	**23**
Regional average	**85.7**	**73**

Source: Tables 2 and 3

into results on the ground. First and foremost, land and water resources should be treated as economic assets to be allocated and used in the most efficient manner.

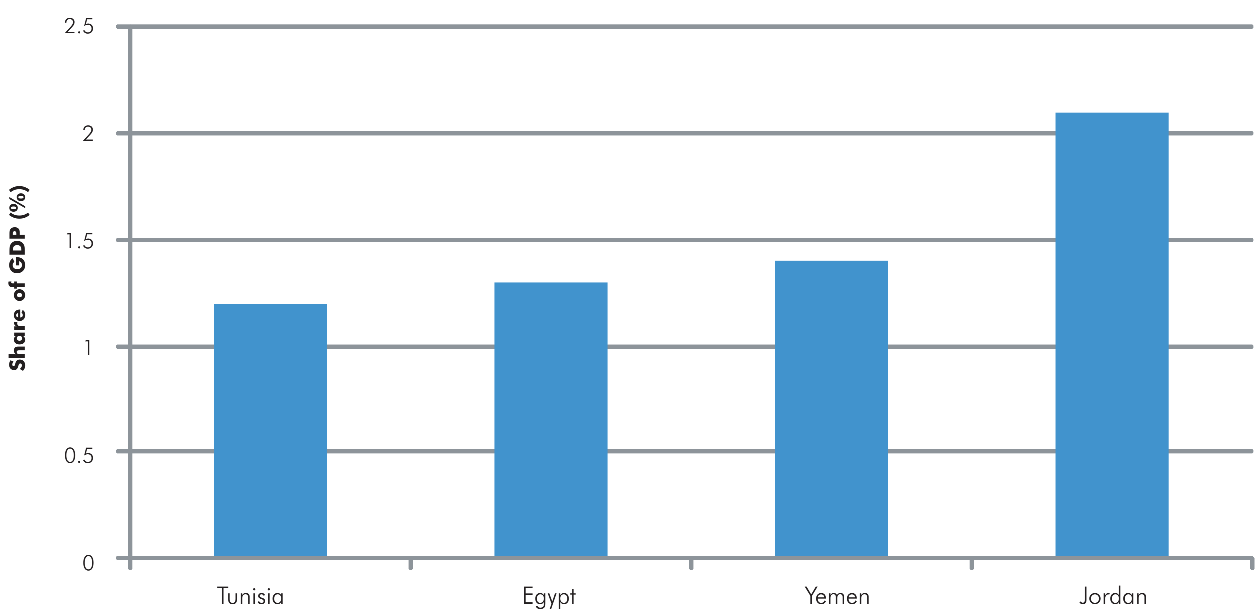
Maintaining nature's bioproductive capacity to provide needed services requires a blend of economic, social, and environmental policies conducive to sustainable development. Current agricultural practices in the Arab region are not only deeply inefficient and wasteful, but they are also depleting the natural capital without due consideration to the costs incurred by continued degradation of land and water resources, and their consequences on agricultural sustainability.

Concern over the earth's depleting biocapacity caused by current development patterns has aroused arguments in favor of an alternative paradigm, presented by AFED in its 2011 annual report Green Economy: Sustainable Transition in a Changing Arab World. According to the report, "the green economy assigns a value to natural capital, allowing externalities of human activities to be incorporated into decision-making process, in the hope of achieving economic development without exceeding the ecological limits of ecosystems or undermining social conditions" (AFED, 2011). A report by the World Bank points out that current growth patterns are not just unsustainable, but they are also deeply inefficient. It argues for an inclusive green growth based on the three pillars of sustainable development, namely, economic, social, and environmental sustainability (World Bank, 2012b).

B. Irrigation Efficiency

Arab countries withdraw water for irrigation at a much higher rate than required for growing crops. Irrigation water requirement as a percentage of water withdrawal for agriculture is a measure of water efficiency. This ratio was 28 percent in Iraq and 54 percent in Tunisia in 2000 (FAO, AQUASTAT). These ratios imply that water used in excess of requirements is wasted. However, some of the water lost could be available for reuse as return flows back to rivers or to recharge groundwater. Nevertheless, with an average irrigation efficiency of 40 percent in the Arab region, there is a considerable potential for improvement that can contribute significantly to food self-sufficiency in view of increasing water scarcity in the region. Reducing water losses by

FIGURE 6 VALUE OF GROUNDWATER DEPLETION IN SELECTED ARAB COUNTRIES AS A SHARE (PERCENT) OF GDP



Source: World Bank, 2011

upgrading and modernizing irrigation water infrastructure can save substantial amounts of water for additional irrigation while generating energy cost savings in water pumping. It has been estimated that raising irrigation efficiency from 40 percent to 70 percent in six Arab countries (Algeria, Egypt, Iraq, Morocco, Sudan, and Syria) can save enough water to produce an additional 35 million tons of cereals in 2030, thereby reducing imports and relieving some pressure on the region's balance of payments (Sadik et al., 2011).

C. Crop Productivity

Crop productivity is key to enhancing food self-sufficiency. It was the pillar of the Green Revolution of the 1960s, whose adoption of improved irrigation and high-yielding plant varieties coupled with the introduction of chemical fertilizers and pesticides, boosted cereal productivity and saved the plight of millions of people in Asia from falling prey to hunger.

Today, the sustainability of the Green Revolution paradigm is no longer attainable and is severely challenged because of the externalities of groundwater depletion and contamination. Arab countries have the opportunity to adopt a new version of the Green Revolution based on 'green agriculture' or sustainable agriculture. This is an option based on utilizing knowledge, experience, and lessons learned in order to maintain the regenerative capacity of land and water resources.

Prospects for self-sufficiency in cereals in the Arab region are constrained by population growth, limited land, and scarce water resources. Increasing crop productivity is key to enhancing food self-sufficiency, particularly in cereals. With the population of Arab countries projected to reach 503 million in 2030 and 633 million in 2050, and cereal production in the Arab region at about 50 million tons in 2010 (Table 1), and average cereal consumption of about 300 kg/capita, it is estimated that the region needs to increase cereal production by about 101 million and 140 million tons to meet demand in 2030 and 2050, respectively. Prospects for increasing cereal production depend largely on improving productivity of both irrigated and rain-fed agriculture.[1]

If the six major cereal producers in the Arab region (Algeria, Egypt, Iraq, Morocco, Sudan and Syria) with projected population of about 337 million in 2030 and about 417 million in 2050 (UN, 2011) could raise their combined cereal productivity to match the world average (Table 1), their combined production would amount to about 87 million tons. Also, by raising their irrigation efficiency from 40 percent to 70 percent they could save water enough to produce an additional 35 million tons of cereal (Sadik et al. 2011). Thus, increasing cereal productivity, coupled with irrigation efficiency raises the quantity of cereal available for consumption to about 122 million tons, sufficient to meet the six countries' demand for cereal in 2030 of about 101 million tons, and cover about 21 percent of the Arab region's unmet demand in the same year.

However, due consideration should be given to the impact of climate change on crop productivity. For example, it is predicted that in Egypt climate change will cause a reduction in the productivity (tons/acre) of rice by 11 percent, barley by 18 percent, corn by 19 percent, and wheat by 18 percent by 2030 compared to the base year (AOAD, 2010b). Researchers have warned of the dangerous effects of climate change on rain-fed agriculture in Arab countries, as rain-fed yields are expected to fluctuate increasingly over time with a downward trend, decreasing by an overall average of 20 percent in Arab countries, and by almost 40 percent in Algeria and Morocco (World Bank et al., 2009). These substantial reductions are indicative of the additional challenges confronting food self-sufficiency in Arab countries, and the need for adaptation measures to minimize the impact of climate change and maintain the viability of rain-fed agriculture.

While Agriculture suffers from the impacts of climate change, it also contributes to it through its environmental externalities such as greenhouse gas emissions. Nevertheless, Agriculture can be part of the solution through mitigating a significant amount of its emissions by using production systems and adopting agricultural practices conducive to agricultural sustainability, such as 'climate–smart' agriculture.

A Paper by FAO (2010) refers to the close linkage between food security and climate change in the agriculture sector, and to the existing key opportunities to transform the sector towards climate-smart systems to address both issues, and provides a number of country examples of climate-smart production systems such as conservation agriculture, among others. It points out that in order to stabilize output and income, production systems must be transformed to become more resilient. "More productive and

resilient agriculture requires transformations in the management of natural resources (e.g. land, water, soil nutrients, and genetic resources) and higher efficiency in the use of these resources and inputs for production. Transitioning to such systems could also generate mitigation benefits by increasing carbon sinks, as well as reducing emissions per unit of agricultural product" (FAO, 2010).

D. Water Productivity

Increasing agricultural yields by maximizing water productivity is a key option for enhancing self-sufficiency in food commodities, especially in staple products such as cereals. It is important to note that while water productivity is a viable option for increasing agricultural production, the maximization of this potential requires a composite of factors capable of reinforcing and complementing each other, such as the adoption of efficient and modern irrigation schemes coupled with improved farming practices and inputs conducive to agricultural sustainability. In this regard, improved agricultural practices are warranted, including drip and sprinkler irrigation, no-till farming, improved drainage, and use of best available germplasm or improved seed varieties, in addition to optimizing fertilizer use, utilizing innovative crop protection technologies, and the provision of extension services (FutureWater, 2011). Furthermore, farming practices such as water harvesting, deficit irrigation, and conservation and organic agriculture are not only conducive to increasing water productivity, but they are also significantly important for agricultural sustainability.

E. Agricultural Research and Development

Considering the very high returns to agricultural research and development (R&D) estimated at 45 percent worldwide and at 36 percent in Arab countries (World Bank et al., 2009), the need for intensification of research efforts to discover high-yielding seed varieties, salt-resistant, and drought-tolerant crops cannot be overemphasized in a dry Arab region dominated by rain-fed agriculture.

Despite the importance of R&D to promoting knowledge-based investments, Sasson (2007)

points out that Arab States rank low in investment in research and technological innovation. He adds that overall spending on R&D, provided primarily by the public sector, is equal to only 0.15 percent of GDP, compared with a world average of 1.4 percent and a European average of 2.5 percent. There were only 500 scientists and engineers involved in R&D per million people in Arab countries in the period 1990-2000, compared with more than 4,000 per million people in North America, 2,500 in Europe, 700 in South and East Asia, and an average of 1,000 per million in the world (Sasson, 2007). Furthermore, important areas of agricultural research that are most needed in Arab countries are not taken up. He points out that with the exception of Egypt, "no genomics work is being carried out, nor is there any development of transgenic crops which are more resistant to pests and tolerant to abiotic stress" (Sasson, 2007).

F. Non-Conventional Water

Two main sources of non-conventional water, namely, desalinated seawater and treated wastewater, can be instrumental in augmenting scarce natural water resources. Some Arab countries with severe scarcity in renewable water resources, particularly the GCC countries, have become heavily dependent on seawater desalination to meet their municipal and industrial water demand. This has been made possible by the region's abundant and subsidized energy resources necessary for energy intensive desalination plant operations.

At the initiative of the World Bank, a study in two parts titled Middle-East and Northern Africa Water Outlook was conducted in 2011. The first part of the study includes water availability and demand analysis under multiple climate change scenarios, and identifies various options to meet supply at national and regional levels along with the associated marginal cost of water supply options (FutureWater, 2011). The second part includes an assessment of the potential of desalination in meeting water demand under the average climate change scenario for the Middle East and North Africa (MENA) region (Fitchner, 2011). It is assumed that over the projected period up to 2050, desalination technology will improve with progressive replacement of conventional energy sources with renewable energy, and that over the long-run renewable energy sources will be less expensive.

Fitchner (2011) shows that water demand for the 18 Arab countries included in MENA will reach 232 billion m^3 in 2030 and 292 billion m^3 in 2050. About 40 percent and 28 percent of the demand in 2030 and 2050, respectively, is expected to be met by conventional desalination and concentrating solar power (CSP) desalination. Wastewater use is expected to meet about 9.5 percent and 15 percent of demand in 2030 and 2050, respectively. GCC countries with severe scarcity of natural water resources are expected to meet about 70 percent and 81 percent of their water demand through combined conventional and CSP desalination and wastewater reuse in 2030 and 2050, respectively, with most desalination supplied by CSP. The increased reliance in the Arab region on CSP desalination and on treated wastewater can have a positive environmental impact, particularly if conventional energy sources are replaced with renewable energy such as solar energy.

G. Virtual Water

The virtual water concept is appealing for water-scare countries. It affords them the opportunity to attain food security by importing water-intensive products instead of using internal water resources to produce low-value water products. Despite concerns over international trade policies in agricultural products and their implications on agricultural development in food importing countries, the virtual water concept not only affords Arab countries the opportunity to enhance cooperation among themselves according to comparative advantages in agricultural resources, but it also provides policy-makers with a tool for water resources management with due consideration to economic, social and environmental implications. Furthermore, the virtual water option can be extended to include cooperation between Arab countries with investable funds and other developing countries endowed with abundant land and water resources based on mutual benefits.[2]

IV. CONCLUSION AND RECOMMENDATIONS

Arab countries have for some decades been pursuing food self-sufficiency, yet they remain far from achieving this goal. Their finite and limited land and water resources, the very source of food, have over time been heavily overused due to population growth and inefficient agricultural practices.
Despite the enormous challenges arising from the current state of agriculture and the impact of anticipated climate change, enhancing food self-sufficiency in the region remains achievable, but is contingent upon the adoption of a new green revolution as a pathway to sustainable agriculture. In this regard, a number of options have been identified, but implementing them successfully requires a strategic framework of policies, laws, incentives, and practices conducive to the efficient and sustainable utilization of land and water assets within their capacity to provide ecological goods and services economically, socially, and environmentally.

With a no-size-fits-all approach, Arab countries need to consider priorities for the implementation of available options based on technical feasibility, economic viability, and social and environmental impact. Available options include, among others, the following:

a. Adoption of agricultural systems, policies and practices to mitigate agricultural environmental externalities, and designing projects for the rehabilitation and restoration of degraded land and depleted aquifers.

b. Improvement of irrigation efficiency through rehabilitation of water transport systems, and on farm application by using modern irrigation techniques and water saving methods.

c. Increasing crop productivity is key to enhancing food self-sufficiency, especially cereals. Water shortages underscore the need to increase productivity of rain-fed crops through intensification of investment in agricultural research and development to develop high-yielding seed varieties, salt-resistant, and drought-tolerant crops.

d. In view of water shortages, water productivity is even more important than crop productivity. In addition to charging appropriate prices for irrigation water and adopting agricultural methods conducive to using less water for growing crops, farmers should be encouraged to diversify into higher-valued crops instead of water-intensive conventional crops.

e. Augmentation of natural water resources by non-conventional sources such as seawater

desalination and treated wastewater is a desirable policy option, provided that fossil fuels are replaced with renewable energy sources. Building local capacity for developing and manufacturing solar technologies, such as concentrating solar power (CSP), brings the added benefits of reducing the cost of technology deployment and generating jobs, while being environmentally sustainable.

f. In view of disparities in land and water resources at national levels, virtual water affords Arab countries opportunities for cooperation on food security matters according to comparative advantages in agricultural resources. Regional trade in food commodities needs to be facilitated and strengthened.

g. In addition to adopting the right policies and best agricultural practices, Arab countries need to mobilize resources to finance their agricultural investments. Whether such investments are financed from domestic sources, official development assistance, the private sector, or a combination thereof, it is essential to ensure that investments are based on well-prepared feasibility studies, accounting not only for production aspects, but also for other value-added chain facilities such as transport, storage, and distribution.

h. All policy and investment options should be evaluated in accordance with a demand management approach capable of maintaining the sustainability of natural land and water assets.

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NOTES

1. For more details, see the box *Improving the Productivity and Stability of Rain-fed Cereal Production* in Sadik et al., 2011.

2. For more details, see the box *Virtual Water* in Sadik et al., 2011.

WATER FOOTPRINT OF ARAB COUNTRIES

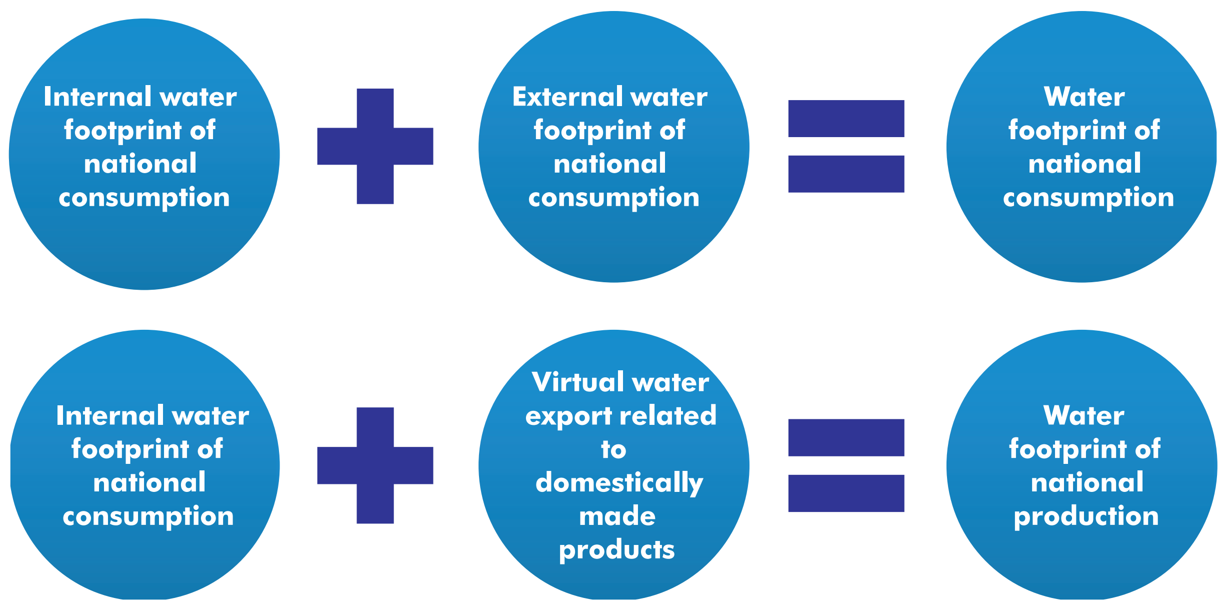
Prepared by: Hadi Tabbara
Reviewed by: Arjen Y. Hoekstra

Water footprint (WF) accounts measure the appropriation of freshwater resources by a defined human population, expressed in terms of volume of water consumed or polluted averaged over a period of time. The water footprint methodology provides a more comprehensive account of water resources use by including data on trade flows of water embedded in agricultural and industrial commodities, as opposed to relying on statistics about rates of renewable water withdrawal. Understanding what fraction of national water demand is being met by internal water resources versus external or 'virtual' sources is relevant to making policy decisions about food security, trade, and alternatives for meeting water demand.

The Water Footprint Network (WFN) has developed a framework for national water footprint accounting that defines a country's water footprint from both a production and consumption perspective (Mekonnen and Hoekstra, 2011). A simplified version of the framework has been adapted from WFN, as illustrated in Figure B1. According to the WFN methodology, the water footprint of national production is defined as "the total freshwater volume consumed or polluted within the territory of the nation as a result of activities within the different sectors of the economy" (Mekonnen and Hoekstra, 2011). Water footprint of national production, therefore, accounts for water-consuming or polluting processes that take place within the national boundaries of a nation, whether the final output is used internally or destined for export. The water footprint of national production is the variable taken to indicate the water footprint of a nation.

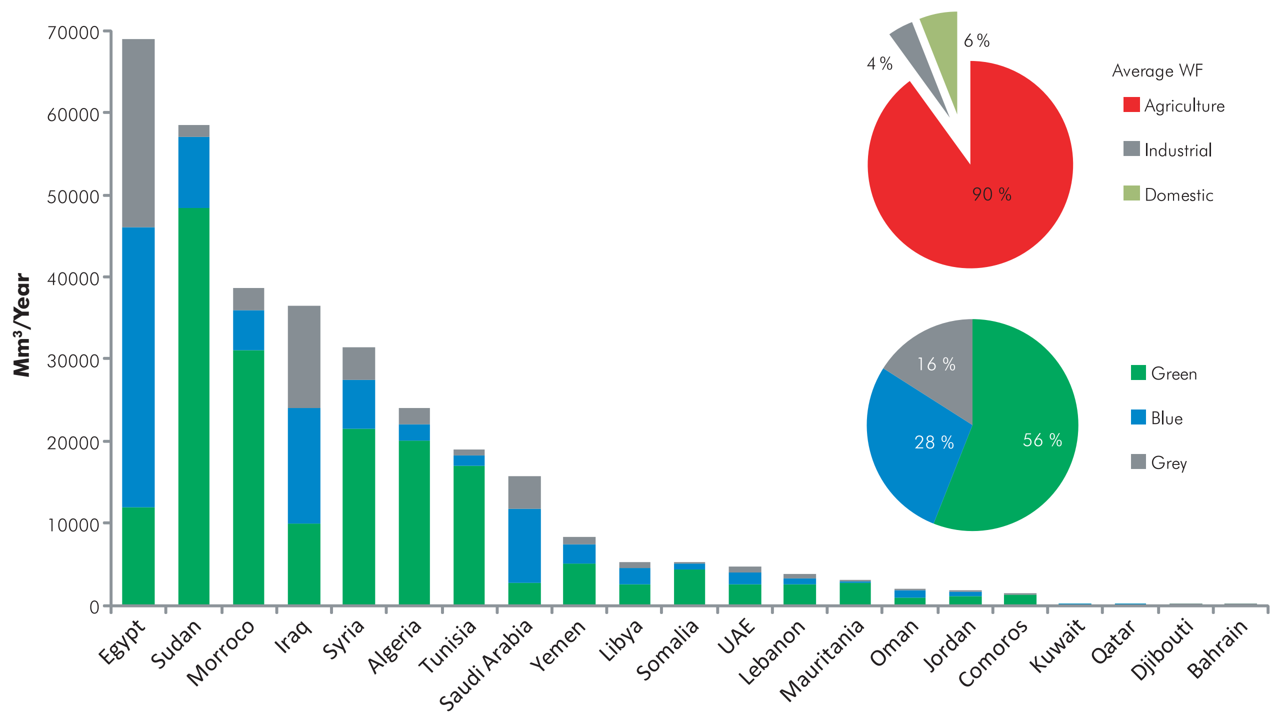
The water footprint of national consumption is defined as "the total volume of freshwater that is used to produce the goods and services consumed by the inhabitants of the nation" (Mekonnen and Hoekstra, 2011). As indicated in Figure B1, the water footprint of national consumption accounts for the use of water resources that are both internal and external to the nation. The external WF of national consumption, therefore, represents virtual water embedded in goods and services imported for final consumption. The internal WF of national consumption is a common component to both the water footprint of national production and the water footprint of national consumption.

FIGURE B1 NATIONAL WATER FOOTPRINT ACCOUNTING DEFINITIONS



Source: Adapted from Mekonnen and Hoekstra, 2011

FIGURE B2 THE WATER FOOTPRINT OF NATIONAL PRODUCTION (MM³/YEAR) IN ARAB COUNTRIES (EXCEPT PALESTINE), 1996-2005. INSERTS SHOW THE AVERAGE WATER FOOTPRINT BY USE CATEGORY AND BY SOURCE OF WATER



Source: Mekonnen and Hoekstra, 2011

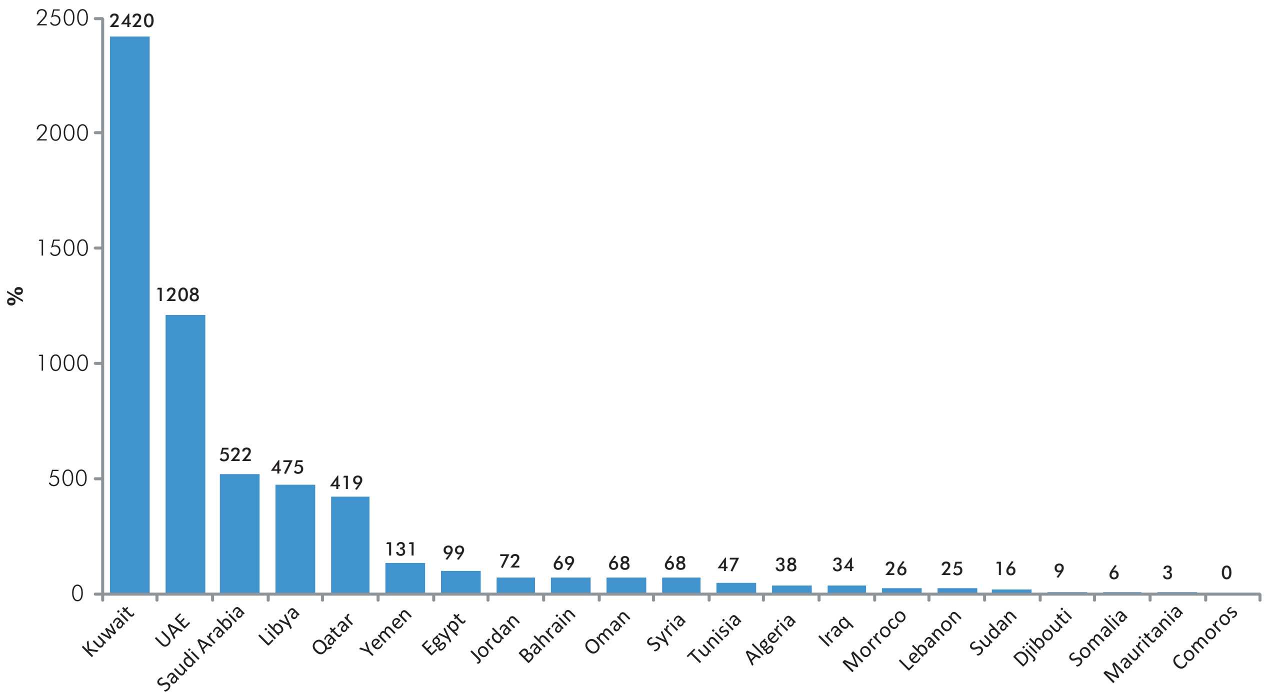
Although not shown in Figure B1, the accounting scheme distinguishes among green water (rainwater or root zone moisture utilized for crop production), blue water (surface and groundwater), and gray water (wastewater) footprints and accounts for contributions from the three main water-using sectors: agriculture, industry, and domestic supply. Gray water footprint refers to pollution and is defined as the volume of freshwater required to assimilate the load of pollutants resulting from agricultural or industrial activities, based on existing ambient water quality standards (Hoekstra et al., 2011).

Mekonnen and Hoekstra (2011) recently estimated the global water footprint, covering the period 1996-2005, by quantifying the WFs of nations from both a production and consumption perspective. International virtual water trade and water savings associated with trade in agricultural and industrial commodities have also been determined. The analysis below on the water footprint of Arab countries is based entirely on data collected and documented by the two authors in their study.

The Water Footprint of Arab Countries

The annual total water footprint (WF) of production in Arab countries in the period 1996-2005 was 325 Gm³/yr. The WF by country is indicated in Figure B2, broken down by use category and by source of water. Green water footprint accounted for 56 percent of the total water footprint of production, compared with a global average of 74 percent, an indication of the relative scarcity of rainwater in Arab countries. The blue and gray water footprints in Arab countries accounted for 28 percent and 16 percent of the total, compared with global averages of 11 percent and 15 percent, respectively. Although all Arab countries face water shortages, they still consume two and half times the world average in terms of the consumptive use of blue surface and groundwater to meet their demand for production, reflecting low irrigation efficiencies and water productivities. Agricultural production contributed 90 percent to the total WF, while domestic supply and industrial production contributed 6 percent and 4 percent, respectively. Almost 95 percent of total blue WF in Arab countries is attributed to crop production, of which one-fifth is for exports.

FIGURE B3 BLUE AND GRAY WF OF PRODUCTION AS A PERCENTAGE OF RENEWABLE WATER RESOURCES IN ARAB COUNTRIES[a] (EXCEPT PALESTINE), 1996-2005



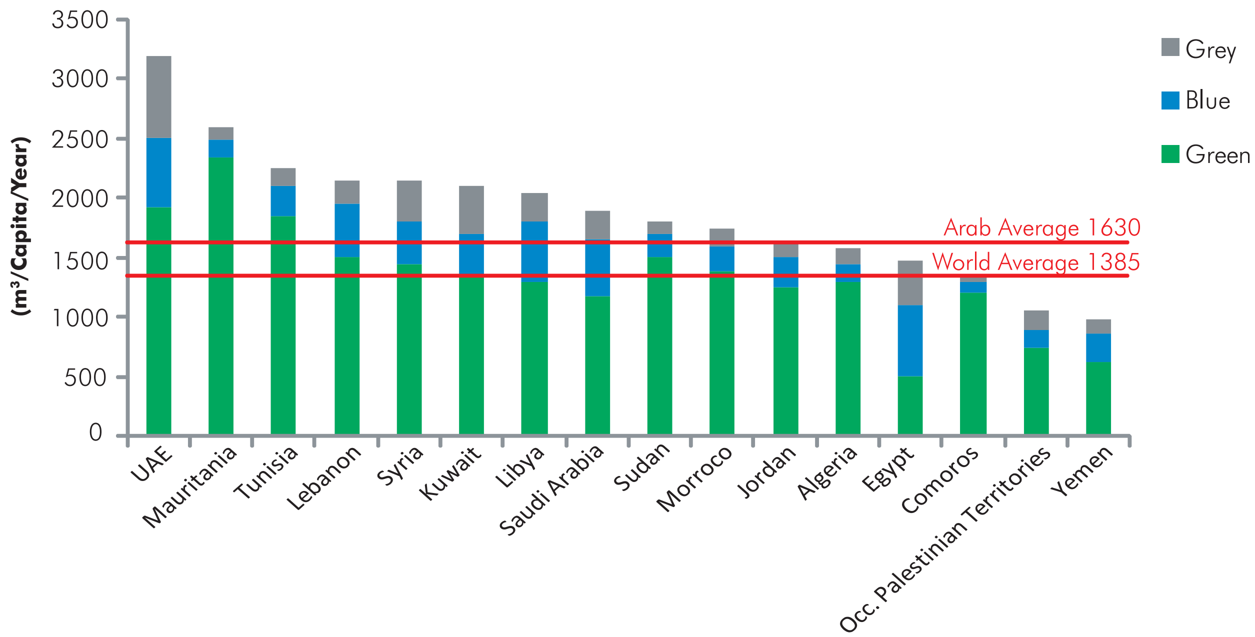
[a] Calculated using renewable water resources data from FAO (AQUASTAT-2009)
Source: Mekonnen and Hoekstra, 2011

Egypt and Sudan have the first and second largest WF of national production in the Arab world, accounting for 39 percent of the total Arab WF. Morocco, Iraq, and Syria are the countries with the next largest WF, accounting for 32 percent of the Arab total. Egypt has by far the largest blue water footprint in the Arab world, accounting for 37 percent of the total, followed by Iraq (15 percent), Sudan (10 percent), Saudi Arabia (10 percent), and Syria (8 percent). The 10 percent figure for Sudan is indicative of the low state of water resources development in the country.

A useful parameter that can be used to further assess the impact of the WF of production on the sustainability of water resources is the ratio of the water footprint (blue and gray water) of production to the total renewable water resources, which also serves as an indicator of water scarcity. A ratio of 1 means that 100 percent of the total annual renewable water resources are being consumed by the blue water needed for production and the gray water needed to dilute the resultant pollutants. As depicted in Figure B3, most Arab countries are already using more than 25 percent of their renewable water resources to satisfy their production needs, with some depleting their resources at an alarming rate, including Kuwait (2420 percent), UAE (1208 percent), Saudi Arabia (522 percent), Libya (475 percent), Qatar (419 percent), and Yemen (131 percent).

The annual average water footprint of national consumption per capita for a number of Arab countries (Algeria, Comoros, Egypt, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, UAE, and Yemen), for which data is available, was 1630 m^3/capita/year in the period 1996-2005, which is 18 percent higher than the global average of 1385 m^3/capita/year. Two factors determine the magnitude of the water footprint of national consumption: (1) the volume and pattern of consumption, and (2) the amount of water consumed per ton of product, which for agricultural products depends on climate, irrigation efficiency, and the intensity of agricultural inputs (Mekonnen and Hoekstra, 2011).

FIGURE B4 THE WATER FOOTPRINT OF NATIONAL CONSUMPTION (M³/CAPITA/YEAR) IN SELECTED ARAB COUNTRIES BY SOURCE OF WATER, 1996-2005. ARAB AVERAGE SHOWN IS FOR THE SELECTED COUNTRIES

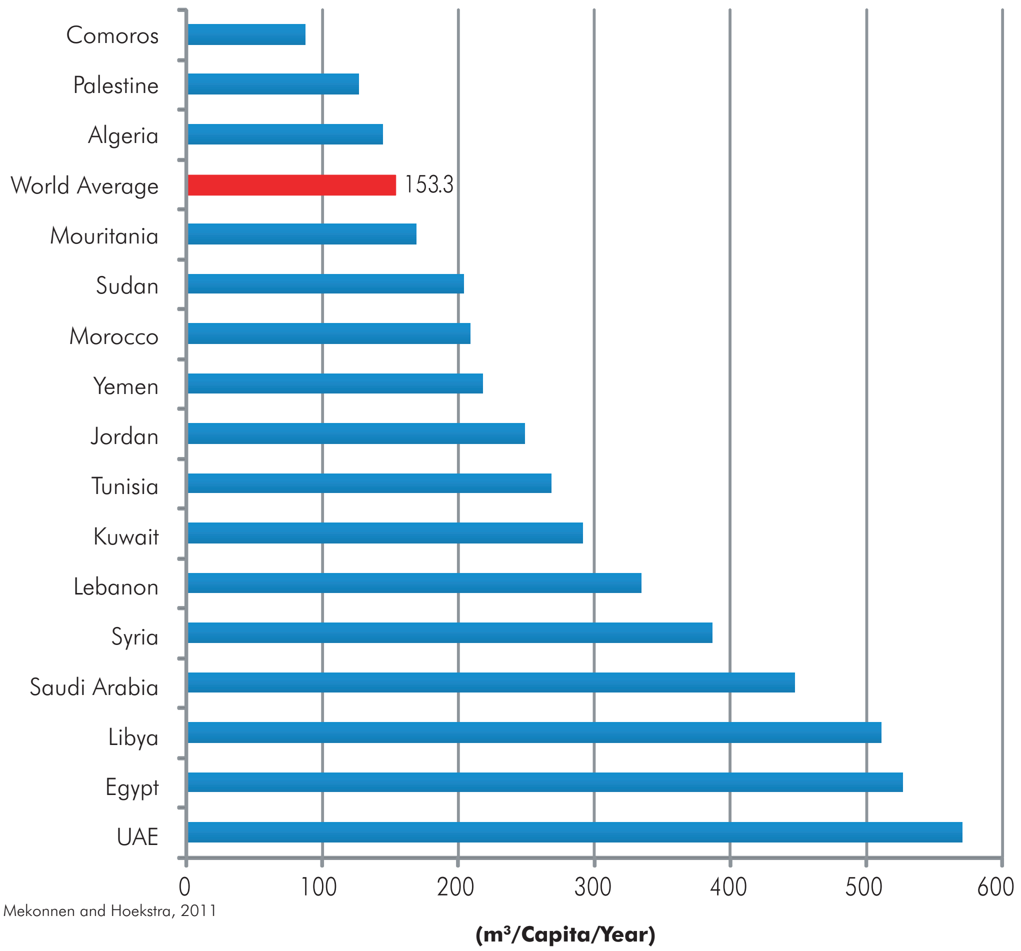


Source: Mekonnen and Hoekstra, 2011

The consumption of water by agricultural products, both those produced locally and those imported, accounts for 94.5 percent of the total WF of national consumption in these Arab countries. Consumption of domestic water supply and industrial products contribute 3.5 percent and 2 percent, respectively, to the total WF of consumption. Cereals consumption contributes the largest share (26 percent), followed by meat (24 percent) and milk (12 percent). Figure B4 indicates the WF of consumption per capita in selected Arab countries. All countries, except Comoros, Egypt, Palestine, and Yemen have a higher water footprint of consumption per capita than the world average, with UAE among the highest in the world. The WF of consumed products such as wheat, meat, and milk are much higher in the Arab world than the world average. For example, the per capita WF of consumed meat (bovine, mutton, and poultry) in UAE is 865 m^3/capita/year compared to the world average of 305 m^3/capita/year, while that for milk is 423 m^3/capita/year compared to the world average of 93 m^3/capita/year.

All Arab countries, except Algeria, Comoros, and Palestine, have a higher per capita blue water footprint of consumption than the world average of 153 m^3/cap/yr, as indicated in Figure B5, with Egypt, Libya, Saudi Arabia, Syria, and UAE among the highest in the world. As a share of the total WF of consumption, the external water footprint varies widely across Arab countries, as illustrated in Figure B6. Those countries with a relatively smaller external WF share of the total include Egypt (29 percent), Morocco (29 percent), Palestine (7 percent), Sudan (4 percent), Syria (16 percent), and Tunisia (32 percent). Although some of these countries have high levels of water stress, they continue to rely on their dwindling water supplies to satisfy their consumption needs. Countries with a large external water footprint share of the total WF of consumption, such as Jordan (86 percent), Kuwait (90 percent), Lebanon (73 percent), Libya (65 percent), Saudi Arabia (66 percent), UAE (76 percent), and Yemen (76 percent), depend on freshwater resources from other countries as a matter of policy because of their high level of water scarcity.

FIGURE B5 **BLUE WATER FOOTPRINT OF NATIONAL CONSUMPTION (M^3/CAPITA/YEAR) IN SELECTED ARAB COUNTRIES, 1996-2005**



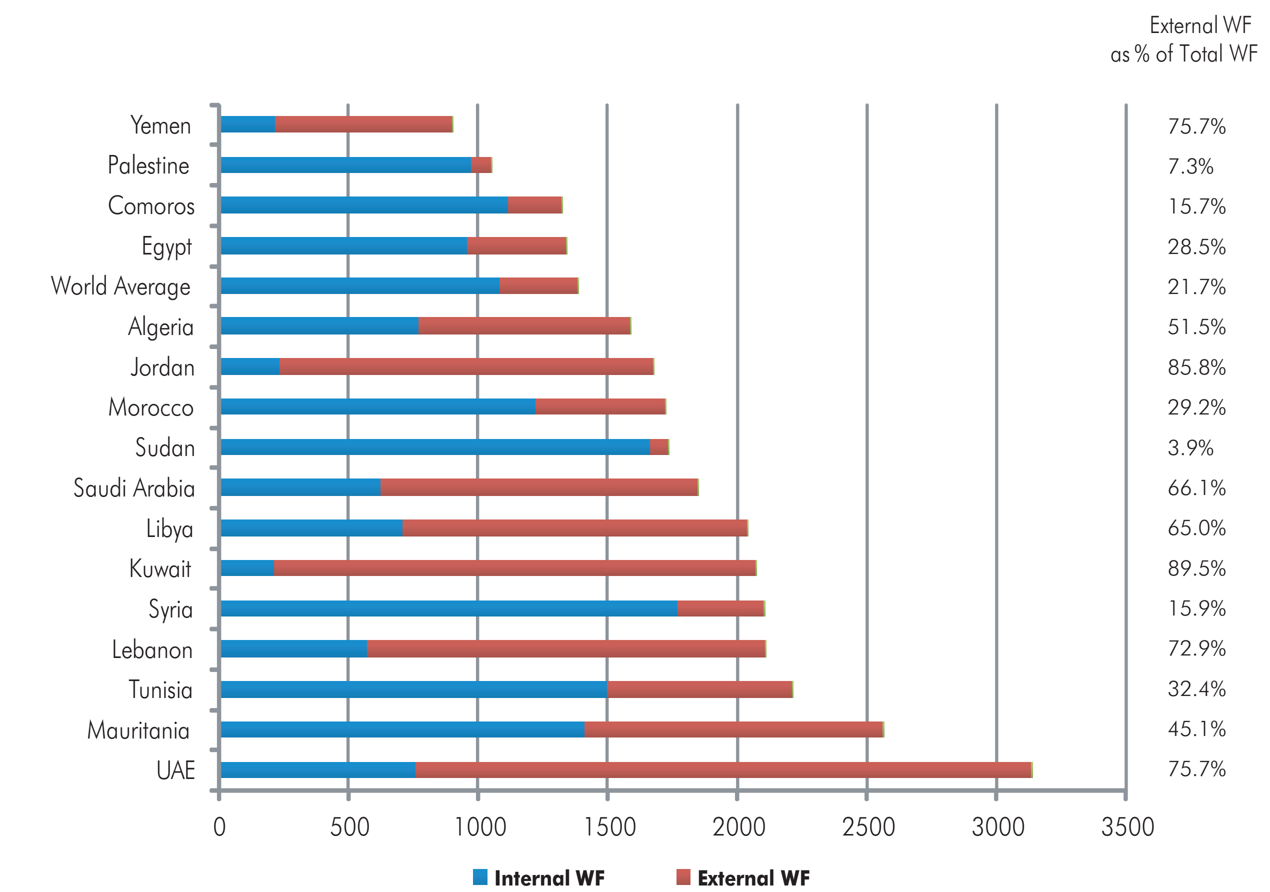
Source: Mekonnen and Hoekstra, 2011

It is argued that in order to meet the water demands for production and consumption while conserving domestic water resources, water stressed countries should import virtual water in the form of water-intensive commodities while exporting virtual water embedded in less water-intensive commodities. Global studies show that North and South America, Australia, and most of Asia and central Africa are net exporters of virtual water, while Europe, the Middle East, and North and Southern Africa are the largest importers. Figure B7 shows the net virtual water trade flow (WF of imports minus exports) map of the Arab world. Over the period 1996-2005, net virtual water imports exceeded 110 Gm^3/yr (Europe is 152 Gm^3/yr), while net virtual water exports exceeded 24 Gm^3/yr. Virtual water imports and exports are dominated by crop products, with a few exceptions. The largest net importers (blue circles) are Yemen (21.7 Gm^3/yr), Saudi Arabia (17.6 Gm^3/yr), Algeria (17.3 ^{3}/yr), Libya (9.5 Gm^3/yr), Egypt (9.0 Gm^3/yr), and Morocco (8.3 Gm^3/yr), while the largest net exporters (red circles) are Somalia (8.2 Gm^3/yr, mostly green water), Djiboti (7.2 Gm^3/yr, mostly green water), Sudan (3.4 Gm^3/yr, blue and green water), Syria (2.2 Gm^3/yr, blue and green Water), Tunisia (1.6 Gm^3/yr, green water), and Iraq (1.5 Gm^3/yr, significant gray water). Egypt and Morocco are also net exporters of blue water. This calls into question the justification for water stressed countries (e.g., Egypt, Morocco, and Syria) to become net exporters of blue virtual water.

Implications on the Sustainability of Freshwater Resources in Arab Countries

It should be pointed out that a lower water footprint is not necessarily the most sustainable. For example,

FIGURE B6 INTERNAL AND EXTERNAL COMPONENTS OF WATER FOOTPRINT OF NATIONAL CONSUMPTION (M^3/CAPITA/YEAR) IN SELECTED ARAB COUNTRIES AND SHARE (PERCENT) OF EXTERNAL WF, 1996-2005

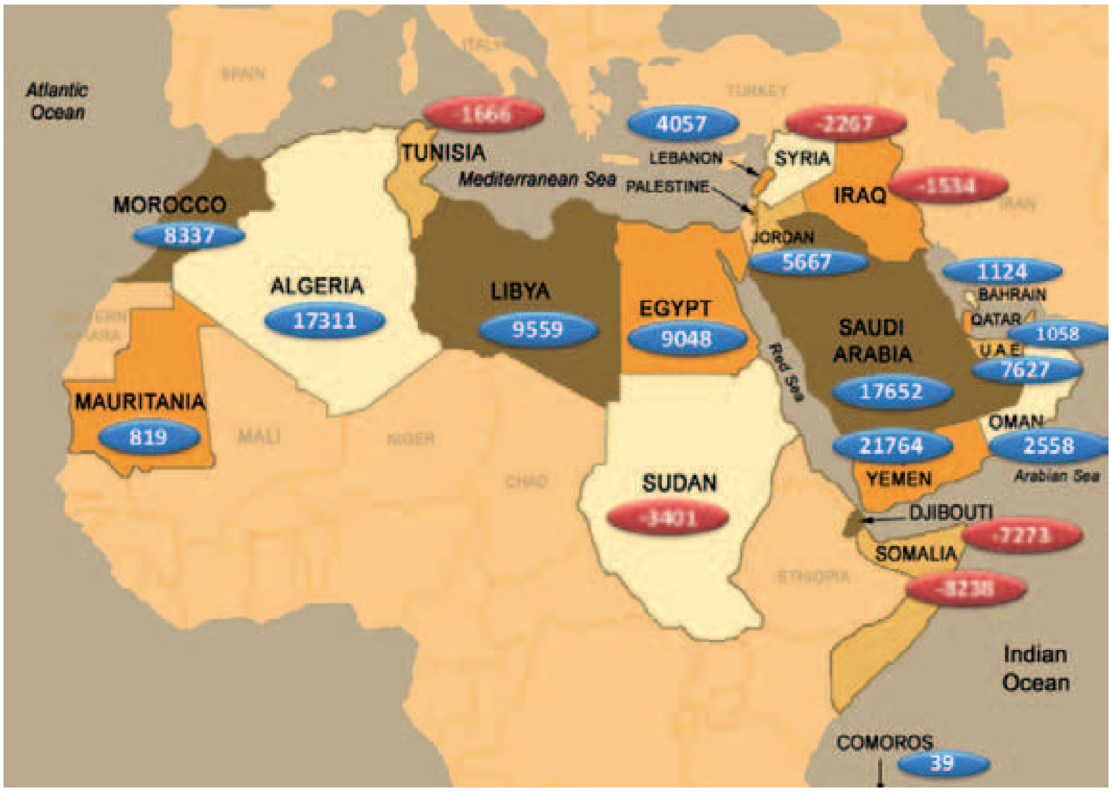


Source: Mekonnen and Hoekstra, 2011

the water footprint of a commodity such as cotton in Syria is 5251 m^3/ton, while that in Egypt is 10272 m^3/ton; but this does not necessarily mean, assuming all cotton was produced locally, that cotton production in Syria is more sustainable. The true criterion is whether the production and supply chain of cotton in the country of origin is water-sustainable in terms of water irrigation efficiency and water crop productivity, taking into consideration water over-exploitation and quality. In other words, a large WF could be sustainable in a water-rich region but unsustainable in a water-poor area. Therefore, a water footprint sustainability assessment should be prepared in order to study the primary impacts on renewable water resources (blue water), environmental flow requirements (blue water), and water quality standards (gray water), as well as secondary impacts such as drinking water shortages, loss of biodiversity, and socio-economic development. Nevertheless one can still draw some conclusions regarding the effects of WF on sustainability.

The average WFs of consumption and production (particularly the blue portion) in Arab countries are significantly higher than the world average. Consumers in UAE, Egypt, Libya, Saudi Arabia, and Syria have the largest blue WF in the world, which impacts the water quantity and quality locally and abroad. Although countries like Kuwait, Jordan, and UAE have externalized their WF by importing water-intensive products, there are cases where export of blue water from already water scarce or stressed countries or regions is considered unsustainable (Egypt, Morocco, and Syria). A more sustainable approach recognizes the need to match production

FIGURE B7 **ANNUAL NET VIRTUAL WATER TRADE FLOWS (MM³/YEAR) OF ARAB COUNTRIES (EXCEPT PALESTINE), 1996-2005. BLUE CIRCLES REPRESENT NET IMPORTS AND RED CIRCLES REPRESENT NET EXPORTS**



Source: Mekonnen and Hoekstra, 2011

to water availability in the producing region.

Green water is underutilized in most Arab countries. Besides having a lower opportunity cost, the use of green water for the production of crops has generally less negative environmental externalities than the use of blue water. Governments should adopt better green water management techniques such as rainwater harvesting, and provide funding to programs such as the green water credit program developed by the International Fund for Agricultural Development (IFAD), which compensates farmer groups in return for green water management.

Gray WF of production and consumption in some Arab countries (Bahrain, Iraq, Kuwait, Qatar, and UAE) is significantly higher than the world average, resulting in high potential pollution levels with detrimental effects on the environment.

Dr. Hadi Tabbara is Professor and Researcher in Water Resources

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Sustainable Energy Options

Ibrahim Abdel Gelil

I. INTRODUCTION

The Arab region is facing a set of development challenges due to the scarcity of productive land and renewable water resources, which will be worsened by climate change. The region is highly deficient in bioproductive capacity. These challenges have been typically confronted by intense utilization of fossil fuels and the importation of food and other resource intensive commodities. These two strategies seem to be unsustainable as they both rely on depletable high carbon resources and remain vulnerable to the price volatilities of global commodity markets. Furthermore, both strategies generate a high Ecological Footprint. Given the imbalance between domestic supply of, and demand for, ecological services, this section will address the options available to shift to a more sustainable energy sector in Arab countries.

II. ROLE OF THE ARAB ENERGY SECTOR IN DEVELOPMENT

Oil and gas revenues, estimated at $483 billion in 2010, account for a major part of Arab countries' income, and particularly so for countries of the Gulf Cooperation Council (GCC). According to the Arab Monetary Fund (AMF), the oil and gas sector made up about 27 percent of total Arab gross domestic product (GDP) in 2010 (AMF, 2011). The petroleum industry plays an important role in the social and economic development of Arab oil-importing countries, who benefit indirectly through worker remittances, trade, and funding of bilateral or joint Arab projects (OAPEC, 2009). In addition, the Arab oil and gas sector offers job opportunities in exploration, production, transportation, refining, and distribution.

Over the past three decades the GCC countries, the major oil exporters, have witnessed an unprecedented economic and social transformation. Oil proceeds have been used to modernize infrastructure, create employment, and improve human development indicators. The United Nations Development Program (UNDP) reports on human development indicators (HDI) show a strong correlation with per capita energy consumption in the region. Countries with very high HDI ranking have had the higher per capita energy consumption, as indicated in Figure 1. However, progress in human development indicators has been accompanied by changes in

consumption patterns and lifestyle choices as a result of rising oil revenues, leading to higher Ecological Footprint and increased demand for bioproductive resources.

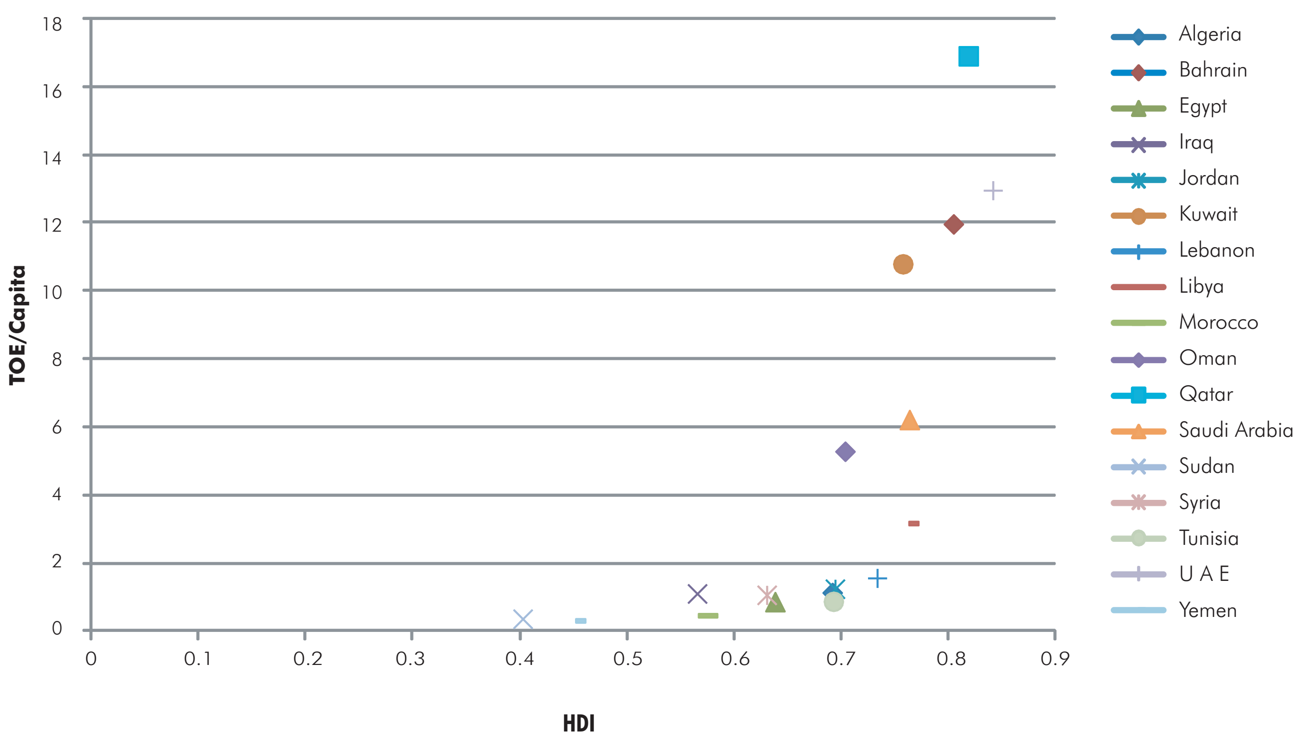
Arab countries hold nearly 58 percent of the world's oil reserves. At the end of 2010, proven oil reserves were estimated at 712.4 billion barrels. Total crude oil production by Arab countries averaged 21.3 million barrels per day in 2010, accounting for 29.4 percent of world production. In addition, the Arab region holds nearly 29 percent of the world's gas reserves. Arab countries produced 458.4 billion cubic meters of gas in 2010, accounting for 14.3 percent of world gas production (OAPEC, 2011). Thus, the hydrocarbon sector in the Arab region has had a long-term commitment to the security of energy supply for the global economy.

Arab economies rely heavily on oil and gas to meet domestic energy demand, and they accounted for nearly 97.3 percent of total Arab energy consumption in 2009. Oil accounts for 52.5 percent of total energy consumption, while gas accounts for 44.8 percent and renewable 2.7 percent.

It is also worth noting that the energy sector plays a major role in meeting water and food needs in Arab countries. Fossil fuel-based combined heat and power thermal plants are commonly used for seawater desalination in the region, which hosts nearly 50 percent of the world's desalination capacity (AFED, 2010). Electricity from fossil-fuel power plants is used as the primary energy source to pump and distribute groundwater. Thus, food production in the region continues to rely on the availability of energy resources. Shifting to renewable sources of energy should be an option to secure sustainable supply of water resources and food production for decades to come.

Arab economies are highly vulnerable to the volatility of the global oil market. High oil prices generate greater revenues for net exporters, but add additional stress on already strained public budgets of Arab oil-importing countries.

FIGURE 1 **HDI AND ENERGY CONSUMPTION (TON OF OIL EQUIVALENT) PER CAPITA IN SELECTED ARAB COUNTRIES (2009)**



TOE: Ton of oil equivalent
Sources: IEA, 2011 and UNDP, 2011

III. ENERGY CHALLENGES

Despite the vital role of the energy sector in the economic and social development of Arab countries, the sector faces several challenges that are derailing the transition to sustainable development. Against a backdrop of rising demand, increased price volatility, gradual depletion of fossil fuel resources, and growing climate change concerns, policymakers face major challenges.

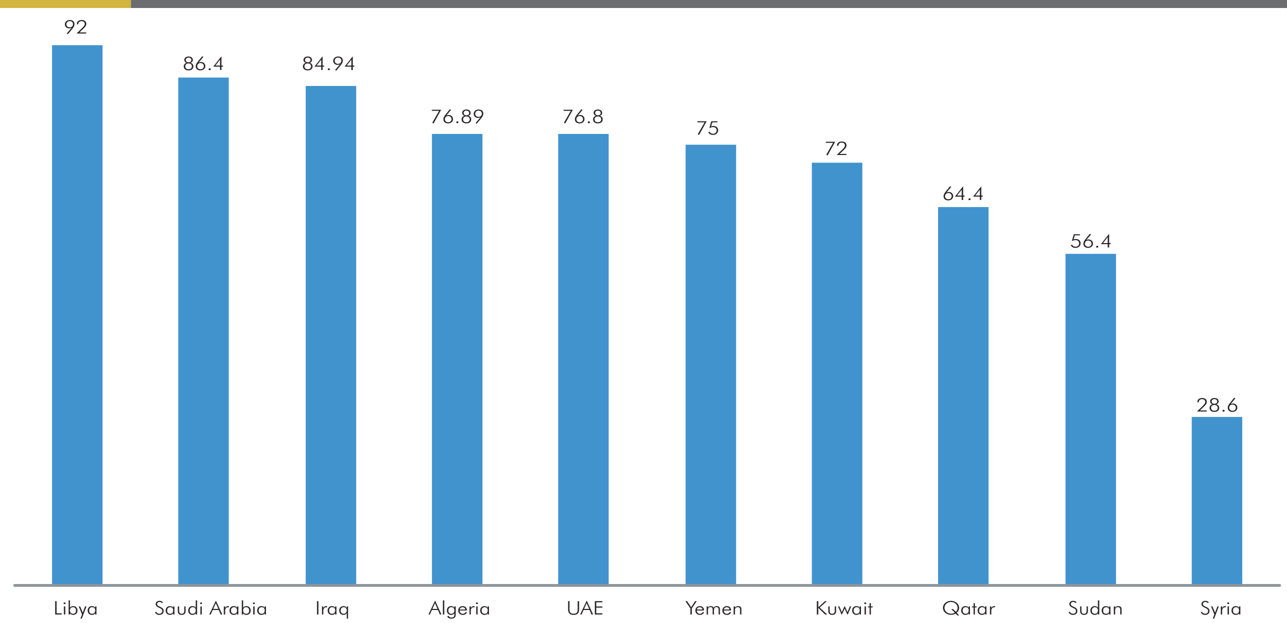
A. Economic Diversification: Security of Supply

With respect to hydrocarbon endowments, Arab countries can be classified into two major groups: energy net exporting countries who are endowed with oil and gas resources with varied degrees, and energy net importing countries, who have little or no hydrocarbon resources. As mentioned above, both groups are highly vulnerable to the volatility of oil markets. Hydrocarbon revenues make up a significant source of governments' revenues in oil exporting countries, as indicated in Figure 2. Any future decrease in demand for fossil fuels, for example as a result of international agreement on climate change mitigation, would cause an emerging economic challenge for Arab oil exporting countries. Thus, the need is unprecedented for shifting away from an economy based on finite fossil fuel extraction to one based on investments in renewable resources. For Arab oil-importing countries, the same shift to green energy sources would foster desperately needed energy security and economic sustainability.

B. Energy Access

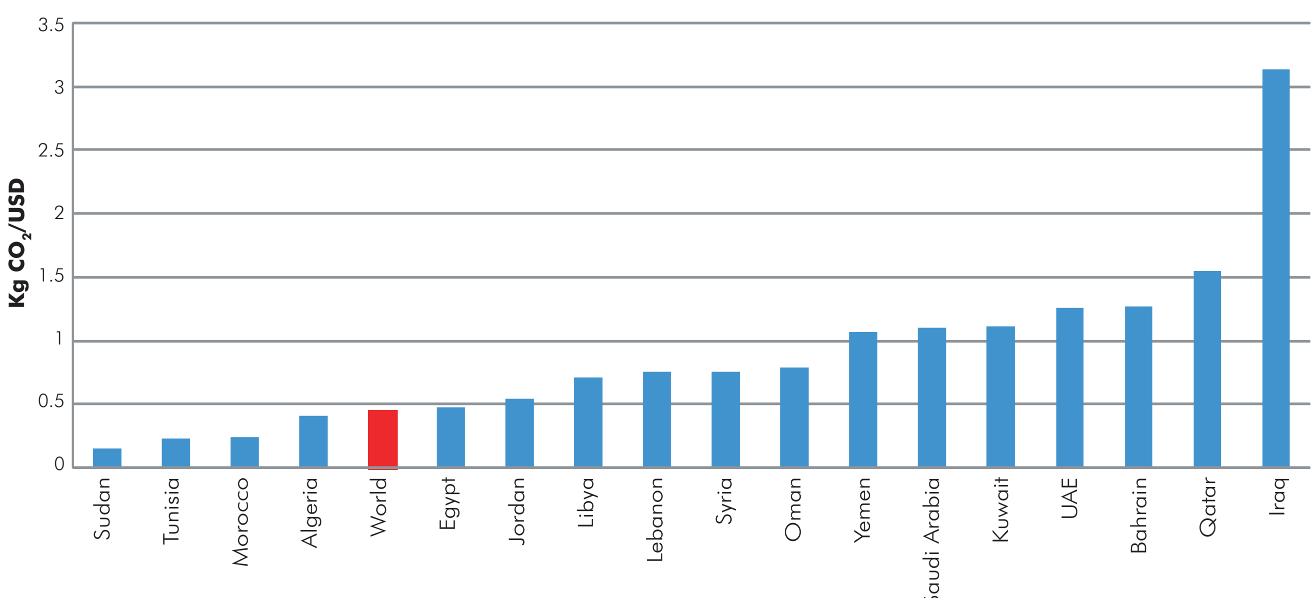
Energy access to poor and rural populations in some Arab countries such as Morocco, Algeria, Sudan, Yemen, and Palestine poses a major development challenge for those countries. Though the per capita energy consumption in the GCC sub-region is nearly four times the world's average, more than 40 percent of the Arab population in rural and urban poor areas does not have adequate access to modern energy services. It is also noted that almost one-fifth of the Arab population relies on non-commercial fuels for different energy uses. Furthermore, the electrification rates in Arab countries in 2007-2008 varied from as high as 100 percent in Kuwait and Bahrain to as low as 25-30 percent in Sudan and Yemen. This is well reflected by the large disparity in per capita energy consumption indicators among different Arab countries in 2009. These were as follows:

FIGURE 2 HYDROCARBON REVENUES (PERCENT) AS A PERCENTAGE OF TOTAL GOVERNMENT REVENUES, 2006-2008



Source: Abdellatif, 2010

FIGURE 3 CARBON INTENSITY OF ARAB COUNTRIES (KG CO_2/USD)



Source: IEA, 2011

The average primary energy consumption of 1.65 ton of oil equivalent (toe) per capita, is slightly less than the world average of 1.80 toe. However, wide disparities exist in the levels of energy consumption among Arab countries. It ranges between 0.32 toe in Yemen to 16.9 toe in Qatar. The average Qatari consumes nearly ten times the global average of energy. Only GCC countries and Libya exceed the global average per capita consumption of energy.

The average electricity consumption reached 2105 kilowatt-hours (kWh) per capita regionally, compared to the world average of 2730 kWh per capita. The same wide disparity in average electricity consumption exists with a range between 115 kWh in Sudan to 17296 kWh in the United Arab Emirates (UAE). The average Emirati consumes nearly six times the global average of electricity. Only GCC countries, Libya, and Lebanon exceed the global average per capita consumption of electricity.

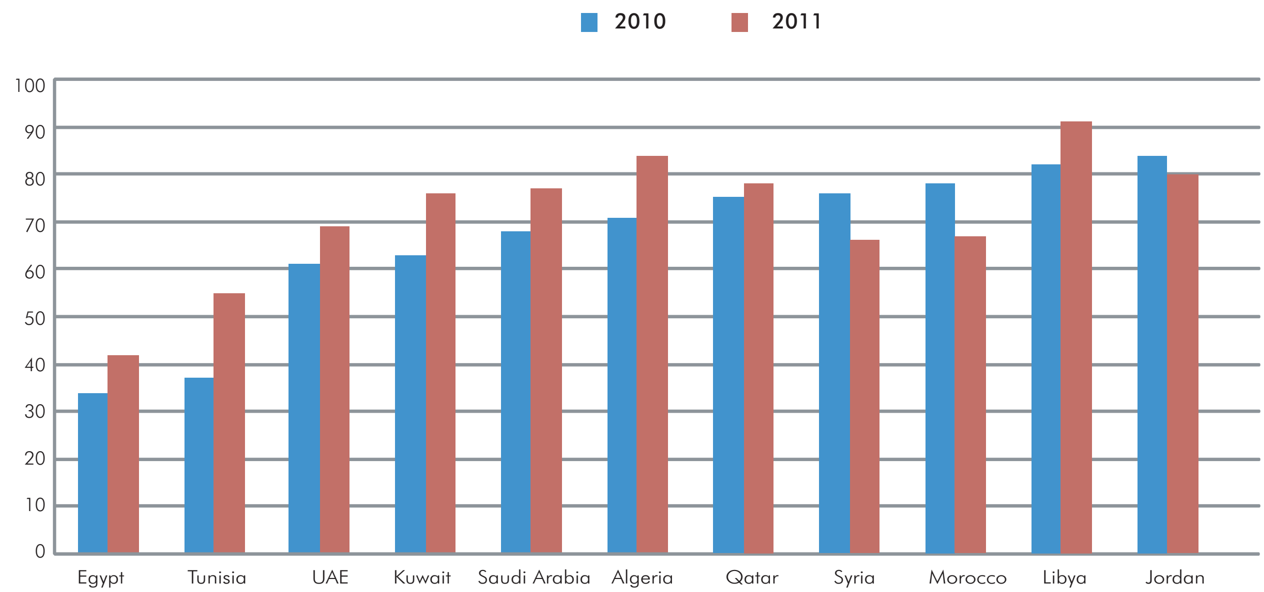
C. Environmental Challenges

The third major challenge facing the energy sector in Arab countries is the heavy reliance on finite fossil fuels to meet their energy needs leading to high carbon footprint. The average per capita carbon emissions in Arab countries combined is 4.1 ton CO_2-equivalent, almost approaching the global average of 4.3 ton CO_2-equivalent. According to the International Energy Agency's Key World Energy Statistics report, the carbon footprint per capita of the GCC countries was estimated to be more than four times the world's average, reflecting high average consumption of fossil fuels (IEA, 2011). The high-energy consumption is attributed to energy intensive economic activities such as desalination, aluminum smelting, cement production, and to the high demand for space air-conditioning needed in harsh climate conditions. The chronic problem of inefficient energy use also contributes to high-energy demand. Only four Arab economies are less carbon intensive than the world's average (IEA, 2011), as indicated in Figure 3.

IV. OPTIONS FOR SUSTAINABILITY: BEYOND POLITICAL DECLARATIONS

Relying heavily on fossil fuels, a finite resource, it is evident that current trends in the Arab energy sector are non-sustainable in economic, environmental, or social terms. To move towards

FIGURE 4 ENERGY SUSTAINABILITY INDEX RANKING FOR SELECTED ARAB COUNTRIES



Source: WEC, 2011

achieving the objectives of energy for sustainable development, the Arab Regional Strategy for Sustainable Consumption and Production identified a set of strategic objectives, among which are improving energy efficiency, increasing the share of renewable energy in the fuel mix, and disseminating renewable energy technologies especially in rural and remote areas. The same strategy pinpointed a whole list of needed policy interventions to achieve those objectives. These include reforming existing energy tariffs so as to integrate environmental and social costs while maintaining energy subsidies for the poor; improving energy efficiency, particularly in energy intensive industries, transport, and electricity generation; developing wide use of renewable energy technologies; and supporting air quality management through better urban planning and land use (CAMRE, 2011).

To address the energy sustainability challenges, Arab countries need to go beyond political declarations both at the regional and national levels. A number of options need to be expediently pursued. These include decoupling economic growth from resource utilization through efficient use of such resources, the de-carbonization of the energy mix to reduce the carbon footprint, and the eradication of energy poverty to achieve social equity and remove disparity in energy and economic indicators alluded to earlier.

The World Energy Council's (WEC) definition of energy sustainability is based on three core dimensions – energy security, social equity, and environmental impact mitigation. The development of stable, affordable, and environmentally sound energy systems defies simple solutions. The Energy Sustainability Index, developed by WEC, enables an empirical measurement of providing affordable energy, accessing secure energy supplies, and supporting environmental objectives. The Energy Sustainability Index ranks countries in terms of their likely ability to address the three core dimensions. According to WEC, the Index "displays the aggregate effect of energy policies applied over time in the context of each country. It is based on an empirical analysis of a range of indicators that reflect the three goals of energy sustainability. These include energy performance indicators across the WEC energy sustainability dimensions and contextual indicators that reflect the broader political, social, and economic circumstances of the country" (WEC, 2011).

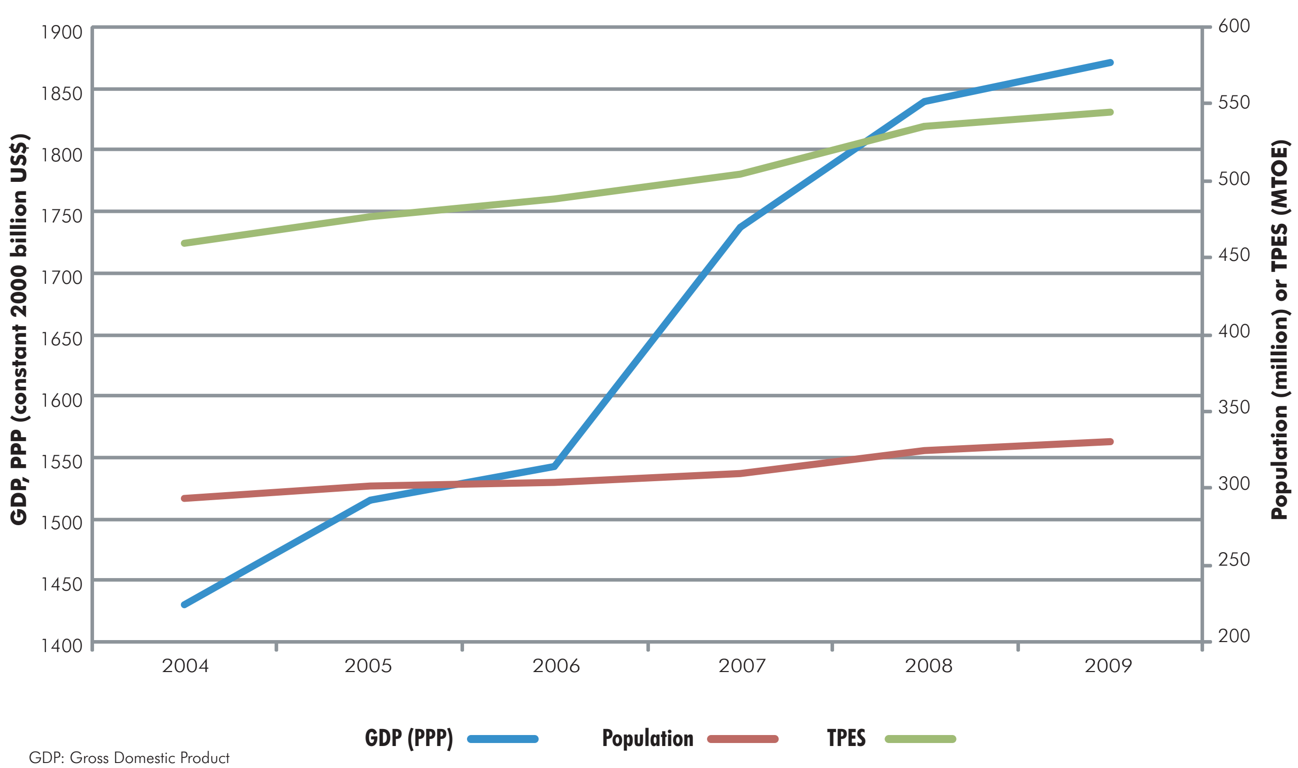
Analysis by WEC across the three energy sustainability dimensions revealed that a country's ranking can be affected by a number of factors, including resource endowment, economic prosperity, standards of living, technological development, and government and institutional support. Not one country in the world has been able to successfully achieve perfect alignment in all three dimensions of energy sustainability yet. Resource-rich and heavy fossil fuel-exporters often use their assets to boost social equity performance, often at a cost to long-term energy security and environmental impact mitigation. Energy importers tend to exhibit a more balanced approach to the energy trilemma, possibly a consequence of relying less on a single conventional resource.

Figure 4 illustrates Energy Sustainability Index rankings for selected Arab countries in 2010 and 2011. The graph does not reveal significant shifts in countries' rankings, which is expected given that some policy measures would need longer time for their effects to become evident. The Figure indicates that the two top performers in 2011 were Egypt and Tunisia. Three countries have achieved progress from 2010 to 2011 (Syria, Morocco, and Jordan), while the rest have slipped down. The political unrest in Tunisia, Egypt, and Libya might have caused the retreat in the three countries.

A. Decoupling Energy Demand and Economic Growth

Since the early 1980s, the consumption of energy has grown faster in the Arab region than in any other region in the world, reflecting the proliferation of energy-intensive industries, and the growing demand for electricity and transport by growing populations. As indicated in Figure 5, during the past five years energy consumption and carbon dioxide emissions in Arab countries have paralleled economic growth. The population in Arab countries is projected to reach 598 million by 2050, driving up the demand for energy (UN DESA, 2009). Meeting the forecasted growth in energy demand over the next decade will require major investments.

FIGURE 5 ENERGY USE, POPULATION SIZE, AND GDP IN ARAB COUNTRIES (2004-2009)



GDP: Gross Domestic Product
PPP: Purchase power parity
TPES: Total primary energy supply
MTOE: Metric ton of oil equivalent
Source: UN DESA, 2010.

Energy intensity – the ratio of energy use to GDP – has dropped dramatically nearly everywhere in the world. Only in Arab countries has energy intensity increased; energy consumption has been rising in concert with or faster than GDP. The region's energy intensity in 2009 is some 50 percent higher than the world's average. The Arab region ranks as the second most energy-intensive region in the world, after Eastern Europe and Central Asia (World Bank, 2009).

The high level of energy consumption in most Arab countries and the inefficiency of use can be attributed to, among others, the historically pervasive adoption of energy subsidies. In most countries of the region, fuel and electricity are subsidized at rates averaging in excess of 50 percent of the cost of supply. Table 1 displays energy subsidies as a proportion of the full cost of supply in selected Arab countries.

TABLE 1 ENERGY SUBSIDIES IN SELECTED ARAB COUNTRIES

Country	Subsidy (percent) as a percentage of fuel cost of supply
Algeria	41.4
Egypt	56.3
Iraq	47.4
Kuwait	53.3
Libya	52.0
Qatar	63.2
Saudi Arabia	78.9
UAE	55.7

Source: AFED, 2011

Subsidies for electricity and petroleum products are intended to allow citizens to share in their countries' natural-resource wealth as in the case of GCC countries, or to make essential energy services available to the poor, particularly in resource scarce countries like Egypt. However, subsidies tend to promote inappropriate consumer behavior, send wrong signals to consumers and suppliers, impair economic viability of sustainable energy options, aggravate environmental pollution and greenhouse gas (GHG) emissions, and pose a rapidly increasing burden on governments' finances. Although fuel subsidies are designed in some cases so as not to deter development and energy access to the poor, they pose a fundamental barrier to promoting energy efficiency.

To secure energy sustainability, Arab countries urgently need to embrace the principles of green economy by decoupling growth from resource depletion. Any consideration of meeting the region's growing demand for energy must include a focus on energy efficiency. Experience gained since the early 1980s indicates that it is theoretically possible to improve the energy efficiency of most sectors by up to a factor of ten. Furthermore, a significant proportion of this potential would appear to be cost-effective at current energy prices (WEC, 2011).

There is no single policy mechanism to drive energy efficiency that fits all. Policy success is often dependent on adapting policies to local circumstances. Best practices include five key operational elements: high-level, long-term commitment reflected in a sound legislative and institutional framework; the right entry points and the right pace of policy change; mobilization of sustained financial resources; effective, sustained measurement of results; and communication with the public. Best practices in these areas must be adapted to each country's unique political, economic, and institutional environment (World Bank, 2009). Accordingly, policymakers in Arab countries are required to formulate policy packages suiting their respective circumstances. A starting point in most Arab countries would be applying a mix of initiatives to overcome existing market barriers to energy efficiency (AFED, 2011). Energy efficiency can be promoted by influencing consumer behavior via incenti ves in order to overcome price and non-price market barriers. Successful energy efficiency labeling offers a combination of information, awareness, and incentives to encourage consumers to adopt energy-efficiency technologies and producers to invest in technology innovation and meet energy performance standards. Governments in most Arab countries can play a powerful role in developing and enforcing such schemes to overcome current energy price distortions.

B. De-Carbonization of Economic Development

Arab countries have a great potential for renewable energy, including solar and wind, as well as hydro and geothermal in specific locations, which are still underutilized. Current installed hydro-

TABLE 2 **ARAB RENEWABLE ENERGY TARGETS**

Country	Target
Algeria	Wind: 100 MW by 2015; solar thermal: 170 MW by 2015; solar PV: 5.1 MW by 2015; cogeneration: 450 MW by 2015; solar CSP: 500 MW by 2010
Egypt	Renewable generation: 20 percent by 2020, including 12 percent from wind (about 7,200 MW) and 8 percent from hydro and solar PV
Jordan	Wind: 600-1,000 MW; solar PV: 300-600 MW; waste-to-energy: 20-50 MW
Kuwait	Renewable capacity: 5 percent by 2020
Lebanon	Renewable capacity: 12 percent by 2020
Libya	Wind: 280 MW by 2012 and 1,500 MW by 2030; solar CSP: 50 MW by 2012 and 800 MW by 2030; solar PV: 150 MW by 2030
Morocco	Solar hot water: 400,000 m^2 by 2012 and 1.7 million m^2 by 2020; wind: 1,440 MW by 2015; small hydro: 400 MW by 2015
Palestine	Renewable capacity: 20 percent by 2020
Saudi Arabia	Solar electricity: 41 GW by 2032 (25 GW SCP and 16 GW PV)*
Tunisia	Wind: 330 MW by 2011; solar PV: 0.015 GW by 2011; solar hot water: 740,000 m^2 by 2011

* Photovoltaic PV-Magazine, 2012
Source: REN21, 2010

electric power capacity stands at 11 GW. Solar resources vary between 1460-3000 kWh/m^2/year. The share of renewable energy in the total installed generation capacity in Arab countries remains relatively low, standing at around 7 percent in 2011, mostly from hydropower in Egypt, Syria, Iraq, Sudan, and Morocco. Solar and wind generation capacity of electricity amounts to more than 500 MW and is primarily limited to Egypt, Morocco, Tunisia, and Jordan (OAPEC, 2011).

Nine Arab countries have already set renewable energy targets to scale up penetration of renewable energy in their national energy mix, as shown in Table 2. Wind power is regarded as the most economically feasible source for renewable power in the region. At the lead is Egypt, with a wind power generation capacity of around 520 MW.

Some Arab countries have unveiled massive renewable energy programs. Morocco is investing US$ 9 billion to develop solar power projects in the country. Saudi Arabia has recently announced an ambitious plan to install 41 gigawatts (GW) of solar energy by 2032, with 25 GW of power generated using concentrated solar power (CSP) and photovoltaic technology supplying the remaining 16 GW. The plan aims to "catapult Saudi Arabia into the group of global leaders in renewable-energy" according to pv magazine (2012). Other investments in solar energy include the US$ 600 million 100 MW Shams-1 CSP plant in Abu Dhabi, a 60 MW integrated solar combined cycle in Kuwait, and a 200 MW CSP plant in Oman.

It is worth noting that a number of Arab countries have announced plans to add nuclear power to their energy mix. The ability of Arab countries to manage the entire lifecycle of nuclear power is questionable. Critical safety issues remain to be resolved. Apart from the risk of accidents in nuclear power plants, nuclear waste storage and disposal are still unresolved, and would pose serious public health risk. As stated in the AFED report (2011), "international concerns about nuclear weapon proliferation associated with nuclear fuel cycle and uranium enrichment has resulted in global restrictions on these technologies, which would force Arab countries to rely on the international supply market for nuclear fuel even if local uranium reserves were available." Furthermore, local technical capabilities to build, operate, and maintain nuclear power plants in Arab countries are extremely weak, which raises major energy security, safety, and dependency concerns over the heavy reliance on foreign expatriate labor. Thus, nuclear energy might not be the most viable policy option for long-term energy supply or security in the Arab region.

The global energy market is increasingly witnessing a remarkable shift to clean energy sources. The shift is propelled by gains in reducing dependence on depleting energy sources, enhancing national security, improving air quality and public health, and mitigating climate change, while creating new jobs and new areas for business growth. This trend is projected to continue for decades to come as the driving forces that have propelled the renewable energy sector over the past 5 or 6 years are still at work. These are energy security, economic development, climate change, and energy access for the poor. In the Arab region, the drivers of promoting

renewable energy in oil-importing countries are even more compelling. They include alleviating the financial burden of oil imports, reducing energy investment requirements for electricity generation, making the best use of existing supply capacities to improve energy accessibility, reducing local pollution, and mitigating GHG emissions. In addition, renewable energy can also play a vital role in addressing water scarcity in the Arab region while reducing the carbon footprint associated with the water sector.

A paradigm shift in energy policy is urgently needed in the Arab region to scale up power generation via renewable energy resources. In addition, strengthening human and institutional capacities is essential. Long-term strategies for capacity building are needed for policy analysis and technology assessment, for supporting development of technologies and related skills in sourcing, marketing, installing, operating, maintaining, and servicing renewable energy equipment, and in sharing best practices (El-Ashry, 2011).

C. Social Equity: Eradicate Energy Poverty

Energy poverty is defined as the absence of sufficient choice in accessing adequate, affordable, reliable, safe, and environmentally benign energy services to support economic and human development. While energy is not in itself a basic need, it is required as a critical input for meeting other essential human needs. Consequently, satisfying basic human needs and poverty alleviation efforts cannot be achieved without improving access to safe and affordable energy services. Access to modern energy services can contribute to poverty alleviation by (i) improving the quality of life through better lighting, access to cleaner cooking fuels, and safe drinking water, and (ii) improving effective delivery of social services by ensuring reliable heating, lighting, refrigeration of vaccines and other medicines, and sterilization of equipment in health centers. Lighting in remote areas also improves educational attainment and therefore employment prospects.

The number of poor people in the Arab region was recently estimated at around 35 million, (UN, 2010). The majority of the poor live in rural or remote areas with no access to modern energy services. Renewable energy technologies could contribute to providing improved energy services for the rural poor, thereby alleviating poverty, while improving environmental quality and mitigating climate change. However, widespread diffusion of such systems faces strong institutional, technical, and financial barriers that need to be overcome for any effective contribution to poverty alleviation. One of the most challenging barriers has to do with the high initial cost of renewable technologies compared to conventional energy options (AFED, 2011). In order to bring the costs within the reach of many low-income communities, it is necessary to spread the high initial costs over a reasonable period of time while putting in place innovative financing mechanisms targeting the poor.

Improved access to microcredit can be an effective option to increase the affordability of renewable energy technologies for low-income groups. Microcredit is an effective way to provide households and small businesses with access to capital, via loans that typically include flexible repayment schedules that match customer income stream and longer loan repayment terms (UN Economic and Social Council, 2003).

As explained earlier, subsidies have often been used as a government policy instrument to provide access to energy services to low-income consumers. Lower income rural households will only benefit from access to renewable energy services with targeted subsidy policies. Therefore, energy subsidies for renewable sources should be designed to carefully target the eradication of energy poverty as part of a national strategy for poverty alleviation.

D. Water-Energy Nexus: Call for policy coherence

As noted before, the Arab region is mainly dependent on non-renewable resources (natural gas and oil). The region is also one of the world's most water stressed regions. Energy and water are inextricably linked: Energy production requires water; and water production, processing, distribution, and end-use requires energy. For instance, the GCC countries rely heavily on desalination plants to meet water demand for agriculture, household, and industrial activities with a high footprint impact. With population rising and economic growth escalating, there will be increasing pressure on water resources and a subsequent increased demand for energy. Furthermore, global climate change would exacerbate water scarcity in the region, putting more pressure on both energy and water resources. Forecasts based on models of the Intergovernmental Panel on Climate Change (IPCC) predict a reduction in runoff of 15 to 30 percent in all MENA countries. This would increase water demand for irrigation (ITT, 2011). Since water is a production factor for biocapacity through its potential to increase the area of productive land, these interconnections between water, energy, food, and climate become highly important and a source of concern.

There is a need to ensure that the future use of

water and energy production is closely considered together in association with plans for climate change mitigation and adaptation.

With the abundance of hydrocarbon resources, the untapped solar, wind, and other renewable resources in the region offer vast options for sustainability. The development of solar desalination technologies would offer a sustainable option for securing water supply. Furthermore, due to large disparities in water and energy endowments across Arab countries, regional cooperation and integration is critical. For example, creating regional power grid networks would increase the possibilities for individual countries to get access to power cost- effectively. Efficiency measures in water and energy use promise to have multiple advantages as every unit of water preserved is a unit of energy saved – and vice versa (ITT, 2011).

It is highly recommended to focus integrated research on the water-energy-climate nexus. It has become crucial to analyze the respective footprint of different technologies, e.g. the water and carbon footprint of any energy supply option as well as the energy and carbon footprint of any water supply option. Additionally, current policy fragmentation needs to be addressed in order to ensure coherence among energy, water, agriculture, and climate policies.

V. CONCLUSION AND RECOMMENDATIONS

Arab governments should develop long-term strategies to decouple economic growth from resource utilization. This is to be realized through economic restructuring and diversification towards knowledge-based economies as an alternative to current resource intensive economies. This, together with scaled up penetration of renewable and clean energy technologies, would drastically reduce the region's carbon footprint. To address energy poverty, public policies should seek to increase the affordability of renewable energy technologies and other modern energy services. The capacity gap in the region needs to be bridged through education, training, and investing in research and development. Finally, the challenge of water scarcity calls for policy reform to achieve coherence between energy, water, and food security.

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Population, Consumption, and Sustainability Options

The Case of the GCC Countries

Bashar M. Zeitoon

I. INTRODUCTION

Introduced by Wackernagel and Rees (1996), 'Ecological Footprint accounting' measures the environmental impact of human activities by determining "the resource consumption and waste assimilation requirements of a defined human population or economy in terms of a corresponding productive land area." It is recognized thus that the two main drivers of Ecological Footprint are population and per capita consumption (de Sherbinin et al., 2007). This chapter will address trends in these two variables affecting Arab countries.

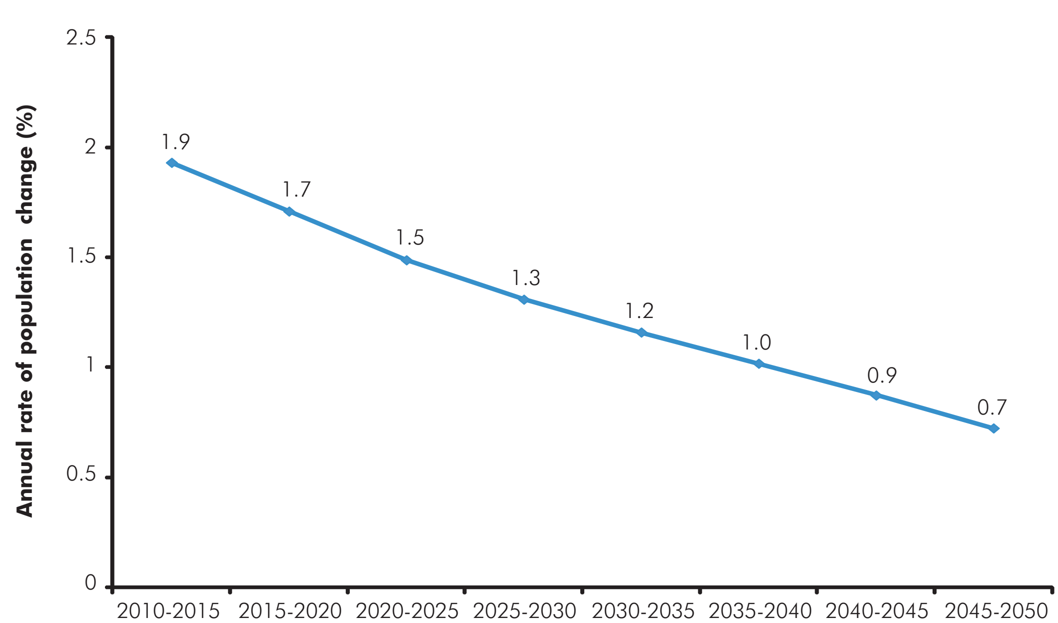
A better understanding of the interrelationships of population, consumption, and environmental change is key to analyzing Ecological Footprint accounts. The insights gained from this analysis bring awareness of the implications of ecological limits on economic security and prosperity. The challenge becomes one of changing consumption patterns, development models, and economic policies, so that equilibrium can be reached with the Earth's ecosystems (Daly, 1996). By making these linkages explicit through analysis, decision makers will be better prepared to weigh available sustainability options.

II. DEMOGRAPHIC TRANSITIONS IN ARAB COUNTRIES

In 2010, the Arab world's population reached 357 million, and it is projected to be 633 million by 2050, according to United Nations (2011) population statistics. Estimated and projected population figures by country are indicated in Table 1. Despite the increase in population, the average annual rate of population change is projected to decline in Arab countries from 2010 to 2050, as illustrated in Figure 1. For example, over a span of 40 years, from 1980 to 2020, the population of Arab countries is projected to increase 2.5-fold, to 431 million, compared with a 1.8-fold increase projected from 2010 to 2050 (UN, 2011). On an annual basis, the average annual rate of population growth of 1.9 percent between 2010 and 2015 is projected to decline to an annual average of 0.7 percent in 2045-2050.

Trends in the total fertility rates (TFR) in Arab countries indicate "a substantial and rapid decline in fertility during the past two decades", with "the average fertility [declining] by more than one-half (56 percent) to 3.1 births per woman", compared with 7.2 births per woman

FIGURE 1 AVERAGE ANNUAL RATE OF POPULATION CHANGE (PERCENT) IN ARAB COUNTRIES, 2010-2050 (MEDIUM VARIANT)



Source: UN, 2011

TABLE 1 **TOTAL POPULATION (1000s) BY COUNTRY (MEDIUM VARIANT); ESTIMATED (1950, 1980, 2010); AND PROJECTED (2020, 2025, 2050)**

	1950	1980	2010	2020	2025	2050
Algeria	8,753	18,811	35,468	40,180	42,043	46,522
Bahrain	116	358	1,262	1,508	1,588	1,801
Comoros	156	329	735	933	1,041	1,700
Djibouti	62	340	889	1,066	1,166	1,620
Egypt	21,514	44,952	81,121	94,810	100,909	123,452
Iraq	5,719	13,744	31,672	42,684	48,885	83,357
Jordan	449	2,299	6,187	7,366	7,906	9,882
Kuwait	152	1,377	2,737	3,394	3,700	5,164
Lebanon	1,443	2,795	4,228	4,516	4,624	4,678
Libya	1,029	3,063	6,355	7,083	7,465	8,773
Mauritania	657	1,518	3,460	4,298	4,742	7,085
Morocco	8,953	19,567	31,951	35,078	36,406	39,200
OPT	932	1,510	4,039	5,317	6,027	9,727
Oman	456	1,181	2,782	3,290	3,470	3,740
Qatar	25	222	1,759	2,199	2,289	2,612
Saudi Arabia	3,121	9,801	27,448	33,535	36,226	44,938
Somalia	2,264	6,436	9,331	12,237	14,152	28,217
Sudan	9,190	20,071	43,552	54,919	60,811	90,962
Syria	3,413	8,907	20,411	24,079	26,009	33,051
Tunisia	3,530	6,457	10,481	11,518	11,921	12,649
UAE	70	1,016	7,512	9,174	9,867	12,152
Yemen	4,316	7,945	24,053	32,232	36,698	61,577
Total	**76,320**	**172,699**	**357,433**	**431,416**	**467,945**	**632,859**

Source: UN, 2011

in the early 1950s (Casterline, 2011). In most countries, a significant part of this decline is recent, taking place in the approximately 30 years between 1980 and 2010, as indicated in Table 2. Over this time period, 15 out of 22 Arab countries have experienced a 50 percent or greater decline in TFRs. Data trends show that "at present the estimated TFR falls below 2.5 births per woman in eight countries – the three large Maghreb countries (Algeria, Morocco, Tunisia), Lebanon, and four Gulf States (Bahrain, Kuwait, Qatar, and United Arab Emirates)", while "eight countries have TFRs in excess of 4.0 births per woman, including the populous countries Iraq, Sudan, and Yemen" (Casterline, 2011). However, because the onset of fertility decline is relatively recent, the Arab region is expected to witness rapid growth in its population over the next few decades (UNDP, 2011), albeit at a declining rate.

Another key trend affecting Arab demographic change is the rising rate of urbanization. The proportion of the population in Arab countries living in urban areas grew from 38 percent in 1970 to 55 percent in 2010, as illustrated in Figure 2. By 2050, 66 percent of the Arab population, or 423 million people, are expected to live in urban areas (UN, 2012; UN, 2011). City planners and municipal officials in Arab countries will have to take seriously the concept of sustainable urbanization as a pre-requisite to improving the quality of life and meeting the rising demand for energy, water, transportation,

TABLE 2 **TOTAL FERTILITY RATE (BIRTHS PER WOMAN), 1950-1955, 1980-1985, 2005-2010; AND DECLINE IN TOTAL FERTILITY RATE (PERCENT), 1950-1985, 1980-2010, 1950-2010 IN ARAB COUNTRIES**

Country	Total fertility rate			Decline in total fertility rate (percent)		
	1950-1955	1980-1985	2005-2010	1950-1985	1980-2010	1950-2010
Algeria	7.3	6.5	2.4	11	63	67
Morocco	7.2	5.4	2.4	25	56	67
Tunisia	6.9	4.9	1.9	29	62	73
Median	*7.2*	*5.4*	*2.4*	*25*	*62*	*67*
Egypt	6.4	5.5	2.9	13	48	55
Iraq	7.3	6.4	4.1	13	35	44
Jordan	7.4	6.8	3.1	8	54	58
Lebanon	5.7	3.9	1.9	32	52	68
Libya	6.9	7.2	2.7	-5	62	60
OPT	7.4	7.0	5.1	5	27	31
Sudan	6.7	6.3	4.2	5	33	36
Syria	7.3	7.2	3.3	2	54	55
Median	*7.1*	*6.6*	*3.2*	*7*	*50*	*55*
Bahrain	7.0	4.6	2.3	34	51	67
Kuwait	7.2	4.9	2.2	33	55	70
Oman	7.2	7.2	3.1	0	57	57
Qatar	7.0	5.5	2.4	22	55	65
Saudi Arabia	7.2	7.0	3.2	2	55	56
UAE	7.0	5.2	2.0	25	63	72
Yemen	8.2	8.7	5.3	-6	39	35
Median	*7.2*	*5.4*	*2.4*	*22*	*55*	*65*
Comoros	6.0	7.1	4.0	-18	43	33
Djibouti	7.8	6.6	4.0	15	40	49
Mauritania	6.3	6.3	4.5	1	28	29
Somalia	7.3	6.7	6.4	8	5	12
Median	*6.8*	*6.6*	*4.3*	*4*	*34*	*31*
Arab median	**7.2**	**6.4**	**3.1**	**10**	**53**	**56**

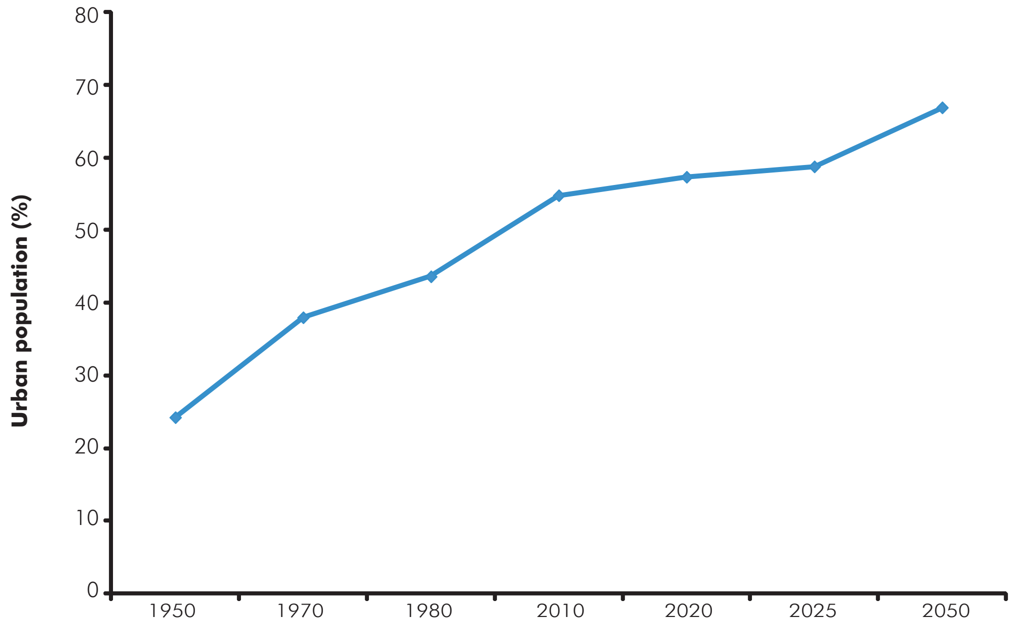
Source: Casterline, 2011

housing, waste management services, and other urban amenities.

A striking feature of the Arab region's demographic transition is the significant rise in the size of the working-age population, as illustrated in Figure 3. According to a report on Arab development challenges (UNDP, 2011), "the share of working-age population (15-64) in total has increased from 51 percent in 1970 to 62.45 percent by 2010 and is expected to peak at 66 percent in the year 2040 and decline to 65 percent by 2050", while "the proportion of older people aged 65 or over is projected to quadruple [by 2050] compared to 1980."

The implications of these demographic transitions in population size, rate of growth, age composition, and urban density on employment, Ecological Footprint, the demand for resources, and social stability are going to be significant over the next few decades.

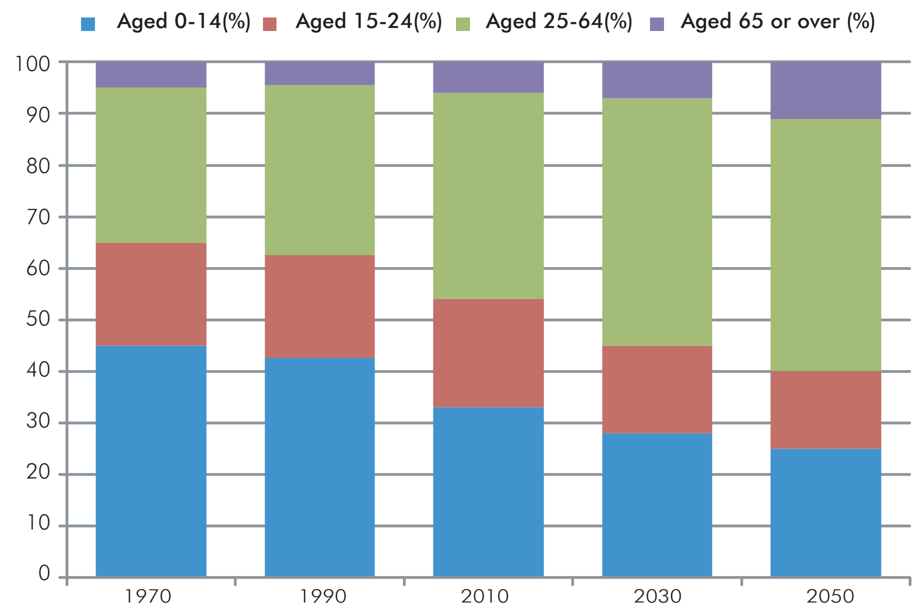
FIGURE 2 URBAN POPULATION (PERCENT) IN ARAB COUNTRIES, 1950-2050 (MEDIUM VARIANT)



Sources: UN, 2012; UN, 2011

The situation in member countries of the Gulf Cooperation Council (GCC) offers an excellent example of the impacts of population and consumption on the Ecological Footprint of these countries, because of the large influx of foreign labor migration over the past four decades, accompanied by fast change in consumption patterns.

FIGURE 3 AGE STRUCTURE OF POPULATION (PERCENT) IN ARAB COUNTRIES[1], 1970-2050



[1] Not all Arab countries are included in the regional averages
Source: UNDP, 2011

III. DEMOGRAPHIC TRANSITIONS IN GCC COUNTRIES

Rapid economic change in the Arabian Peninsula quickly ensued following the award of the first oil concessions in the Gulf region during the 1930s. Out of the shadow of fishing, pearling, herding, and sea trade, oil-based economies were born overnight. The desire to utilize oil revenues to meet basic needs and later to accelerate development, prompted the rulers of the Gulf to develop public services – hospitals, water, roads, schools, electricity, and so on – which paved the way for the creation of a welfare state system. Given the low levels of education and skill available locally at that time, the emerging Gulf States quickly became dependent on foreign workforce. The policies of immediate development and growth contributed to a quick rise in the demand for labor. The initial wave of migrant workers came from Arab countries, but, "as time went on, and particularly when development really took off in the 1970s, increasing number of recruits were found in Asia" (Owen and Pamuk, 1999).

Dependence on a foreign workforce in the GCC countries continues to this day. In his study of labor migration and nation building in the Gulf States, Fargues (2011,) concludes that "oil-generated wealth has allowed demographic growth through high fertility among nationals, and high immigration among non-nationals", and that "the faster growth among non-nationals has produced societies with a continuously shrinking proportion of nationals."

The first rapid rise in population followed the sharp rise in the price of oil in the early seventies and the subsequent spending boom. National and foreign population growth in the GCC countries as a group is indicated in Table 3. What is notable is the growth of the foreign population size by nine-fold over a span of 15 years, from 1975 to 1990, at an annual rate of growth 4.5 faster than national population growth (Fargues, 2011). The proportion of foreign population was 9.7 percent in 1975, soaring to 36.6 percent in 1990 and reaching 42.7 percent in 2010.

National and foreign populations and their proportions by country over the period 1975-2010 indicate that Bahrain, Kuwait, Qatar, and United Arab Emirates (UAE) have small national populations, below one million, as illustrated in Table 4. In these four states, national populations have become a minority. According to official statistics, nationals

TABLE 3 **NATIONAL AND FOREIGN POPULATIONS IN THE GCC COUNTRIES, 1975-2010**

		Population (1000s)		Proportion (percent)		Annual growth rate (percent)	
Year	**Total**	**National**	**Foreign**	**National**	**Foreign**	**National**	**Foreign**
1975	9,731.2	8,790.2	941.0	90.3	9.7	3.2	14.5
1990	22,522.6	14,281.2	8,241.4	63.4	36.6	3.3	5.0
2010	41,093.6	23,536.4	17,557.2	57.3	42.7	-	-

Source: Fargues, 2011

account for 13 percent (2010) and 18 percent (2009) of the total population in Qatar and UAE, respectively, while non-nationals make up almost a third of the total population in Oman and Saudi Arabia (Fargues, 2011).

Although the Gulf States have adopted policies to promote high birth rates among their national populations, the size of non-national populations has continued to grow as a proportion of the total population due to the high rate of labor migration. Moreover, the various workforce nationalization policies have failed to stem the demand for foreign or yield significant increases in the proportion of nationals in the labor force.

It is worth noting that fertility rates among female nationals in GCC countries have been decreasing significantly since the early 1990s as a result of better access to education. Projecting into the future, as the Gulf States continue to adopt ambitious plans to develop their economies, population growth by non-nationals will dominate (Fargues, 2011) because the national labor force will be insufficient to meet the needs of fast pace economic development.

In his study, Fargues employed national statistical data provided by GCC States, which may overestimate national population and/or underestimate non-national population figures. Since the publication of his study, more recent estimates have been produced, indicating higher proportions of non-nationals. For example, according to the General Secretariat of the Supreme Council for Planning and Development (SCPD, 2010) in Kuwait, the proportion of nationals in the country in 2008 was 31 percent out of a total population of 3.4 million. In the UAE, population estimates from the National Bureau of Statistics (2011) indicate that the country's population increased by 65 percent from 2006 to the end of June 2010 to 8.26 million. The Bureau estimated that "the UAE nationals accounted for 11.5 percent, or about 948,000, of the population" (Emirates247.com, 2011).

The most recent surge in non-nationals occurred from 2004 to 2008 and is attributed to the high levels of public spending on infrastructure modernization and development projects that was made possible by the high rise in crude oil prices during that time. Hence, the Qatar General Secretariat for Development Planning (GSDP, 2011) attributes the current population growth in the country to "massive urban development, large-scale investment projects and rising government expenditures, which have led to a large increase in expatriate workers", particularly over the period 2006-2009. A more recent Qatari estimate put the country's population at 1.64 million at the end of 2010 (GSDP, 2011).

More challenging trends pertain to employment figures and rates of labor participation by national citizens in the economy. According to the most recent surveys (2001-2011), the unemployment rate was 4.6 percent in the GCC region, but soared to an alarming level of 23.3 percent among youth (15-24 age groups), which is double the world average of 11.9 percent (UNDP, 2011). The public sector tends to dominate employment of nationals. For example, Kuwaiti manpower accounted for 69.3 percent of the total labor force in the

public sector in 2010-2011, while the private sector claimed only 6.5 percent (SCPD, 2010). In Qatar, the percentage of national citizens working in the private sector in 2009 was only 5 percent (GSDP, 2011).

IV. CONSUMPTION TRENDS IN GCC COUNTRIES

Gross domestic product (GDP), electricity consumption, and CO_2 emissions are usually used as indicators of consumption. Growth rates in these indicators in the GCC countries over the past 4 decades point to highly rising rates of per capita consumption, compared to the rest of the world. Real GDP (in constant US$ 2000) in the United Arab Emirates (UAE) was 1.5 times higher in 2010 than it was in 2000, having grown at a compound annual growth rate (CAGR) of 4.3 percent in real terms (World Bank, 2012). Qatar's real GDP (in constant US$ 2000) grew at a compound annual growth rate of 13.2 percent from 2000 to 2009, representing a 13-fold increase, compared with real GDP (in constant US$ 2000) growth in the world of 2.3 percent over the same period (2000-2009).

Changes in per capita CO_2 emissions in the GCC countries over the past two decades shed light on the intensity of consumption. Figure 4 indicates CO_2 emissions per capita from 1975 to 2009 in two GCC countries compared with world emissions. The percentage rise in CO_2 emissions per capita from 1990 to 2009 in the UAE and Qatar was 15 percent and 33 percent, respectively, compared to 8 percent for the world (IEA, 2011). Put differently, the CO_2 emissions produced by an average consumer in the UAE and Qatar were 7 and 9 times higher, respectively, than those generated by a world consumer in 2009. In absolute terms, the percentage increase in CO_2 emissions from 1990 to 2009 was 183 percent and 300 percent in the UAE and Qatar, respectively, compared to 38 percent in the world (IEA, 2011).

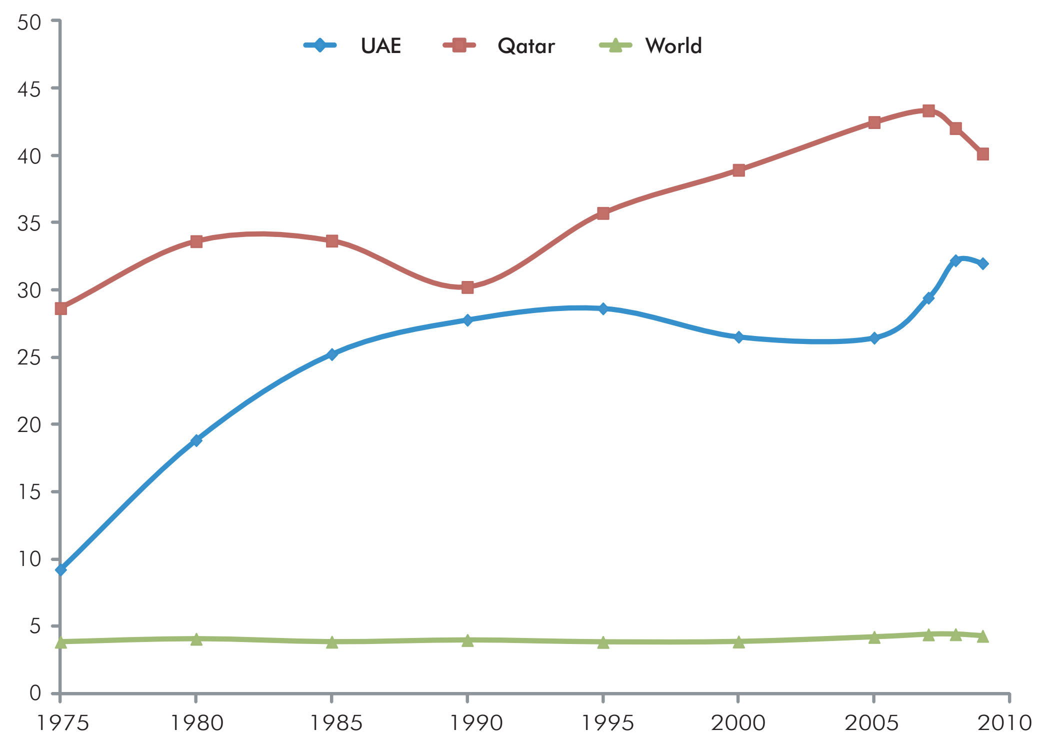
Electric power consumption in the GCC countries shows similar trends, as indicated in Figure 5. In 2009, the consumption of electric power by an average consumer in the UAE and Qatar was four and five times higher, respectively, than the consumption by a world consumer. The decline in per capita electricity consumption since 2005 in the two countries, a statistical aberration, is attributed to the surge in the influx of foreign workers over the same time period. In absolute terms, electric power consumption grew at a rate of nine percent annually in both countries from

TABLE 4 **NATIONAL AND FOREIGN POPULATIONS IN THE GCC COUNTRIES, SELECTED YEARS 1975-2010**

	Population (1000s)			Proportion (percent)		Annual growth rate (percent)	
Year	Total	National	Foreign	National	Foreign	National	Foreign
Bahrain							
1976	281.6	213.2	68.4	76	24	2.2	9.9
1981	350.8	238.4	112.4	68	32	2.9	4.8
1990	484.0	310.8	173.2	64	36	2.5	3.5
1995	558.9	352.9	206.0	63	37	2.4	3.0
2000	637.6	398.2	239.4	62	38	3.9	10.5
2005	888.8	484.8	404.0	55	45	4.2	11.8
2007	1,039.3	527.4	511.9	51	49	-	-
Kuwait							
1975	994.8	472.1	522.7	47	53	3.6	8.3
1980	1,358.0	565.6	792.3	42	58	3.7	5.0
1985	1,697.3	681.3	1,016.0	40	60	-3.8	8.6
1990	2,125.6	564.3	1,560.8	27	73	2.9	-10.5
1995	1,575.6	653.6	922.0	41	59	3.0	3.7
2005	2,213.4	880.8	1,332.6	40	60	-	-
Oman							
1977	901.0	820.0	81.0	91	9	3.6	19.6
1980	1,060.0	914.0	146.0	86	14	3.8	21.5
1981	1,130.0	949.0	181.0	84	16	3.7	13.8
1985	1,416.0	1,102.0	314.0	78	22	3.6	-0.6
1990	1,625.0	1,321.0	304.0	81	19	3.3	12.7
1995	2,131.0	1,557.0	574.0	73	27	2.7	1.7
2000	2,402.0	1,778.0	624.0	74	26	0.7	1.3
2005	2,509.0	1,843.0	666.0	73	27	2.2	10.0
2008	2,867.0	1,967.0	900.0	69	31	-	-
Qatar							
1990	467.0	97.2	369.8	21	79	4.2	1.9
1995	526.0	120.1	405.9	23	77	3.9	3.0
2000	617.0	146.3	470.7	24	76	3.3	8.3
2005	885.0	172.1	712.9	19	81	3.3	12.1
2010	1,508.0	202.6	1,305.4	13	87	-	-
Saudi Arabia							
1992	16,948.4	12,310.1	4,638.3	73	27	3.2	1.3
1998	19,895.2	14,872.8	5,022.4	75	25	2.4	2.3
2000	20,846.9	15,588.8	5,258.1	75	25	1.5	3.9
2004	22,678.3	16,527.3	6,150.9	73	27	2.1	5.3
2010	27,137.0	18,707.6	8,429.4	69	31	-	-
United Arab Emirates							
1975	557.9	201.5	356.3	36	64	5.3	9.7
1985	1,277.3	341.8	935.5	27	73	5.1	6.8
1996	2,567.0	599.0	1,968.0	23	77	3.6	5.5
2000	3,142.0	692.0	2,450.0	22	78	3.5	5.8
2005	4,106.0	825.0	3,281.0	20	80	2.8	5.8
2009	5,066.0	923.0	4,143.0	18	82	-	-

Source: Fargues, 2011

FIGURE 4 CO_2 EMISSIONS (TONS) PER CAPITA, 1975-2009



Source: IEA, 2011

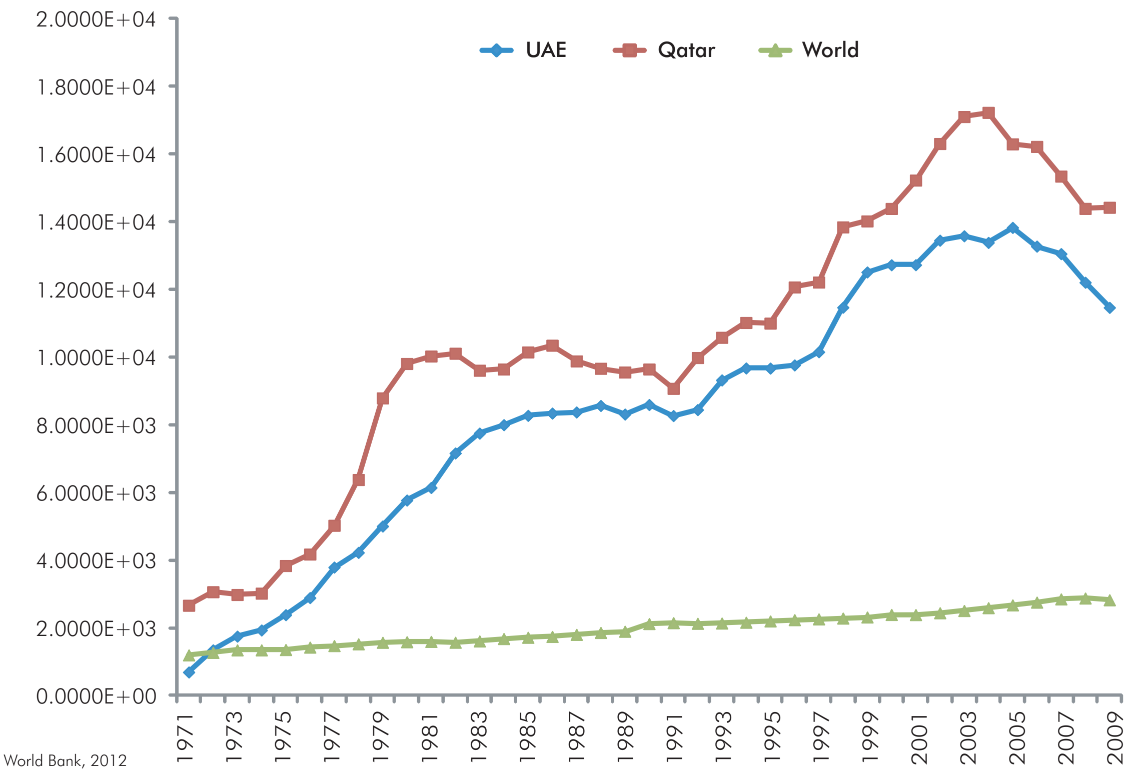
1990 to 2009, which corresponds to a percentage change of 412 percent for the UAE and 404 percent for Qatar, compared to 214 percent for the Arab world (World Bank, 2012).

Future projections for growth and resource use in the GCC indicate that current consumption trends will not slow down significantly in the near or medium term. Every GCC country has announced a multi-year development plan as part of a long-term vision of becoming a regional and global center of finance, commerce, logistics, education, media, and/or health care. For example, Kuwait has recently approved a 2010-2014 US$108 billion development plan as part of the Kuwait Vision 2035 (Al Bawaba, 2010). The four-year plan is the first of six consecutive development plans designed to catapult the country to becoming the region's leading finance and trade center by 2035.

Other GCC countries have also developed strategic development plans guided by grand vision statements. As part of its National Vision 2030, Qatar has allocated US$125 billion for the country's first five-year development plan called the National Development Strategy 2011-2016 (Al-Shorfa, 2011). According to the Qatar General Secretariat for Development Planning (GSDP, 2008), "the National Vision aims at transforming Qatar into an advanced country by 2030, capable of sustaining its own development and providing for a high standard of living for all of its people for generations to come." The total real gross domestic investment is estimated to approach US$ 225 billion during 2011-2016 (GSDP, 2011). In Saudi Arabia, the government has allocated US$ 384 billion for the country's 2010-2014 five-year development plan (Arab News, 2010). This does not include the "US$ 129 billion in spending designed to address social discontent" announced in February and March of 2011 (Clawson, 2012).

The Abu Dhabi Economic Vision 2030 seeks to increase the emirate's GDP five-fold by 2030, representing a compound annual growth rate (CAGR) of 6.7 percent from 2006 to 2030 (Government of Abu Dhabi, 2008). Per capita income is expected to increase by more than 50

FIGURE 5 ELECTRICAL POWER CONSUMPTION (KWH) PER CAPITA, 1971-2009



Source: World Bank, 2012

percent. An article in the Middle East Economic Digest (MEED, 2011) described Abu Dhabi's Vision 2030 as "the most ambitious economic development strategy the region has ever seen", which "aims to make Abu Dhabi one of the world's most modern economies and a business hub of global significance."

Considering the building and construction sector alone, a study conducted by MEED Projects for the 2012 Arabian World Construction Summit in Dubai concludes that the GCC States are set to award US$ 286 billion for construction and infrastructure projects alone between 2012 and 2016 (Arab News, 2012). "This kind of growth cannot be seen anywhere else in the world, and is still driven by huge petrodollar reserves", the authors of the study said.

V. ECOLOGICAL FOOTPRINT ACCOUNTS IN GCC COUNTRIES

Informed by Ecological Footprint assessment results for all Arab countries presented in another part of this report, the recorded Ecological Footprint per capita in the GCC countries was 5.7 global hectares (gha) in 2008, while the available biocapacity recorded was 0.8 gha per capita. This biocapacity deficit indicates that in 2008 the consumption of ecological resources by GCC countries to support economic activities exceeded the capacity to supply these resources by 600 percent, as illustrated in Figure 6. In absolute terms, the Ecological Footprint grew from 6 to 239 million global hectares between 1961 and 2008. This rise is attributed to rapidly rising populations, high levels of per capita consumption, and high intensity of resource use per unit of GDP. The available biocapacity, which measures the capacity to provide biological resources and absorb CO_2 emissions, was estimated at 33 million global hectares in 2008.

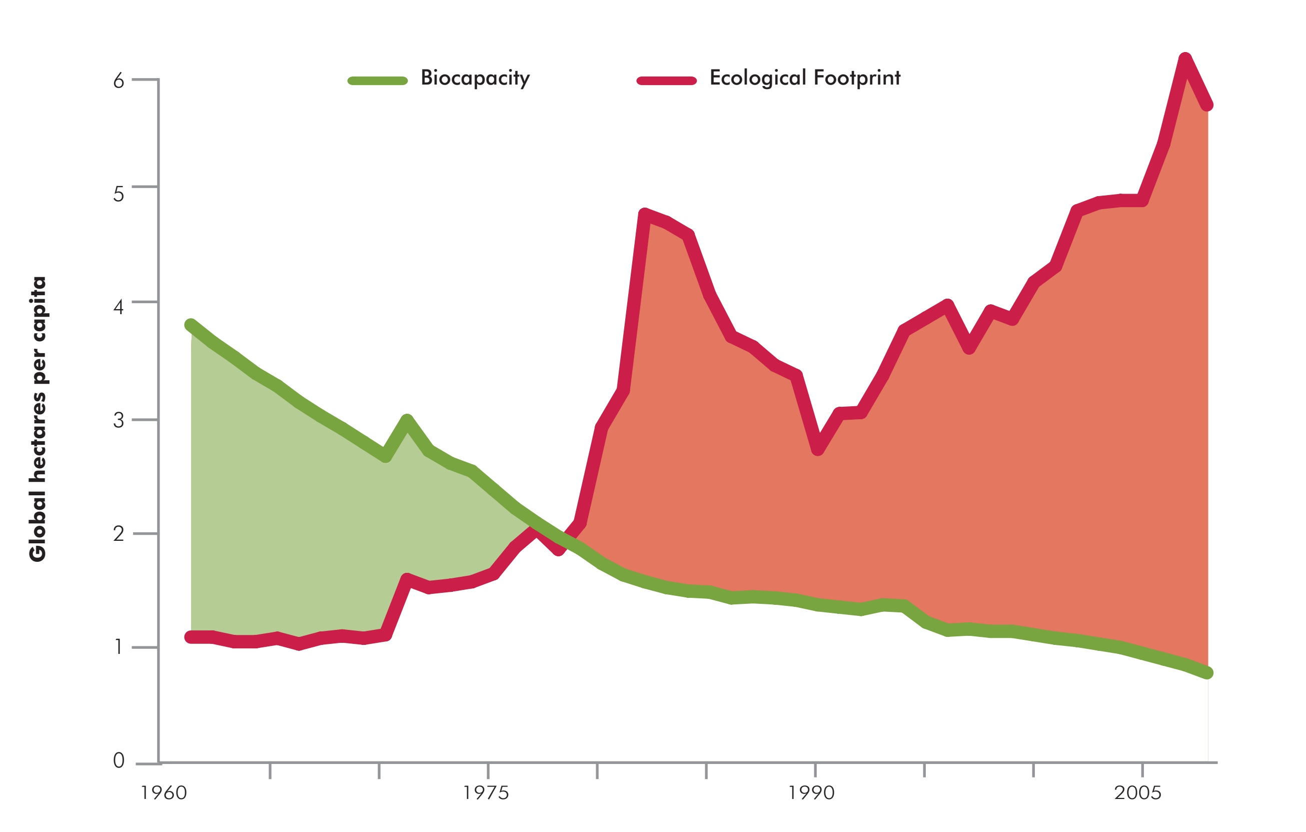
If the increasing trends in population and material consumption persist as predicted, the deficit in biocapacity will only increase, leading to serious implications for the wellbeing of the region. This deficit can only be maintained by overusing local environmental resources

and relying on imports, both of which are unsustainable strategies. In the long-term, overuse will lead to the depletion and degradation of the stocks of renewable natural resources (e.g., groundwater and fisheries), while dependence on imports introduces economic insecurity concerns. To wipe out the deficit, the supply of available biocapacity (in absolute terms) has to increase by more than 7-fold or 206 million global hectares.

To offer a comparative perspective, the average Ecological Footprint per person in the GCC was 5.7 gha in 2008, more than twice the global average footprint. Moreover, if the Ecological Footprint per person in the world were equal to that of an average person from a GCC country, the world would need 3 planets to satisfy the consumption and carbon emissions rates of every inhabitant on Earth.

Consistent with global trends, carbon emissions by GCC countries make up 67 percent of the total Ecological Footprint of the group. In addition, the carbon footprint component has been the only one to increase significantly since 1961 on a per capita basis, as illustrated in Figure 7. This is consistent with the intensive use of fossil fuels observed in GCC countries to accelerate the pace of modernization and economic growth. Figure 7 indicates a sudden and steep rise in carbon emissions after 1979. This is consistent with historical events in the oil market at the time. The 1979 oil price shocks provided the GCC with higher incomes, leading to accelerated spending on infrastructure and development, and hence greater consumption of energy per capita. With the oil glut of the mid 1980s, economic growth declined in the GCC countries, with some countries experiencing negative growth, leading to a retreat in carbon emissions and a

FIGURE 6 ECOLOGICAL FOOTPRINT AND BIOCAPACITY (GHA/CAPITA) IN GCC COUNTRIES, 1961-2008



reduction in the region's per capita Ecological Footprint, as illustrated in Figure 7. The cycle of higher oil prices followed by higher GDP growth and escalating Ecological Footprint has also been experienced in the 2000s.

Having established that the Ecological Footprint of GCC countries is much greater than its biocapacity (Figure 6), it should be borne in mind that this biocapacity is largely comprised of fishing grounds (57 percent), as illustrated in Figure 8. Sea-based biocapacity is as high as 1.9 gha per capita for Oman and Qatar (2008), compared to less than 0.01 gha per capita in Lebanon, which is the highest in the Levant region. Consequently, the demands on other land use types in the GCC exceed biocapacity by a much greater amount than is at first apparent.

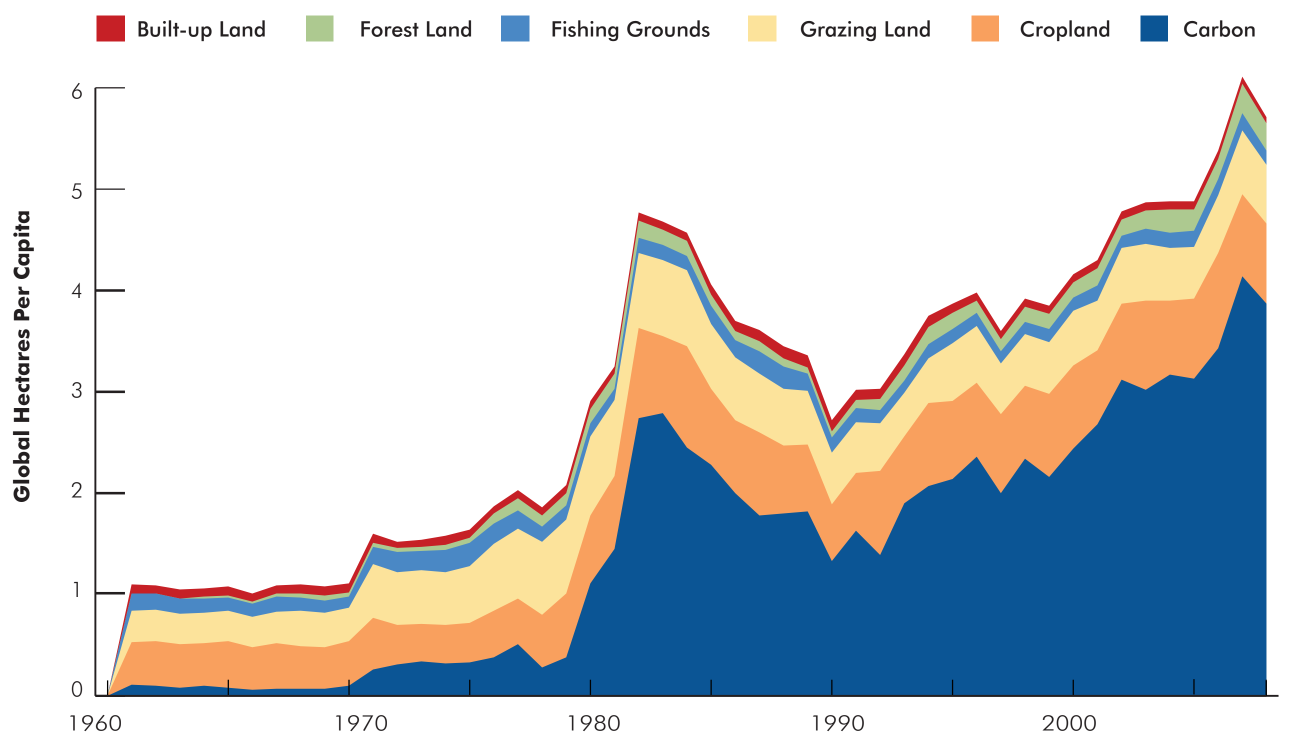
The significant reduction in the availability of biocapacity (per capita) from 1961 to 2008, illustrated in Figure 8, is largely attributed to the high rate of population growth in the GCC countries, particularly since the 1970s, but may also reflect a decline in the productive capacity of marine fisheries in the Gulf due to pollution, habitat destruction, and over-fishing.

VI. POPULATION GROWTH AND PER CAPITA CONSUMPTION

There is no question that the policies of economic growth have fueled the demand for labor in the GCC states, causing a surge in the influx of foreign workers. Today, the proportion of migrant workers in the GCC states varies from one-third to more than four-fifths of the total population: Qatar, 87 percent (2010); Bahrain, 49 percent (2007); United Arab Emirates, 88.5 percent (2010); and Kuwait, 69 percent (2008). Non-nationals account for one-third of the population in Oman (2008) and Saudi Arabia (2010).

While there is no question that a larger population size places greater pressures on

FIGURE 7 ECOLOGICAL FOOTPRINT (GHA/CAPITA) IN GCC COUNTRIES BY LAND USE TYPE, 1961-2008



ecological resources and results in a smaller share in per capita biocapacity, it would be an oversimplification to accept uncritically all the views held about an absolute direct relationship between population size and Ecological Footprints. These relationships are complex, as testified by an expanding body of research that seeks "to deconstruct population into its component parts and to understand how human social institutions in all their complexity (e.g., markets, policies, communities) mediate the impact of population variables on the use of resources, waste generation, and environmental impacts" (de Sherbinin et al., 2007).

Nevertheless, even with a declining rate of population growth in a region known for its scarce land and water resources and for reliance on food imports, it is possible to draw qualitative generalizations about the added pressure effects of a growth in population and urbanization on the ecological resources and services of the region. Given the large biocapacity deficit in GCC countries, rapid population growth, caused in this case by the rapid influx of foreign workers, accelerates resource use and waste generation and quickens the pace of environmental degradation.

The high proportion of migrant workers has also had the undesirable effect of reducing the share of national citizens in the workforce. For example, the rapidly growing expatriate population is responsible for "more than halving the share of Qataris in the labor force from 14 percent in 2001 to 6 percent in 2009" (GSDP, 2011). This reduced role of national citizens in the labor force, common in all GCC countries, also reflects deeper challenges in addressing the lack of motivation among national citizens to seek education, stay in the workforce, and pursue high-skill jobs in the private sector. Policy planners in some GCC countries have expressed these concerns, stating that "despite rapid economic development and efforts to improve male education, labor force participation rates of Qatari men are low and declining – with men leaving the labor force at a young age", and adding that "private sector employers are discouraged by the skill level, work attitudes, and motivation of new Qatari entrants into the labor market", concluding that "currently, Qataris have little incentive to excel in education and training" (GSDP, 2011). These concerns are common to all GCC countries.

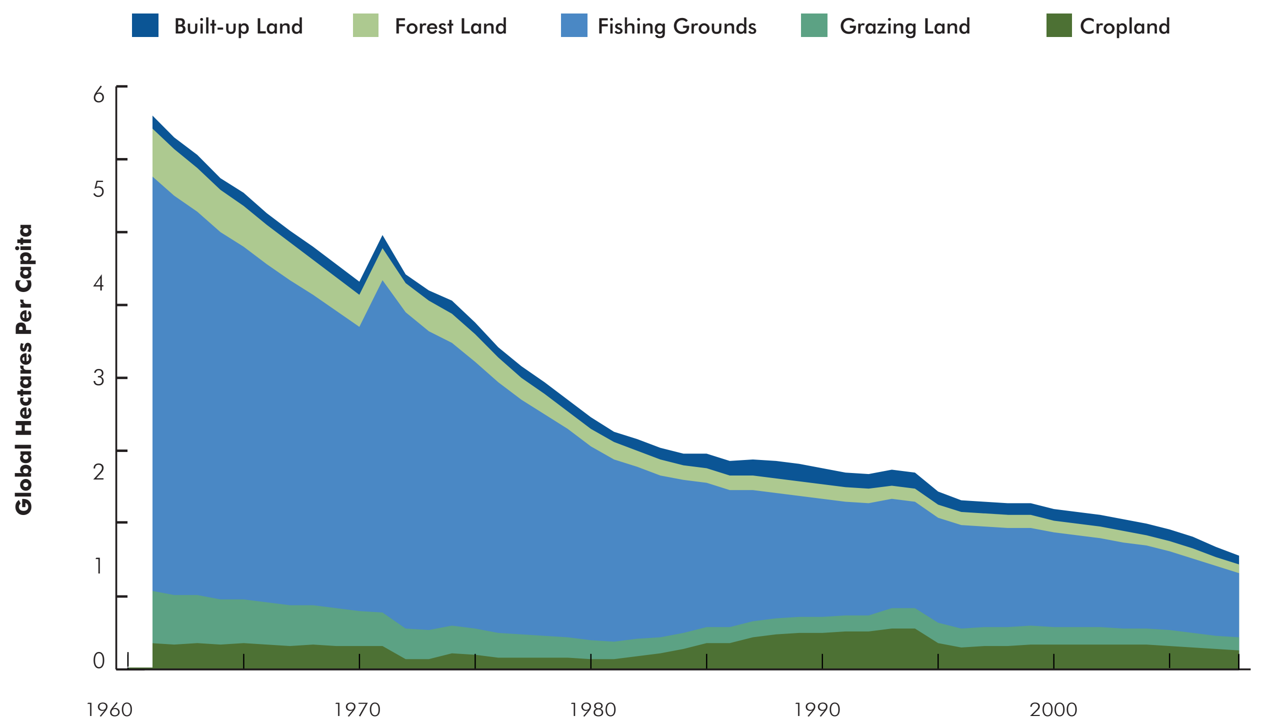
The demand for foreign workers in GCC countries may have been a necessity in the early period of state and institutional building, when only low levels of education and skill were available locally. Given that the GCC countries have already achieved comparatively high standards of living by undertaking infrastructure investments to support social and economic development, even achieving a higher per capita GDP in 2008 than the European Union (EU) countries as a group (Clawson, 2012), it is now necessary to re-evaluate current economic development structures and accord social and environmental goals a higher priority.

If GCC States confine themselves to reasonable rates of economic growth in proportion to the needs of their populations, there would be less demand for a proportionally larger expatriate workforce. This would relax the pressure on natural resources as well as open more opportunities to increase the participation rate

of national citizens in the economic and social lives of their societies.

As population growth continues to stabilize in Arab countries over the next few decades, the per capita consumption rate is quickly becoming a source of even more serious concern. Prior to the global financial crisis of 2008, most Arab

FIGURE 8 BIOCAPACITY (GHA/CAPITA) IN GCC COUNTRIES BY LAND USE TYPE, 1961-2008



THE UAE ECOLOGICAL FOOTPRINT INITIATIVE

Laila Abdullatif and Tanzeed Alam

The UAE is a rapidly developing country that has experienced a long period of extraordinary economic growth. This has resulted in an increasing rate of consumption of natural resources such as energy, food, fiber, and timber accessed from within and outside the country's borders. Because of the hot and arid conditions of the UAE, a significant amount of energy is consumed for space cooling and seawater desalination. These dynamics, when combined with inefficient consumption of natural resources, have resulted in a high per capita Ecological Footprint (EF) since 2006. The UAE has the third highest footprint per capita in the world, measuring 8.4 gha/person, trailing Qatar (11.7 gha/person) and Kuwait (9.7 gha/person), according to the 2012 Living Planet Report.

Approximately 71% of the UAE's EF is due to the consumption of carbon-intensive goods and services, in particular energy. Because the UAE relies almost completely on natural gas to generate electricity and desalinated water, energy and water security is always a concern, as demand is outstripping supply. Energy demand more than doubles in the summer mainly due to the need for space cooling, leading to gas shortages. To meet the peak demand for power in the summer time, the UAE burns crude oil and diesel fuel to generate electricity for local consumption at subsidized rates, which reduces the amount of oil exported and the potential revenue.

Thus, energy security, social and economic development, and the environment are now all recognized as key drivers to policy making in the UAE. This is manifested in the country's Vision 2021, the Dubai Integrated Energy Strategy 2030, the Abu Dhabi Environment 2030 plan, and the Green Economy Initiative. These different strategies seek to foster a green growth agenda to diversify and build a knowledge-based economy where sufficient skills, capacities, and jobs are developed to support growth in new green sectors, such as clean energy. In addition, the UAE is pursuing natural resource conservation to ensure that the country's growth targets are achieved without neglecting environmental limits.

In 2007, the government took significant measures to address the UAE's EF, making it the third country in the world to do so after Japan and Switzerland. Thus, the UAE Ecological Footprint Initiative (EFI) was born to utilize in-depth research to understand and manage the country's EF and facilitate the development of science-based policies. A unique public, private, and civil society partnership was set up bringing together the Ministry of Environment and Water (MOEW), the Environment Agency – Abu Dhabi (EAD) represented by its subsidiary body the Abu Dhabi Global Environmental Data Initiative (AGEDI), the Emirates Wildlife Society in association with WWF (EWS-WWF), the Global Footprint Network (GFN), and the Emirates Authority for Standardization and Metrology (ESMA). A federal steering committee was set up including high-level stakeholders from the energy and water sectors to provide strategic guidance. By working together to understand the UAE's natural resource consumption patterns, the EFI has prioritized actions seeking to catalyze change in both societal awareness and policy development.

In 2007-2008, the EFI completed the verification of the UAE EF data, concluding that it is an accurate estimate of the country's consumption patterns. From 2008-09, key drivers of the EF were identified, indicating that UAE households are responsible for 57% of national consumption, followed by business/industry (30%) and government (12%). These findings have guided the development of a sustainable lifestyles campaign known as 'Heroes of the UAE'4, which seeks to raise awareness about the EF and climate change, and what consumers can do to mitigate their effects.

As the EF is a retrospective indicator, there was a need to develop a science-based, policy relevant modeling tool. The goal is to predict the effectiveness of the strategies used to reduce the UAE's EF and carbon emissions, particularly those generated by the energy and water sectors. The energy sector is targeted as a strategic priority because it contributes the most to the carbon footprint.

In 2009-2010, the EFI partnered with academic experts at the Masdar Institute of Science and Technology to develop a science-based EF model that would act as a decision support tool. The EF model, which targets the electricity and water sectors, serves as an analytical tool for assessing the impact of policy options on the Emirate of Abu Dhabi's carbon dioxide emissions and UAE's overall EF up to the year 2030. Modeling results have indicated that by the year 2030, a portfolio of policy measures could help reduce CO_2 emissions in the Emirate of Abu Dhabi by up to 40% and the UAE's per capita EF by 1 gha/person. This would require more ambitious renewable energy targets, stronger building codes, and energy efficiency standards for appliances.

Building on this research, the EFI will continue to develop science-based policies to reduce the UAE's carbon dioxide emissions and per capita EF over the next three years by adopting a 3-pronged approach:

Track 1 focuses on developing a policy demonstration cycle to institute a lighting standard for the household sector.

Track 2 focuses on conducting a socio-economic assessment of the policies outlined in the EF scenario model.

Track 3 focuses on improving the verification of the UAE's EF in advance of the publication of each Living Planet Report, and communicating the results to policy makers. This will involve sourcing data from relevant authorities and building the capacity for knowledge creation and sharing.

Track 1 – Energy efficiency standards for lighting

Feedback from high level decision makers has highlighted the need to develop a policy demonstration cycle for energy efficiency standards to help reduce the UAE's overall EF and act as a blueprint for future policy development. Energy efficiency standards are seen to have high carbon abatement potential at low costs.

Depending on location, lighting accounts for as much as 20% of the electricity consumed by the residential sector. Thus, emphasis is being placed on establishing energy-efficient lighting and associated policy measures. Lighting energy efficiency standards for the residential sector are particularly applicable to this region, since lighting is the largest electricity consumer in UAE households after cooling. Lighting also affects the cooling load because it generates waste heat. Because consumption by households accounts for approximately 57% of the UAE's EF, the residential sector was established as a key target for improving energy efficiency and reducing the UAE's EF.

ESMA will conduct research seeking to develop a science-based energy efficiency standard and a labeling system for lighting at the residential level for the UAE. Research will include an international best practice review, development of a comprehensive residential lighting assessment for the UAE, benchmarking of a UAE lighting standard based on its economic and technical potential, sustainability impact assessment, and the identification of a policy and regulatory framework for the lighting standard. This will be complemented by extensive stakeholder engagement throughout the process to secure data and political buy-in.

Track 2 - Socio-economic assessment of energy and water policies for the UAE

A consultation process was undertaken with different stakeholders in 2010 to obtain feedback on how relevant, credible, and robust the EF scenario modeling was. Feedback has indicated that the current EF scenario model could be made more significantly relevant to decision makers if capabilities are added to quantify the socio-economic implications of the different policy scenarios and to expand the model to a federal level, along with separate emirate level analysis.

The aim of this research track is to conduct a socio-economic assessment of the energy and water policy scenarios modeled in order to facilitate more effective policy design and prioritization. The socio-economic evaluation will measure the effects of policies on: GDP growth, economic diversification, green job creation, energy and water security, UAE's competitiveness, UAE's export revenues and investments in renewable energy.

To conclude, the knowledge gained from the EFI has benefited the country by creating opportunities for UAE government leaders and residents to increasingly promote more effective sustainable development behavior. Initiatives that actively advance sustainable development and facilitate partnerships between the public, private, and civil society sectors are essential to bring about the needed change in the UAE, the Arab region, and the world to make the transition towards a sustainable future.

Laila Abdullatif is Project Manager of the Ecological Footprint Initiative (EFI) and Tanzeed Alam is Policy Director at the Emirates Wildlife Society (EWS-WWF)

countries have experienced extraordinarily high rates of economic growth, as measured by fast rising GDP. To this day, economic policies by Arab governments are rooted in the belief that economic growth is the main factor for societal wellbeing. These long-held beliefs need to be questioned.

Unfortunately, it can be argued that a significant amount of economic growth in Arab countries is motivated by the desire to accumulate private economic wealth, even though it is socially unequal and ecologically calamitous. Pursuing growth without addressing ecological limits and social inclusion may not turn out to be in the best long-term national interest of Arab countries.

Political leaders and economic planners in Arab countries must, therefore, address what level and type of GDP growth is needed to attain a sufficient level of wellbeing. New research by economists has emerged questioning the relationship between economic growth and societal wellbeing, demonstrating that "economic growth, beyond a certain level, provides little improvement in societal wellbeing" (Brown, 2012).

Nations can no longer achieve real prosperity by pursuing a development policy predicated on high per capita GDP growth accompanied by high per capita consumption. By adopting a strategic policy of unquestioned and excessive economic growth, Arab countries will generate substantial GDP growth in the short-term, but will incur long-term social and environmental costs that will translate into vulnerability to economic insecurity. The findings of this report reveal the fundamental fact that biophysical and/or economic limits are already being felt as a result of unquestioned GDP growth. An economy predicated on high rates of per capita consumption and which ignores ecological limits will see its short-term progress in wellbeing and quality of life seriously set back, regardless of the high level of per capita income or GDP achieved. Economist Herman Daly has described this scenario as 'uneconomic growth', "where the costs of growth exceed the benefits" (Victor, 2008). Today, the economic costs of growth are underrated, but may turn out to be significant in the future, with implications that go beyond economic insecurity to include social and political instability.

Economic development policies should give precedence to sustainability, with due importance allocated to social and environmental aspects. Beyond this, investments are needed to improve the resource productivity of the region's economies, particularly concerning water and energy use, given the region's water scarcity and much higher-than-average energy use. Because energy intensity has increased in Arab countries faster than GDP, even becoming 50 percent higher than the world's average in 2009, it is key to consider strategies where the rate of reduction in energy use per unit of GDP is greater than the rate of GDP growth to ensure that gains made in efficiency are not cancelled out by economic over-expansion.

VII. ECOLOGICAL DEFICITS AND THREATS TO ECONOMIC SECURITY

The deficit in the Arab region's ecological services, driven by high rates of population growth and per capita consumption, raises challenging questions for Arab countries about managing the demand for natural capital. These challenges are set against a background of water scarcity, food insecurity, and poverty. The implications for the region's long-term economic sustainability and ecological health should be given serious thought. Specifically, it is feared that the ecological deficit is creating a logic whereby the prospects for economic security become threatened. In fact, there is emerging evidence today that the Arab region is already vulnerable to limits to economic growth.

There are multiple sources precipitating these limitations to growth. One source stems from over-dependence on imports to meet the demand for primary products. This makes Arab countries vulnerable to disruptions in global supply chains, trade restrictions, and price volatilities. These unpredictable disruptions in trade flows, which may be accompanied by food shortages and soaring prices, indicate that ecological deficits cannot be addressed by relying on imports indefinitely. The financing of these imports presents yet another source of economic limitation because fossil fuel resources are inherently finite and crude oil price levels are highly subject to global economic cycles, all of which accentuates the risks of an extractive, one-source economy. Low-income Arab countries finance their imports through external borrowing and foreign assistance, adding debts to future generations. As external debts and interest payments escalate for these Arab countries, their prospects for economic security and survival diminish.

Public health concerns, fuelled by the policies of unquestioned, runaway economic growth in Arab countries are also placing limitations on wellbeing. There is ample proof that uncontrolled urbanization accompanied by irresponsible patterns of investments in construction, industrialization, and tourism with all the resource consumption entailed in these activities have negative impacts on the environment, causing many diseases to be initiated, promoted or sustained. The resulting public health deterioration places considerable

and long-term burdens on the economy and productivity and degrades the quality of life and wellbeing, the very same noble objectives economic growth is supposed to achieve.

Another area of major concern today is the sustained health and productivity of fisheries. Taking the Gulf region as an example, fishing stocks there have provided inhabitants of the region with a major source of food and income for hundreds of years. Increasingly, there is evidence that pressures on marine fisheries are mounting, leading to the depletion of some fish species. In a sign of deteriorating fisheries, some GCC States are investing in aquaculture to meet local demand. The extensive use of chemicals, processed feed, and accelerated fattening techniques in aquaculture bring their own set of environmental and health consequences.

In addition, intensive industrialization and urbanization activities in coastal areas are raising concerns about the uncontrolled discharge of nutrients (e.g., nitrates and phosphates) into the Gulf, which can lead to many negative environmental consequences, such as the phenomenon of red tides or Harmful Algal Blooms (HAB) (Al-Omar, 2009). It is believed that this nutrient influx may generate favorable conditions for initiating and developing and even expanding future HAB events in the gulf, posing a continuous threat to tourism, fishing, marine ecosystems, and the supply of drinking water, with significant economic losses. For example, the red tide of 2008-2009 affecting the coastal waters of Oman, UAE, Qatar, and Iran was described as catastrophic, "killing thousands of tons of fish and limiting traditional fishery operations, damaging coral reefs, impacting coastal tourism, and forcing the closure of desalination plants in the region" (Richlen et al., 2010).

VIII. CONCLUSION AND RECOMMENDATIONS

As a result of rapidly rising populations and high levels of per capita consumption, the Ecological Footprint of Arab countries has exceeded available biocapacity for the past 30 years. Consequently, Arab economies are dependent on global trade flows for importing food, virtual water, and other primary products. Disruptions in global supply chains and hikes in global food prices have increased the sense of economic insecurity. Low-income Arab countries rely on borrowing and foreign assistance to finance their imports, thereby adding a heavy debt burden to future generations. Arab oil-exporting countries rely on their substantial financial assets to pay for their imports, thus remaining vulnerable to global economic cycles, given the volatility of global oil prices and potential over-supply by unconventional sources of oil and gas. In the meantime, renewable resources such as aquifers, topsoil, and fisheries continue to be depleted as a result of wasteful consumption and over-exploitation.

Given that most Arab countries have biocapacity deficits now, rising populations will continue to create pressures on the demand for resources, even though rates of population growth are declining. While population pressures are expected to moderate as demographic transitions stabilize over the next few decades, the high rates of per capita consumption will continue to be a significant driver of Ecological Footprint. Changing lifestyles are creating disturbing patterns of wasteful consumption and over-consumption in the Arab region.

To address Arab countries' ecological deficits and the economic insecurity concerns entailed, transformative actions are needed. To this end, Arab governments are urged to focus on the following:

A. In light of the increased pace of urbanization and the building boom, Arab countries need to commit to achieving the highest levels of sustainable urban development. Land use patterns should emphasize compact, dense, and mixed-use design, smaller housing units, and access to public transit. Current patterns of urbanization should be replaced with models that are more responsive to the needs of the majority of the people and more attuned to the region's climate and hydrological cycles. Native vegetation should be used extensively in creating more green spaces than is now available. This can be achieved by treating cities as living organisms receiving at one end resources such as water, energy, and materials, and rejecting waste materials and low-quality energy at the other. This conception allows city planners to use ecological design principles to create an urban built environment that emulates the sufficient, efficient, and cyclical metabolism of living systems in nature.

B. Economic development policies should give precedence to sustainability: economic, social, and environmental, where "the associated values of sufficiency, equity, and efficiency become the central organizing principles of the economy" (Daly, 1996). Given the region's water scarcity and much higher-than-average energy use, investments are needed to improve the resource productivity of the region's economies, particularly concerning water and energy use.

C. Political leaders and policy makers are urged to reflect on the Ecological Footprint impacts of investment decisions and financial flows, giving priority to ecological health and economic security. A new vision is needed, guided by the creation of more balanced consumption within Arab countries and less inequality in consumption across Arab countries, even if this leads to a slower GDP growth in the short-term. This also suggests the need to reduce poverty without extracting a high Ecological Footprint price. Attitudes about prevailing patterns of (over)-consumption and lavish lifestyles and their association with self-esteem and social status need to be questioned. Changes in economic incentives can be used to bring about a shift from a consumptive lifestyle to a more productive one. Wisdom and ethical values need to be brought to bear on the meaning of consumption and on making societal decisions about a more meaningful lifestyle.

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CONTRIBUTORS

NAJIB SAAB (EDITOR)
Publisher and Editor-in-Chief of *Al-Bia Wal-Tanmia* (Environment & Development),the leading Arabic magazine on sustainable development, and Secretary General of the Arab Forum for Environment & Development (AFED). Architect, university lecturer and writer, he is a 2003 laureate of the United Nations Environment Programme's Global 500 Award and the 2011 laureate of Sheikh Zayed International Prize for Environment. He co-edited AFED Annual Reports for 2008, 2009, 2010 and 2011.

DR. ABDUL-KARIM SADIK
Economic Adviser at Kuwait Fund for Arab Economic Development for over 25 years, including eight years as Executive Director for the State of Kuwait at the International Fund for Agricultural Development (IFAD), and Adviser to executive Director at the World Bank. He authored and co-authored a number of published papers on various development issues, including on water economics, water problems, water security, and food in Arab countries.

DR. IBRAHIM ABDEL GELIL
Academic Chair of Sheikh Zayed Bin Sultan AI Nahayan, and Director of the Environmental Management Program at the Arabian Gulf University in Bahrain. He was the CEO of the Egyptian Environmental Affairs Agency (EEAA), and the chairman of the Egyptian Organization for Energy Planning (OEP). He authored and co-authored around 70 publications on energy and environment, including AFED reports 2008-2011.

BASHAR M. ZEITOON
Program director at the Arab Forum for Environment and Development (AFED). Residing in Boston, USA where he graduated from MIT and Harvard's Kennedy School of Government, he was manager of corporate environmental partnership programs where he helped Fortune 500 companies redesign operations to increase efficiency and reduce air pollution emissions. Co-editor of AFED reports 2010-2011

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(In alphabetical order)

Ibrahim Abdel Gelil (AGU), Maher Abu Jaafar (University of Petra), Said Al-Fakhani (LAU), Ibrahim Al-Ghusain (UDC), Mayada Al-Hayali (University of Petra), Duraid Al-Mahasneh (Water and Marine Biologist Expert), Mohamad Al-Sayrafi (Anti Doping Lab - Qatar), Mohammad Al-Zein (LAU/AUB), Hamed Assaf (Civil and Environmental Engineer), Adnan Badran (University of Petra), Fidele Byiringiro (ESCWA), Capricia Chabarekh (Ecodit - Ministry of Environment, Lebanon), Imad Dabbas (Jordan Environment Society), Souheila Edriss (OBBA), Rana El-Hajj (IFI - AUB), Asma El-Kasmi, (UNESCO), Pierre El-Khoury (L.C.E.C.), Monah Geha (AUB), Dana Hamra (G), Hassan Harajli (CEDRO Project), Fouad Hashwa (LAU), Raji Hattar (Aramex), Khaled Irani (Royal Society for Conservation of Nature), Joseph Jabbra (LAU), Ahmed Kofahi (Jordan Environment Society), Adel Mahasneh (Jordan University), Hanan Malkawi (Yarmouk University), Zaher Mansour (Sukleen - Averda), Carla Nassab (CEDRO Project), Reem Nejdawi (ESCWA), Jessica Obeid (CEDRO Project), Christian Oussi (LAU), Najib Saab (AFED), Abdel-Karim Sadik (KFAED), Hadi Tabbara (Water Expert), Riyad Tabbara, (Center for Development Studies and Projects – MADMA / UNFPA), Mostafa Kamal Tolba (AFED), Batir Wardam (UNDP), Bashar Zeitoon (AFED).

Acronyms and Abbreviations

AAAID	Arab Authority for Agricultural Investment and Development
AC	Air-conditioning
AC	Alternating current
ABSP	Agricultural Biotechnology Support Programme
ACSAD	Arabic Centre for the Studies of Arid Zones and Drylands
ADA	Arriyadh Development Authority (Riyadh)
ADFD	Abu Dhabi Fund for Development
ADR	Alternative Disputes Resolution
ADWEA	Abu Dhabi Water & Electricity Authority
AED	United Arab Emirates Dirham
AEPC	African Environmental Protection Commission
AEPS	Arctic Environmental Protection Strategy
AEWA	African-Eurasian Waterbird Agreement
AFED	Arab Forum for Environment and Development
AFESD	Arab Fund for Economic and Social Development
AG	Associated gas
AGERI	Agricultural Genetic Engineering Institute
AGU	Arabian Gulf University
AHD	Aswan High Dam
AHDR	Arab Human Development Report
AIA	Advance Informed Agreement
AIDS	Acquired Immunodeficiency Syndrome
AIECGC	Arab Investment and Export Credit Guarantee Corporation
AKTC	Aga Khan Trust for Culture
Al	Aluminum
ALBA	Aluminium Bahrain
ALECSO	Arab League Educational, Cultural, and Scientific Organization
ALOA	Association for Lebanese Organic Agriculture
AMCEN	African Ministerial Conference on the Environment
AMF	Arab Monetary Fund
AMU	Arab Maghreb Union
ANME	National Agency for Energy Management
AoA	Agreement on Agriculture (WTO Uruguay Round)
AOAD	Arab Organization for Agricultural Development
API	Arab Planning Institute
AREE	Aqaba Residence Energy Efficiency
ASABE	American Society of Agricultural and Biological Engineers
ASR	Aquifer storage and recovery
AU	African Union
AUB	American University of Beirut
AUM	American University of Madaba (Jordan)
AWA	Arab Water Academy

AWC	Arab Water Council
AWCUA	Arab Water Countries Utilities Association
BADEA	Arab Bank for Economic Development in Africa
BAU	Business-as-usual
BCH	Biosafety Clearing House
BCWUA	Branch Canal Water User Association
BDL	Central Bank of Lebanon
BGR	German Geological Survey
BMP	Best Management Practices
BMZ	German Federal Ministry of Economic Cooperation and Development
BOD	Biological Oxygen Demand
boe	Barrels of oil equivalent
BREEAM	Building Research Establishment Environmental Assessment Method
BRS	ARZ Building Rating System
BRO	Brackish Water Reverse Osmosis
BU	Boston University
C&D	Construction and demolition
C&I	Commercial and industrial
CA	Conservation agriculture
CAB	Centre for Agriculture and Biosciences
CAGR	Compound Annual Growth Rate
CAIP	Cairo Air Improvement Project
CAN	Competent National Authority
CAMP	Coastal Area Management Project
CAMRE	Council of Arab Ministers Responsible for the Environment
CBC	Community-Based Conservation
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CBSE	Center for the Study of the Built Environment (Jordan)
CCS	Carbon Capture and Storage
CD	Compact disk
CDM	Clean Development Mechanism
CDRs	Certified Emissions Reductions
CEDRO	Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon
CEIT	Countries with Economies in Transition
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CEP	Coefficient of performance
CERES	Coalition for Environmentally Responsible Economics
CFA	Cooperative Framework Agreement
CFC	Chloro-Fluoro-Carbon
CFL	Compact Fluorescent Lamp
CGIAR	Consultative Group on International Agricultural Research
CHN	Centre Hospitalier du Nord
CH4	Methane
CHP	Combined Heat and Power
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
CIRAD	Agricultural Research for Development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CIWM	Chartered Institution of Wastes Management
CLO	Compost-like-output
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CIHEAM	International Centre for Advanced Mediterranean Agronomic Studies

CMI	Community Marketing, Inc.
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CNA	Competent National Authority
CNCA	Public Agricultural Bank
CNG	Compressed Natural Gas
CO	Carbon monoxide
CO2	Carbon Dioxide
CO2eq	CO2-equivalents
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CPB	Cartagena Protocol on Biosafety
CPC	Calcined petroleum coke
CRS	Center for Remote Sensing
CSD	Commission on Sustainable Development
CSP	Concentrated Solar Power
CSR	Corporate social responsibility
CTAB	Technical Center of Organic Agriculture
cum	Cubic meters
CZIMP	Coastal Zone Integrated Management Plan
DALYs	Disability-Adjusted Life Years
DBO	Design-Build-Operate
DC	Direct current
DED	Dubai Economic Department
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DEM	Digital Elevation Model
DESA	Department of Economic and Social Affairs
DEWA	Dubai Electricity and Water Authority
DFID	UK Department for International Development
DHW	Domestric Hot Water
DII	DESERTEC Industrial Initiative
DMN	Moroccan National Meteorological Office
DNE	Daily News Egypt
DOE	United States Department of Energy
DSIRE	Database of State Incentives for Renewables & Efficiency
DTCM	Dubai Department for Tourism and Commerce Marketing
DTIE	UNEP Division of Technology, Industry, and Economics
DTO	Dublin Transportation Office
DUBAL	Dubai Aluminium Company Limited
E3G	Third Generation Environmentalism
EAD	Environment Agency AbuDhabi
ECA	Economic Commission for Africa
ECE	Economic Commission for Europe
ED	Electrodialysis
EDF	Environmental Defense Fund
EDL	Electricité du Liban
EE	Energy efficiency
EEAA	Egyptian Environmental Affairs Agency
EF	Ecological Footprint
EGBC	Egyptian Green Building Council
EGPC	Egyptian General Petroleum Corporation
EGS	Environmental Goods and Services
EIA	Energy Information Administration
EIA	Environmental Impact Assessment

EITI	Extractive Industries Transparency Initiative
EMA	Europe, the Middle East, and Africa
EMAL	Emirates Aluminium Company Limited
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
ENPI	European Neighborhood and Partnership Instrument
ENSO	El Niño-Southern Oscillation
EOR	Enhanced oil recovery
EPA	US Environmental Protection Agency
EPD	European Patent Office
EPDRB	Environmental Program for the Danube River Basin
EPSA	Exploration and Production Sharing Agreement
EPI	Environment Performance Index
ESAUN	Department of Economic and Social Affairs
ESBM	Ecosystem-Based Management
ESCWA	United Nations Economic and Social Commission for Western Asia
ESI	Environment Sustainability Index
ESMAP	World Bank Energy Sector Management Assistance Program
ETM	Enhanced Thematic Mapper
EU	European Union
EU ETS	European Union Emission Trading System
EVI	Environmental Vulnerability Index
EWS	Emirates Wildlife Society
EWRA	Egyptian Water Regulatory Agency
FACE	Free Air Carbon Enrichment
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
FFEM	French Fund for Global Environment
FiBL	Research Institute of Organic Agriculture
FIFA	Fédération Internationale de Football Association
FIT	Feed-in-tariff
FOEME	Friends of the Earth Middle East
FTIAB	Packaging and Newspaper Collection Service (Sweden)
G7	Group of Seven: Canada, France, Germany, Italy, Japan, United Kingdom, United States
G8	Group of Eight: Canada, France, Germany, Italy, Japan, Russian Federation, United Kingdom, United States
GAPs	Good Agricultural Practices
GAS	Guarani Aquifer System
GATT	General Agreement on Tariffs and Trade
GERD	Gross Domestic Expenditure on Research and Development
GBC	Green Building Council
GBIF	Global Biodiversity Information Facility
GCC	Gulf Cooperation Council
GCM	General Circulation Model
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GE	General Electric
GECF	Gas Exporting Countries Forum
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GEO	Global Environment Outlook
GFEI	Global Fuel Economy Initiative
GFU	Global Facilitation Unit for Underutilized Species

Gha	Global hectare
GHGs	Greenhouse Gases
GIPB	Global Partnership Initiative for Plant Breeding Capacity Building
GIS	Geographical Information Systems
GIWA	Global International Waters Assessment
GLASOD	Global Assessment of Soil Degradation
GLCA	Global Leadership for Climate Action
GM	Genetically Modified
GMEF	Global Ministerial Environment Forum
GMO	Genetically Modified Organism
GNI	Gross National Income
GNP	Gross National Product
GPC	Green petroleum coke
GPRS	Green Pyramid Rating System
GRI	Global Reporting Initiative
GRID	Global Resource Information Database
GSI	IISD Global Subsidies Initiative
GSLAS	General Secretariat of League of Arab States
GSDP	General Secretariat for Development planning-Qatar
GSR	Global Status Report
GTZ	German Technical Cooperation (Gesellschaft für Technische Zusamm)
GVC	Civil Volunteers' Group (Italy)
GW	Greywater
GWI	Global Water Intelligence
GWP	Global Water Partnership
ha	Hectares
HACCP	Hazardous Analysis and Critical Control Points
HDI	Human Development Index
HFCs	Hydrofluorocarbons
HIV	Human Immunodeficiency Virus
HNWI	High net worth individuals
HVAC	Heating, ventilation, and air-conditioning
I/M	Inspection and maintenance
IAASTD	International Assessment of Agricultural Knowledge Science and Technology for Development
IAS	Irrigation Advisory Service
IC	Irrigation Council
ICAM	Integrated Coastal Area Management
ICARDA	International Center for Agricultural Research in Dry Areas
ICBA	International Center for Biosaline Agriculture
ICC	International Chamber of Commerce
ICGEB	International Center for Genetic Engineering and Biotechnology
ICM	Integrated Coastal Management
ICPDR	International Commission for the Protection of the Danube River
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IDA	International Desalination Association
IDB	Islamic Development Bank
IDRC	International Development Research Center
IDSC	Information and Decision Support Center
IEA	International Energy Agency
IEADSM	International Energy Agency Demand-side Management
IEEE	Institute of Electrical and Electronic Engineers

IFOAM	International Federation of Organic Agriculture Movements
IFPRI	International Food Policy Research Institute
IEA	International Energy Agency
IFA	International Fertilizer Industry Association
IFAD	International Fund for Agricultural Development
IHP	International Hydrology Program
IIED	International Institute for Environment and Development
IIIEE	Lund University International Institute for Industrial Environmental Economics
IIIP	Integrated Irrigation Improvement Project
IIP	Irrigation Improvement Project
IISD	International Institute for Sustainable Development
ILO	International Labour Organization
IMC	Istituto Mediterraneo Di Certificazione
IMF	International Monetary Fund
IMO	International Maritime Organization
InWEnt	Capacity Building International-Germany
IO	Input-Output
IPCC	Intergovernmental Panel on Climate Change
IPF	Intergovernmental Panel on Forests
IPM	Integrated Pest Management
IPP	Independent power producer
IPR	Intellectual Property Rights
IPTRID	International Program for Technology and Research in Irrigation and Drainage
IRENA	International Renewable Energy Agency
IRR	Internal rate of return
ISCC	Integrated solar combined cycle
ISESCO	Islamic Educational, Scientific, and Cultural Organization
ISWM	Integrated solid waste management
ISO	International Organization for Standardization
ISIC	UN International Standard Industrial Classification
ITC	Integrated tourism centers
ITC	International Trade Center
ITSAM	Integrated Transport System in the Arab Mashreq
IUCN	International Union for Conservation of Nature
IUCN	World Conservation Union (International Union for the Conservation of Nature and Natural Resources)
IWRB	International Waterfowl and Wetlands Research Bureau
IWRM	Integrated Water Resources Management
IWMI	International Water Management Institute
IWPP	Independent water and power producer
JBAW	Jordan Business Alliance on Water
JD	Jordanian Dinar
JI	Joint Implementation
JMWI	Jordan Ministry for Water and Irrigation
JVA	Jordan Valley Authority
KA-CARE	King Abdullah City for Atomic and Renewable Energy
KAUST	King Abdullah University of Science and Technology
KFAED	Kuwait Fund for Arab Economic Development
KfW	German Development Bank
KISR	Kuwait Institute for Scientific Research
KSA	Kingdom of Saudi Arabia
kWh	Kilowatt-hours
LADA	Land Degradation Assessment of Drylands

LAS	League of Arab States
LATA	Lebanese Appropriate Technology Association
LAU	Lebanese American University
LBNL	Lawrence Berkeley National Laboratory
LCEC	Lebanese Center for Energy Conservation
LDCs	Least Developed Countries
LED	Light-emitted diode
LEED	Leadership in Environmental Design
LEMA	Suez Lyonnaise des Eaux, Montgomery Watson and Arabtech Jardaneh
LGBC	Lebanon Green Building Council
LNG	Liquefied natural gas
LowCVP	Low Carbon Vehicle Partnership
LMBAs	Land and Marine Based Activities
LMEs	Large Marine Ecosystems
LMG	Like Minded Group
LMO	Living Modified Organism
LPG	Liquefied Petroleum Gas
LRA	Litani River Authority
MAAR	Syrian Ministry of Agriculture and Agrarian Reform
MAD	Moroccan Dirham
MALR	Ministry of Agriculture and Land Reclamation
MAP	UNEP Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MBT	Mechanical-biological treatment
MCM	Million Cubic Meters
MD	Membrane distillation
MDGs	Millennium Development Goals
MEA	Multilateral Environmental Agreement
MECTAT	Middle East Centre for the Transfer of Appropriate Technology
MED	Multiple-Effect Distillation
MED-ENEC	Energy Efficiency in the Construction Sector in the Mediterranean
MED WWR WG	Mediterranean Wastewater Reuse Working Group
MEES	Middle East Economic Survey
MEMAC	Marine Emergency Mutual Aid Centre
MENA	Middle East and North Africa
METAP	UNEP Mediterranean Environmental Technical Assistance Program
MEW	Lebanese Ministry of Energy and Water
MGD	Million gallon per day
MHT	Mechanical heat treatment
MICE	Meetings, incentives, conferences, and events
MIST	Masdar Institute of Science and Technology
MOQ	Maersk Oil Qatar
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSF	Multi-Stage Flash
MSW	Municipal solid waste
MT	Million ton
MTPY	Metric tons per year
Mt	Megatonnes
MW	Megawatt
MWRI	Ministry of Water Resources and Irrigation
NARI	National agricultural research institutes
NASA	National Aeronautics and Space Administration

NBC	National Biosafety Committee
NBDF	Nile Basin Discourse Forum
NBF	National Biosafety Framework
NBI	Nile Basin Initiative
NBM	Nile Basin Management
NCSR	Lebanese National Council of Scientific Research
ND	Neighborhood development
NDW	Moroccan National Drought Watch
NEEAP	National energy efficiency action plans
NEEREA	National Energy Efficiency and Renewable Energy Action (Lebanon)
NF	Nano-Filtration
NFC	Nile Forecast Center
NGV	Natural gas vehicles
NGWA	Northern Governorates Water Authority (Jordan)
NOAA	National Oceanic and Atmospheric Administration
NOC	National oil company
NOGA	National Oil and Gas Authority (Bahrain)
NORDEN	Nordic Council of Ministers
NOx	Nitrogen oxides
NRC	National Research Council
NREL	National Renewable Energy Laboratory
NRW	non-revenue water
NSAS	Nubian Sandstone Aquifer System
NWRC	National Water Research Center (Egypt)
NWSAS	North Western Sahara Aquifer System
NEAP	National Environmental Action Plan
NFP	National Focal Point
NGO	Non-Governmental Organization
NPK	Nitrogen, Phosphates and Potash
NPP	Net Primary Productivity
NUS	Neglected and underutilized species
O&M	Operation and Maintenance
OAPEC	Organization of Arab Petroleum Exporting Countries
OAU	Organization for African Unity
ODA	Official Development Assistance
ODS	Ozone-Depleting Substance
OECD	Organisation for Economic Co-operation and Development
OFID	OPEC Fund for International Development
OMW	Olive mills wastewater
ONA	Omnium Nord-Africain
ONEP	National Office of Potable Water
OPEC	Organization of Petroleum Exporting Countries
OSS	Sahara and Sahel Observatory (Observatoire du Sahara et du Sahel)
PACD	Plan of Action to Combat Desertification
PC	Personal computer
PCB	Polychlorinated biphenyls
PCFPI	Per Capita Food Production Index
PCFV	Partnership for Clean Fuels and Vehicles
PERSGA	Protection of the Environment of the Red Sea and Gulf of Aden
PFCs	Perfluorocarbons
PICs	Pacific Island Countries
PIM	participatory irrigation management
PM	Particulate matter

PMU	Program Management Unit
PNA	Palestinian National Authority
PNEEI	Tunisian National Program of Irrigation Water Conservation
PPIAF	Public-Private Infrastructure Advisory Facility
PPP	public-private partnership
POPs	Persistent Organic Pollutants
PPM	Parts Per Million
PPM	Process and Production Methods
PRM	Persons with reduced mobility
PRY	Potential researcher year
PTSs	Persistent Toxic Substances
PV	Photovoltaic
PWA	Palestinian Water Authority
QP	Qatar Petroleum
QSAS	Qatar Sustainable Assessment System
R&D	Research and Development
RA	Risk Assessment
RADEEMA	Régie autonome de distribution de l'eau et de l'électricité de Marrakech
RBO	River Basin Organization
RBP	Restrictive Business Practices
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RCM	Regional Circulation Model
RDF	Refuse derived fuel
RE	Renewable energy
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
REN21	Renewable Energy Policy Network for the 21st Century
RO	reverse osmosis
RM	Risk Management
ROPME	Regional Organization for the Protection of the Marine Environment of the sea area surrounded by Bahrain, I.R. Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates
RPS	Renewable portfolio standard
RSA	Ropme Sea Area
RSCN	Royal Society for the Conservation of Nature
RSC	Royal Society of Chemistry (UK)
RSGA	Red Sea and Gulf of Aden
S&T	Science and Technology
SAIC	Science Applications International Corporation
SAP	Strategic Action Program
SCP	Sustainable Consumption and Production
SCPI	Sustainable crop production intensification
SD	Sustainable development
SEA	Strategic Environmental Assessment
SFD	Saudi Fund for Development
SHS	Solar home system
SIR	Shuttle Imaging Radar
SIWI	Stockholm International Water Institute
SL	Syrian Pound
SLR	Sea Level Rise
SME	Small and medium-size enterprises
SPM	Suspended Particulate Matter
SONEDE	Société Nationale d'Exploitation et de Distribution des Eaux
SoE	State of the Environment

SOx	Sulfur oxides
SRES	Special Report on Emission Scenarios
SRTM	Shuttle Radar Topography Mission
SWCC	Saline Water Conversion Corporation
SWH	solar water heating
SWRO	Seawater Reverse Osmosis
TAC	Technical Advisory Committee
TAR	Third Assessment Report
TDM	Transportation demand management
TDS	Total Dissolved Solids
TFP	Total factor productivity
TIES	The International Ecotourism Society
TOE	Tonnes of Oil Equivalent
TRI	Toxics Release Inventory
TRIPs	Trade-Related Aspects of International Property Rights
TRAFFIC	Trade Records Analysis for Flora and Fauna in International Commerce
TRMM	Tropical Rainfall Measuring Mission
UAE	United Arab Emirates
UCLA	University of California at Los Angeles
UCS	Union of Concerned Scientists
UF	ultrafiltration
UfM	Union for the Mediterranean
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNESCO-ROSTAS	UNESCO Regional Office for Science and Technology for the Arab States
UIS	UNESCO Institute for Statistics
USA	United States of America
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
USPTO	United States Patent and Trademark Office
UHI	Urban Heat Island
UMA	Union du Maghreb Arabe (Arab Maghreb Union)
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNCHS	United Nations Centre for Human Settlements (now UN-Habitat)
UNCLOS	United Nations Convention on the Law of the Sea
UNCOD	United Nations Conference on Desertification
UNCTAD	United Nations Conference on Trade and Development
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commission for Refugees
UNICE	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNWTO	United Nations World Tourism Organization
UPC	Abu Dhabi Urban Planning Council
UPI	United Press International

USA	United States of America
USCCSP	United States Climate Change Science Program
USAID	United States Agency for International Development
USEK	Université Saint-Esprit De Kaslik
USEPA	United States Environmental Protection Agency
USJ	Saint Joseph University
UV	Ultraviolet (A and B)
VAT	Value-added tax
VC	vapor compression
VCM	Volatile combustible matter
VMT	Vehicle miles traveled
VOC	Volatile organic compounds
VRS	Vapor recovery system
WaDImena	Water Demand Initiative for the Middle East and North Africa
WAJ	Water Authority of Jordan
WALIR	Water Law and Indigenous Rights
WB	West Bank
WDM	Water Demand Management
VOC	Volatile Organic Compound
WBCSD	World Business Council for Sustainable Development
WBGU	German Advisory Council on Global Change
WCED	World Commission on Environment and Development
WCD	World Commission on Dams
WCMC	UNEP World Conservation Monitoring Center
WCP	World Climate Programme
WCS	World Conservation Strategy
WDPA	World Database on Protected Areas
WEEE	Waste of electronic and electrical equipment
WEF	World Economic Forum
WEI	Water Exploitation Index
WF	Water Footprint
WFN	Water Footprint Network
WFP	World Food Programme
WGP-AS	Water Governance Program in the Arab States
WHO	World Health Organization
WMO	World Meteorological Organization
WNA	World Nuclear Association
Wp	Watt-peak
WRI	World Resources Institute
WSSCC	Water Supply and Sanitation Collaborative Council
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WTTC	World Travel and Tourism Council
WWAP	World Water Assessment Programme
WWC	World Water Council
WWF	World Wide Fund for Nature
WUA	water user association
WWAP	World Water Assessment Program
WWF	World Water Forum
WWI	First World War
WWII	Second World War

المنتدى العربي للبيئة والتنمية
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AFED

ARAB ATLAS OF FOOTPRINT & BIOCAPACITY

Global Footprint Network
Advancing the Science of Sustainability

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ARAB ATLAS OF FOOTPRINT AND BIOCAPACITY

Prepared by the Global Footprint Network for the Arab Forum for Environment and Development (AFED) as part of AFED 2012 Annual Report

GLOBAL FOOTPRINT NETWORK

David Moore
Primary Author and Researcher

Alessandro Galli
Senior Reviewer

Mathis Wackernagel
Adviser

ARAB FORUM FOR ENVIRONMENT AND DEVELOPMENT

Bashar Zeitoon
Senior Reviewer

Charbel Mahfoud
Production Manager

Najib Saab
Adviser

Divisions between countries shown in this Atlas are for graphic presentation purposes in the context of footprint and biocapacity accounts, and may not precisely reflect internationally recognized boundaries.

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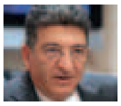


Najib Saab – Secretary General
Arab Forum for Environment and Development (AFED)

Mathis Wackernagel – President
Global Footprint Network

Annual reports of the Arab Forum for Environment and Development (AFED) have two primary, ambitious functions: to foster the use of science in policy and decision making in Arab countries; and to report to the Arabs on the condition of their environment. This year AFED presents Ecological Footprint accounts to analyze options in the Arab region for building prosperous and stable economies in a resource constrained world.

As a basis for the analysis, AFED has commissioned Global Footprint Network to produce a footprint and biocapacity atlas exploring resource constraints in Arab countries from the perspective of the regenerative capacity of nature. Global Footprint Network terms regenerative capacity as biocapacity, and defines it as the capacity of ecosystems to produce biological materials and absorb waste. Biocapacity encompasses the entire portfolio of life-supporting ecological services and the resources these services provide. This accounting framework uses data from well-established international organizations, primarily the Food and Agriculture Organization (FAO) and the International Energy Agency (IEA), among others. Data collected by AFED in its previous reports has also been used in Global Footprint Network's Arab survey, where appropriate.

Ecological Footprint accounting seeks to provide an ecological bank statement for the Arab region, evaluating its endowment of ecological services and contrasting this with its demand on the global biosphere, both for resource provision and waste absorption.

The results for the Arab region's Ecological Footprint assessment are critical for understanding the region's competitive advantages and disadvantages:

- The average Ecological Footprint in Arab countries increased by 78 percent from 1.2 to 2.1 global hectares (gha) per capita between 1961 and 2008.

- Population has increased by 250 percent over the same time period; the overall regional Ecological Footprint has therefore increased by more than 500 per cent.

- Between 1961 and 2008, the available average biocapacity per capita in Arab countries decreased by 60 percent from 2.2 to 0.9 gha per capita.

- In 2008, only 4 nations contributed more than 50 percent of the Arab region's Ecological Footprint: Egypt (19 percent), Saudi Arabia (15 percent), UAE (10 percent), and Sudan (9 percent).

- Only 2 nations provided approximately 50 per cent of the biocapacity in the Arab region in 2008: Sudan (32 percent) and Egypt (17 percent).

- Since 1979 the region as a whole has been experiencing a biocapacity deficit, with its demand for ecological services increasingly exceeding local supply. In order to bridge this gap, the import of ecological services from outside the region's borders has been necessary.

These findings indicate that the region has rapidly moved into a significant biocapacity deficit with demand for ecological services far exceeding domestic supply. This condition could well place severe limits on economic prosperity and human wellbeing. This report thus seeks to encourage decision makers and the general public to incorporate ecological accounting into their daily practices so that the region can maintain a viably competitive economy and a healthy ecology well into the future.

November, 2012

Resource Constraints and Economic Performance

Life competes for the planet's limited surface areas. Some of those surfaces are biologically productive – they represent the regenerative capacity, or biocapacity of the planet. While the surface of the planet is limited and finite, biocapacity can be enhanced or degraded. The Ecological Footprint represents the human demand for this biocapacity and includes human use of ecological services to the extent that this use is competing for bioproductive space. The Ecological Footprint thus accounts for the area of biologically productive land and sea required to provide the resources we use and to absorb our waste. These areas include cropland, grazing land, forest, and fishing grounds required to produce the food, fibre, and timber consumed by humans, and the productive land on which we build infrastructure. It also includes the area needed to absorb and store carbon dioxide emissions, which come from the burning of fossil fuels, land-use changes such as the conversion of forest to cropland, chemical processes such as 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, which is available.

Human societies and economies depend on the biosphere's natural capital and its many life-supporting ecological services. As human demand for resources increases and is exceeding in many instances what nature can renew, national success can no longer be secured without carefully managing and tracking the demand for and availability of natural capital.

Since the late 1940s, governments have used gross domestic product (GDP) to measure the health and vitality of their economies. In recent years, a new variable in the form of a secure access to resources has become an ever more significant driver of economic performance. But most economic decision makers have not reacted to this new context yet. Some may have started to recognize the link between access to resources and economic performance, but for most, ecological deficits are not among their top priorities, nor are they considered to be among the top limiting factors of economic performance.

In this new era of resource insecurity, tracking resource variables is essential not only to ensure countries' economic competitiveness, but also to meet basic needs of food and water security. Leaders

will need to look beyond GDP and complement traditional analysis with information on renewable resource consumption and availability in order to make more effective policy decisions.

Within this report, we use the term regenerative capacity to mean biocapacity defined by the Global Footprint Network as the capacity of Earth to produce biological materials and absorb waste, encompassing the entire portfolio of life-supporting ecological services and the resources these services provide. This indicator is based upon data from well-established international organizations, primarily the Food and Agriculture Organization (FAO) and the International Energy Agency (IEA), among others.

For economies, biocapacity is becoming the limiting "fuel", or as economists might say, their limiting "production factor for the 21st century." Even human use of fossil energy is constrained by biocapacity due to nature's limited absorptive capacity of CO_2, the concentration of which may already be greater than what scientists consider a safe level. In other words, from a climate perspective, there are limits to fossil fuel use, and alternatives such as biomass-based energy will compete with cropland used for food production, making biocapacity even more of a limiting factor. This quality is further compounded by the problem that fossil fuels are inherently depletable resources, and that the maintenance of lifestyles that exceed domestically available biocapacity is currently founded upon the assumption that revenues from fossil fuel extraction will continue indefinitely.

Whether we have the wisdom towards energy efficiency and cleaner use, or continue with unsustainable practices and move to a world with radical climate change, biocapacity will be the limiting factor in either scenario.

Recognizing this limitation for economies, the questions become: What level of resource consumption is most advantageous for a city, a region, or a nation, considering their available biocapacity? What are the key implications for our economies, and consequently, what are the unresolved questions? What course of action is in our city's or nation's interest to pursue?

Measuring Demand for and Availability of Biocapacity with the Ecological Footprint

Ecological Footprint accounting addresses a simple research question: How much of the biosphere's regenerative capacity is demanded by human populations? The driving need for an answer to this question is clear: sustainability requires that human demand for resources is less than what the biosphere can renew.

As with any account, Ecological Footprint accounting includes two parts: income and expenditure, or more precisely, availability of and demand for biocapacity. Biocapacity measures the ability of the biosphere to renew resources and sequester wastes; the Ecological Footprint measures demand for that biocapacity. They are thus resource flow measures. However, rather than being expressed in tons per year, each flow is expressed in terms of the bioproductive land area, expressed in global hectares (gha), necessary to provide (or absorb) the respective resource flows.

A global hectare is a hectare of the planet's biologically productive area, with world average productivity. By standardizing hectares, and scaling them proportionally to the regenerative capacity on that hectare, this unit allows us to compare areas across the world.

Six main types of bioproductive areas are considered: 1) cropland for the provision of plant-based food and fiber products; 2) grazing land and cropland for the provision of animal-based feed and other animal products; 3) marine and inland fishing grounds for the provision of fish-based food products; 4) forest areas for the provision of timber and other forest products; 5) carbon uptake land for the absorption of anthropogenic CO_2 emissions (considered to be forests dedicated to carbon sequestration); and 6) built-up areas representing productivity foregone due to the occupation of physical space for shelter and other infrastructure. For any economy, the Ecological Footprint of consumption (EFC) is calculated by adding to the footprint embedded in locally produced goods and services (EFP) the footprint embedded in imported products (EFM) and subtracting the footprint embedded in exported products (EFX).

Both the Ecological Footprint and biocapacity are measured in global hectares. These global hectares are calculated using yield and equivalence factors:

- The yield factor is a factor that accounts for differences between countries in productivity of a given land type. For a given year, each country has yield factors for cropland, grazing land, forest, and fisheries. For example, in 2008, German cropland was 2.3 times more productive than world average cropland.

- Equivalence factors are evaluated each year for each land category as reported in Wackernagel et al. (2005) and are used to convert world-average land of a specific area type, such as cropland or forest, to global hectares. By converting physical hectares into the "common currency" of global hectares based on productivity, comparisons between footprints and biocapacities of different land types are possible. In 2008, for example, world-average cropland was estimated to be 2.5 times more productive than a world-average hectare of all biologically productive land and sea area on Earth. Thus, one hectare of world-average cropland was equivalent to 2.5 global hectares, and thus its equivalence factor was 2.5.

The overall biocapacity available in each nation is calculated as the sum of the biocapacity supplied by each land type. For any land use type, biocapacity (BC) is calculated as the area available for a given land use type multiplied by

the yield and equivalence factors for that land use type, respectively.

For example, the German cropland yield factor of 2.3, multiplied by the cropland equivalence factor of 2.5 converts the average German cropland hectares into global hectares: one hectare of German cropland becomes equal to 5.7 gha worth of biocapacity.

Similarly, Ecological Footprints can be calculated by translating each individual flow into the corresponding appropriation of bioproductive land area through dividing the amount of a product harvested or CO_2 emitted per year by the national average yield per year for the product. This is then multiplied by the yield and equivalence factors for the land use type in question.

CARBON

accounts for the amount of forest land required to accommodate for the carbon Footprint, meaning to sequester CO_2 emissions, primarily from fossil fuels burning, international trade and land use practices, that are not uptake by oceans.

FOREST

represents the area of forests required to support the annual harvest of fuel wood, pulp and timber products.

CROPLAND

consists of the area required to grow all crop products required for human consumption (food and fibre), as well as to grow livestock feeds, fish meals, oil crops, and rubber.

GRAZING LAND

represents the area of grassland used, in addition to crop feeds, to raise livestock for meat, diary, hide and wool products. It comprises all grasslands used to provide feed for animals, including cultivated pastures as well as wild grasslands and prairies.

FISHING GROUNDS

represent the area of marine and inland waters necessary to generate the annual primary production required to support catches of aquatic species (fish and seafood) and from aquaculture.

BUILT-UP LAND

represents the area of land covered by human infrastructure such as transportation, housing, industrial structures and reservoirs for hydroelectric power generation.

Source: Mediterranean Ecological Footprint Trends, Global Footprint Network 2012

The State of the World's Ecological Footprint

The world's population is currently placing demands on the Earth's biosphere by an amount that exceeds its regeneration rate or its biocapacity. In 2008, the most recent year for which data is available, the Ecological Footprint of humans was 18.2 billion global hectares (gha), or 2.7 gha per person, as indicated in Figure 1 and Figure 2. In that same year, there were 1.8 gha available per person, meaning that human demand for biocapacity exceeded supply by about 50 percent. The size of the biocapacity deficit or overshoot is indicated in Figure 2. The consequences of this can be seen in phenomena such as deforestation, soil erosion, and carbon dioxide accumulation in the atmosphere. Continued over-demand is unlikely to be met in the long-run, leading to worldwide shortages in essential ecological services, and potentially devastating impacts from global warming.

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. Translating moderate United Nations (UN) projections on population growth, agricultural productivity, and energy use suggests that these very drivers would push human demand to exceed supply by 100 percent by around 2030, and nearly 200 percent by 2050. Figure 3 indicates those projections by displaying the number of planet Earths needed to meet the rising demand for resources. Whether such a level of global overshoot can be maintained or even reached is unlikely. But the fact remains that this would be the consequence if these moderate projections became reality.

FIGURE 1
The global Ecological Footprint per capita, by land use type, in global hectares per person, 1961-2008

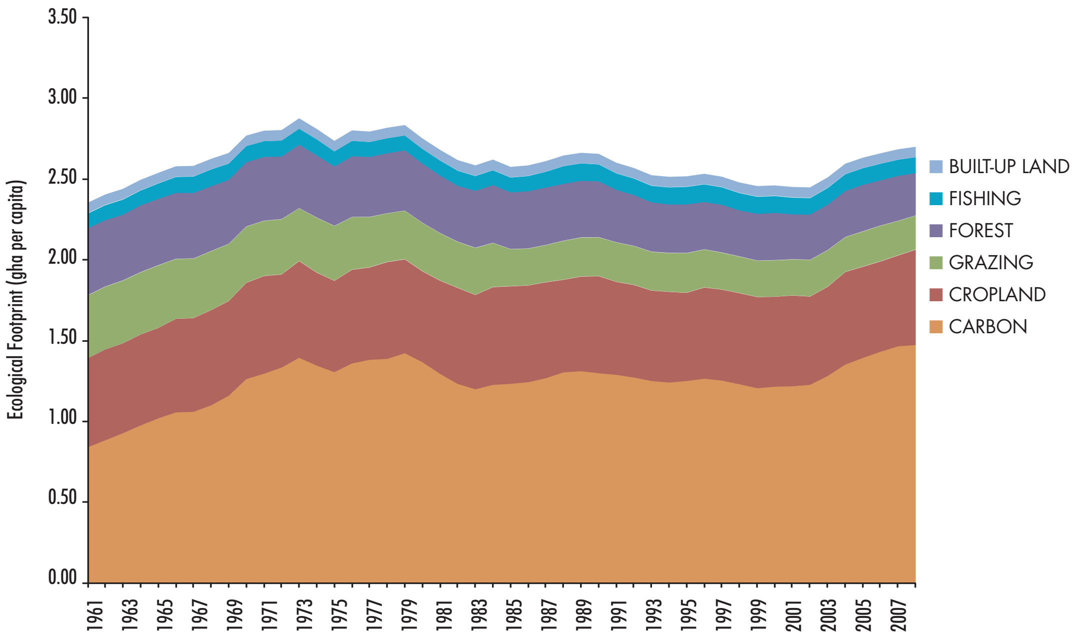


FIGURE 2
The global Ecological Footprint and biocapacity per capita, 1961-2008. The red area indicates global biocapacity deficit, where humans demand, in aggregate, more than nature can supply. This over-demand reduces the natural capital available for later generations, through direct depletion of stocks and the build-up of wastes in the atmosphere

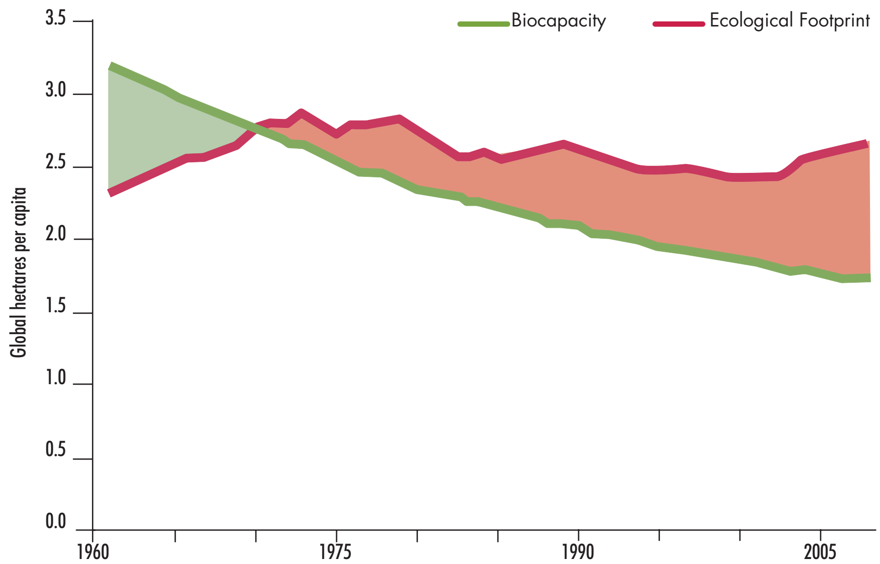
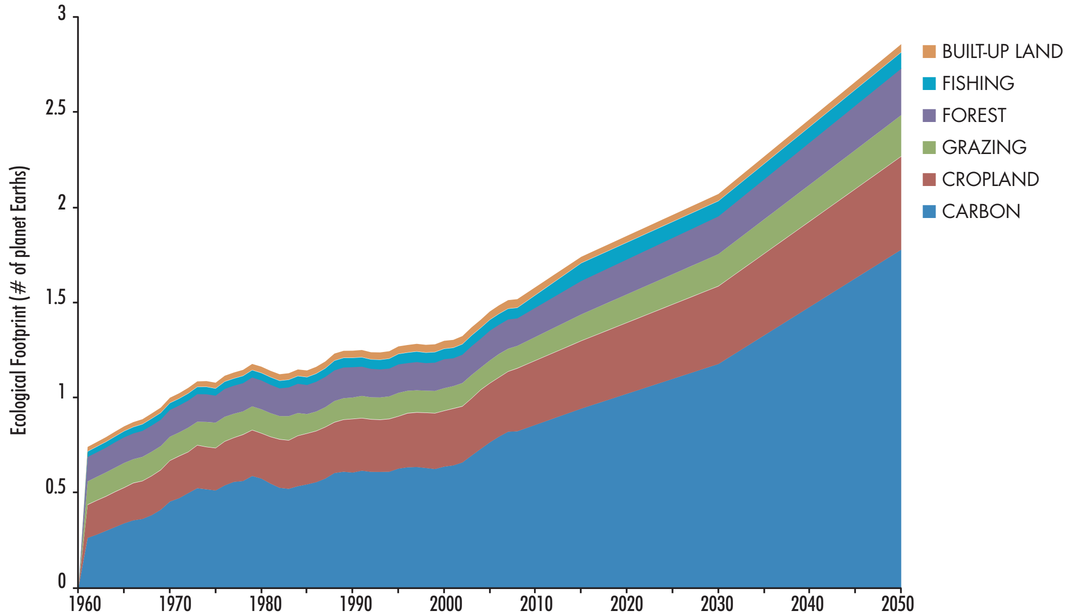
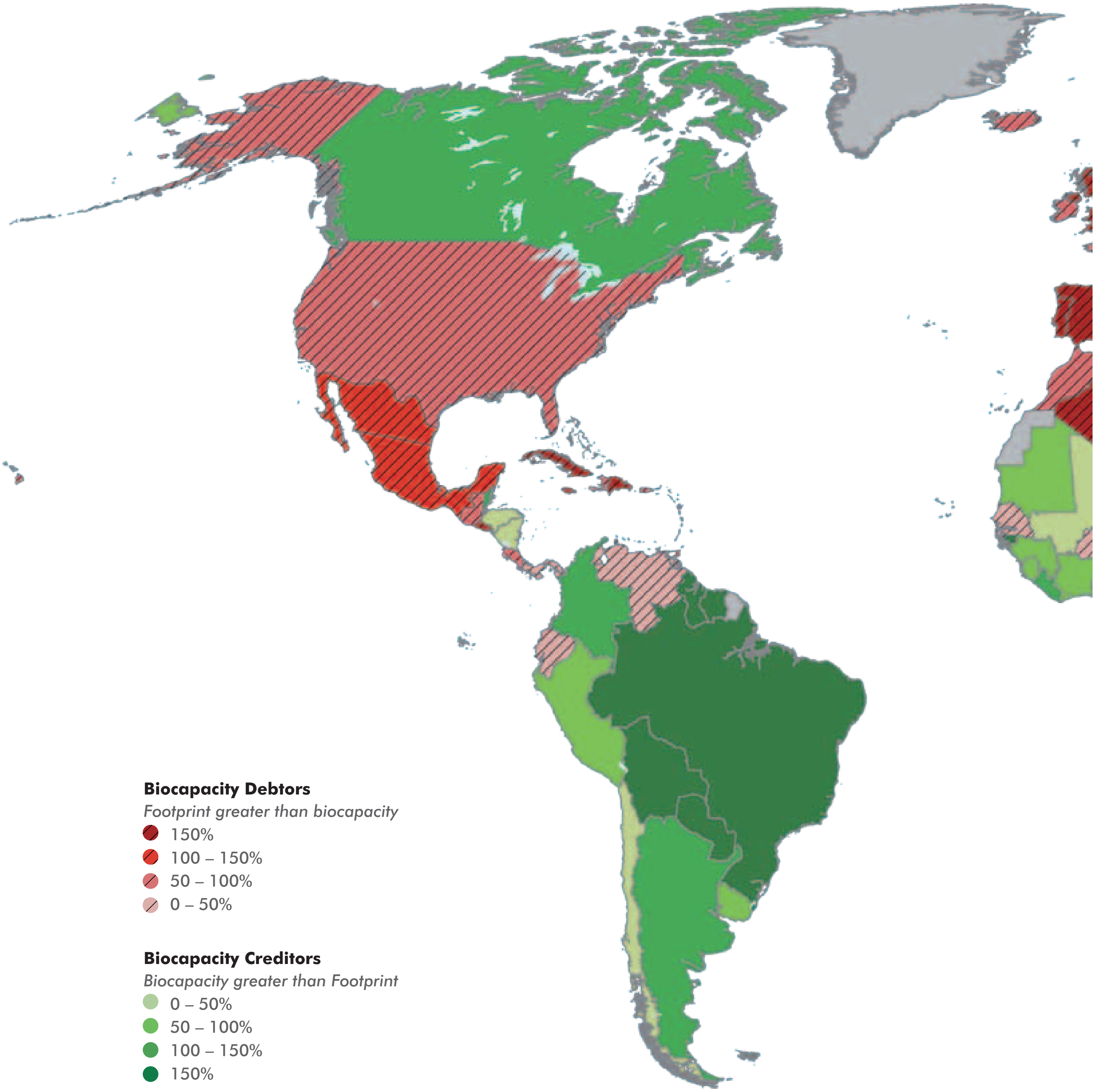


FIGURE 3
Historic and projected global Ecological Footprint by land use type, 1961-2050, in number of planet Earths. The value of 1, reached in the early 1970s, indicates that humans were using all the biocapacity available on the planet at that time. As of 2008, figures are projected. Based on translating most moderate UN scenario into footprint and biocapacity trends.



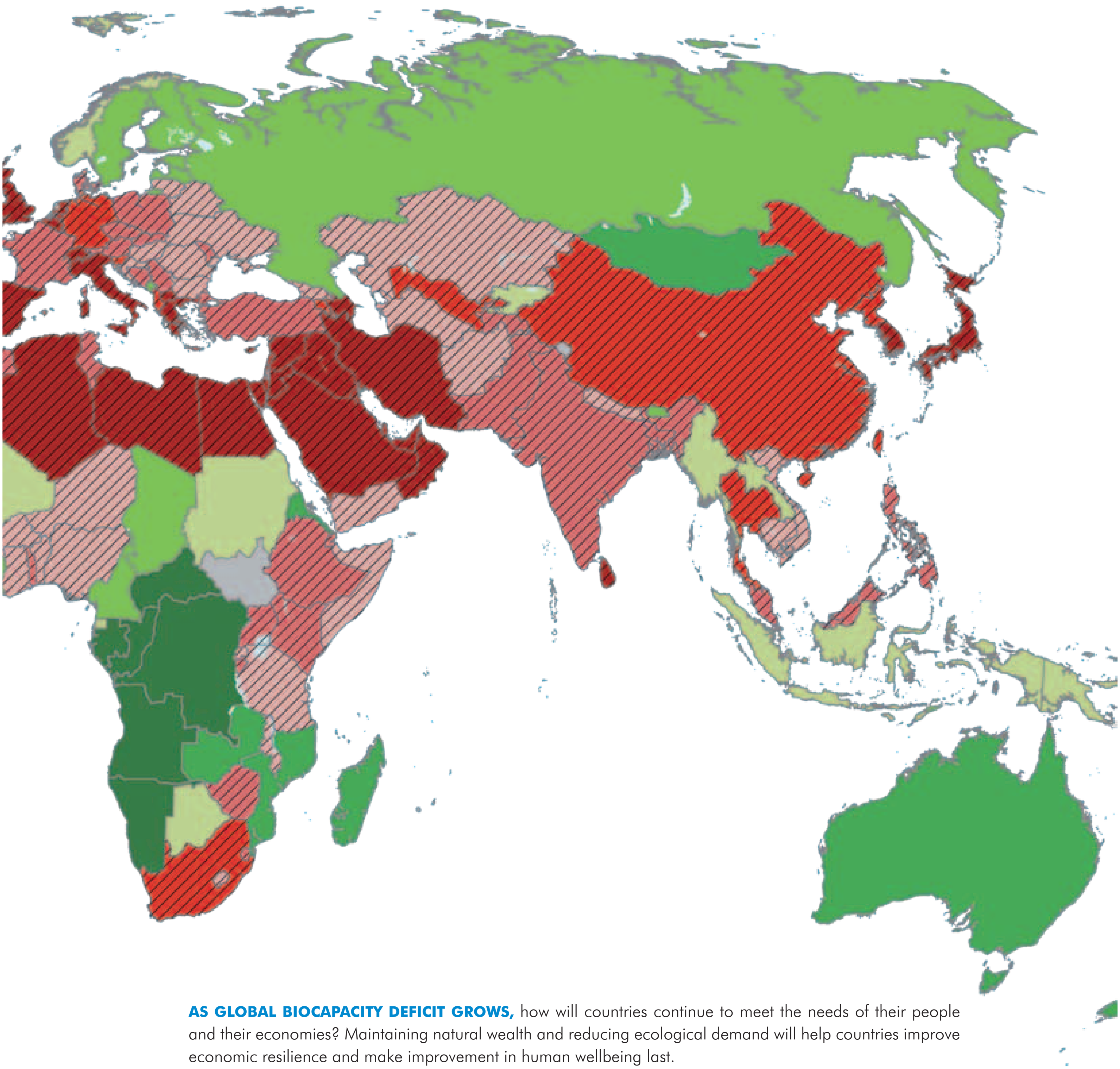
The global Ecological Footprint and biocapacity trends show a world in which renewable natural resources are becoming ever more constrained. These constraints will either affect resource prices, or lead to disruptions as resource availability becomes limited without initial price warnings. In addition, degradation of ecosystems or extreme weather conditions in distant countries will rapidly disrupt international supply chains and domestic capabilities. A country with a high Ecological Footprint typically indicates an economy dependent on global resources and trade flows, and thus one that faces greater exposure to international supply disruptions.

The Ecological Wealth of Nations



Biocapacity Debtors
Footprint greater than biocapacity
- 150%
- 100 – 150%
- 50 – 100%
- 0 – 50%

Biocapacity Creditors
Biocapacity greater than Footprint
- 0 – 50%
- 50 – 100%
- 100 – 150%
- 150%



AS GLOBAL BIOCAPACITY DEFICIT GROWS, how will countries continue to meet the needs of their people and their economies? Maintaining natural wealth and reducing ecological demand will help countries improve economic resilience and make improvement in human wellbeing last.

Source: Global Footprint Network Annual Report 2011

Summary

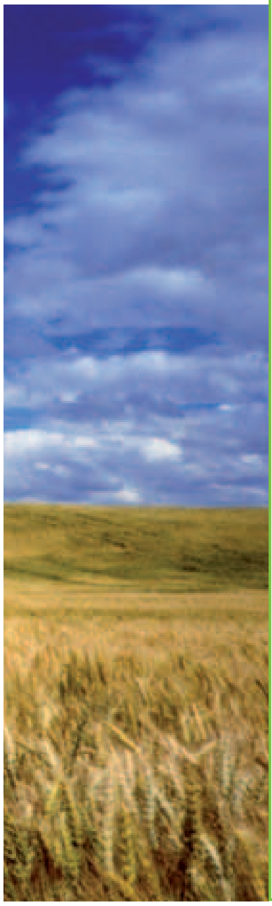
This survey explores resource constraints in Arab countries from the perspective of the regenerative capacity of nature. As measured by Ecological Footprint accounts in the year 2008, the average resident in Arab countries demanded more than twice what is available locally. However, in 2008 the average Arab resident recorded a footprint of 2.1 gha, which is less than the world average of 2.7 gha per capita. Moreover, Arab countries, on average, had relatively little of their resources within their borders, having recorded a biocapacity per capita of only 0.9 gha in 2008. This is down from 2.2 gha per capita in 1961, mostly because of population growth. The deficit has been maintained, in large part, by the importation of resources, by the depletion of both renewable and non-renewable resources, and by high per capita carbon emissions. Arab countries' imports are financed by revenues of fossil fuel exports, foreign aid, and debt. As prices for, say, commodity agricultural imports increase, this model will not remain economically sustainable.

These regional averages of the Arab states mask great internal disparity: in 2008 the average resident of Qatar had the highest Ecological Footprint in the world (11.7 gha per capita), higher than the Ecological Footprint of the average Yemeni (0.9 gha per capita) by 13-fold. Additionally, biocapacity availability per person also varies greatly, with Sudan (2.3 gha per capita) having nearly 10 times that of Iraq or Jordan (0.2 gha per capita) in 2008.

While the biocapacity available per capita has fallen across the whole region, the cropland component of biocapacity has remained relatively stable since 1961, at around 0.3 gha per capita. This indicates that the area and yields of cropland have kept pace with the rapid population growth in the region. However, this has placed ever greater pressure on water and land resources and is unlikely to be maintained in the future.

The Arab region has one of the greatest variations in Ecological Footprint, biocapacity, and income of any region in the world. In order to pursue sustainable wellbeing for all residents in the region, attention should be given towards more regional economic integration and cooperation and towards more inter-Arab trade free of barriers, where the free flow of goods, capital, and people works to the benefit of all countries. In addition, difficult policy questions regarding population and consumption growth will also need to be addressed in the near future.

Quick Facts



- The average Ecological Footprint per person in the Arab region is 2.1 gha per capita, a 78 percent increase from 1961.

- Biocapacity availability per person in the Arab region is 0.9 gha per capita, a 60 percent decrease from 1961.

- If all humans lived like the average resident of member countries of the Arab League, 1.2 planets would be required to satisfy humans' resource needs.

- If all humans lived like the average resident of Qatar, 6.6 planets would be required to satisfy this level of consumption and emissions of carbon dioxide. In contrast, if everyone lived like an average Yemeni, humans would demand half of planet Earth.

- Residents in the country with the highest per capita footprint, Qatar (11.7 gha per capita), consume on average more than 13 times that of residents of Yemen.

- Globally, the largest component of the Ecological Footprint is the carbon footprint at 55 percent. In Arab countries, the carbon footprint portion is 45 percent of the total footprint. The carbon footprint component has been the only one to increase, on a per capita basis, since 1961.

- Globally, the largest component of the biocapacity is forest land at 43 percent. In Arab countries, cropland is the largest at 32 percent of the total biocapacity, and has been the only land use type in which there has not been a significant decrease in availability per capita since 1961. This might have been achieved by employing intensive agricultural practices and extensive ground water extraction.

- 1.9 billion people live in countries with a higher Ecological Footprint per capita than that in Arab countries.

- 2.7 billion people live in countries with a higher biocapacity per capita than that in Arab countries.

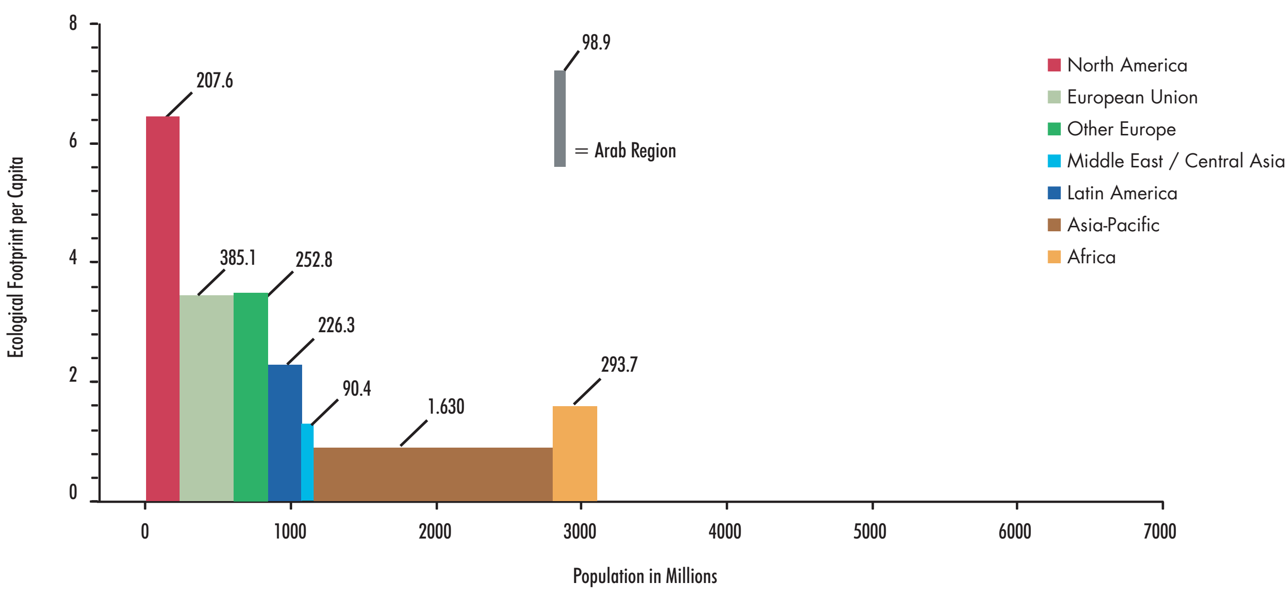
Detailed graphical data representations for footprint, biocapacity, and demographic profiles for all Arab countries as a group as well as for each individual Arab country are summarized in the appendix section.

Results and Discussion

The total Ecological Footprint of Arab countries was 717 million gha in 2008 (4 percent of the world total), up from 116 million in 1961 (2 percent of that year's world total). This is approximately the same footprint determined for the Middle East and Central Asia regions combined, or the non-EU European region, but only a third of the total North American footprint. As can be seen, the drivers behind these regional comparisons differ: North America, for example, has approximately the same population size but much higher individual consumption, as can be inferred from Figures 4 and 5. In North America, the population has increased by about 65 percent since 1961; in the Middle East and Central Asia the population went up by 330 percent in the same time span. This change far exceeds per capita changes in consumption over the same time period.

Figures 6 and 7 indicate the changes in per capita biocapacity from 1961 to 2008 in Arab countries. The average biocapacity available per person declined in all countries but Egypt. As a group, these countries had an average biocapacity of 0.9 gha per person, a 60 percent reduction from 1961. However, total biocapacity across the Arab region increased by about 40 percent from 1961 to 2008, largely due to more intensive forms of irrigation and agriculture. In spite of this absolute increase, the 3.5-fold increase in population led to a decrease in the per capita availability of

FIGURE 4 | The Ecological Footprint per capita and population of major world regions, in 1961. The area of each block represents the total Ecological Footprint (population times per capita footprint)



biocapacity in the region. Declines ranged from 17 percent in Lebanon to over 85 percent in Kuwait and Qatar.

Egypt was the only country to increase its biocapacity per person, by about 20 percent, despite a nearly three-fold increase in the population of the country over the same time period. This increase in per capita biocapacity in Egypt was possible because the percentage increase in total biocapacity was higher than the percentage increase in population size. The rise in total biocapacity can be attributed primarily to increased agricultural productivity and the addition of more cropland areas achieved through increased irrigation and the application of modern, industrial farming methods, all of which tend to increase the Ecological Footprint. Therefore, in spite of the boost in Egypt's per capita biocapacity, the country's biocapacity deficit still increased due to a rapidly increasing Ecological Footprint.

Water is a significant production factor for biocapacity through its potential to increase the area of land under production or increase bioproductivity. Current data sets do not allow us yet to identify the specific contribution of water to biocapacity, or inversely the threat to biocapacity due to lack of fresh water, but it is clear that future water scarcity will place pressure on the biocapacity of Arab countries.

In 2008, Arab countries were using more resources than their domestic biocapacity could renew, as indicated in Figure 8. Although the demand for resources by the region's inhabitants is below the world's average, the local availability of biocapacity per person is also low, partially as a result of the region's arid conditions and high population growth. Up until 1980, the Ecological Footprint of Arab countries was still less than their biocapacity, on a per capita basis (Figure 8). In addition, the Arab region's consumption of fossil fuel has been rising to meet the increased demand for electricity and desalinated water, which has added to the region's footprint and biocapacity deficit and is expected to limit the region's future options with rising populations and high local subsidies. The Arab region thus falls into the category of regions that are dependent on the import of external biocapacity.

Arab countries had 5 percent of the world's population and only 2.5 percent of total

FIGURE 5 | The Ecological Footprint per capita and population of major world regions, in 2008. The area of each block represents the total Ecological Footprint. The light grey area for the Arab region represents the values in 1961, which has grown in both per capita consumption and population as indicated by the white arrow

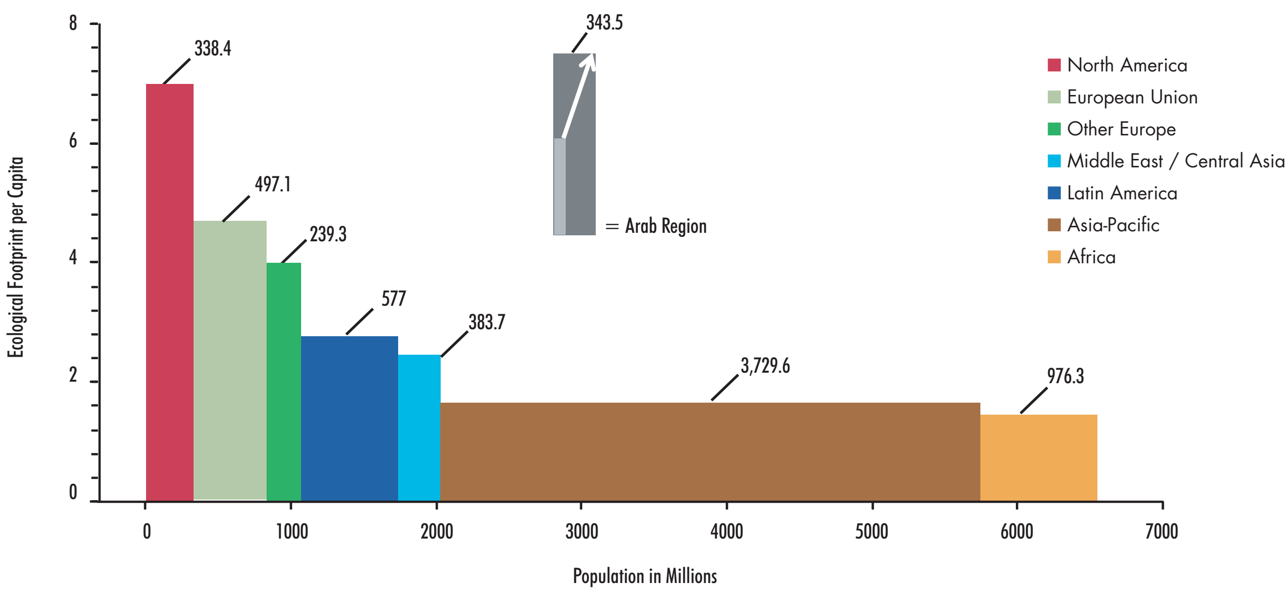


FIGURE 6 | Biocapacity per capita in Arab countries, 1961

global biocapacity in 2008. The biocapacity is concentrated primarily in the Nile Valley (with 49 percent of the region's biocapacity). In 2008, total biocapacity across the Arab region in absolute terms was 302 million global hectares, less than half its total footprint of approximately 717 million global hectares. In 1961, the region's biocapacity was 86 percent greater than its footprint, as indicated in Figures 9 and 10. The shift has occurred largely because population has been increasing at a much faster rate (250 percent increase since 1961) than total biocapacity (40 percent increase since 1961).

Today, the majority of Arab countries are ecological debtors, with less biocapacity than they use to meet their own consumption demands. The result of this deficit is twofold: an accumulation of wastes such as carbon dioxide in the atmosphere, and the liquidation of ecosystem stocks (agricultural land, fisheries, and aquifers) that have gradually amassed over time. Today we are seeing clear consequences of biocapacity deficit in land degradation, water pollution, depleting groundwater, 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. Today, the biocapacity deficit in Arab countries is balanced out by importing resources from elsewhere. For oil-producing countries, such imports are possible through income derived from the exports of their abundant oil and gas reserves.

Yet, exporting fossil fuels may not work as a long-term strategy for covering a growing biocapacity deficit for a number of reasons, including: a) local demand for fossil fuels, especially for desalination and electricity generation, may reduce export potential; b) global demand for fossil fuel may decrease if measures are taken by the rest of the world to shift to low-carbon alternatives as a climate change mitigation measure; and c) fossil fuel reserves will decline and eventually deplete.

FIGURE 7 | Biocapacity per capita in Arab countries, 2008

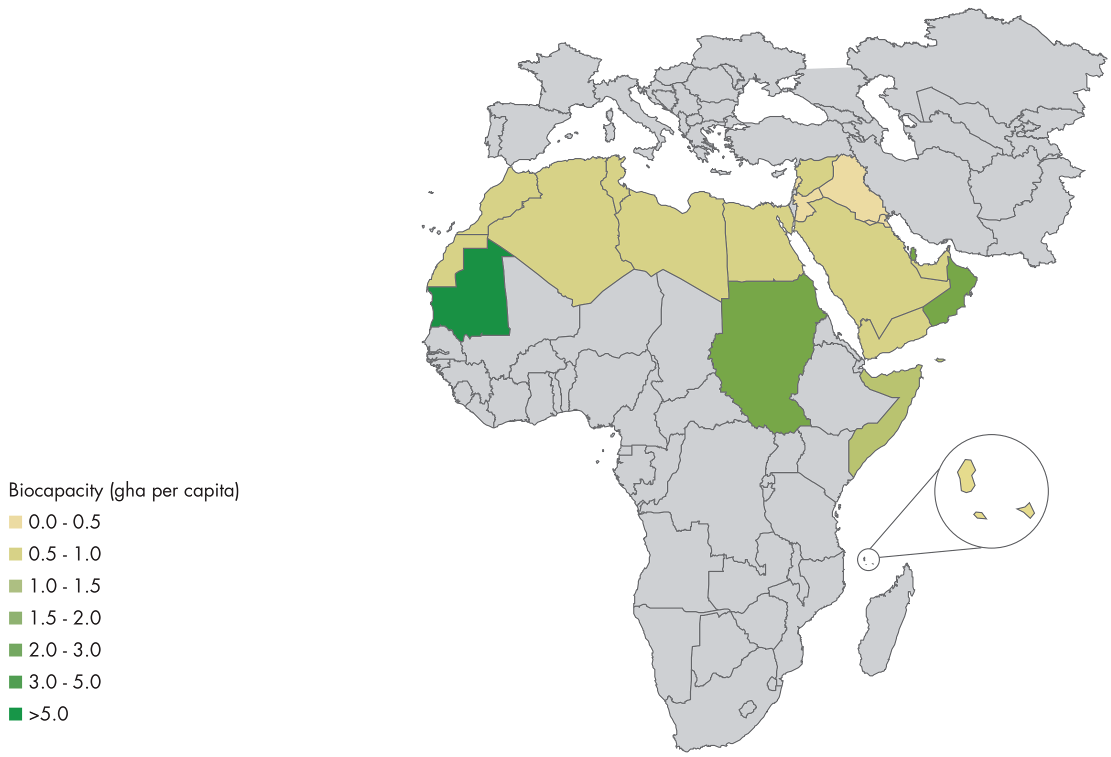
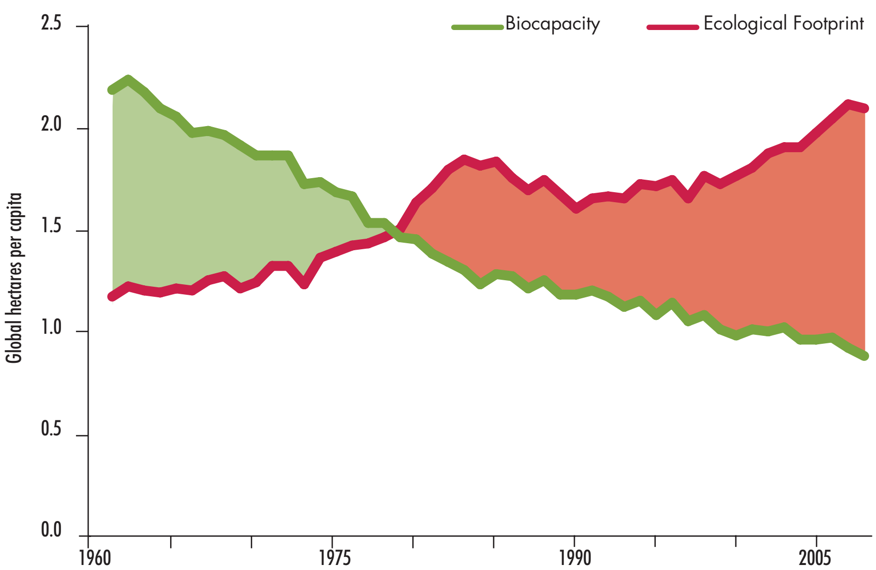


FIGURE 8 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Arab countries. The red area indicates the biocapacity deficits: Arab countries demand for renewable resources exceeds what nature can supply



A failure by Arab countries to address growing biocapacity deficits places an ever greater gamble that they can adapt quickly enough in response to these future conditions.

Human societies depend on the ability of the biosphere to provide ecological services, both for resource generation and waste sequestration. In a world of growing resource insecurity, any development that ignores ecological limits simply will not last. For a time, higher-income Arab countries may be able to maintain their access to increasingly expensive resources by importing them from other countries. Lower-income Arab countries will not have this option, and may need to depend more on their own biocapacity and potentially deplete their own resource base, and/or rely on borrowing and foreign assistance, thus adding debts to future generations.

Therefore, tracking the status of renewable resources in Arab countries is fundamental to economic survival in this new era of resource insecurity. Using this information to develop a pathway towards resource security, at the intersection of the issues surrounding water, energy and food, will be a key step towards ensuring sustainable wellbeing for the Arab region's residents in the future.

FIGURE 9 | Creditor-debtor status in 1961 for Arab countries. Red shading indicates that the footprint is greater than biocapacity (debtor status), while green shading indicates that biocapacity is greater than the footprint (creditor status). Data are unavailable for the United Arab Emirates in 1961, so they have been assumed to be at a level equal to that of surrounding states

Ecological Footpint...
- > 150 % larger than biocapacity
- 100 - 150 % larger
- 50 - 100 % larger
- 0 - 50 % larger

Biocapacity...
- 0 - 50 % larger than Footprint
- 50 - 100 % larger
- 100 - 150 % larger
- > 150 % larger

Commonly asked questions about the Ecological Footprint methodology

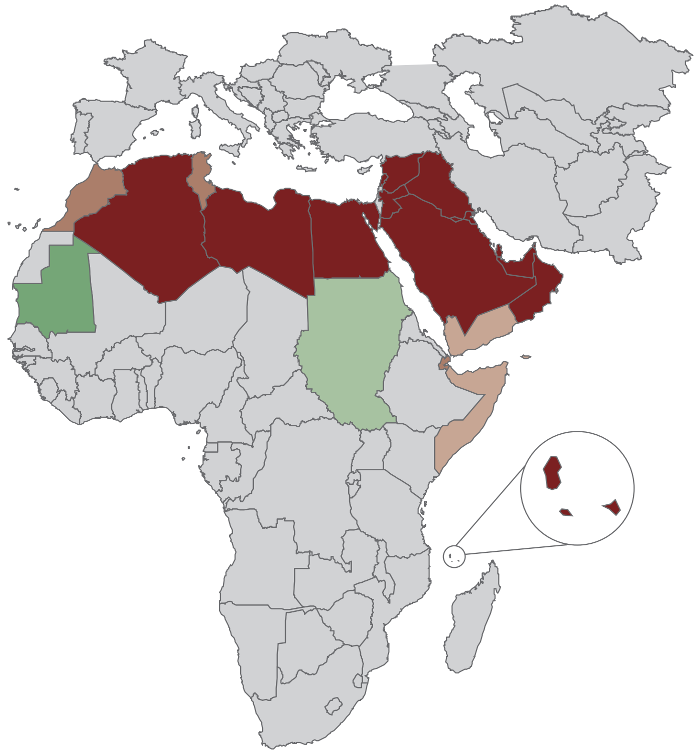
There are three concerns that are often raised when these imbalances are shown for wealthy, oil exporting Arab countries, which are addressed by the Ecological Footprint methodology:

1. **"Is the Ecological Footprint higher for fossil fuel exporting countries because of the carbon dioxide released when those fuels are burned?"**
   The Ecological Footprint is calculated on a consumer principle, with the final impact attributed to the country which consumes the final good or service. In the case of fossil fuels, the Ecological Footprint for carbon dioxide production is assigned to the country in which combustion of the fuel takes place.

2. **"Is the Ecological Footprint higher for countries with lots of low productivity land, such as deserts?"**
   The Ecological Footprint represents only the demand side, whereas biocapacity represents supply. In countries with lots of low productivity land, we typically see a low biocapacity per capita; the Ecological Footprint is dependent upon consumption.

3. **"If a country has the financial means to import resources, why does a high Ecological Footprint matter?"**
   In a world of increasing resource constraints, running a biocapacity deficit becomes an economic risk for any country. Costs can increase uncontrollably, or if resource scarcity is not anticipated by price increase, disruptions may upset supply chains. Resource dependence is embedded into the infrastructure of economies – the way cities are built, the energy systems in place, the size of the population. All these aspects change slowly.

FIGURE 10 | Creditor-debtor status in 2008 for Arab countries. Red shading indicates that the footprint is greater than biocapacity (debtor status), while green shading indicates that biocapacity is greater than the footprint (creditor status)



Ecological Footpint...
- > 150 % larger than biocapacity
- 100 - 150 % larger
- 50 - 100 % larger
- 0 - 50 % larger

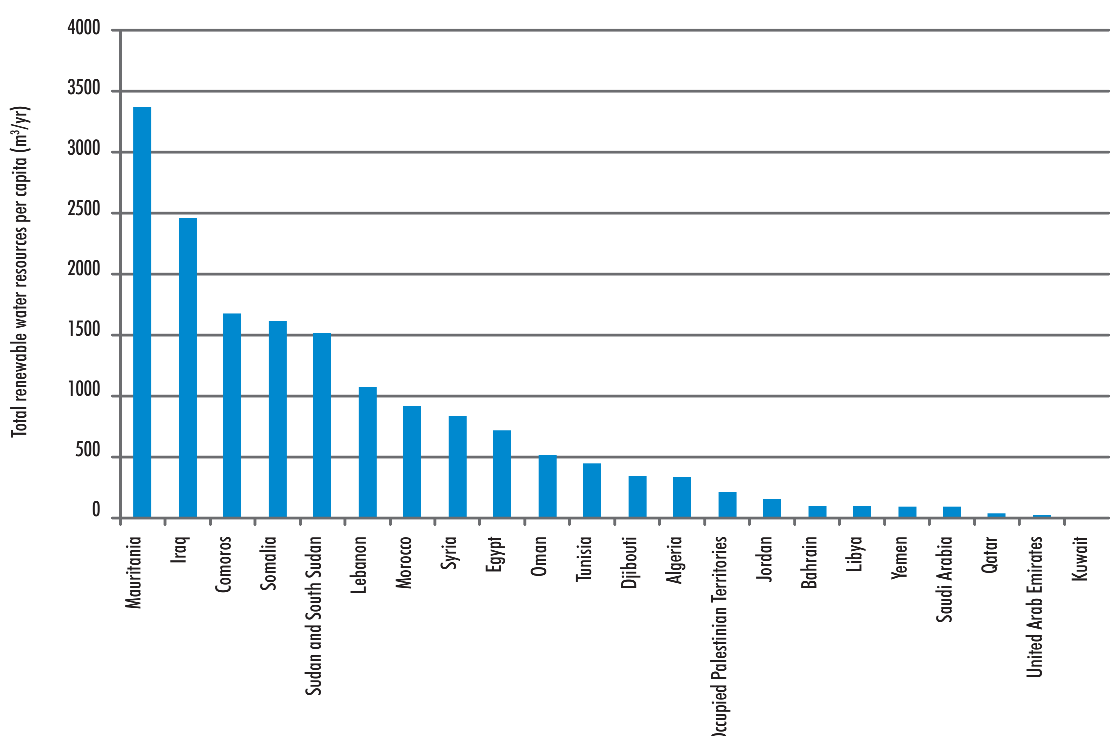
Biocapacity...
- 0 - 50 % larger than Footprint
- 50 - 100 % larger
- 100 - 150 % larger
- > 150 % larger

Water

The availability of freshwater, especially in areas with low precipitation, is a critical factor for biological productivity, affecting the biocapacity of forests, cropland, and grazing land. It is estimated that today the agricultural sector accounts for 70 percent of human demand for global freshwater resources (FAO, 2003); in Arab countries agricultural water use accounts for 85 percent.

Although the Arab region is considered generally arid, rainfall varies widely, from an average annual rainfall of only 51 mm in Egypt to 660 mm in Lebanon (FAO, 2011). Water supply sources in the Arab world, two-thirds of which originate outside the region, are being stretched to their limit. Major rivers in the region, such as the Nile, Tigris, and Euphrates, which supply additional water to Sudan, Egypt, and Iraq, originate outside their borders. 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 social goals. Already renewable freshwater resources per capita is

FIGURE 11 | Total renewable water resources available per capita in Arab countries, 2008



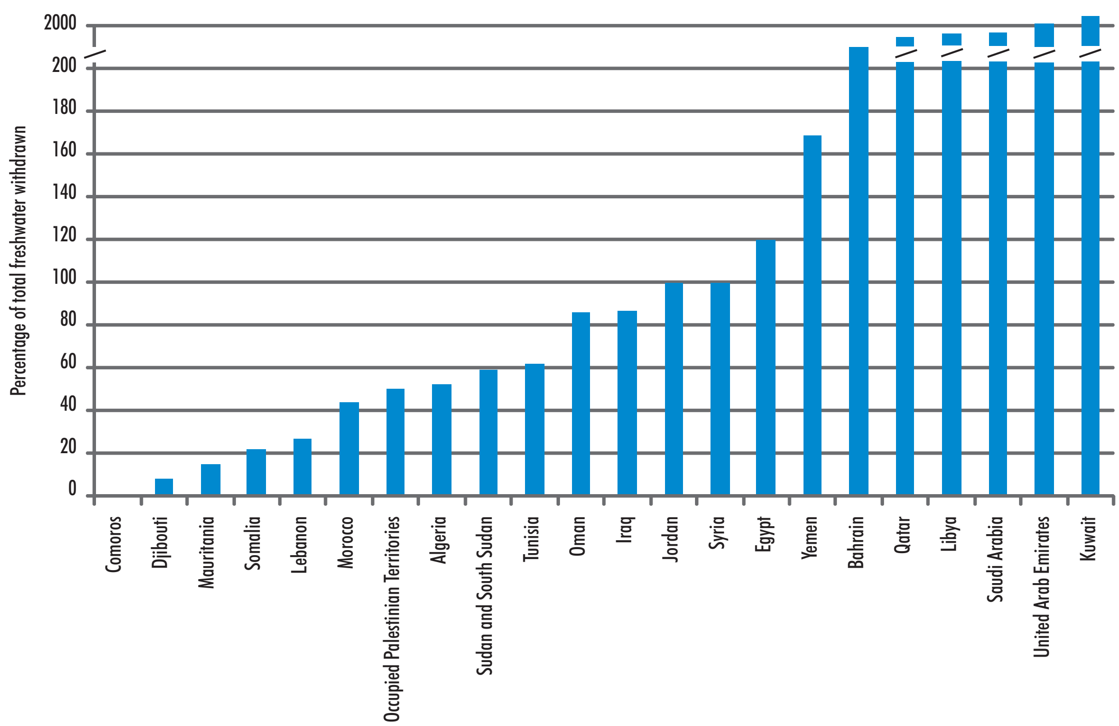
below 100 cubic meters per year in six Arab countries, as indicated in Figure 11. FAO has defined water-scarce countries as those that use more than 20 percent of their annual freshwater supplies: nearly every country in the Arab region by far exceeds this threshold, from 22 percent in Somalia to over 2000 percent in Kuwait and the UAE. As indicated in Figure 12, only Mauritania, Djibouti, and the Comoros are not classified as water-scarce by this metric.

An average per capita share of renewable freshwater below 1,000 cubic meters per year is considered water scarcity, and below 500 is severe scarcity. The report on Water: Sustainable Management of a Scarce Resource produced by AFED in 2010 showed that as early as 2015, the average in the Arab world might fall below the 500 cubic meters threshold.

Thirteen Arab countries are among the world's nineteen most water-scarce nations. By 2015, the per capita share of renewable freshwater will be 114 cubic meters in Jordan, 77 in Saudi Arabia, 26 in the UAE, and 5 in Kuwait. The situation is still expected to worsen with the effects of climate change, while populations continue to multiply. As a result, some Arab countries have opted to fill the gap by desalinating sea water, using highly expensive and often polluting methods, with high footprint impact. Still, 43% of wastewater is not treated, and out of the treated wastewater only one-third is reused (AFED, 2008, 2009, 2010, 2011).

Water-scarce countries can meet some of their needs by importing food commodities 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 biocapacity embedded in trade. While the consumption of virtual water can help alleviate local demand for scarce water resources, it may also increase the carbon portion of the Ecological Footprint, as water intensive products are transported from afar.

FIGURE 12 | Percentage of total freshwater resources withdrawn, 2008. Qatar, Libya, Saudi Arabia, UAE, and Kuwait all withdraw more than 400 percent of their annual renewable freshwater resources



Conclusion

Footprint and biocapacity data for individual Arab countries and for sub-regional groupings are summarized in Table 1. The Table also contains data on freshwater availability, population, and GDP. More detailed graphical data representations for footprint, biocapacity, and demographic profiles for all Arab countries as a group as well as for each individual Arab country are summarized in appendices A through I.

There is clearly a divide between countries that comprise the Arab world: small, very wealthy states with little biocapacity on one side, and large, financially poor, but relatively biocapacity-rich states on the other side. However, there are two unifying factors across the whole region: biocapacity availability per capita is decreasing rapidly due to population growth; the maintenance of biocapacity in the future is likely to be highly constrained by the availability of freshwater resources.

The Ecological Footprint per capita has increased for most countries, due to increased consumption. The exceptions are generally the very low-income countries including Yemen, Sudan, Mauritania, Djibouti, and Somalia.

As competition for ecological resources and services increases, effective management of biocapacity, both of demand and supply, will help meet Arab nations' need for resources, and can provide a potential source of continuing income for Arab countries.

The region is intricately connected by culture, geography, and trade: difficulties in one country will have a large impact throughout the entire region. Cooperation is therefore essential. Technology transfer has the potential to ensure that agricultural yields are kept to a common standard across the region. Additionally, increased trade has the potential to ensure that degradation of individual countries' ecosystems is limited.

The connections within the broader Arab region are most intense within the geographic groupings

described in the following sections. Nevertheless, trade and cooperation will need to be situated within a broader framework. Therefore, it is essential to conduct negotiations at both the international, regional and sub-regional levels simultaneously. With environmental issues, primarily biocapacity and water, at the forefront, such cooperation towards more free trade has the potential to lift the region into an economically competitive position, whilst ensuring wellbeing for all.

TABLE 1 | Population, gross domestic product, Ecological Footprint, biocapacity, and freshwater availability in Arab countries in 1961 and 2008

	Population [millions]		GDP* [constant $US 2000 per capita]		GDP [current $US per capita]
	1961	**2008**	**1975**	**2008**	**2008**
Bahrain	0.17	1.05		12,505	20,813
Kuwait	0.30	2.55		25,308	57,842
Oman	0.57	2.64	4,598	11,386	22,968
Qatar	0.05	1.40		31,214	82,389
Saudi Arabia	4.17	26.17	14,979	9,513	18,203
United Arab Emirates		8.07	56,038	25,574	50,727
GCC	**5.26**	**41.87**	**16,415**	**13,970**	**28,396**
Yemen	5.21	22.63		567	1,190
GCC plus Yemen	**10.47**	**64.50**		**9,132**	**18,568**
Iraq	7.57	29.82		744	2,867
Jordan	0.93	5.85	1,119	2,510	3,797
Lebanon	1.97	4.17		5,895	7,219
Occ. Palestinian Territory		3.83			
Syria	4.72	19.69	909	1,452	2,678
Levant	**15.19**	**63.36**	**953**	**3,524**	**3,198**
Egypt	28.65	78.32	601	1,859	2,079
Sudan	11.84	41.41	287	507	1,401
Nile valley	**40.49**	**119.74**	**507**	**1,391**	**1,880**
Algeria	11.01	34.43	1,632	2,174	4,967
Libya	1.40	6.15		7,865	15,150
Mauritania	0.88	3.29	460	616	1,088
Morocco	11.95	31.32	886	1,734	2,793
Tunisia	4.30	10.25	1,251	3,023	4,345
North Africa	**29.53**	**85.44**	**1,220**	**2,464**	**4,678**
Comoros	0.20	0.70		341	761
Djibouti	0.09	0.86		869	1,148
Somalia	2.89	8.92			
African Horn	**3.17**	**10.47**		**632**	**974**
League of Arab states	**98.85**	**343.51**	**1,997**	**3,234**	**6,133**

* 1975 is earliest date available for near complete coverage. Note that the regional groupings are averages weighted by population based on countries with data available in 1975.
The World Bank defines GDP as: "GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in

	Ecological Footprint [gha per capita]		Biocapacity [gha per capita]		Freshwater availability [m³ per capita]	
	1961	**2008**	**1961**	**2008**	**1961**	**2008**
Bahrain	5.4	6.6	4.0	0.7	695	110
Kuwait	2.1	9.7	3.0	0.4	68	8
Oman	1.1	5.7	9.5	2.2	2,452	531
Qatar	7.8	11.7	53.5	2.1	1,137	42
Saudi Arabia	0.8	4.0	2.5	0.7	575	92
United Arab Emirates	0.0	8.9	0.0	0.6		19
GCC	**1.1**	**5.7**	**3.8**	**0.8**	**1,159**	**146**
Yemen	1.2	0.9	2.5	0.6	403	93
GCC plus Yemen	**1.1**	**4.0**	**3.2**	**0.7**	**783.0**	**127.0**
Iraq	0.9	1.4	0.8	0.2	9,988	2,535
Jordan	2.6	2.1	1.0	0.2	1,002	160
Lebanon	1.7	2.8	0.5	0.4	2,289	1,081
Occ. Palestinian Territory	0.0	0.5	0.0	0.1		219
Syria	1.2	1.5	1.3	0.6	3,562	853
Levant	**1.2**	**1.5**	**0.9**	**0.3**	**6,442**	**1,544**
Egypt	0.9	1.7	0.5	0.7	2,000	732
Sudan	1.8	1.6	7.2	2.3	5,449	1,557
Nile valley	**1.1**	**1.7**	**2.5**	**1.2**	**3,008**	**1,017**
Algeria	0.8	1.6	1.5	0.6	1,060	339
Libya	2.0	3.2	2.0	0.7	429	98
Mauritania	5.0	2.9	19.9	5.2	12,969	3,460
Morocco	0.9	1.3	1.1	0.7	2,427	926
Tunisia	0.9	1.8	1.2	1.0	1,069	448
North Africa	**1.1**	**1.7**	**1.9**	**0.8**	**1,939**	**670**
Comoros	0.9	1.1	0.6	0.3	6,091	1,722
Djibouti	2.5	1.9	6.4	1.1	3,333	350
Somalia	2.7	1.4	4.3	1.4	5,095	1,648
African Horn	**2.5**	**1.5**	**4.1**	**1.3**	**5,107**	**1,547**
League of Arab states	**1.2**	**2.1**	**2.2**	**0.9**	**3,027**	**871**

the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources." *(http://data.worldbank.org/indicator/NY.GDP.PCAP.KD)*. In the first two columns, GDP data are in constant year 2000 US dollars (adjusted for inflation referenced to the year 2000). The third column has current GDP data in US dollars for the year 2008 *(http://data.worldbank.org/indicator/NY.GDP.PCAP.KD)* - Accessed on 17.09.2012

APPENDIX A

Definition of Terms

ECOLOGICAL FOOTPRINT

Ecological Footprint accounts answer a specific research question: how much of the biological capacity of the planet is demanded by a given human activity or population? To answer this question, the Ecological Footprint measures the amount of biologically productive land and water area an individual, a city, a country, a region, or all of humanity uses to produce the resources it consumes and to absorb the carbon dioxide emissions it generates, with today's technology and resource management practices. This demand on the biosphere can be compared to biocapacity, a measure of the amount of biologically productive land and water available for human use.

BIOCAPACITY

Biocapacity represents the ability of ecosystems to produce useful biological materials and to absorb carbon dioxide emissions (CO_2) generated by humans, using current management and extraction technologies. Useful biological materials are defined as those materials that the human economy actually demanded in a given year. Biocapacity includes only biologically productive land: cropland, forest, fishing grounds, grazing land, built-up land; deserts, glaciers, and the open ocean are excluded.

BIOCAPACITY DEFICIT

Biocapacity deficit occurs when a country's Ecological Footprint exceeds its biocapacity. Biocapacity deficits are maintained through the import of natural resources from abroad, overuse of domestic resources, or dependency on the global commons (through the release of CO_2 to the atmosphere).

PRICE OF BIOCAPACITY DEFICIT

By attaching the world market prices (FAO, 2012) for internationally traded commodities, it is possible to attach a price to the biocapacity deficit. This price represents either the direct money paid to import primary goods or the present value of a reduction in stocks. The price attached to carbon dioxide sequestration services was taken from Costanza et al. (1997), and was kept constant throughout the period from 1961-2008.

POPULATION

The population trends (UNESA, 2010) of a country often are the driving force behind changes in the Ecological Footprint (see Ecological Footprint drivers). A large youthful population (ages 0-14) usually translates into high population growth for the next few decades. A large working-age population (15-64) usually means that economic growth is higher (the so called "demographic dividend"). However, once this population moves into the older age group (65+) greater pressure is put on the state infrastructure to provide for it, potentially reducing economic growth.

Ecological Footprint Accounts
Sub-Regional Profiles

Gulf Cooperation Council (GCC)

Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE

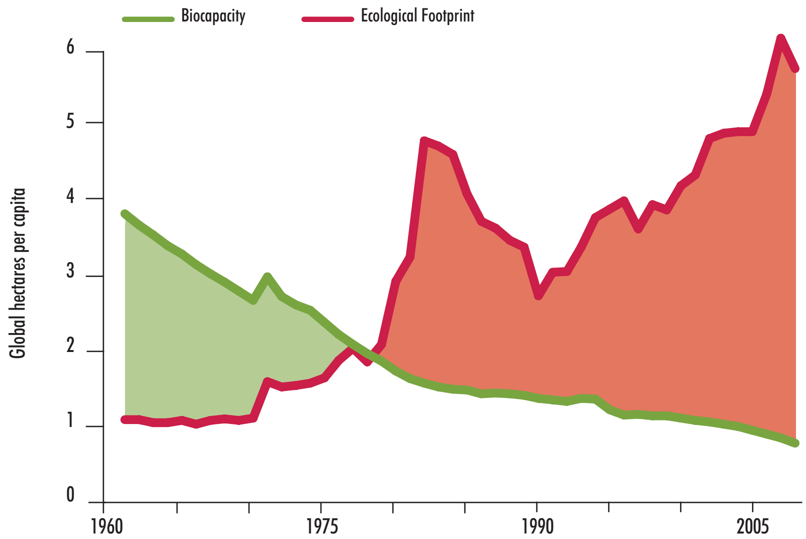
The GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates) occupy 203 million hectares of productive land and water, as of 2008. Of those, 1.3 million are forest, 4.1 million are cropland, 172.2 million are grazing land, and 1.8 million support the region's built infrastructure. The GCC also has 23.9 million hectares of continental shelf and inland water to support fisheries.

Even though the Ecological Footprint of GCC countries is much greater than its biocapacity, as indicated in Figure 13, it should also be borne in mind that this biocapacity is largely comprised of fishing grounds (57 percent). Sea-based biocapacity reaches as high as 1.9 gha per capita for Oman and Qatar, compared to less than 0.01 gha per capita in Lebanon, which is the highest within the Levant. Consequently, the demands on other land use types in the GCC exceed biocapacity by a much greater amount than is at first apparent. This is in contrast to the Levant region, where only 2 percent of biocapacity comes from fishing grounds.

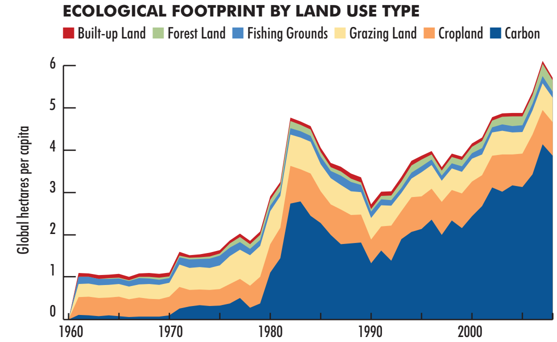
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, the GCC's total biocapacity is 33 million gha. This is much less than its total Ecological Footprint of 239 million gha.

The GCC's average Ecological Footprint per person is 5.7 gha, more than twice the global average footprint of 2.7 gha, using 2008 data.

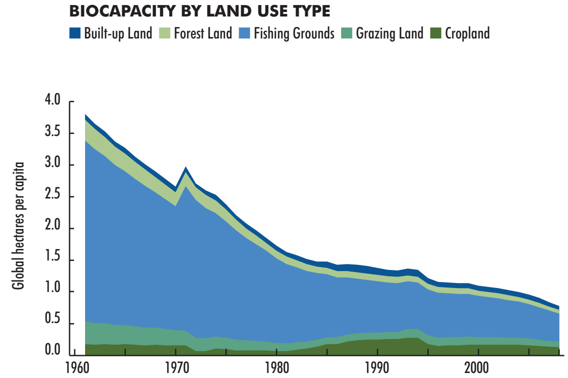
FIGURE 13 | The Ecological Footprint and biocapacity per capita, 1961-2008, in the GCC region. The red area indicates the biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds what nature can supply



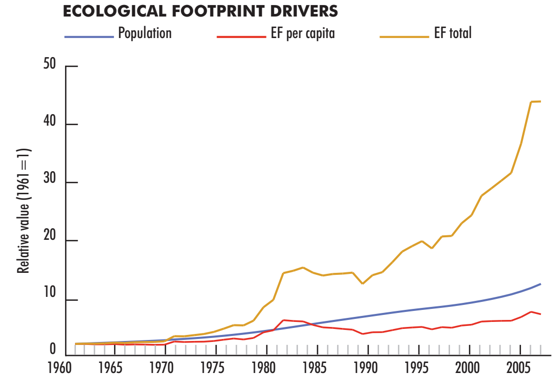
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



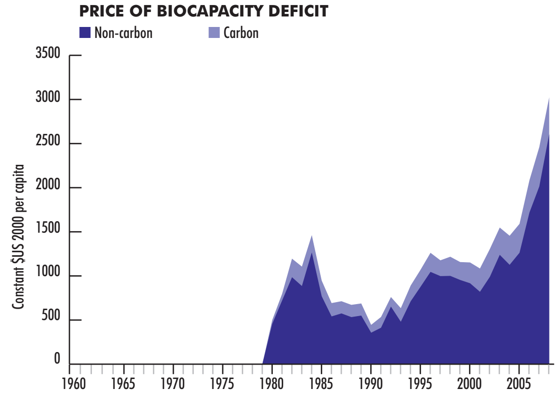
BIOCAPACITY BY LAND USE TYPE



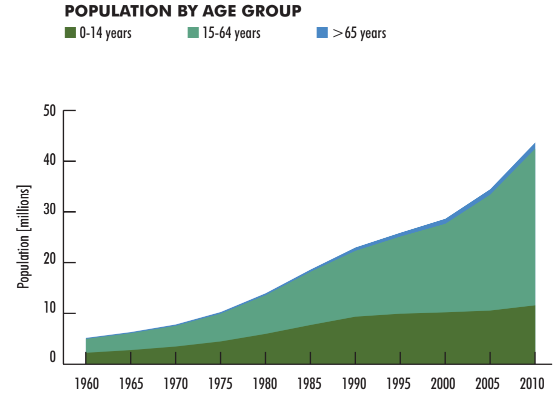
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



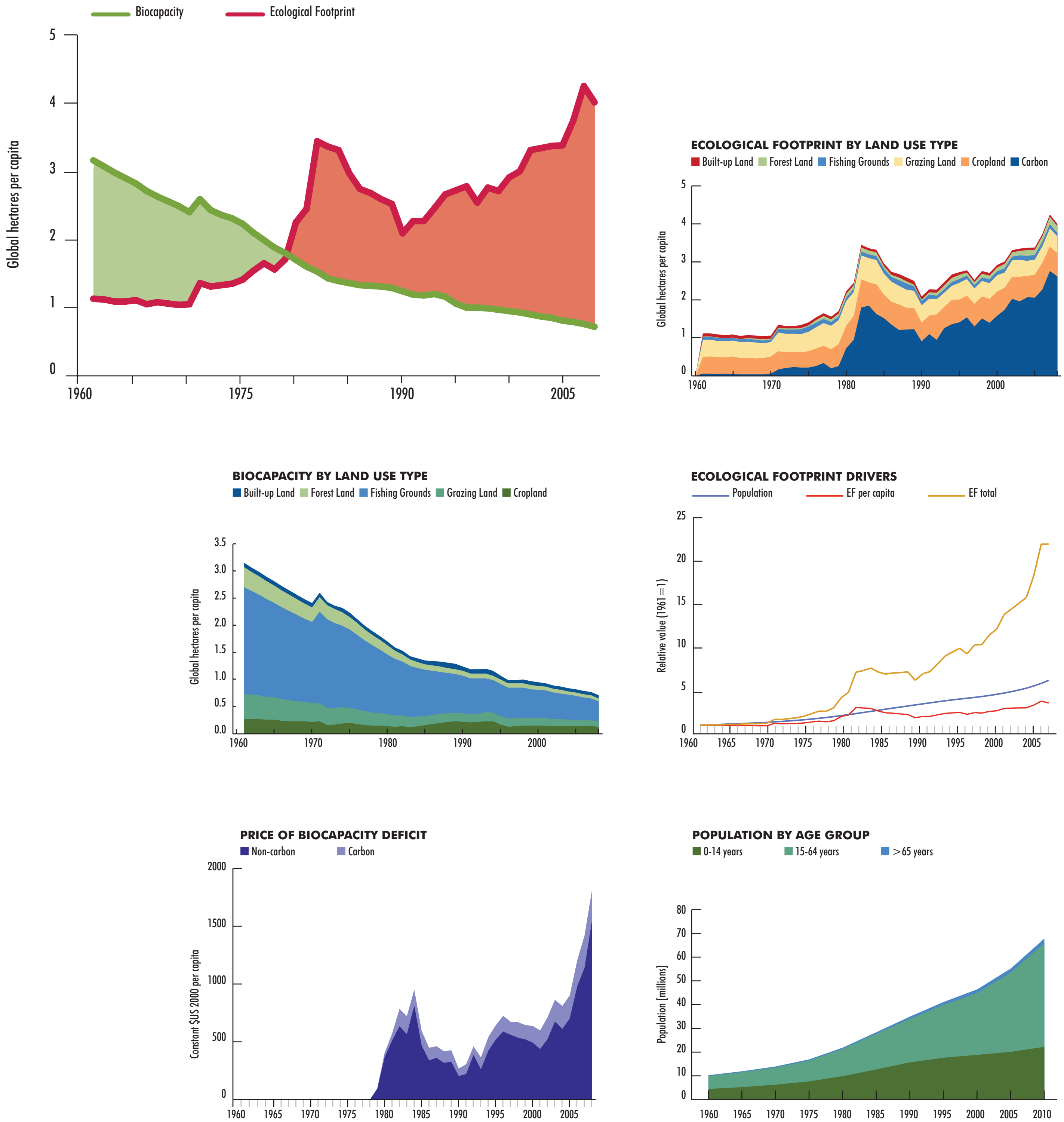
GCC Plus Yemen

Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE, plus Yemen

Situated in southwest of the Arabian Peninsula, Yemen might geographically be considered as part of the Gulf region. The average Ecological Footprint of Yemen was 0.9 gha per person in 2008. By comparison, the GCC's average footprint is six-fold higher. Since Yemen accounts for 35 percent of the total population, if included, the population-weighted footprint for the GCC and Yemen combined comes down to an average of 4.0 gha per person, as indicated in Figure 14.

The GCC's Ecological Footprint per person is much greater than the 0.8 gha of biocapacity available per person (with the inclusion of Yemen, this decreases to 0.7 gha per capita). This disparity is rapidly growing due to a high rate of population growth. The region's population grew from 5.3 million to 41.9 million between 1961 and 2008, an average annual increase of 4.4 percent; Yemen's population only averaged an annual increase of 3.1 percent. Population growth is the primary driver of a decreasing availability of biocapacity in the region: over the same time period, the biocapacity available per person in the GCC decreased by 79 percent.

FIGURE 14 | Ecological Footprint and biocapacity per capita, 1961-2008, in the GCC region plus Yemen. The red area indicates biocapacity deficit, which shows that, even with the inclusion of relatively resource-rich Yemen, population demands, in aggregate, will still exceed what nature can supply



Levant

Jordan, Iraq, Lebanon, Palestine, Syria

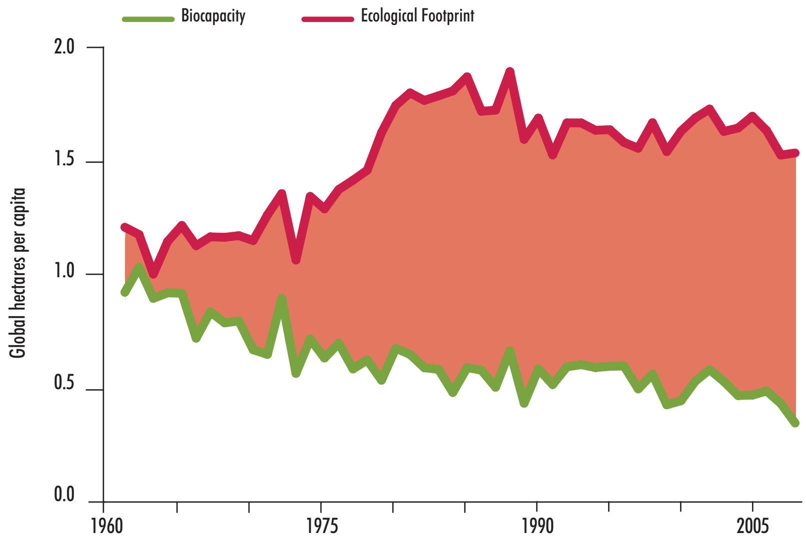
The Levant countries (Lebanon, Syria, Iraq, Jordan, the Occupied Palestinian Territories) occupy 73 million hectares of land. Of those, 1.5 million are forest, 12 million are cropland, 14 million are grazing land, and 2 million support the region's built infrastructure. The Levant also has 0.6 million global hectares of continental shelf and inland water to support fisheries.

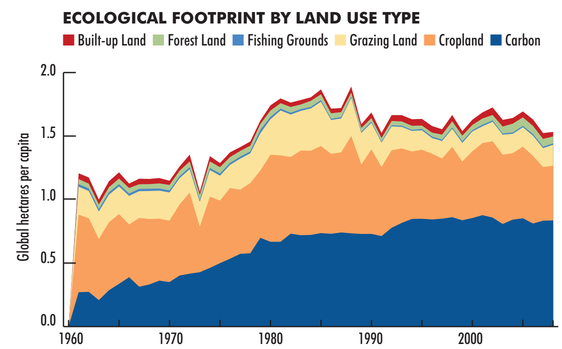
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, the Levant's total biocapacity is 22 million gha. This is much less than its total Ecological Footprint of 98 million gha.

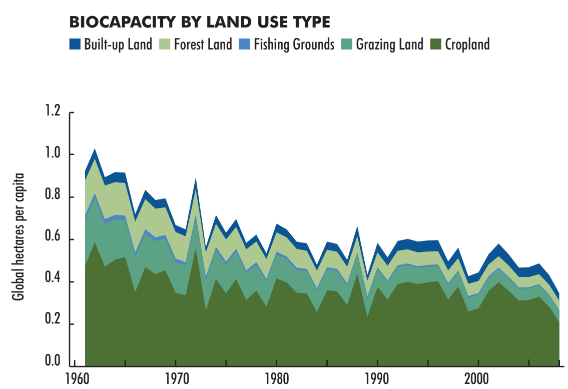
The Levant's average Ecological Footprint per person is 1.5 gha, slightly more than half the global per capita footprint of 2.7 gha. Compared to the rest of the world, the average inhabitant of a Levant country has a smaller footprint, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the region's population must have greater access to renewable natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of this region will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

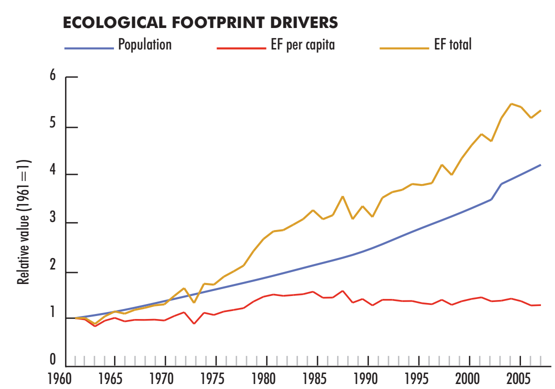
The Levant's Ecological Footprint per person is much greater than the region's 0.3 global hectares of biocapacity available per person due to a high rate of population growth. The region's population grew from 15 million to 63 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 62 percent, as indicated in Figure 15.

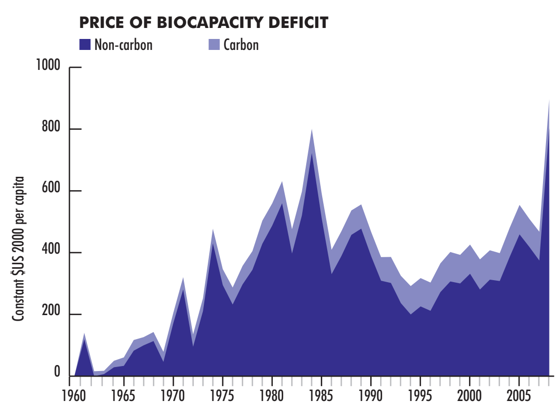
FIGURE 15 | The Ecological Footprint and biocapacity per capita, 1961-2008, in the Levant region. The red area indicates the biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds what nature can supply

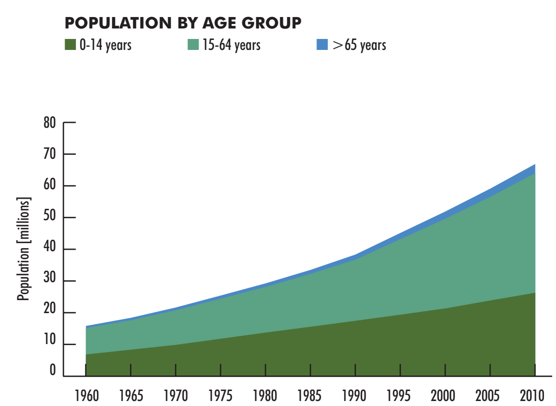












Nile Valley

Egypt, Sudan

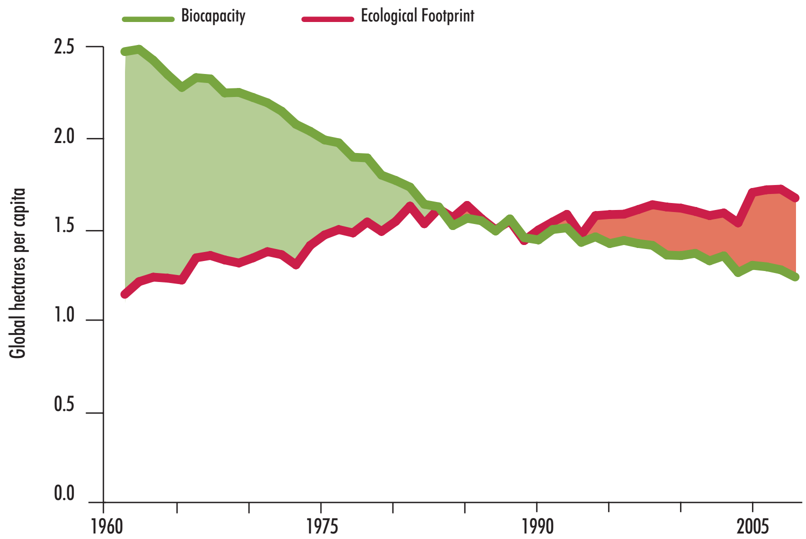
The Nile Valley countries (Egypt and Sudan) occupy 337 million hectares of land. Of those, 70 million are forest, 24 million are cropland, 117 million are grazing land, and 3 million support the region's built infrastructure. The Nile Valley also has 20 million global hectares of continental shelf and inland water to support fisheries.

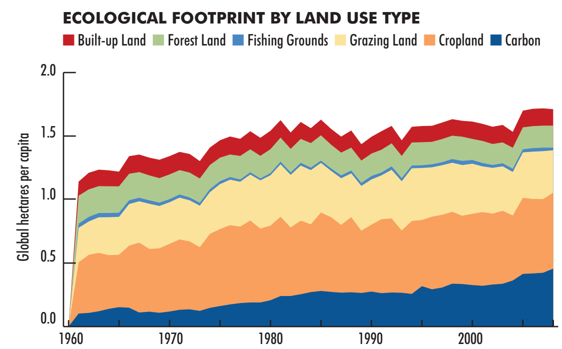
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, the Nile Valley's total biocapacity in 2008 was 148 million gha. This was less than its total Ecological Footprint of 200 million gha.

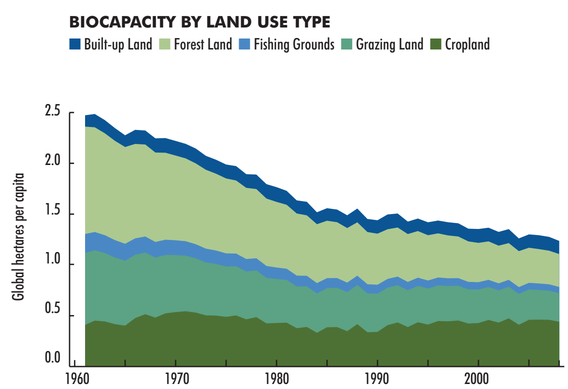
The Nile Valley's average Ecological Footprint per person was 1.7 gha, slightly more than half the global per capita footprint of 2.7 gha. Compared to the rest of the world, the average inhabitant in the Nile Valley has a smaller footprint, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the region's population must have greater access to renewable natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of this region will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

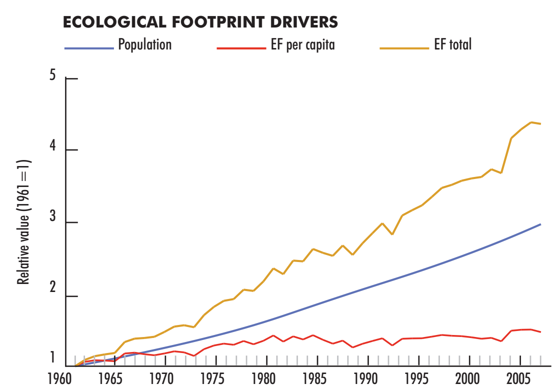
The Nile Valley's Ecological Footprint per person is greater than the 1.2 global hectares of biocapacity available per person due to a high rate of population growth. The region's population grew from 41 million to 120 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 50 percent, as indicated in Figure 16.

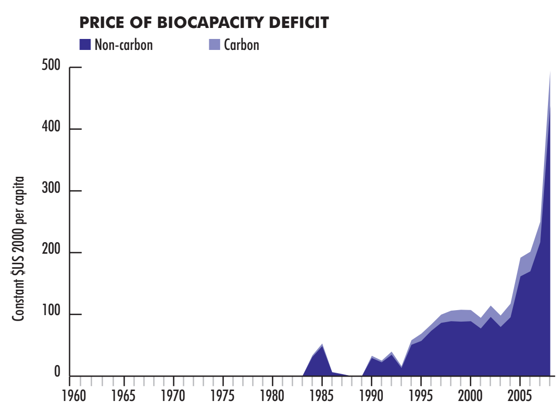
FIGURE 16 | The Ecological Footprint and biocapacity per capita, 1961-2008, in the Nile Valley region. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds what nature can supply

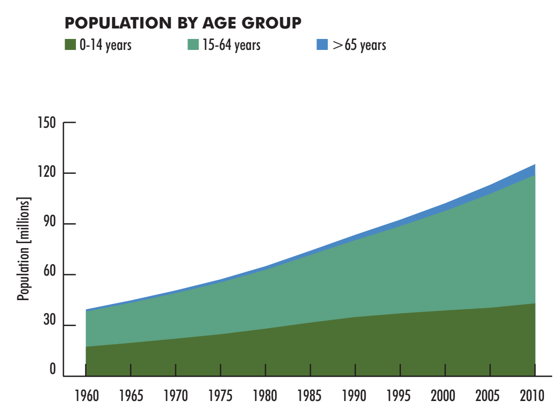












North Africa

Algeria, Libya, Mauritania, Morocco, Tunisia

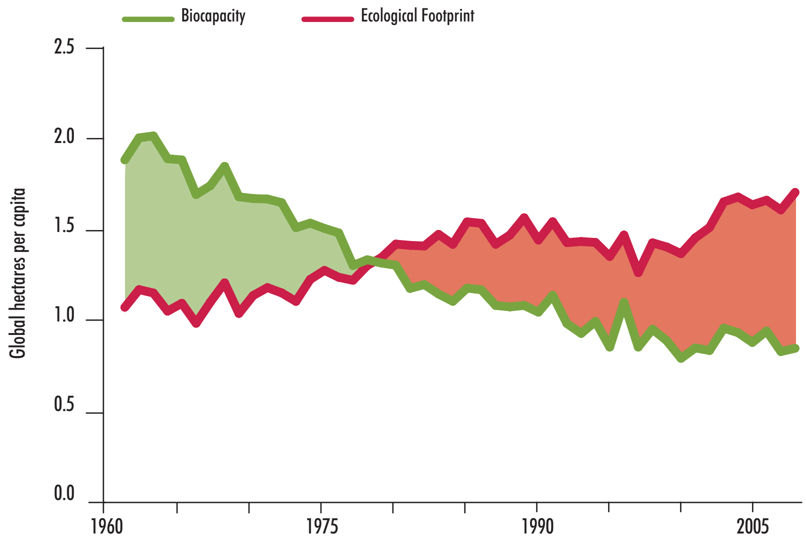
The North Africa countries (Algeria, Libya, Mauritania, Morocco, Tunisia) occupy 577 million hectares of land. Of those, 8 million are forest, 25 million are cropland, 112 million are grazing land, and 3 million support the region's built infrastructure. North Africa also has 25 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, North Africa's total biocapacity is 72 million gha. This is much less than its total Ecological Footprint of 150 million gha.

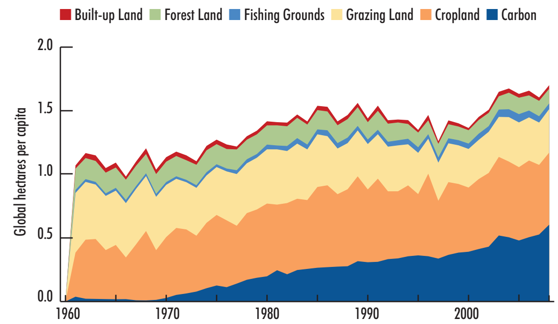
North Africa's average Ecological Footprint per person is 1.7 gha, slightly more than half the global per capita footprint of 2.7 gha. Compared to the rest of the world, the average inhabitant in the North Africa region has a smaller footprint, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the region's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of this region will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

North Africa's Ecological Footprint per person is greater than the 0.8 global hectares of biocapacity available per person due to a high rate of population growth. The region's population grew from 30 million to 85 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 55 percent, as indicated in Figure 17.

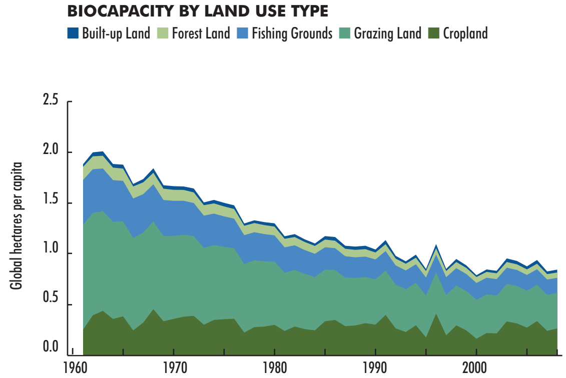
FIGURE 17 | The Ecological Footprint and biocapacity per capita, 1961-2008, in the North Africa region. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds what nature can supply



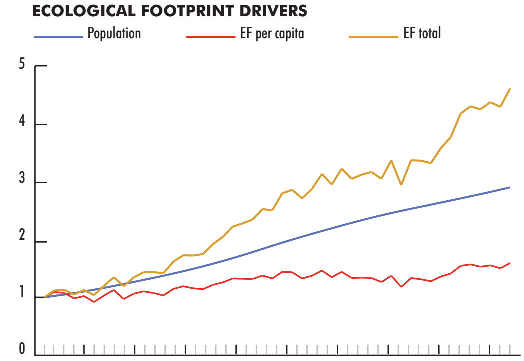
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



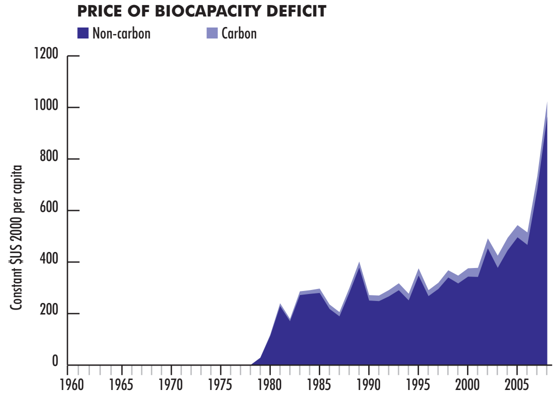
BIOCAPACITY BY LAND USE TYPE



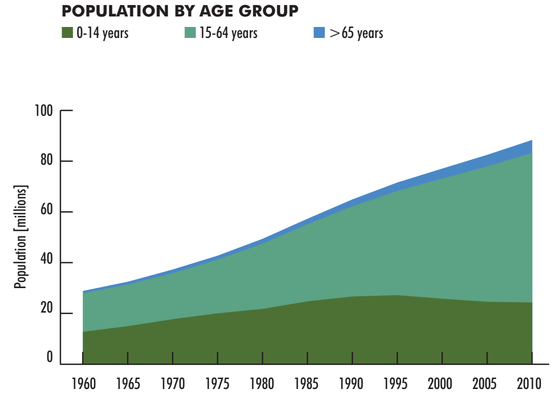
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



African Horn

Comoros, Djibouti, Somalia

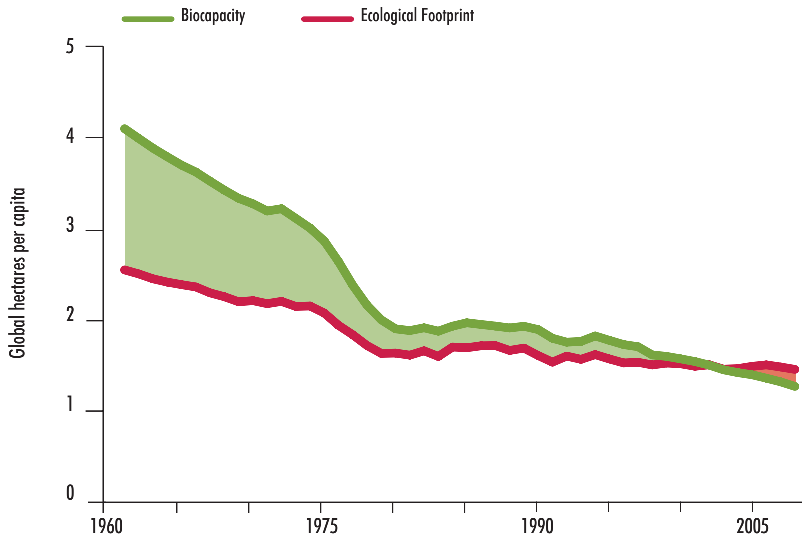
The African Horn countries (Comoros, Djibouti, and Somalia) occupy 65 million hectares of land. Of those, 7 million are forest, 1.2 million are cropland, 45 million are grazing land, and 0.6 million support the region's built infrastructure. The African Horn also has 6 million global hectares of continental shelf and inland water to support fisheries.

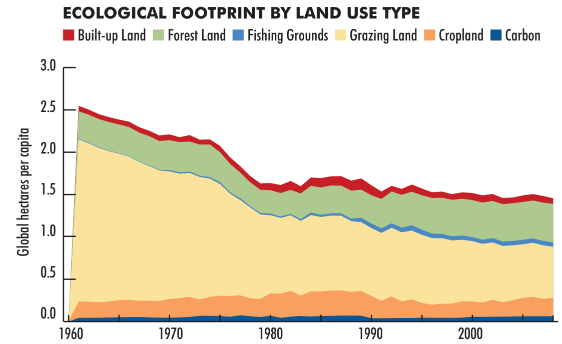
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, the African Horn's total biocapacity is 13 million gha. This is less than its total Ecological Footprint of 15 million gha.

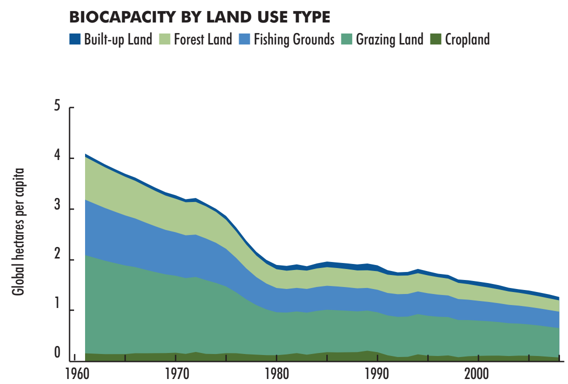
In 2008, the African Horn's average Ecological Footprint per person was 1.5 gha, slightly more than half the global per capita footprint of 2.7 gha. Compared to the rest of the world, the average inhabitant of an African Horn country has a smaller footprint, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the region's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of this region will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

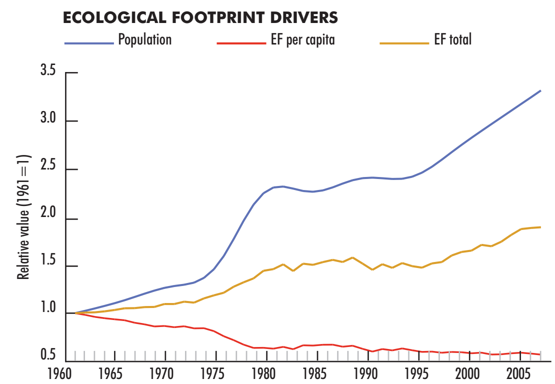
The African Horn's Ecological Footprint per person is greater than the 1.3 global hectares of biocapacity available per person due to a high rate of population growth. The region's population grew from 3.2 million to 10.5 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 69 percent, as indicated in Figure 18.

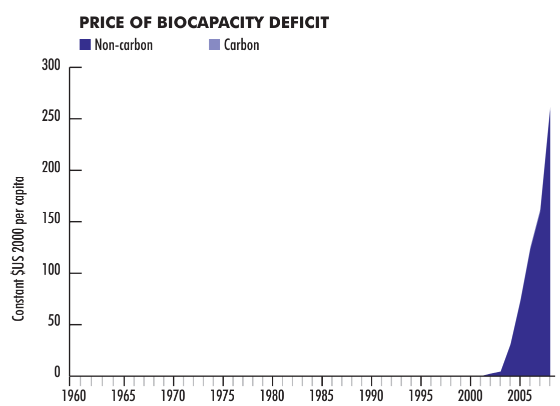
FIGURE 18 | The Ecological Footprint and biocapacity per capita, 1961-2008, for the African Horn region. The red area indicates a small biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds what nature can supply

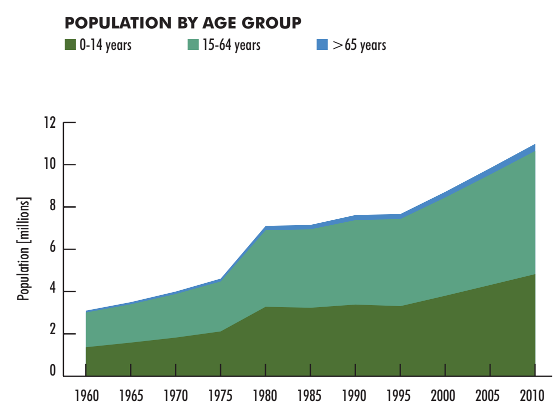




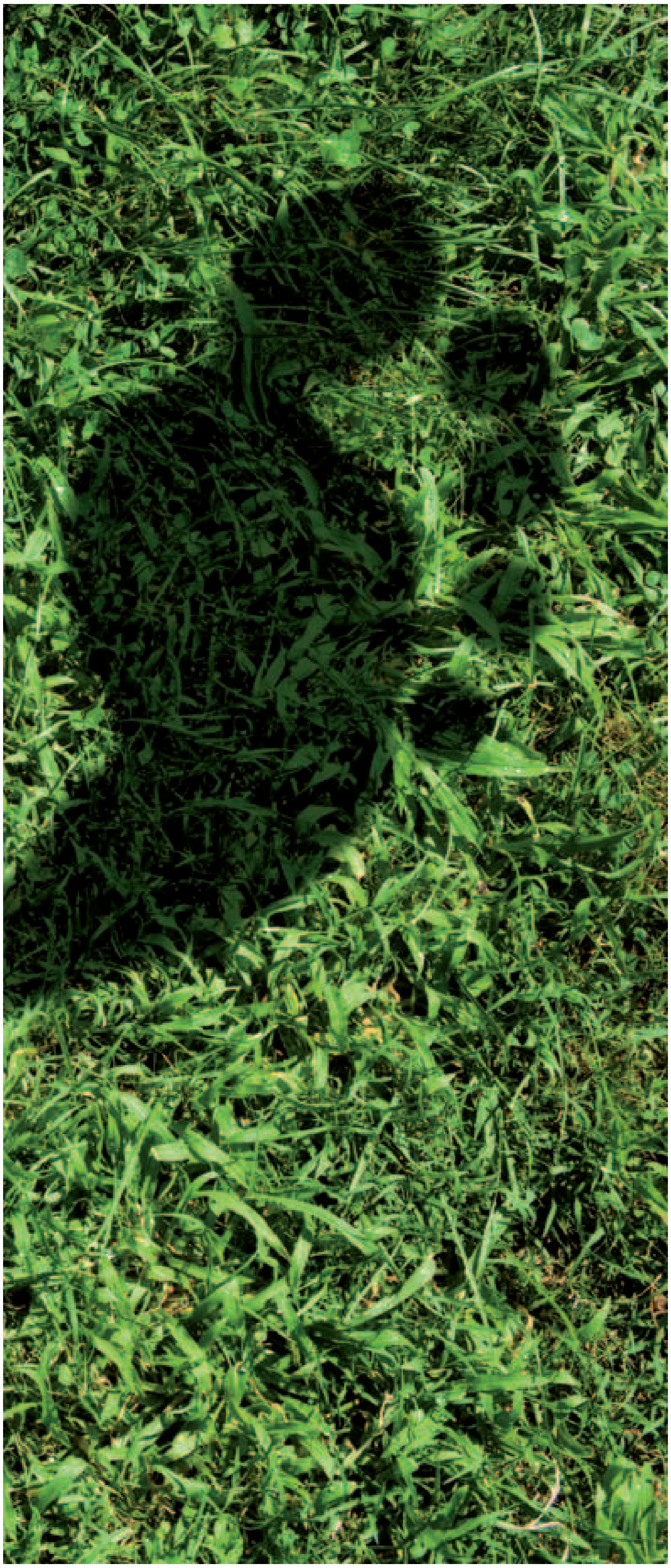








APPENDIX C



Ecological Footprint Accounts

Country Profiles

Algeria

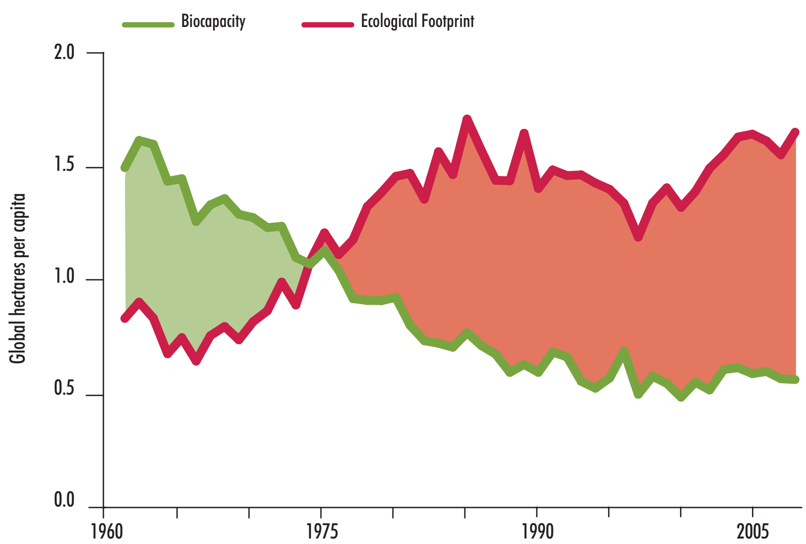
Algeria occupies 44.8 million hectares of productive land and water. Of those, 1.5 million are forest, 8.4 million are cropland, 32.9 million are grazing land, and 1.1 million support the country's built infrastructure. Algeria also has 1.0 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Algeria's total biocapacity is 19.3 million gha. This is much less than its total Ecological Footprint of 56.7 million gha.

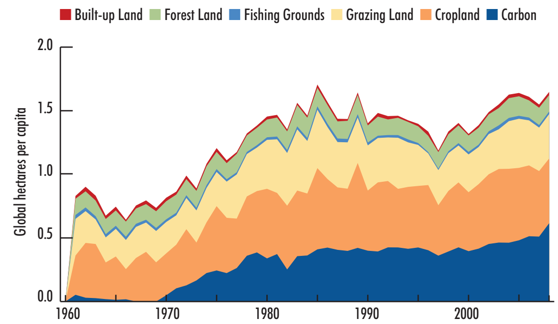
Algeria's average Ecological Footprint per person is 1.6 gha, slightly more than half the global per capita footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Algeria is smaller, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Algeria will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 19, Algeria's Ecological Footprint per person is greater than the country's 0.6 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 11.0 million to 34.4 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 62 percent.

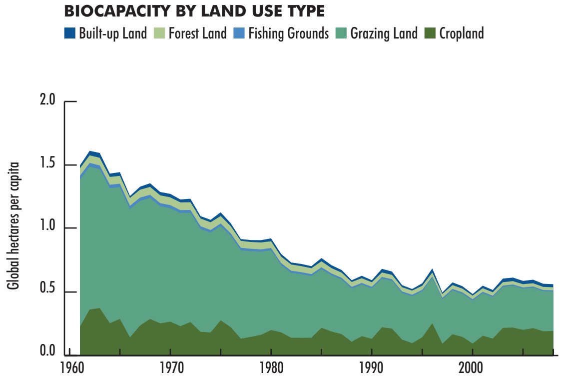
FIGURE 19 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Algeria. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



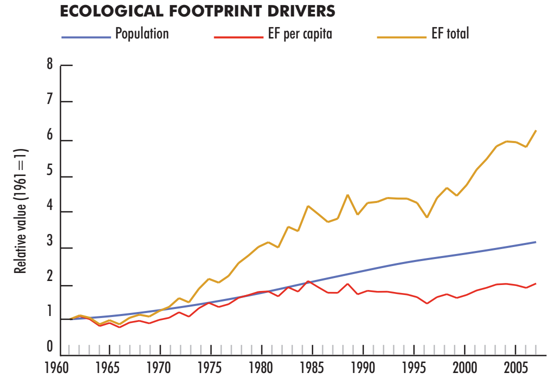
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



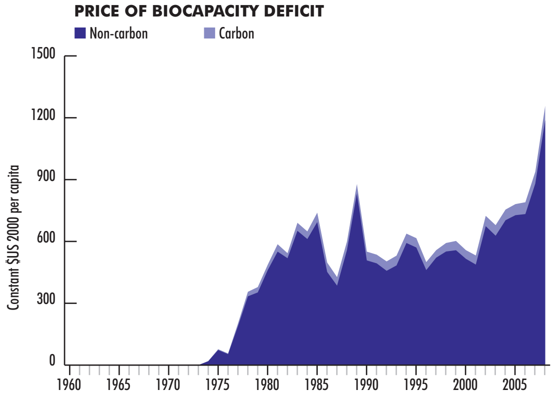
BIOCAPACITY BY LAND USE TYPE



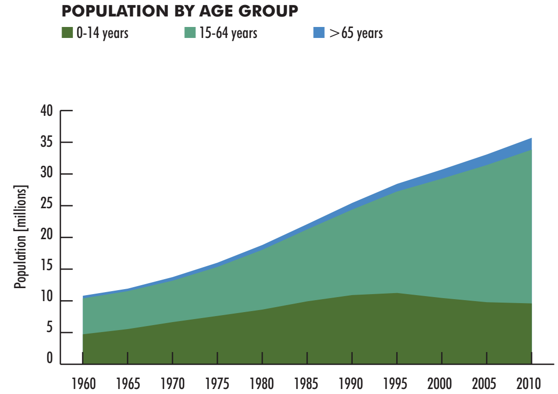
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Bahrain

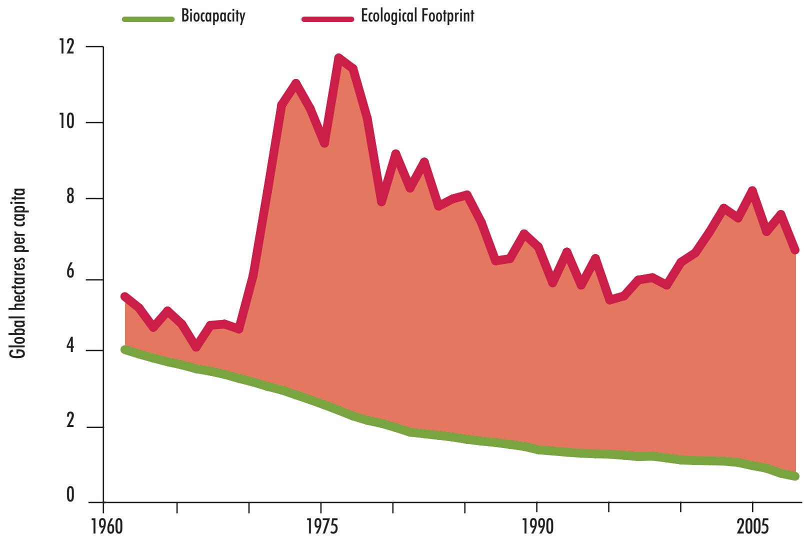
Bahrain occupies 828 thousand hectares of productive land and water. Of those, 4 thousand are cropland, 4 thousand are grazing land, and 24 thousand support the country's built infrastructure. Bahrain also has 797 thousand hectares of continental shelf and inland water to support fisheries.

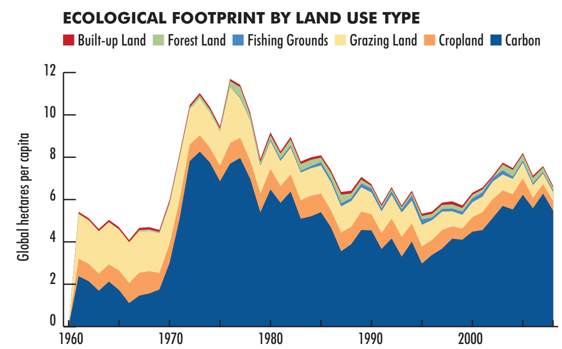
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Bahrain's total biocapacity is 725 thousand gha. This is much less than its total Ecological Footprint of 7.0 million gha.

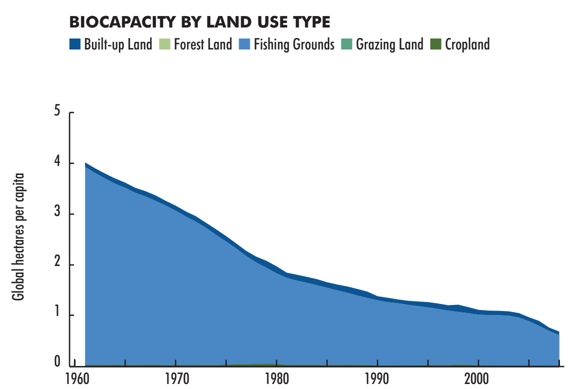
Bahrain's average Ecological Footprint per person is 6.6 gha, 2.5 times higher than the global average per capita footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Bahrain is large, and is on a par with other high-income countries such as the United States.

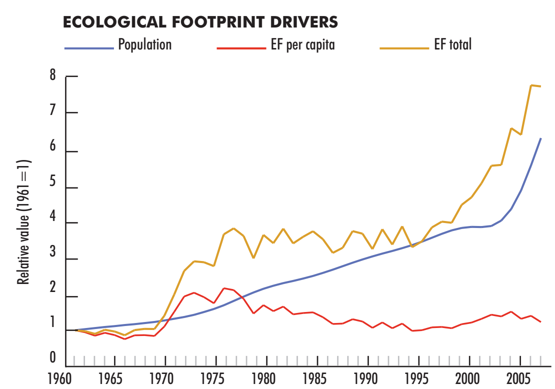
As indicated in Figure 20, Bahrain's Ecological Footprint per person is much greater than the country's 0.7 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 167 thousand to 1.1 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 83 percent.

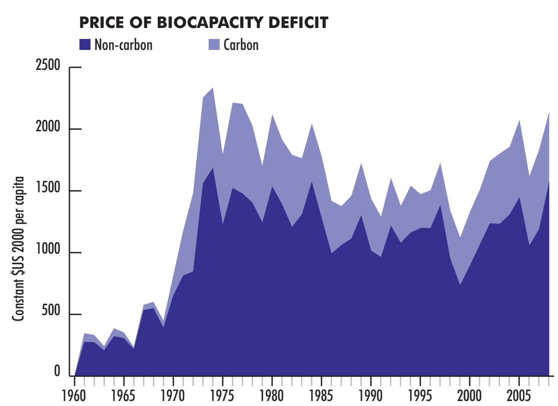
FIGURE 20 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Bahrain. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand

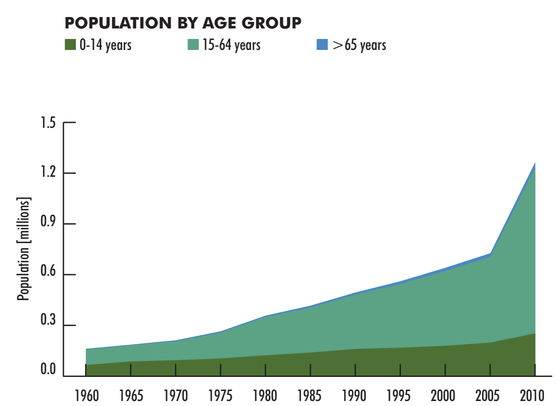












Comoros

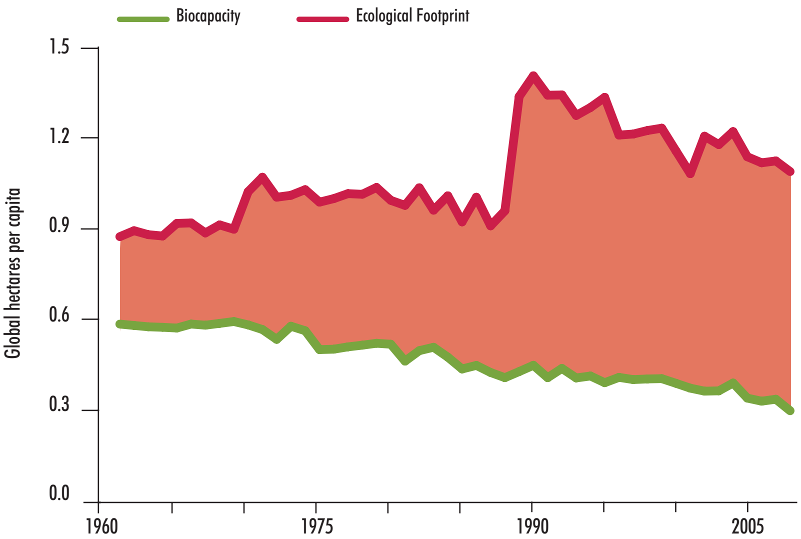
Comoros occupies 295 thousand hectares of productive land and water. Of those, 3 thousand are forest, 135 thousand are cropland, and 15 thousand are grazing land. Comoros also has 142 thousand hectares of continental shelf and inland water to support fisheries.

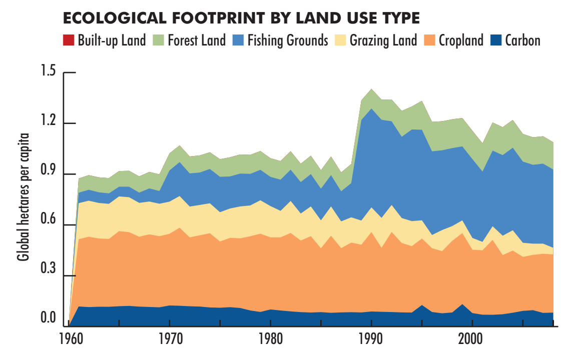
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Comoros's total biocapacity is 210 thousand gha. This is much less than its total Ecological Footprint of 759 thousand gha.

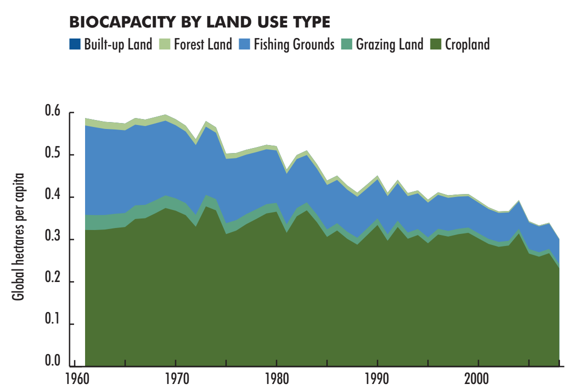
Comoros's average Ecological Footprint per person is 1.1 gha, less than half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Comoros is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Comoros will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

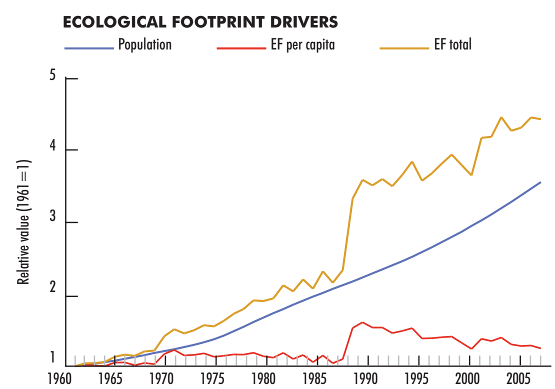
As indicated in Figure 21, Comoros's Ecological Footprint per person is greater than the country's 0.3 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 197 thousand to 697 thousand between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 49 percent.

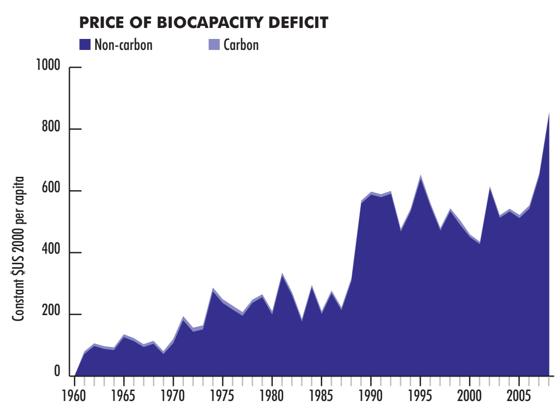
FIGURE 21 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Comoros. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand

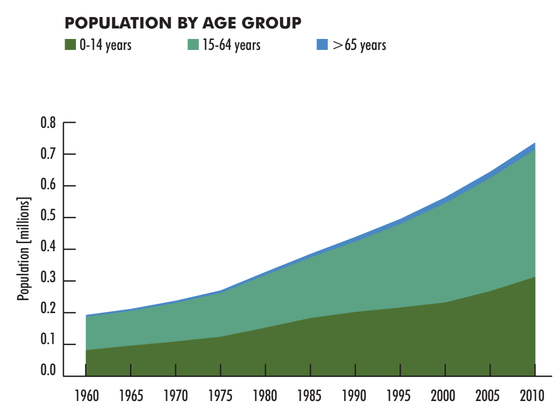












Djibouti

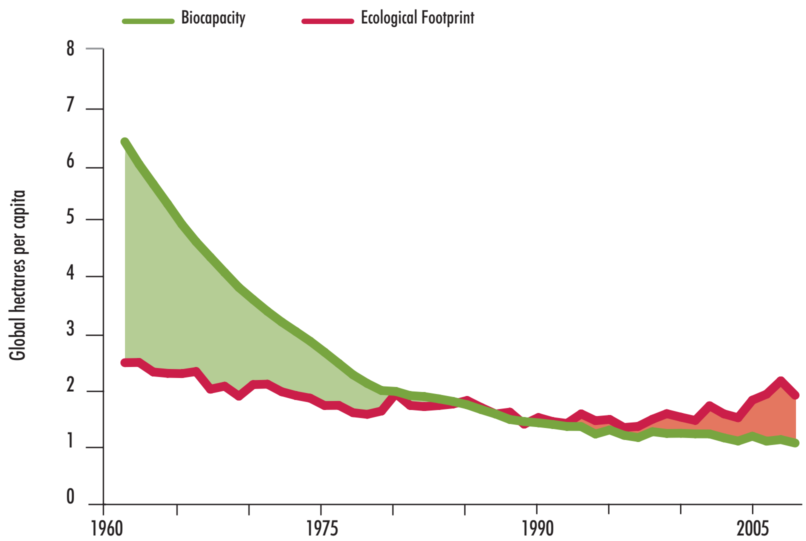
Djibouti occupies 2.1 million hectares of productive land and water. Of those, 5 thousand are forest, 1 thousand are cropland, 1.7 million are grazing land, and 22 thousand support the country's built infrastructure. Djibouti also has 343 thousand hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Djibouti's total biocapacity is 923 thousand gha. This is much less than its total Ecological Footprint of 1.6 million gha.

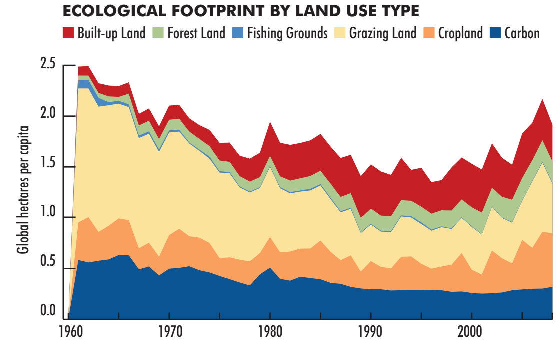
Djibouti's average Ecological Footprint per person is 1.9 gha, more than half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Djibouti is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Comoros will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 22, Djibouti's Ecological Footprint per person is greater than the country's 1.1 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 90 thousand to 856 thousand between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 83 percent.

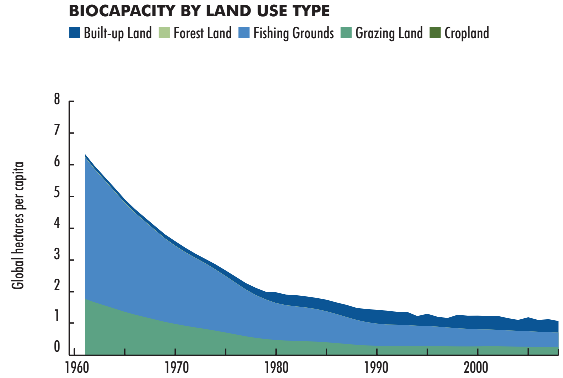
FIGURE 22 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Djibouti. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



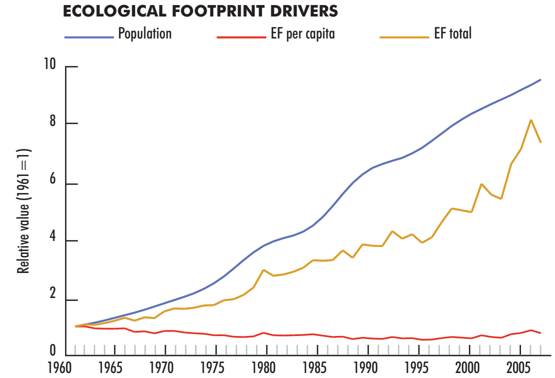
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



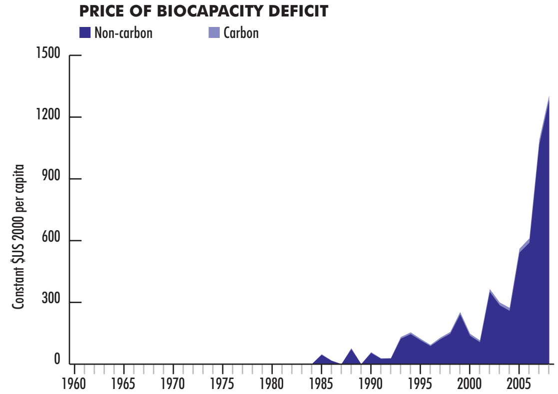
BIOCAPACITY BY LAND USE TYPE



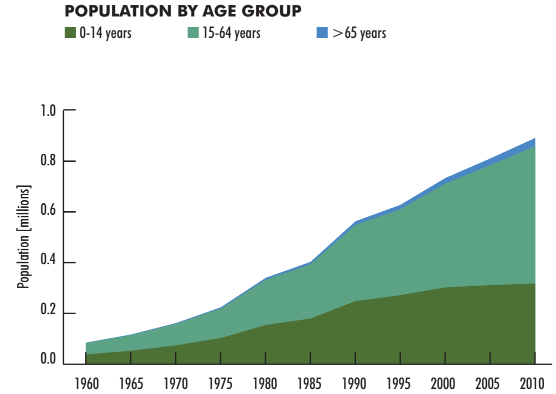
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Egypt

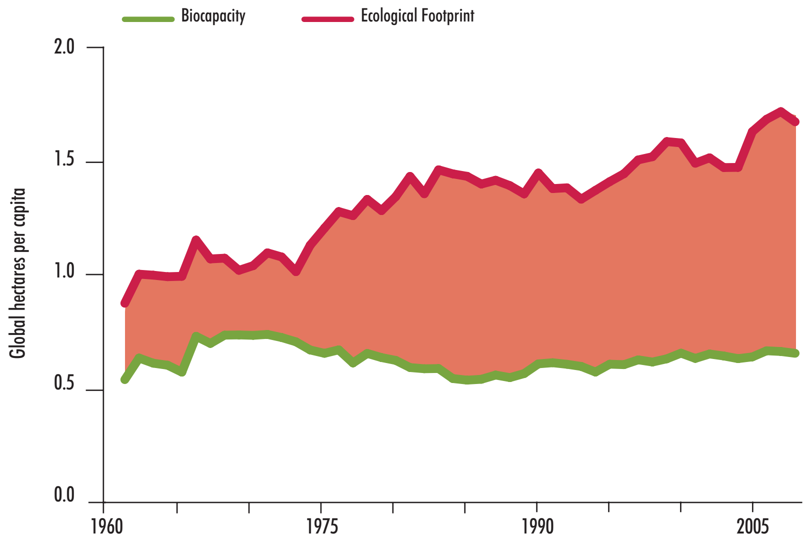
Egypt occupies 10.6 million hectares of productive land and water. Of those, 68 thousand are forest, 3.5 million are cropland, and 1.4 million support the country's built infrastructure. Egypt also has 5.6 million hectares of continental shelf and inland water to support fisheries.

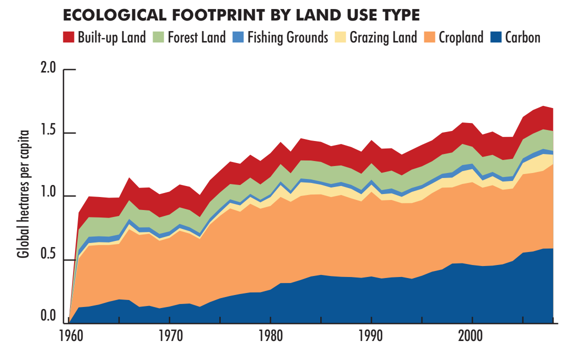
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Egypt's total biocapacity is 51 million gha. This is much less than its total Ecological Footprint of 133 million gha.

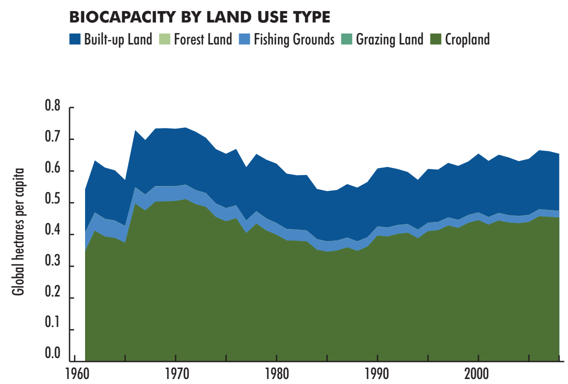
Egypt's average Ecological Footprint per person is 1.7 gha, slightly more than half the global per capita footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Egypt is small, and for many, it is too small to meet basic food, shelter, health, and sanitation, needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Egypt will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

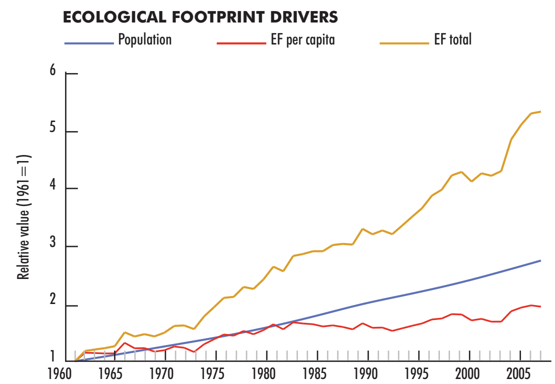
As indicated in Figure 23, Egypt's Ecological Footprint per person is greater than the country's 0.7 global hectares of biocapacity available per person due to a high rate of growth in both consumption and population. The country's Ecological Footprint per person grew 94 percent between 1961 and 2008, while the population grew by almost 3-fold. Over the same time period, the biocapacity available per person increased by only 21 percent.

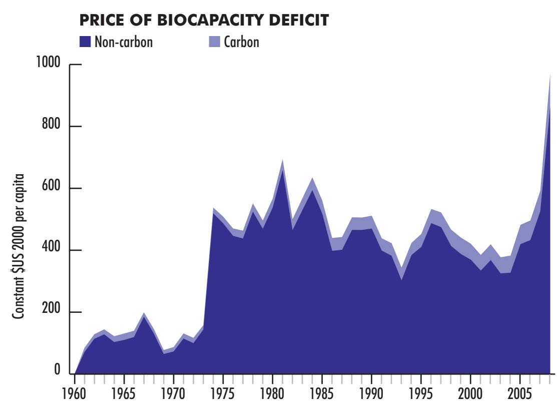
FIGURE 23 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Egypt. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand

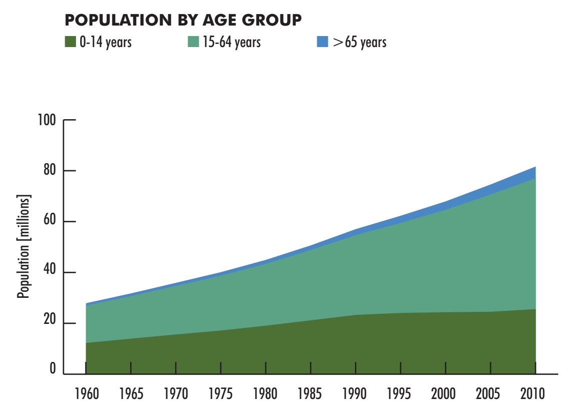












Iraq

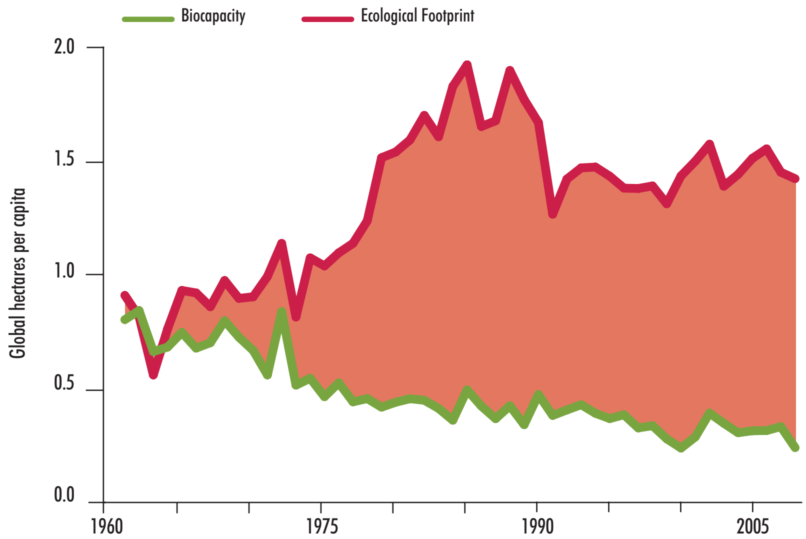
Iraq occupies 11.4 million hectares of productive land and water. Of those, 4.0 million are forest, 5.5 million are cropland, 4 million are grazing land, and 932 thousand support the country's built infrastructure. Iraq also has 198 thousand hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Iraq's total biocapacity is 7.2 million gha. This is much less than its total Ecological Footprint of 42.4 million gha.

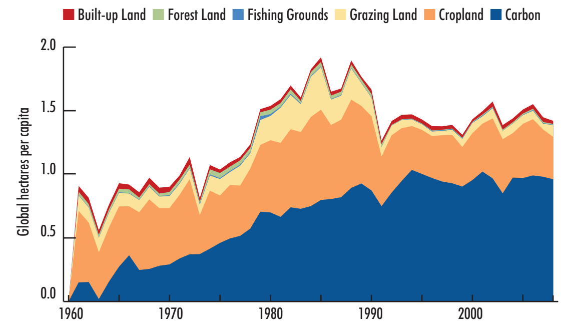
Iraq's average Ecological Footprint per person is 1.4 gha, half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Iraq is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Iraq will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 24, Iraq's Ecological Footprint per person is much greater than the country's 0.2 global hectares of biocapacity available per person due to a high rate of population growth since 1961 and more recently due to the country's political upheaval caused by war, invasion, and sanctions. The country's population grew from 7.6 million to 29.8 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 70 percent.

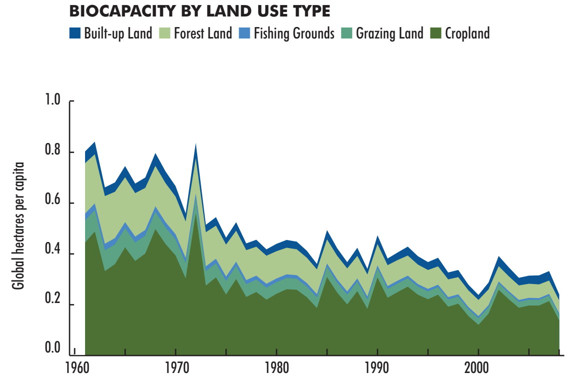
FIGURE 24 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Iraq. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



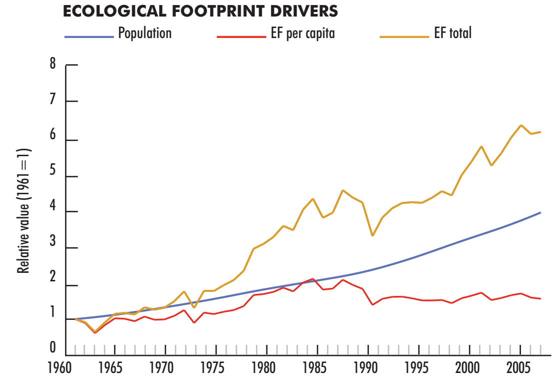
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



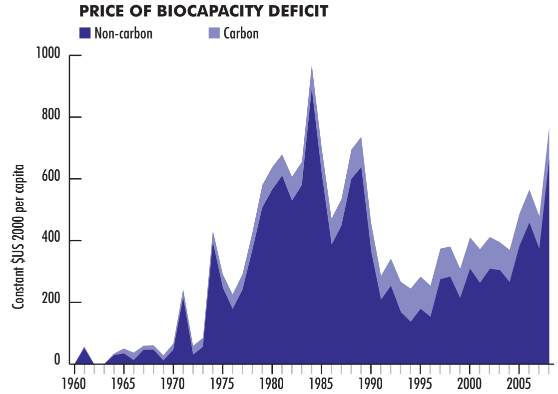
BIOCAPACITY BY LAND USE TYPE



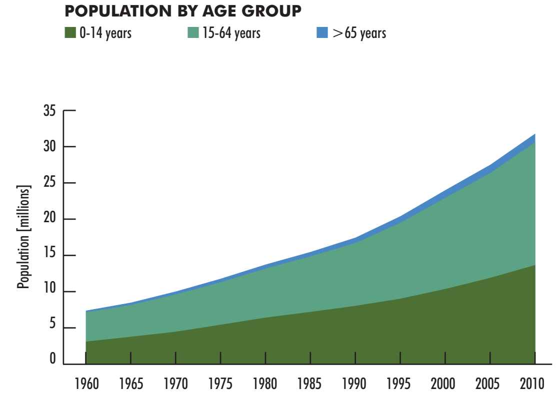
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Jordan

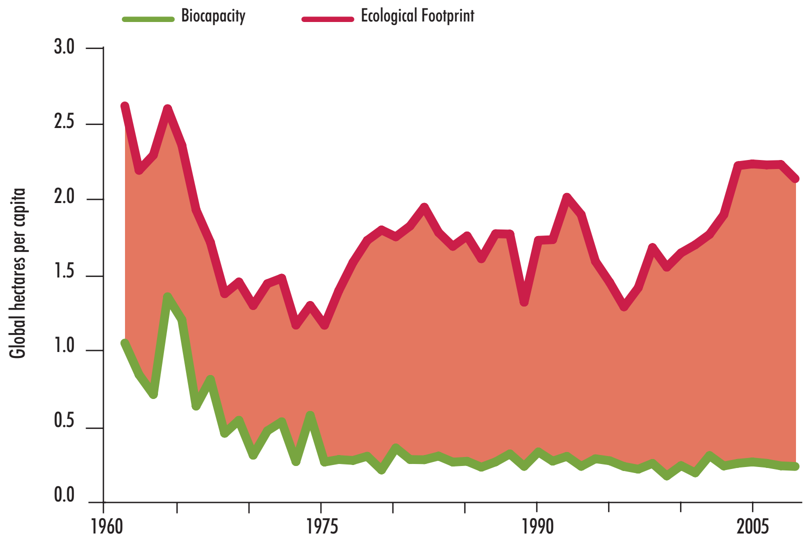
Jordan occupies 1.3 million hectares of productive land and water. Of those, 97 thousand are forest, 230 thousand are cropland, 743 thousand are grazing land, and 211 thousand support the country's built infrastructure. Jordan also has 62 thousand hectares of continental shelf and inland water to support fisheries.

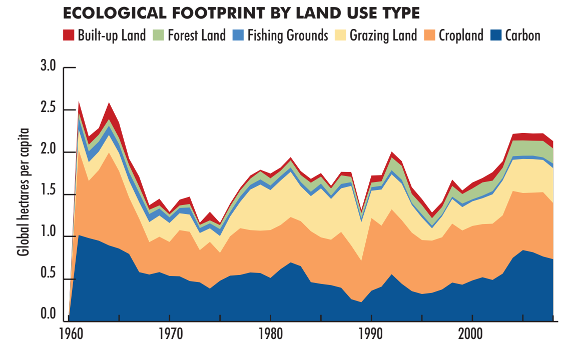
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Jordan's total biocapacity is 1.4 million gha. This is much less than its total Ecological Footprint of 12.5 million gha.

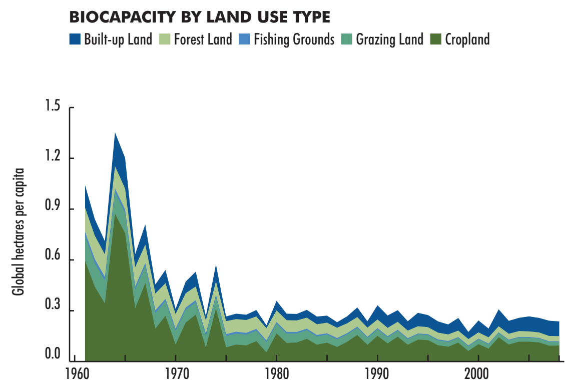
Jordan's average Ecological Footprint per person is 2.1 gha, while the global average footprint is 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Jordan is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Jordan will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

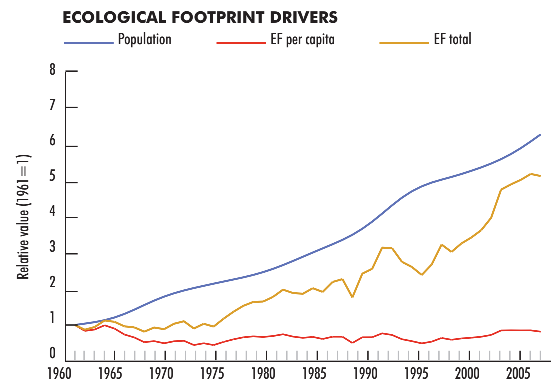
As indicated in Figure 25, Jordan's Ecological Footprint per person is much greater than the country's 0.2 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 935 thousand to 5.8 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 77 percent.

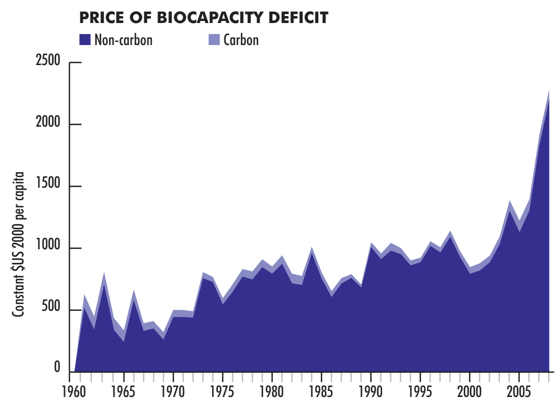
FIGURE 25 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Jordan. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand

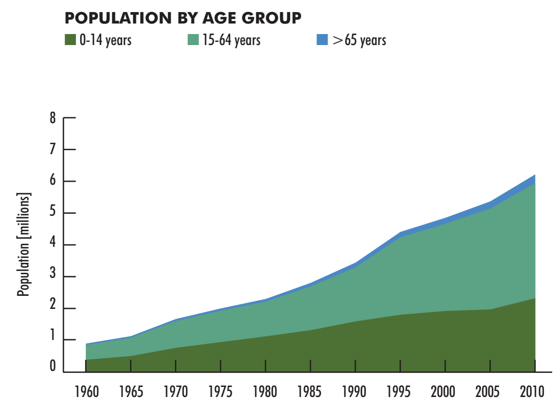












Kuwait

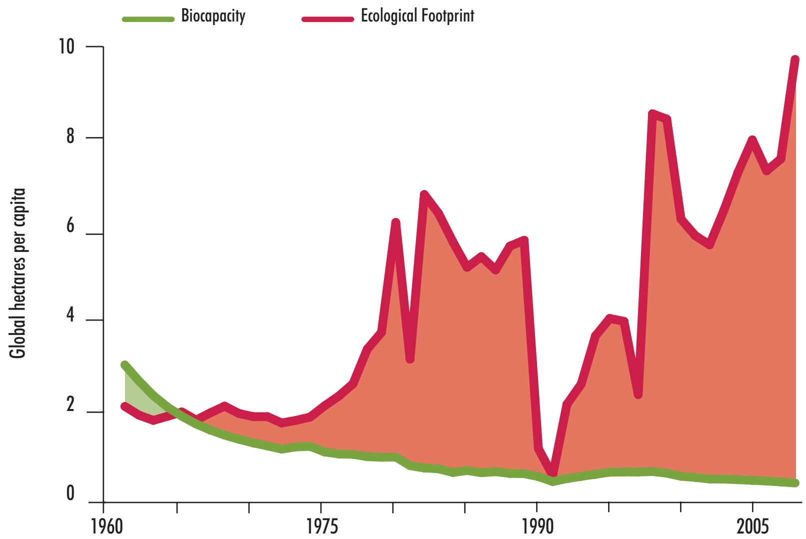
Kuwait occupies 885 thousand hectares of productive land and water. Of those, 5 thousand are forest, 15 thousand are cropland, 136 thousand are grazing land, and 76 thousand support the country's built infrastructure. Kuwait also has 653 thousand hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Kuwait's total biocapacity is 1.1 million gha. This is much less than its total Ecological Footprint of 24.8 million gha.

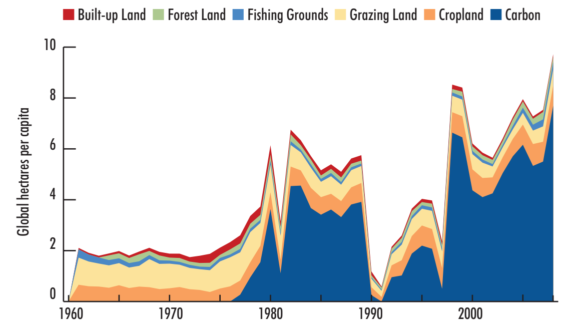
Kuwait's average Ecological Footprint per person is 9.7 gha, more than 3.5-times the global average footprint of 2.7 gha per person. The average footprint of an inhabitant in Kuwait is greater than it is in most high-income countries in the world.

As indicated in Figure 26, Kuwait's Ecological Footprint per person is much greater than the country's 0.4 global hectares of biocapacity available per person. The large overshoot is caused by a rapidly growing population and a high rate of economic growth. Kuwait's population grew from 296 thousand to 2.5 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 86 percent.

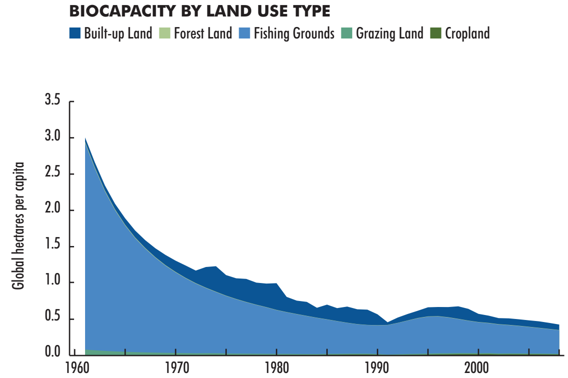
FIGURE 26 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Kuwait. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



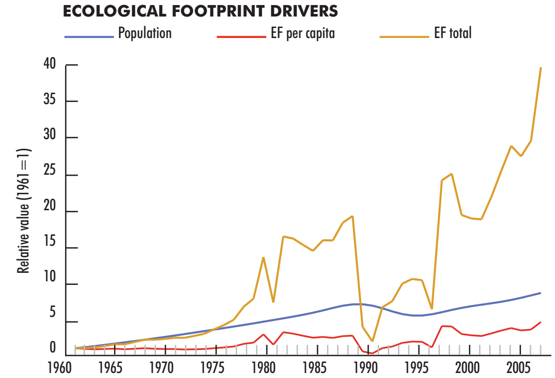
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



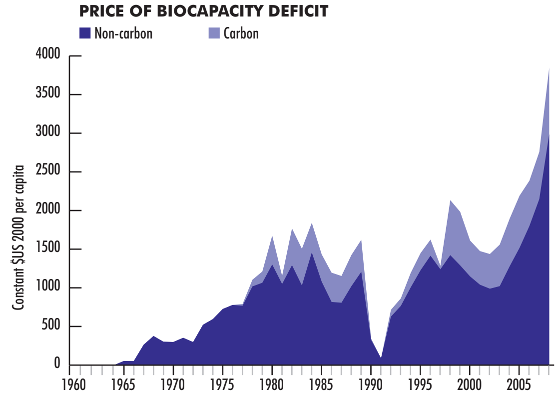
BIOCAPACITY BY LAND USE TYPE



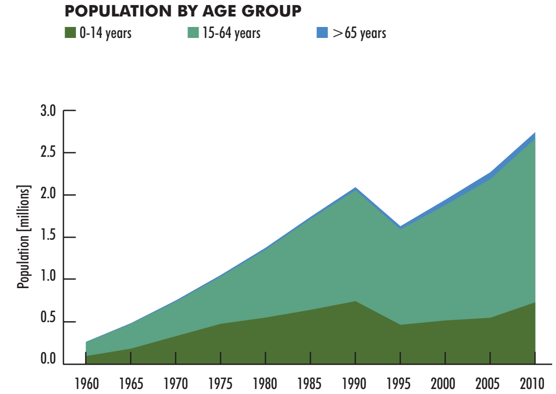
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Lebanon

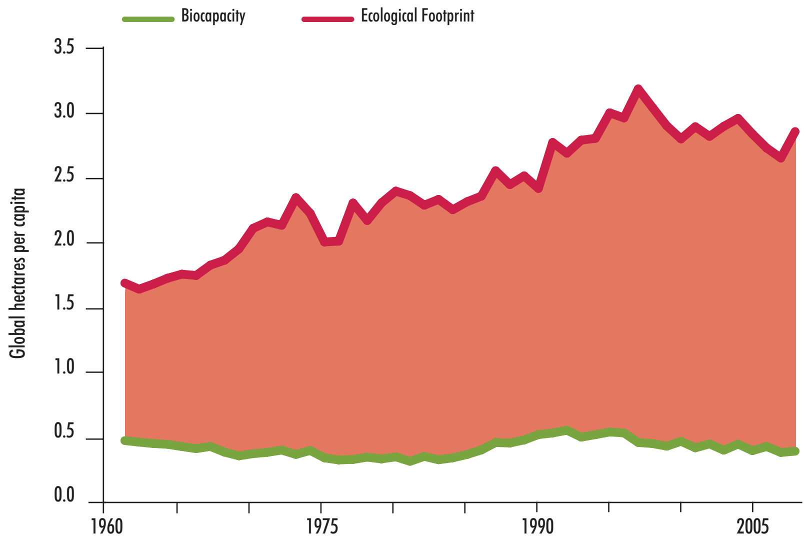
Lebanon occupies 1.0 million hectares of productive land and water. Of those, 136 thousand are forest, 286 thousand are cropland, 400 thousand are grazing land, and 69 thousand support the country's built infrastructure. Lebanon also has 139 thousand hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Lebanon's total biocapacity is 1.6 million gha. This is much less than its total Ecological Footprint of 11.9 million gha.

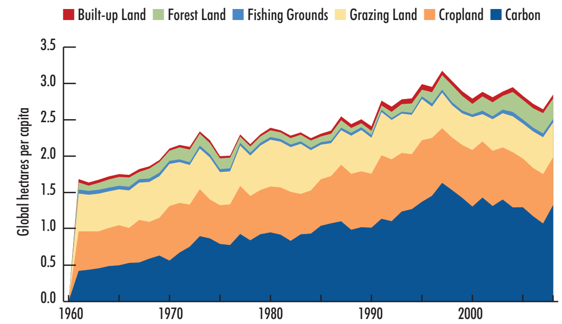
Lebanon's average Ecological Footprint per person is 2.8 gha, on par with the global average footprint of 2.7 gha. However, inequality in consumption means that many inhabitants still fail to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Lebanon will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 27, Lebanon's Ecological Footprint per person is much greater than the country's 0.4 global hectares of biocapacity available per person. The overshoot is caused by a high rate of population growth and by the neglect to biocapacity assets during the country's civil war. The country's population grew from 2.0 million to 4.2 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 17 percent.

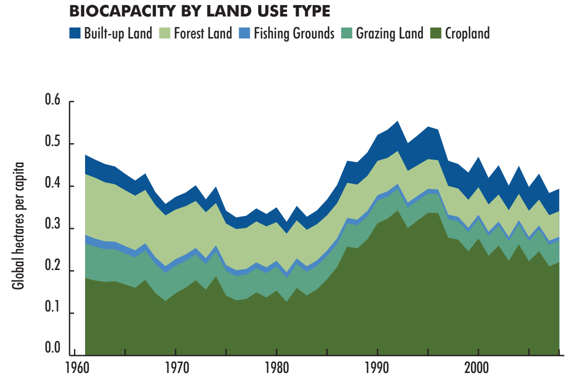
FIGURE 27 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Lebanon. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



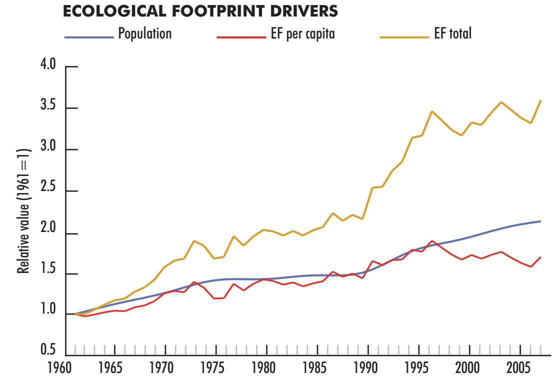
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



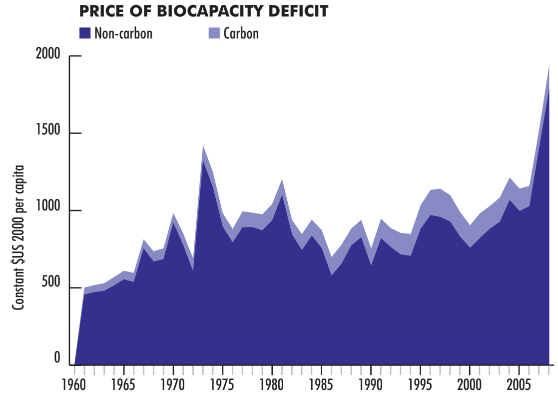
BIOCAPACITY BY LAND USE TYPE



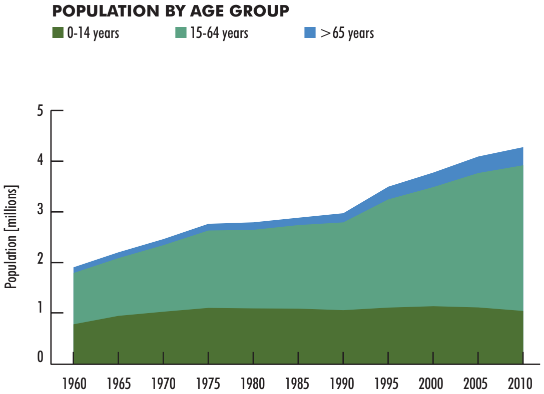
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Libya

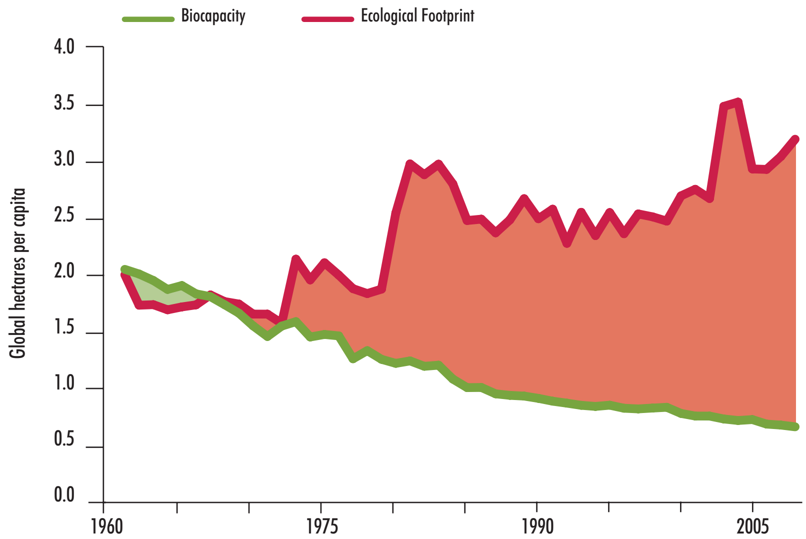
Libya occupies 22.4 million hectares of productive land and water. Of those, 217 thousand are forest, 2.1 million are cropland, 13.5 million are grazing land, and 244 thousand support the country's built infrastructure. Libya also has 6.4 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Libya's total biocapacity is 4.1 million gha. This is much less than its total Ecological Footprint of 19.6 million gha.

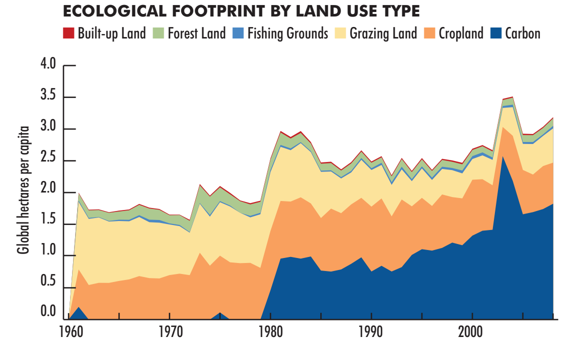
Libya's average Ecological Footprint per person is 3.2 gha, greater than the global average footprint of 2.7 gha. However, inequality in consumption and access to resources means that many residents still fail to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Libya will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 28, Libya's Ecological Footprint per person is much greater than the country's 0.7 global hectares of biocapacity available per person due to a high rate of population growth. Libya's population grew from 1.4 million to 6.2 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 68 percent.

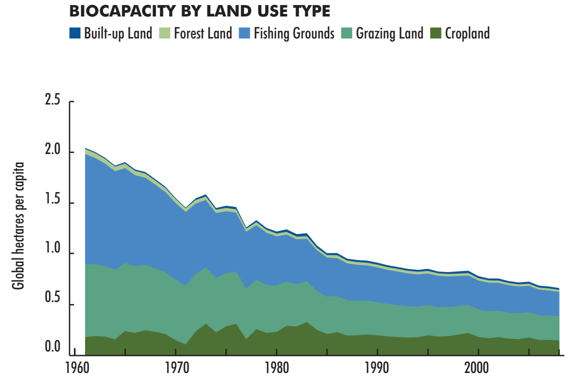
FIGURE 28 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Libya. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



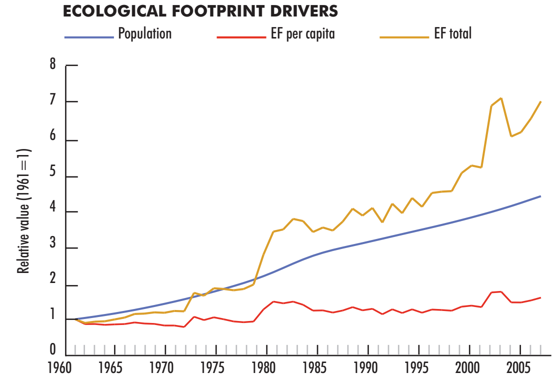
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



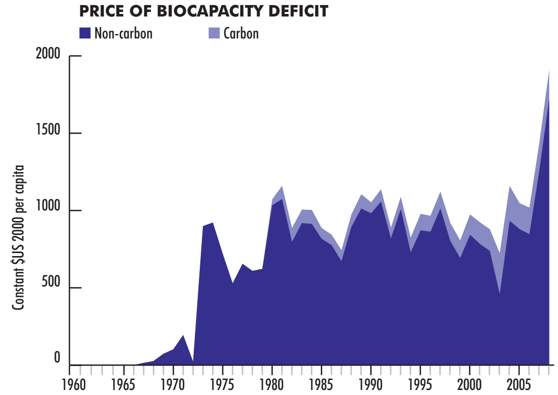
BIOCAPACITY BY LAND USE TYPE



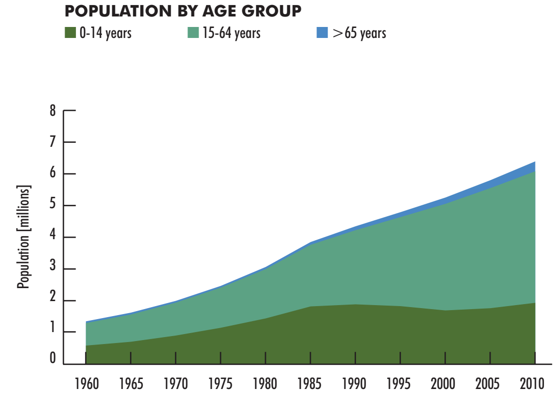
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Mauritania

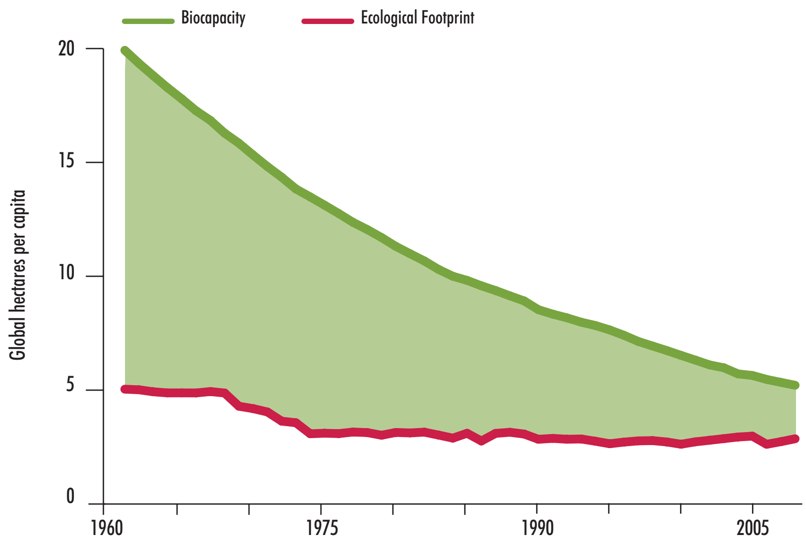
Mauritania occupies 42.9 million hectares of productive land and water. Of those, 252 thousand are forest, 411 thousand are cropland, 39.3 million are grazing land, and 161 thousand support the country's built infrastructure. Mauritania also has 2.8 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Mauritania's total biocapacity is 17.2 million gha. This is greater than its total Ecological Footprint of 9.4 million gha.

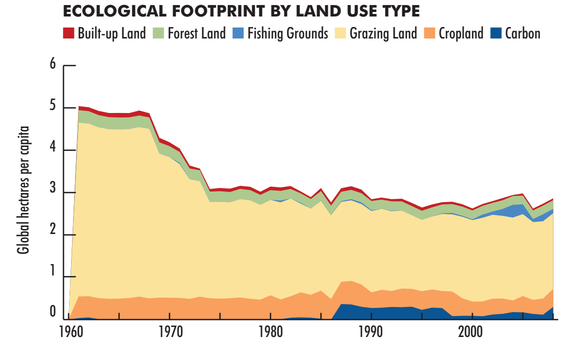
Mauritania's average Ecological Footprint per person is 2.9 gha, on par with the global average footprint of 2.7 gha. However, inequality in consumption means that many residents still fail to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production.

Mauritania's Ecological Footprint per person is less than the country's 5.2 global hectares of biocapacity available per person. However, the biocapacity surplus is rapidly disappearing, as indicated by Figure 29, due to a high rate of population growth. The country's population grew from 879 thousand to 3.3 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 74 percent.

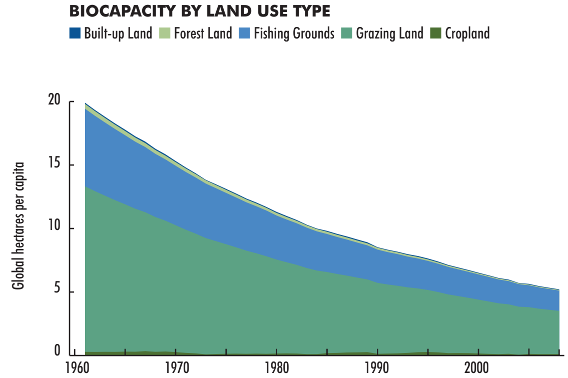
FIGURE 29 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Mauritania. The green area indicates ecological surplus, in global hectares per capita, where the demand for resources, in aggregate, is below the country's ecological capacity to meet this demand



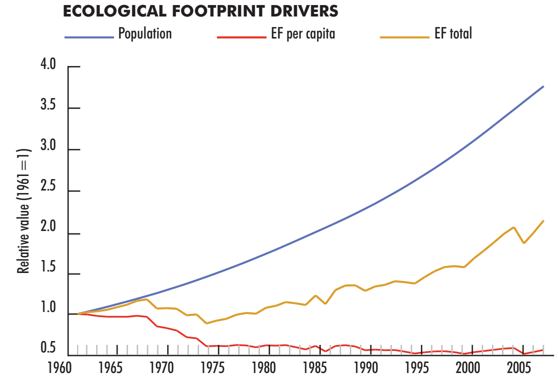
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



BIOCAPACITY BY LAND USE TYPE



ECOLOGICAL FOOTPRINT DRIVERS



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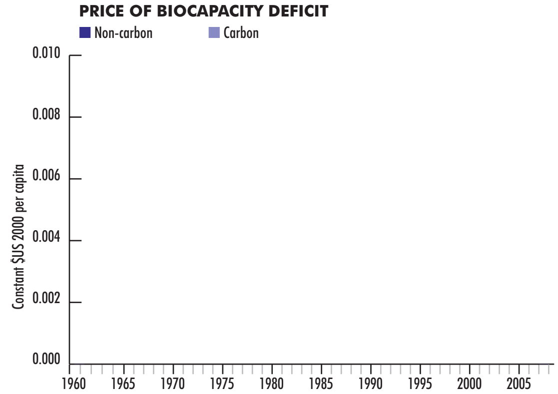
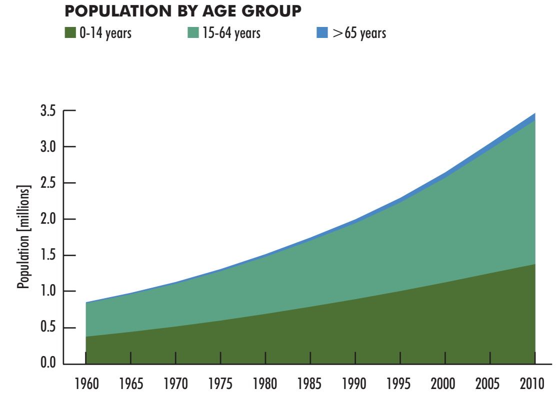


POPULATION BY AGE GROUP



Morocco

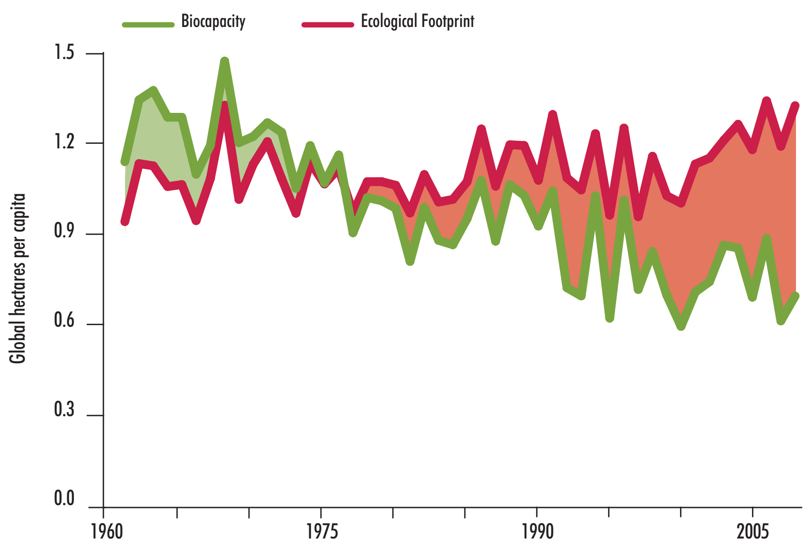
Morocco occupies 43.1 million hectares of productive land and water. Of those, 5.1 million are forest, 9.0 million are cropland, 21.0 million are grazing land, and 911 thousand support the region's built infrastructure. Morocco also has 7.1 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Morocco's total biocapacity is 21.8 million gha. This is much less than its total Ecological Footprint of 41.5 million gha.

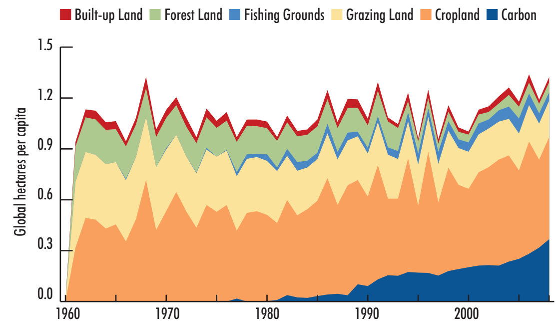
Morocco's average Ecological Footprint per person is 1.3 gha, half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Morocco is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Morocco will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 30, Morocco's Ecological Footprint per person is greater than the country's 0.7 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 11.9 million to 31.3 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 39 percent.

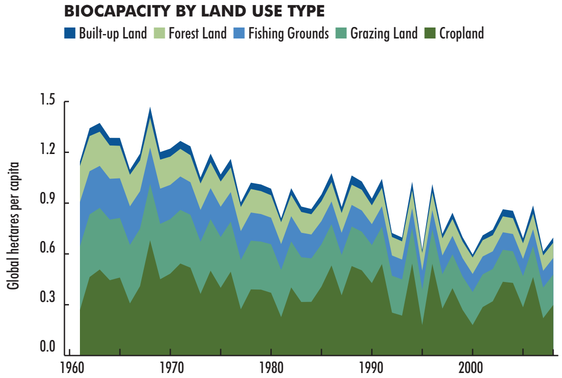
FIGURE 30 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Morocco. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



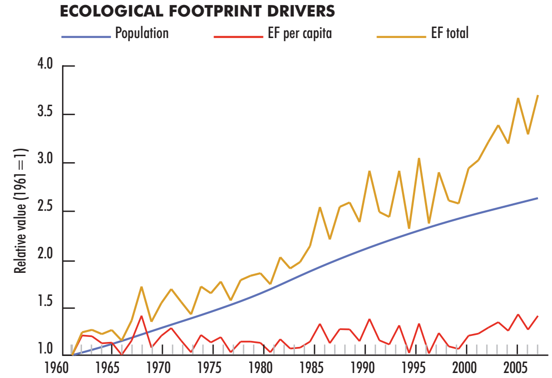
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



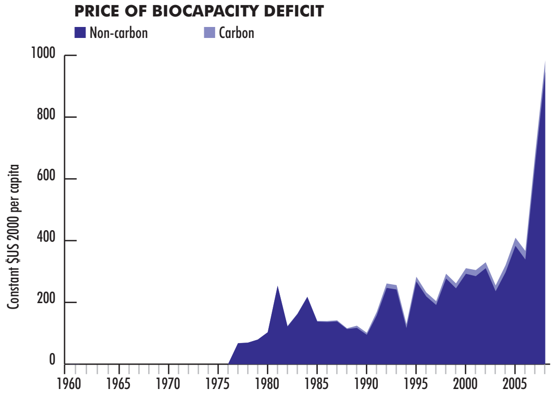
BIOCAPACITY BY LAND USE TYPE



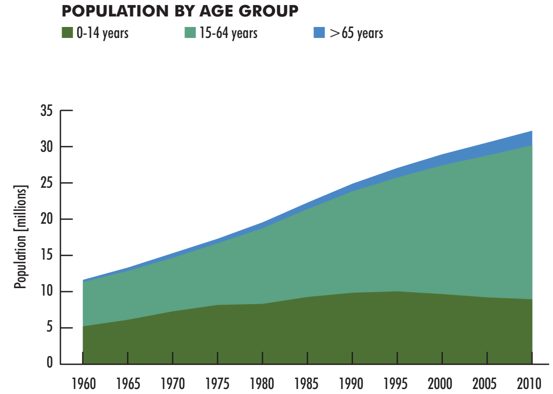
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Oman

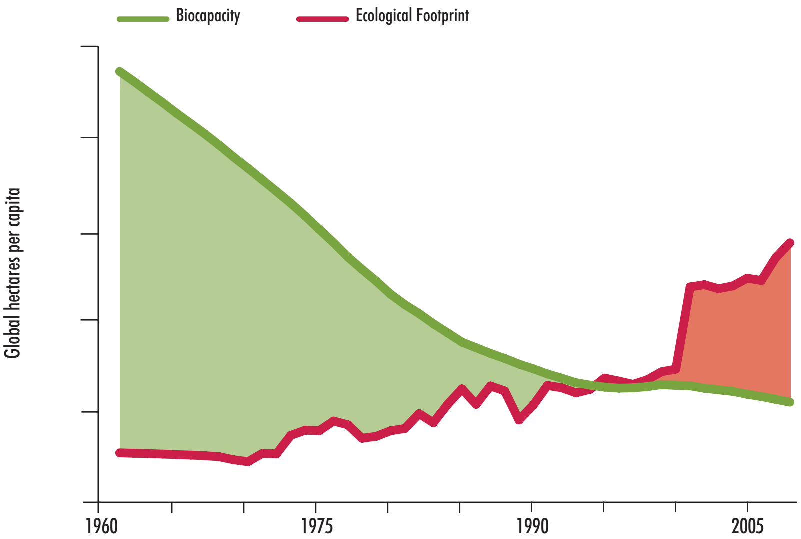
Oman occupies 6.6 million hectares of productive land and water. Of those, 2 thousand are forest, 94 thousand are cropland, 1.7 million are grazing land, and 111 thousand support the country's built infrastructure. Oman also has 4.7 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Oman's total biocapacity is 5.8 million gha. This is much less than its total Ecological Footprint of 15.0 million gha.

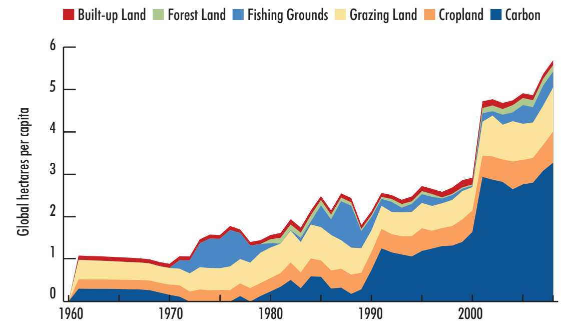
Oman's average Ecological Footprint per person is 5.7 gha, 2 times the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Oman is large, and is equivalent to the per capita footprint in many high-income countries in Europe and North America.

As indicated in Figure 31, Oman's Ecological Footprint per person is much greater than the country's 2.2 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 571 thousand to 2.6 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 77 percent.

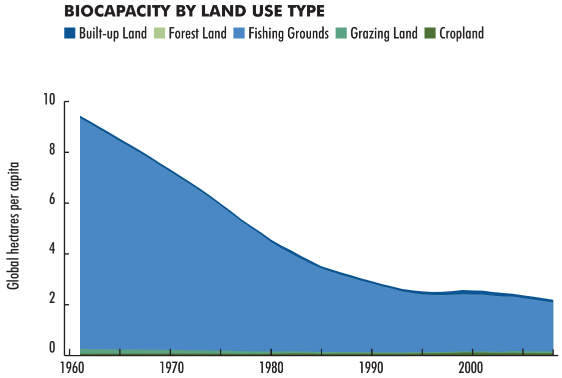
FIGURE 31 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Oman. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



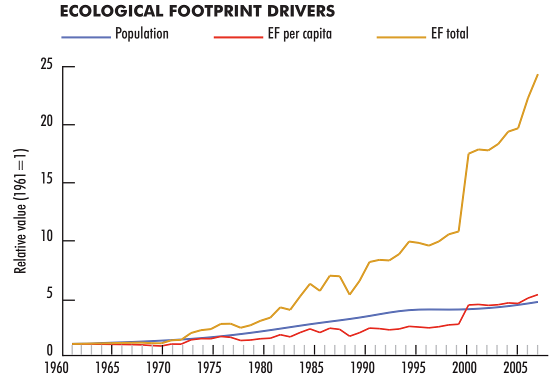
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



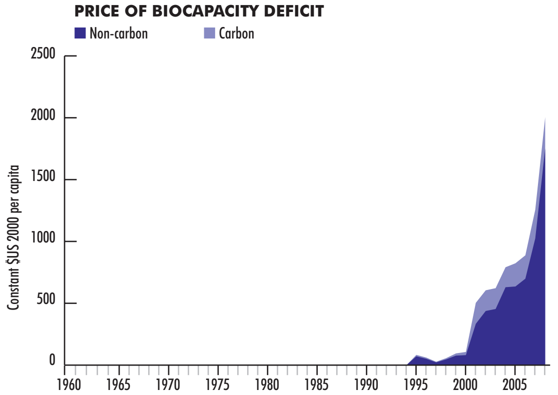
BIOCAPACITY BY LAND USE TYPE



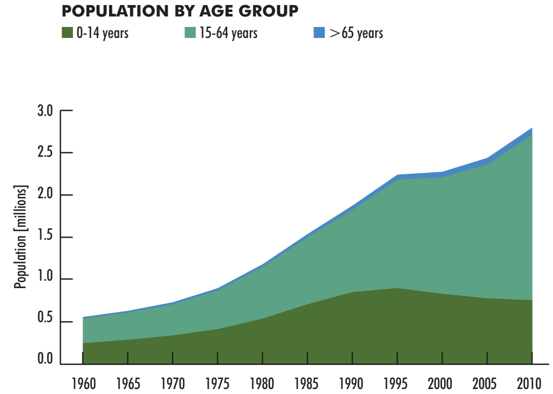
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



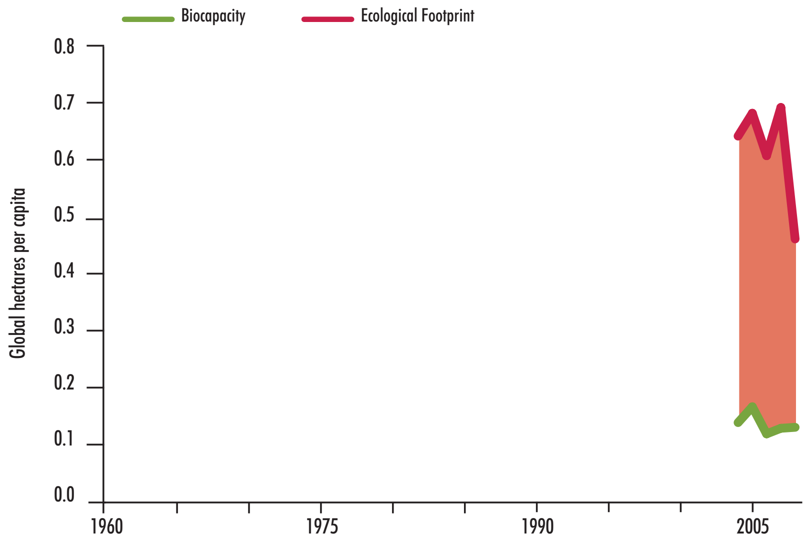
Occupied Palestinian Territories

The Occupied Palestinian Territories occupies 377 thousand hectares of productive land and water. Of those, 9 thousand are forest, 218 thousand are cropland, and 150 thousand are grazing land.

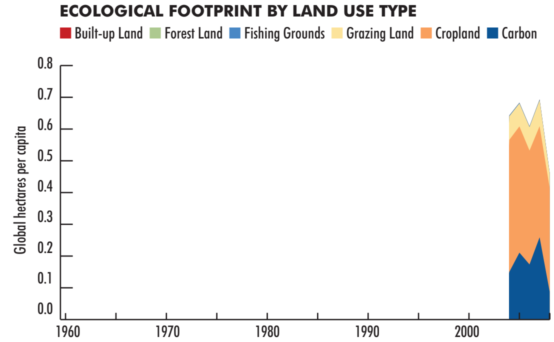
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, the Occupied Palestinian Territories' total biocapacity is 132 thousand gha. This is much less than its total Ecological Footprint of 1.8 million gha.

The Occupied Palestinian Territories' average Ecological Footprint per person is 0.5 gha, less than a fifth of the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Palestine is small, and for nearly all, 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 the territories' population must have greater access to natural resources. Meeting this need must first involve ending the occupation regime, establishing credible Palestinian control over the country's biocapacity assets, and setting up local and national mechanisms for natural resource governance.

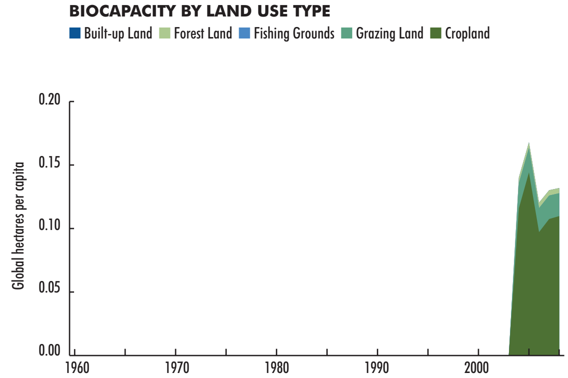
FIGURE 32 | The Ecological Footprint and biocapacity per capita, 2004-2008, in the Occupied Palestinian Territories. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the territories' ecological capacity to meet this demand



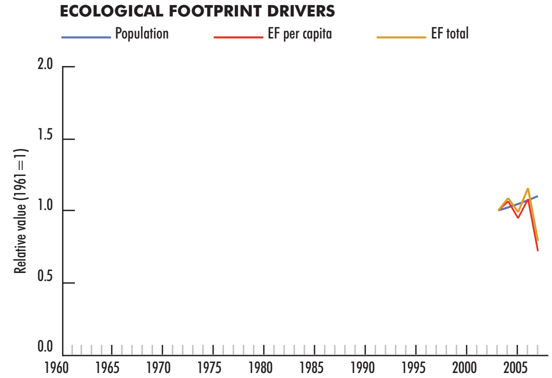
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



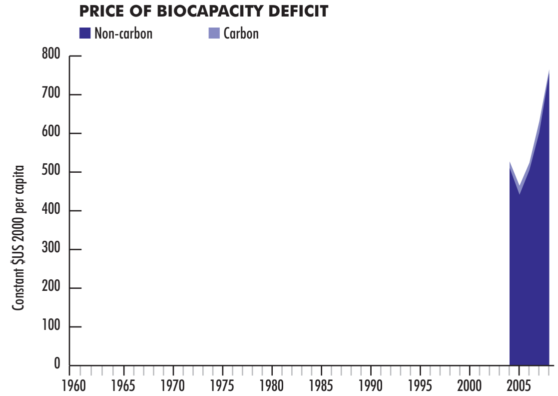
BIOCAPACITY BY LAND USE TYPE



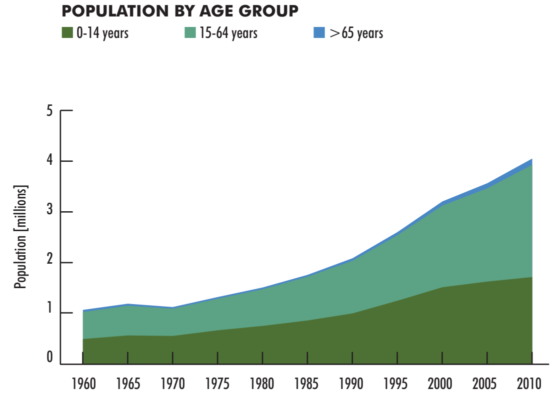
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Qatar

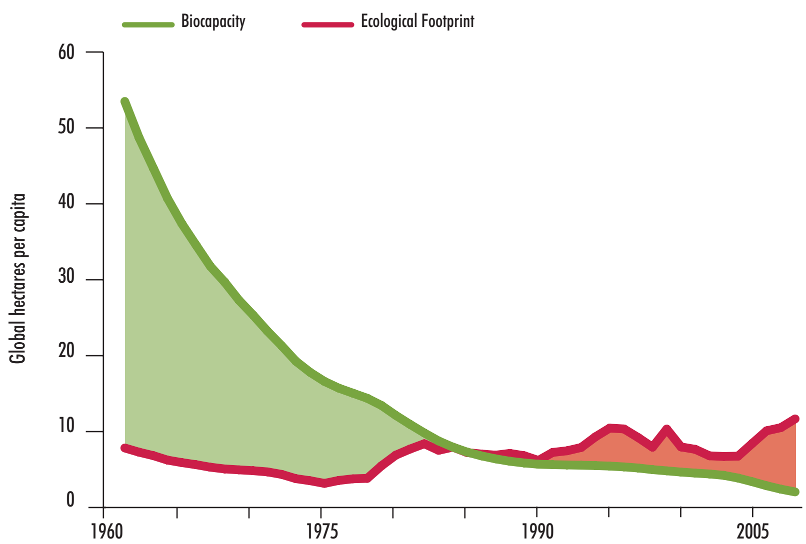
Qatar occupies 3.2 million hectares of productive land and water. Of those, 16 thousand are cropland, 50 thousand are grazing land, and 52 thousand support the country's built infrastructure. Qatar also has 3.1 million hectares of continental shelf and inland water to support fisheries.

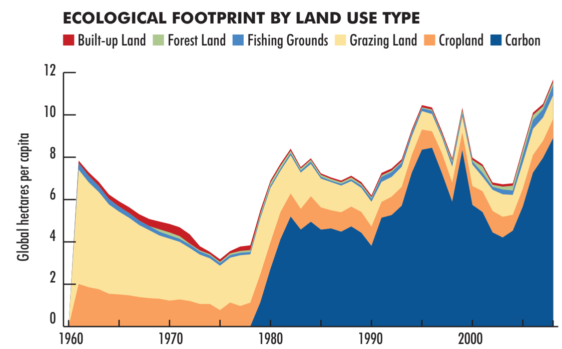
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Qatar's total biocapacity is 2.9 million gha. This is much less than its total Ecological Footprint of 16.3 million gha.

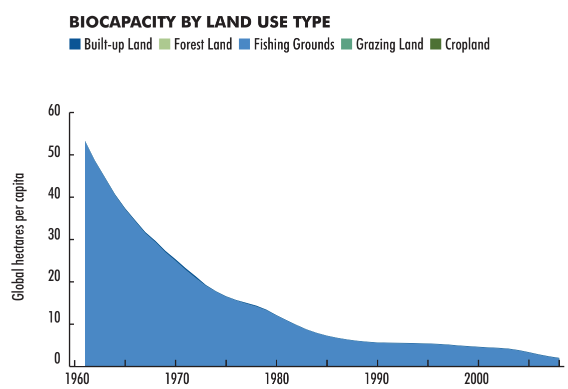
Qatar's average Ecological Footprint per person is 11.7 gha, more than 4-times the global average footprint of 2.7 gha. Qatar owns the highest Ecological Footprint in the world. If all humans lived like the average resident of Qatar, 6.6 planets would be required to satisfy this level of consumption. Reducing the country's Ecological Footprint will involve multiple strategies: significant improvement in resource efficiency; change in consumption patterns; and expansion of biocapacity without resource intensive production.

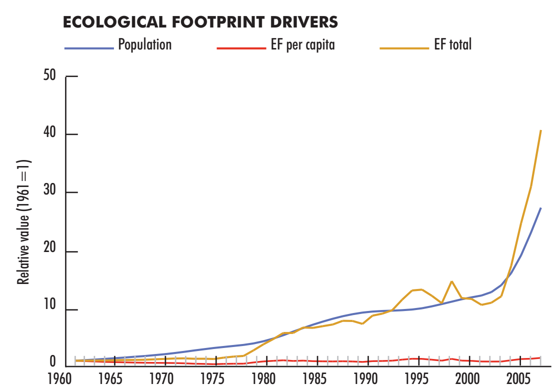
As indicated in Figure 33, Qatar's Ecological Footprint per person is much greater than the country's 2.1 global hectares of biocapacity available per person. The overshoot is caused by a high rate of consumption and population growth. The country's population grew from 51 thousand to 1.4 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 96 percent.

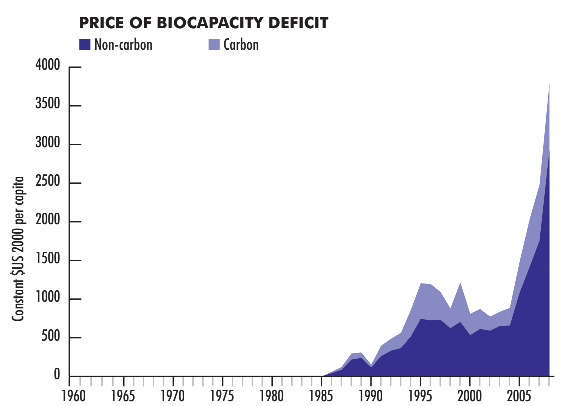
FIGURE 33 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Qatar. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand

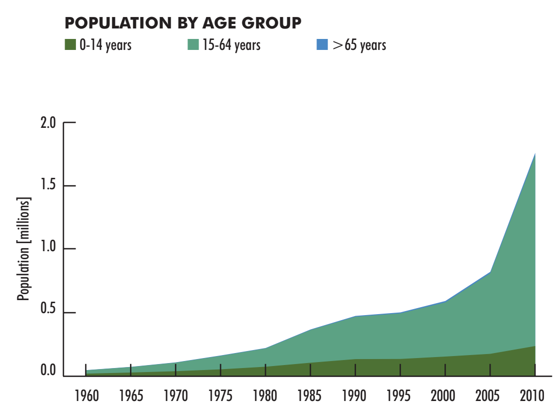












Saudi Arabia

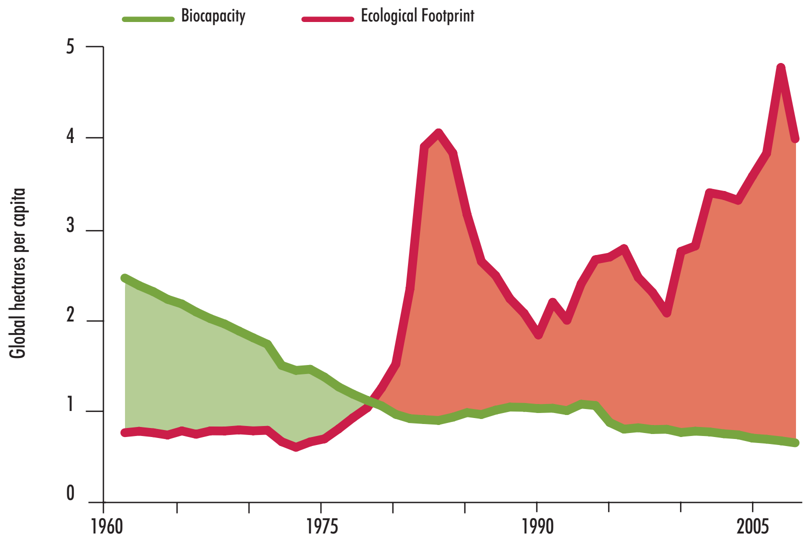
Saudi Arabia occupies 185.6 million hectares of productive land and water. Of those, 977 thousand are forest, 3.7 million are cropland, 170 million are grazing land, and 1.4 million support the country's built infrastructure. Saudi Arabia also has 9.6 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Saudi Arabia's total biocapacity is 17.1 million gha. This is much less than its total Ecological Footprint of 104 million gha.

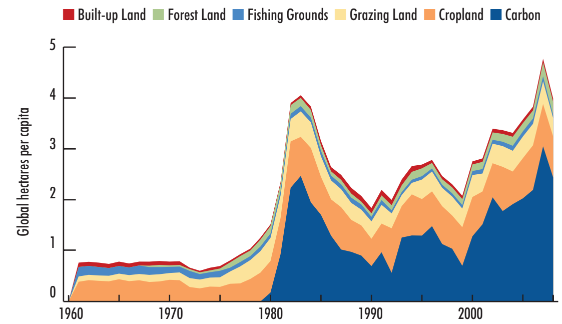
Saudi Arabia's average Ecological Footprint per person is 4.0 gha, 1.5-times the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Saudi Arabia is somewhat larger, and is equivalent to many upper middle-income countries. Reducing the country's Ecological Footprint will involve multiple strategies: significant improvement in resource efficiency; change in consumption patterns; and expansion of biocapacity without resource intensive production.

As indicated in Figure 34, Saudi Arabia's Ecological Footprint per person is much greater than the 0.7 global hectares of biocapacity available per person. The overshoot is caused by a high rate of consumption and population growth. The country's population grew from 4.2 million to 26.2 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 27 percent.

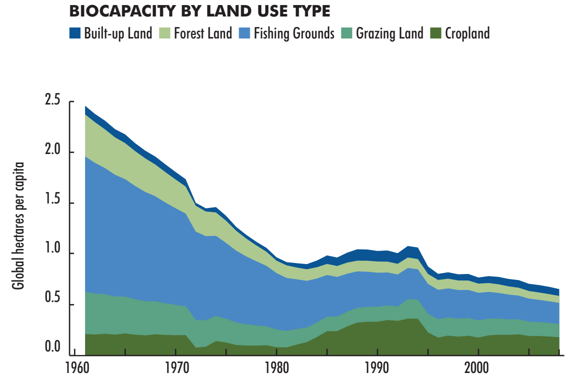
FIGURE 34 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Saudi Arabia. The red area indicates biocapacity deficit, in global hectares per capita, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



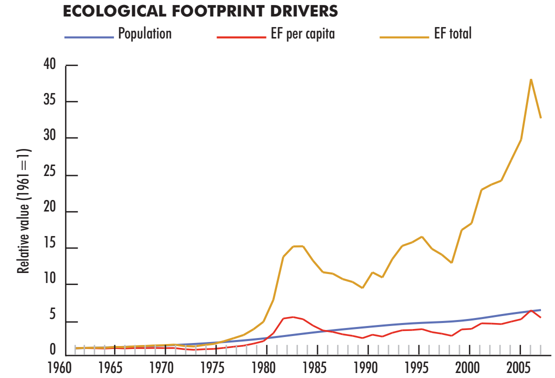
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



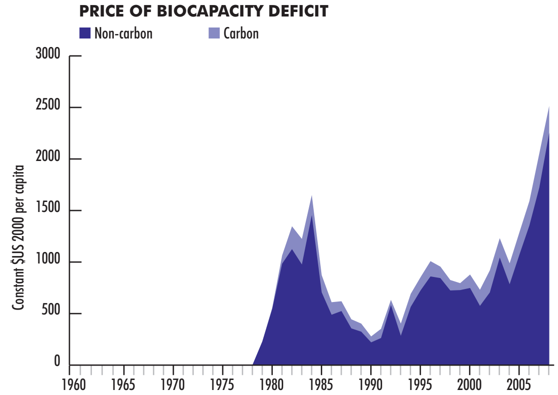
BIOCAPACITY BY LAND USE TYPE



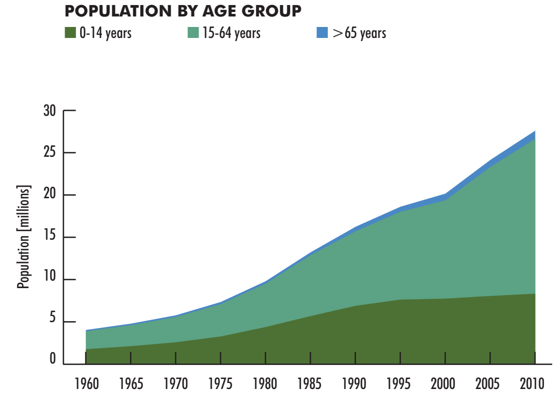
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Somalia

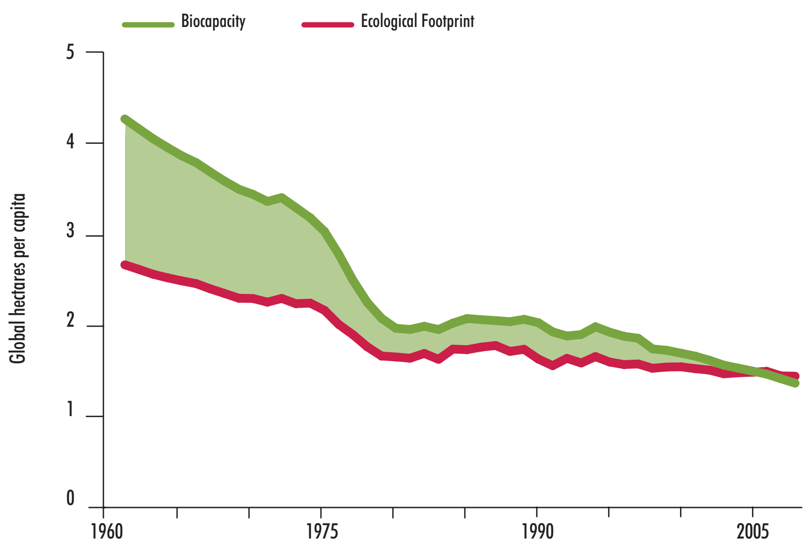
Somalia occupies 56.6 million hectares of productive land and water. Of those, 6.9 million are forest, 1.0 million are cropland, 43.0 million are grazing land, and 596 thousand support the country's built infrastructure. Somalia also has 5.1 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Somalia's total biocapacity is 12.2 million gha. This is slightly less than its total Ecological Footprint of 12.9 million gha.

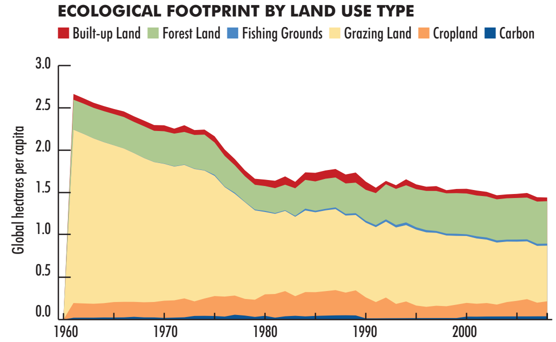
Somalia's average Ecological Footprint per person is 1.4 gha, half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Somalia is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need must first involve ending the country's political turmoil, restoring political stability, establishing control over the country's biocapacity assets, and setting up an effective local and national mechanism for renewable resource governance.

As indicated in Figure 35, Somalia's Ecological Footprint per person is roughly equal to the country's global hectares of biocapacity available per person. However, the biocapacity available per person is decreasing due to a high rate of population growth and more recently to the country's political and social upheavals caused by war, droughts, and instability. The country's population grew from 2.9 million to 8.9 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 32 percent.

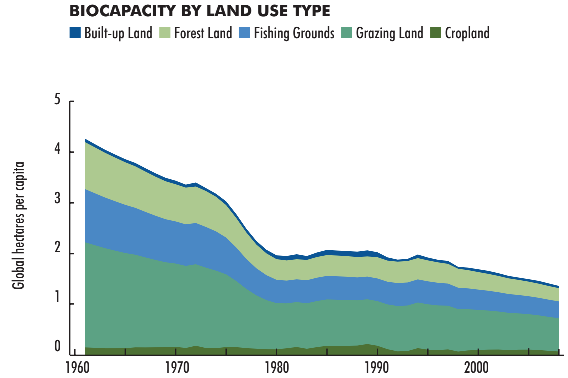
FIGURE 35 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Somalia. The green area indicates biocapacity surplus, in global hectares per capita, where the demand for resources, in aggregate, is below the country's ecological capacity to meet this demand



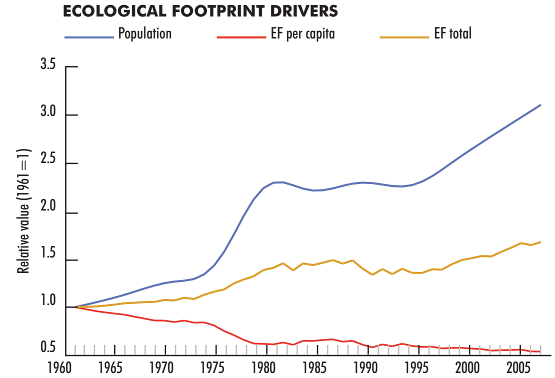
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



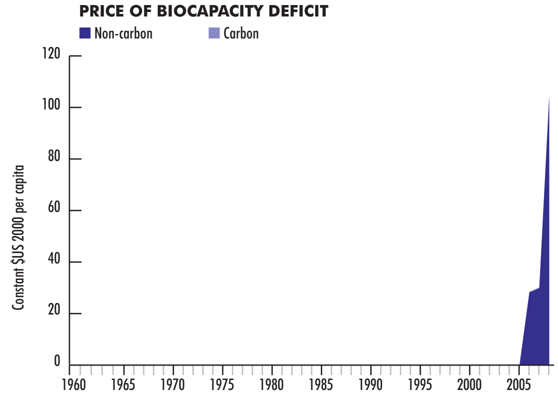
BIOCAPACITY BY LAND USE TYPE



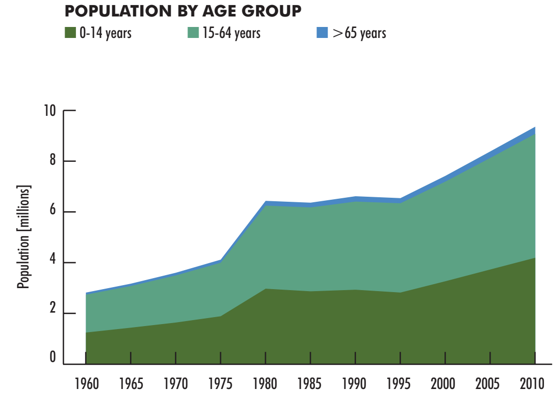
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Sudan

(Includes South Sudan)*

Sudan occupies 224.4 million hectares of productive land and water. Of those, 70.1 million are forest, 20.9 million are cropland, 117 million are grazing land, and 1.7 million support the country's built infrastructure. Sudan also has 14.6 million hectares of continental shelf and inland water to support fisheries. As this survey covers the period 1961-2008, the figures include Sudan and South Sudan.

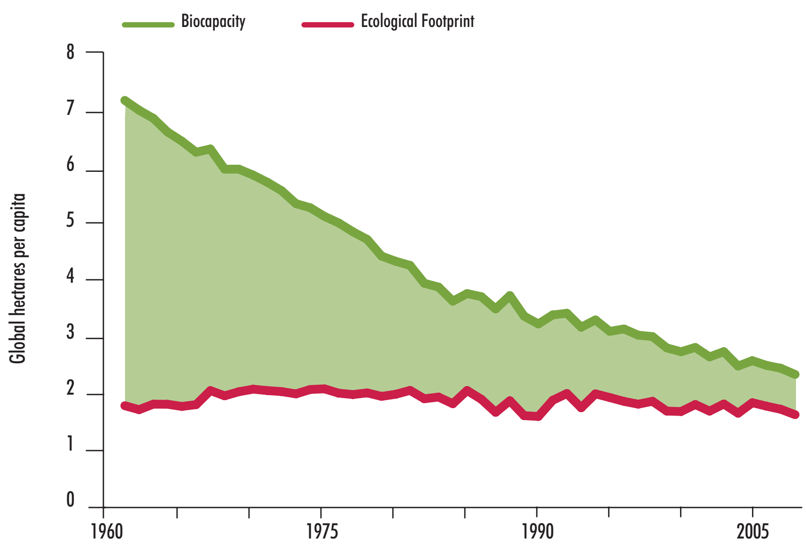
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Sudan's total biocapacity is 96.8 million gha. This is greater than its total Ecological Footprint of 67.5 million gha.

Sudan's average Ecological Footprint per person is 1.6 gha, slightly greater than half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Sudan 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 the country's population must have greater access to natural resources. Meeting this need must involve more equitable distribution of resources and their better utilization through improved resource efficiency and expansion of biocapacity without resource intensive production.

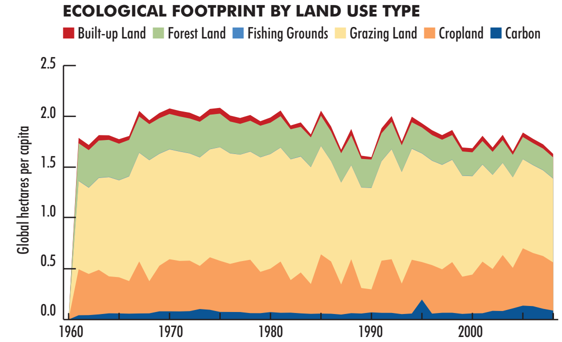
As indicated in Figure 36, Sudan's Ecological Footprint per person is smaller than the country's 2.3 global hectares of biocapacity available per person. However, the surplus biocapacity is rapidly decreasing due to a high rate of population growth. The country's population grew from 11.8 million to 41.4 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 33 percent.

* Data was collected for former Sudan, before South Sudan was accepted into the United Nations.

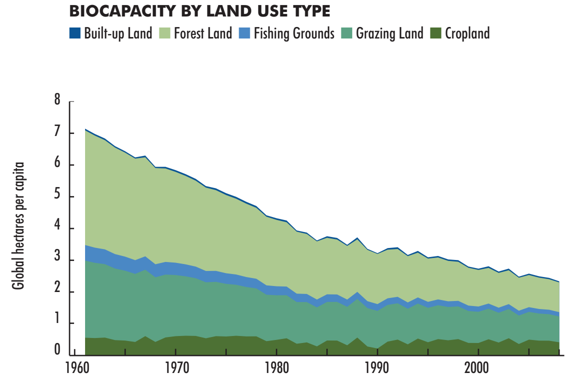
FIGURE 36 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Sudan. The green area indicates biocapacity surplus, in global hectares per capita, where the demand for resources, in aggregate, is below the country's ecological capacity to meet this demand



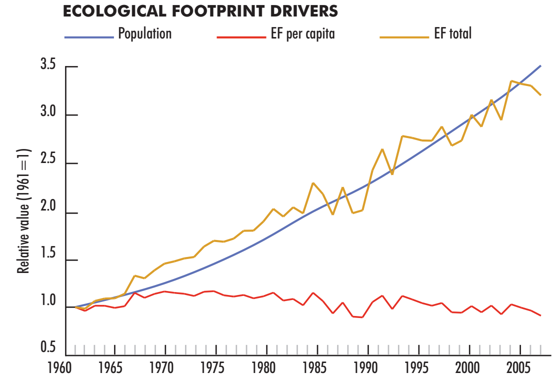
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



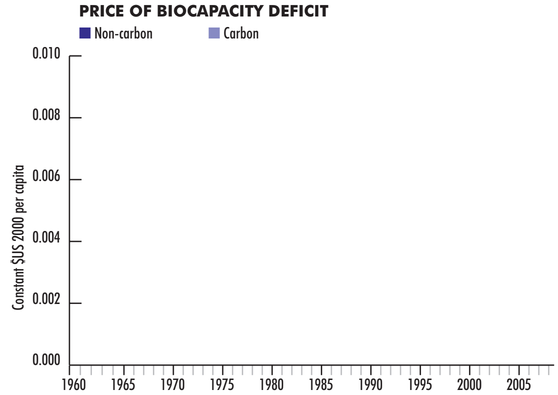
BIOCAPACITY BY LAND USE TYPE



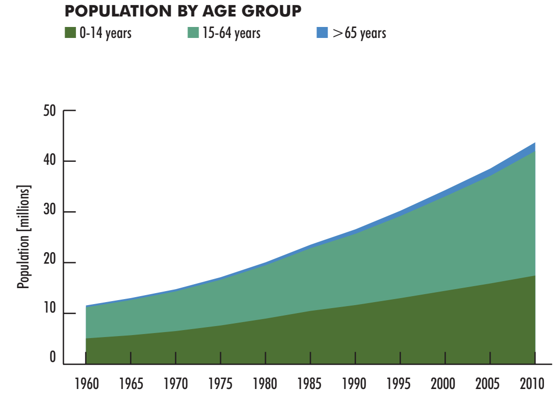
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Syria

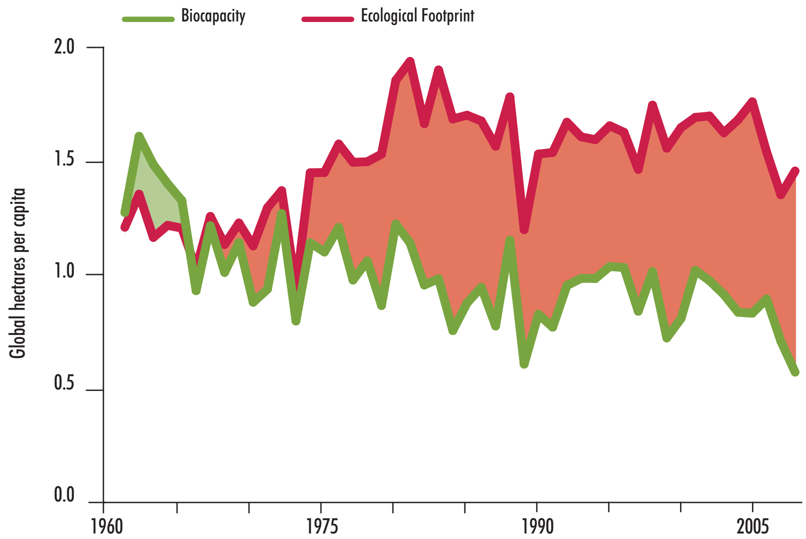
Syria occupies 15.2 million hectares of productive land and water. Of those, 479 thousand are forest, 5.7 million are cropland, 8.2 million are grazing land, and 612 thousand support the country's built infrastructure. Syria also has 239 thousand hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Syria's total biocapacity is 11.3 million gha. This is much less than its total Ecological Footprint of 28.6 million gha.

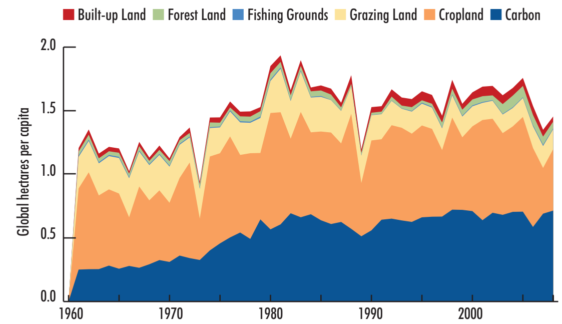
Syria's average Ecological Footprint per person is 1.5 gha, half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Syria is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Syria will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 37, Syria's Ecological Footprint per person is much greater than the 0.6 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 4.7 million to 19.7 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 45 percent.

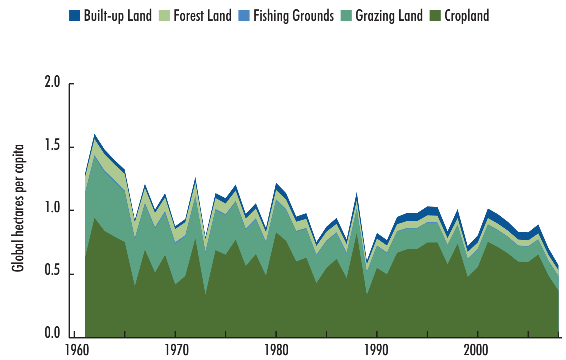
FIGURE 37 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Syria. The red area indicates biocapacity deficit, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



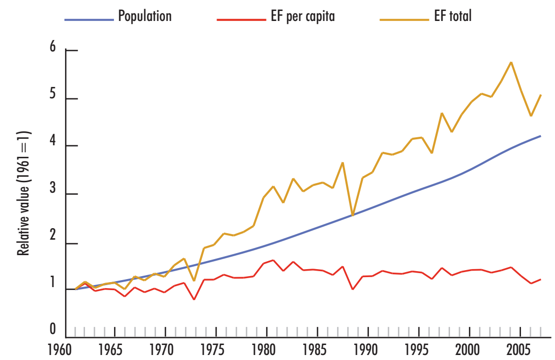
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



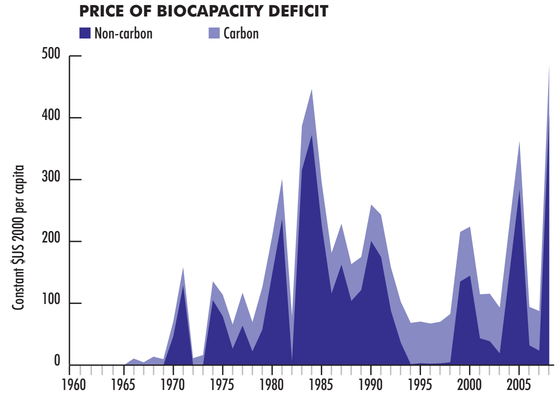
BIOCAPACITY BY LAND USE TYPE



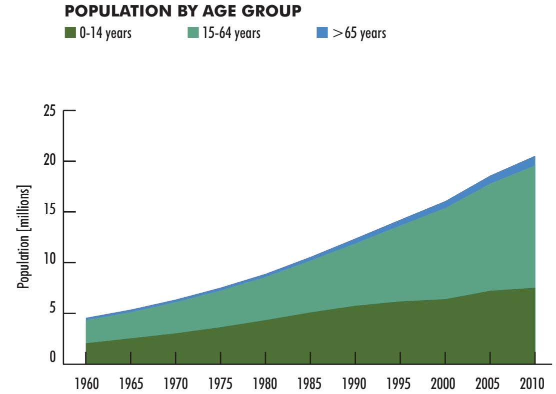
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Tunisia

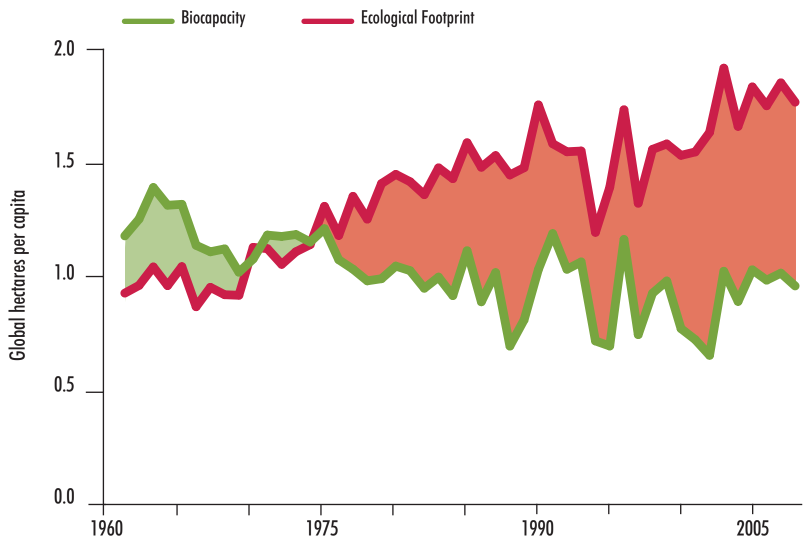
Tunisia occupies 18.5 million hectares of productive land and water. Of those, 4.8 million are forest, 5.0 million are cropland, 4.8 million are grazing land, and 330 thousand support the country's built infrastructure. Tunisia also has 7.4 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Tunisia's total biocapacity is 9.8 million gha. This is much less than its total Ecological Footprint of 18.1 million gha.

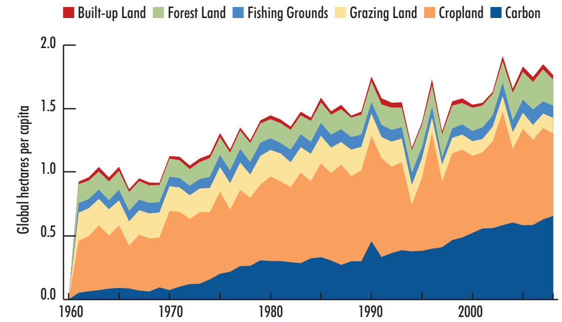
Tunisia's average Ecological Footprint per person is 1.8 gha, higher than half the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Tunisia is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Tunisia will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

As indicated in Figure 38, Tunisia's Ecological Footprint per person is greater than the 1.0 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 4.3 million to 10.2 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 81 percent.

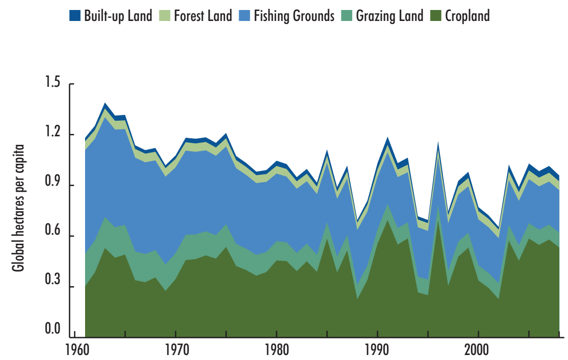
FIGURE 38 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Tunisia. The red area indicates biocapacity deficit, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



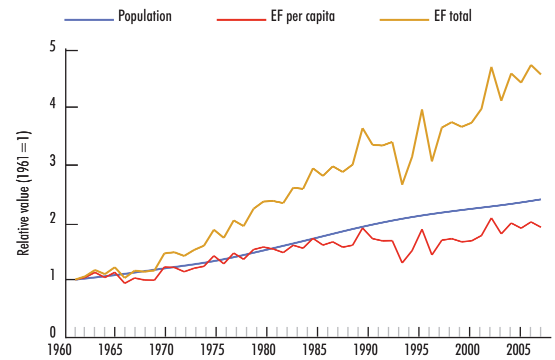
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



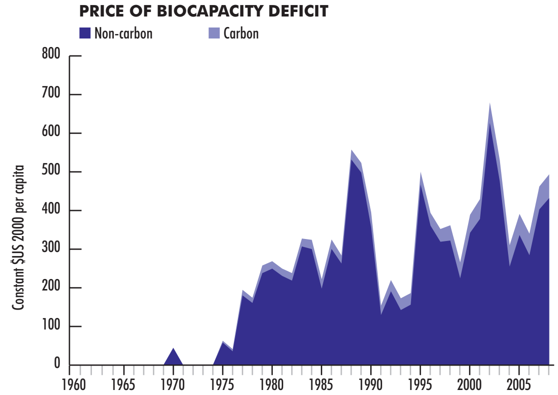
BIOCAPACITY BY LAND USE TYPE



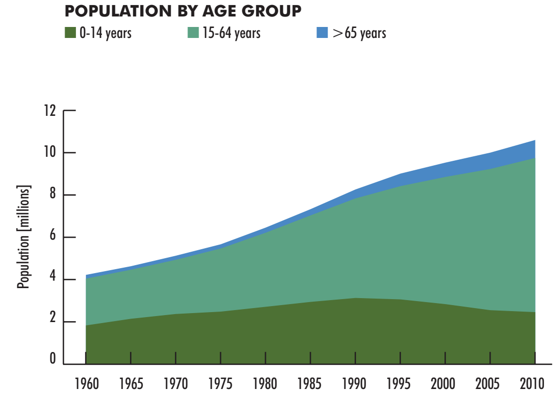
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



United Arab Emirates

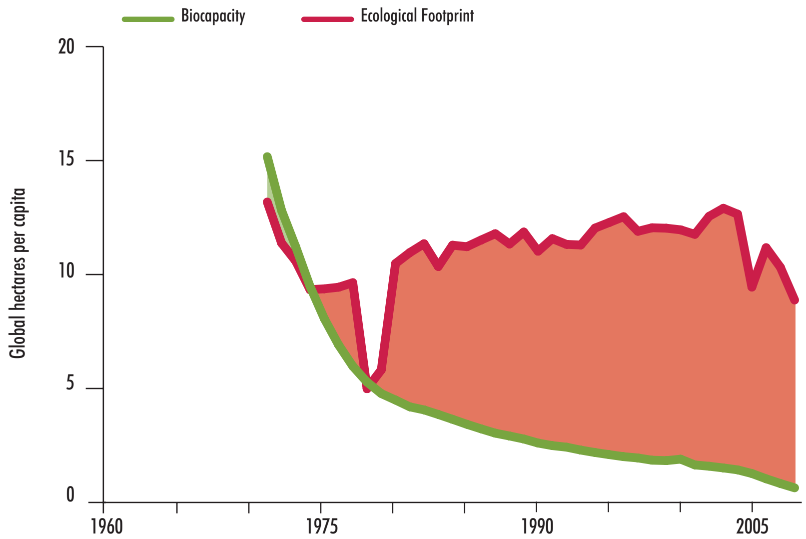
The United Arab Emirates (UAE) occupies 6.2 million hectares of productive land and water. Of those, 315 thousand are forest, 265 thousand are cropland, 305 thousand are grazing land, and 139 thousand support the country's built infrastructure. United Arab Emirates also has 5.1 million hectares of continental shelf and inland water to support fisheries.

Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, United Arab Emirates' total biocapacity is 5.2 million gha. This is much less than its total Ecological Footprint of 71.7 million gha.

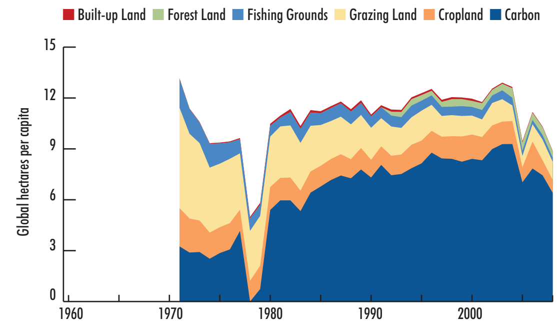
The United Arab Emirates' average Ecological Footprint per person is 8.9 gha, more than 3-times the global average footprint of 2.7 gha. The United Arab Emirates owns one of the highest Ecological Footprints in the world. If all humans lived like the average resident of the UAE, 5 planets would be required to support this level of consumption. Reducing the country's Ecological Footprint will involve multiple strategies: significant improvement in resource efficiency; change in consumption patterns; and expansion of biocapacity without resource intensive production.

As indicated in Figure 39, the United Arab Emirates' Ecological Footprint per person is much greater than the 0.6 global hectares of biocapacity available per person. This disparity is rapidly growing due to high rates of consumption, economic, and population growth. The country's population grew from 273 thousand to 8.1 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 96 percent.

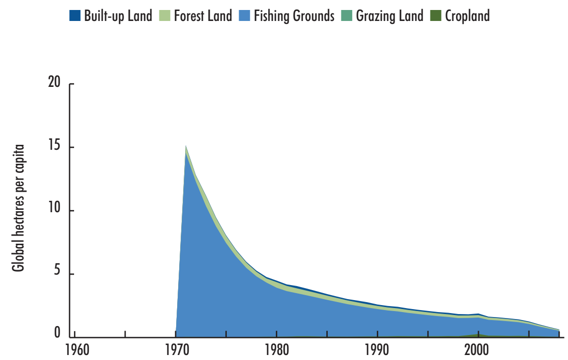
FIGURE 39 | The Ecological Footprint and biocapacity per capita, 1971-2008, in United Arab Emirates. The red area indicates biocapacity deficit, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand



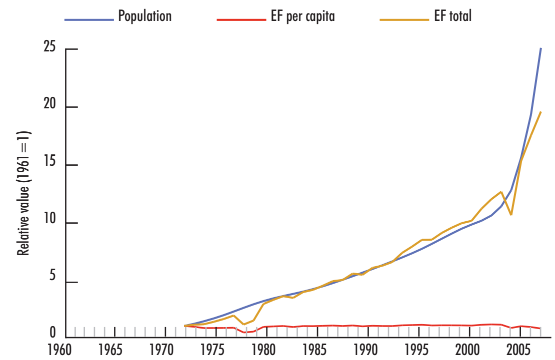
ECOLOGICAL FOOTPRINT BY LAND USE TYPE



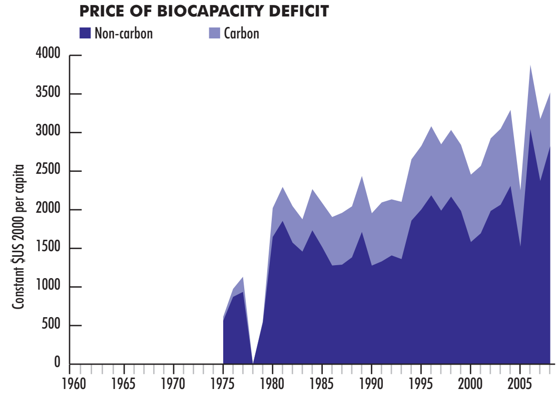
BIOCAPACITY BY LAND USE TYPE



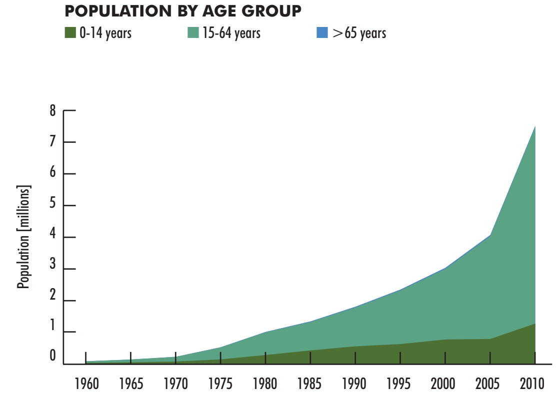
ECOLOGICAL FOOTPRINT DRIVERS



PRICE OF BIOCAPACITY DEFICIT



POPULATION BY AGE GROUP



Yemen

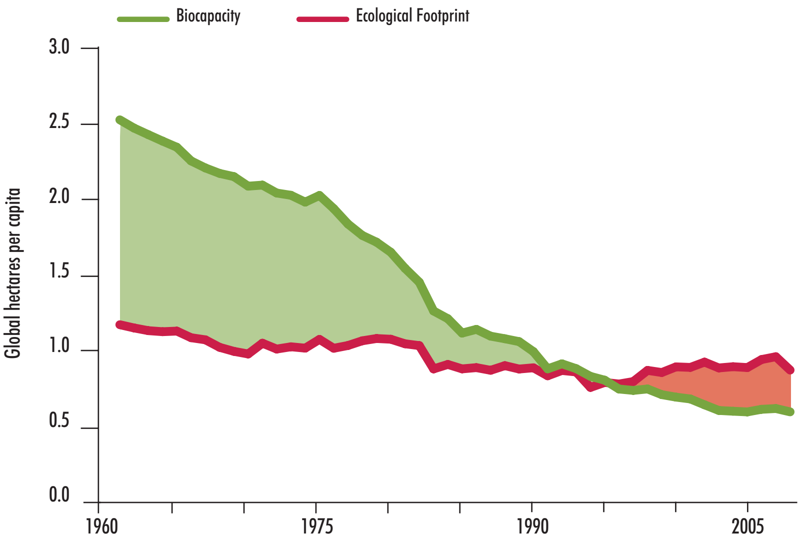
Yemen occupies 31.3 million hectares of productive land and water. Of those, 549 thousand are forest, 1.6 million are cropland, 22.0 million are grazing land, and 634 thousand support the country's built infrastructure. Yemen also has 6.5 million hectares of continental shelf and inland water to support fisheries.

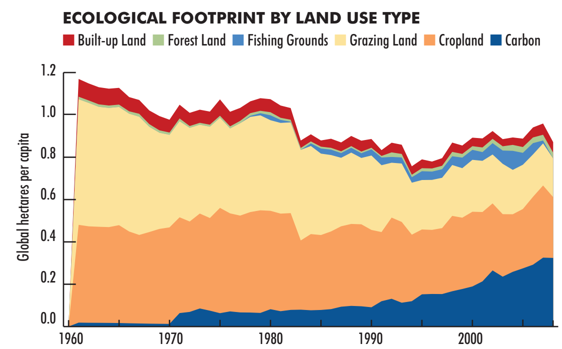
Taking into account differences between average regional yields for cropland, grazing land, forest, and fisheries as compared with corresponding global yields, Yemen's total biocapacity is 13.5 million gha. This is much less than its total Ecological Footprint of 19.7 million gha.

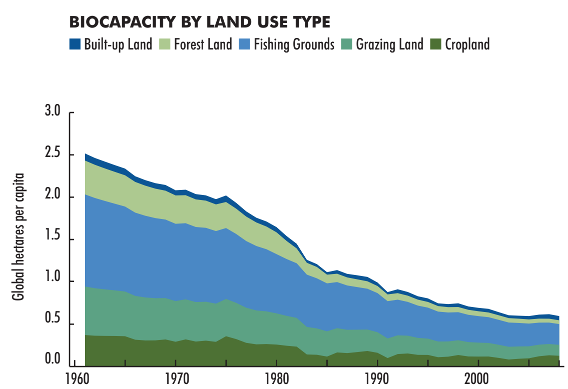
Yemen's average Ecological Footprint per person is 0.9 gha, a third of the global average footprint of 2.7 gha. Compared to the rest of the world, the average footprint of an inhabitant in Yemen is small, and for many, it is too small to meet basic food, shelter, health, and sanitation needs. In order to make vital quality of life improvements, large segments of the country's population must have greater access to natural resources. Meeting this need will involve multiple strategies: significant improvement in resource efficiency and expansion of biocapacity without resource intensive production. Since it is likely that the Ecological Footprint of Yemen will then rise, a corresponding decrease will be required in the Ecological Footprint of other high per capita consumption regions of the world, just to maintain the global average footprint constant.

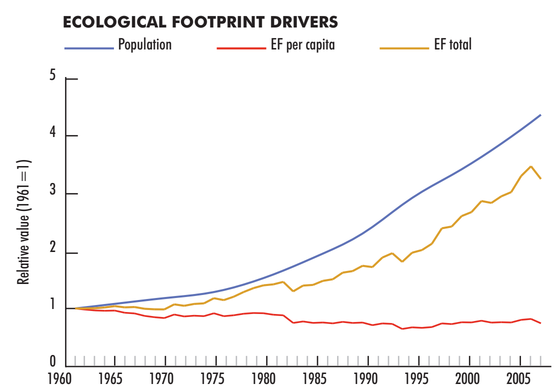
As indicated in Figure 40, Yemen's Ecological Footprint per person is greater than the country's 0.6 global hectares of biocapacity available per person due to a high rate of population growth. The country's population grew from 5.2 million to 22.6 million between 1961 and 2008. Over the same time period, the biocapacity available per person decreased by 76 percent.

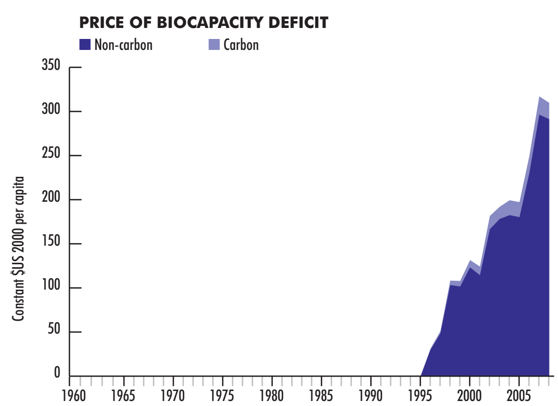
FIGURE 40 | The Ecological Footprint and biocapacity per capita, 1961-2008, in Yemen. The red area indicates biocapacity deficit, where the demand for resources, in aggregate, exceeds the country's ecological capacity to meet this demand

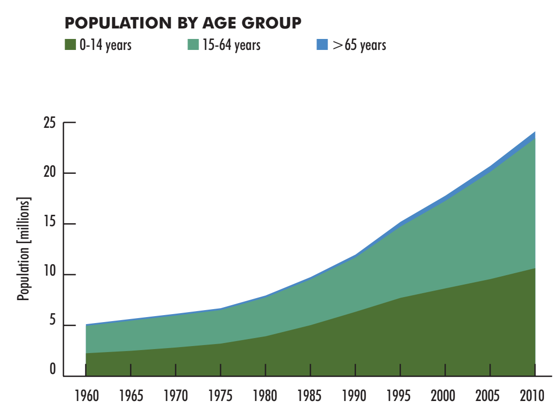








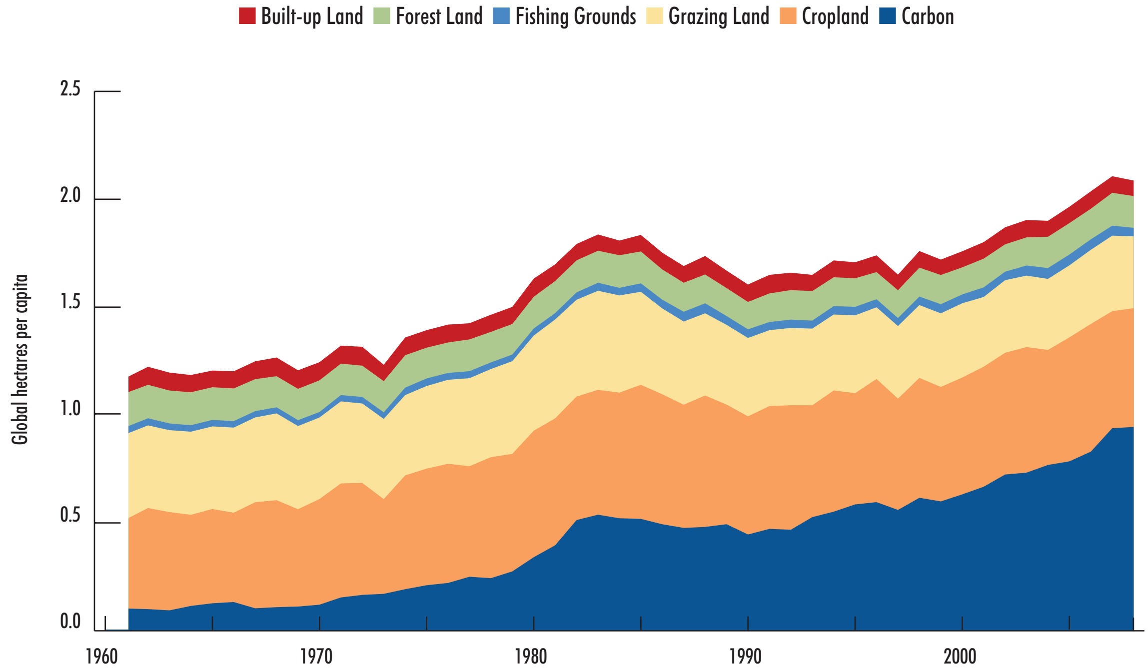




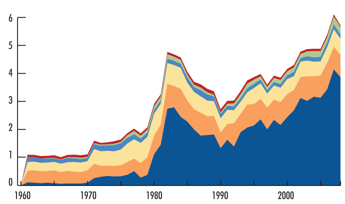
ECOLOGICAL FOOTPRINT BY LAND USE TYPE

The Ecological Footprints, by land use type, of the League of Arab States and the countries and sub-regions of which it is comprised, 1961-2008. On average, the only component of the per capita footprint that has substantially increased is carbon.

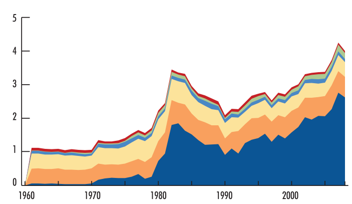
LEAGUE OF ARAB STATES AVERAGE



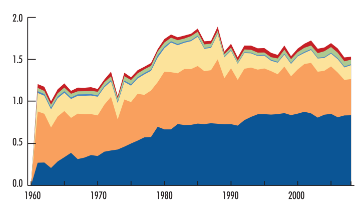
GCC



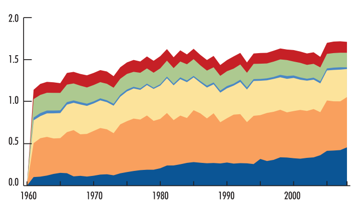
GCC PLUS YEMEN



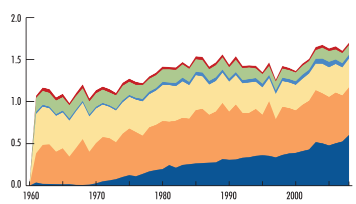
LEVANT



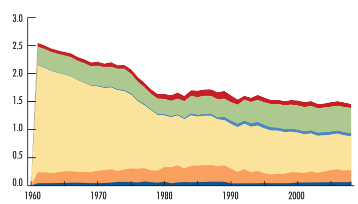
NILE VALLEY



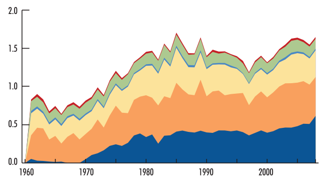
NORTH AFRICA



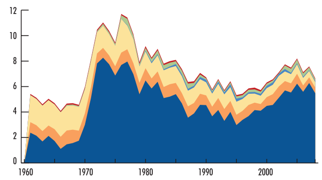
AFRICAN HORN



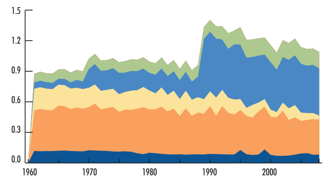
ALGERIA



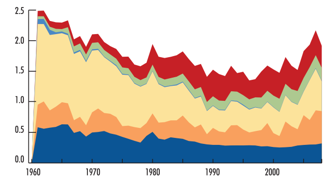
BAHRAIN



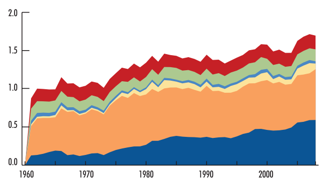
COMOROS



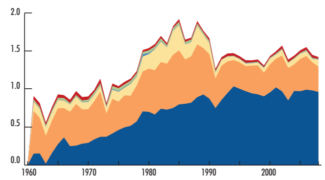
DJIBOUTI



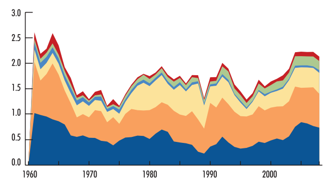
EGYPT



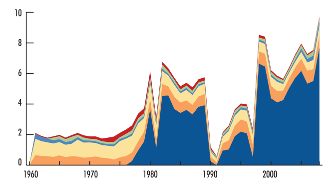
IRAQ



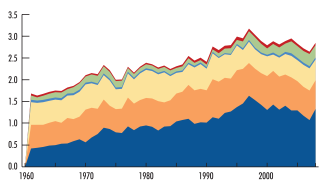
JORDAN



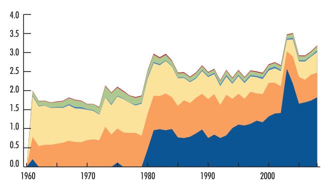
KUWAIT



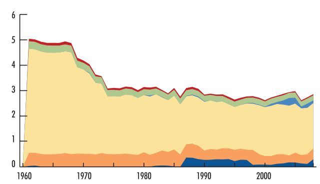
LEBANON



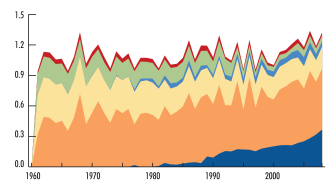
LIBYA



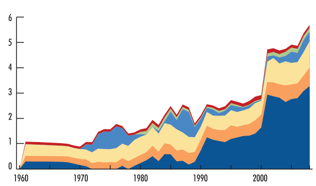
MAURITANIA



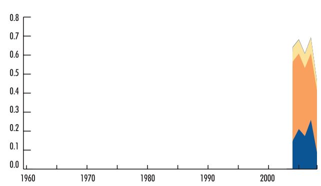
MOROCCO



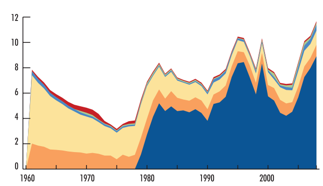
OMAN



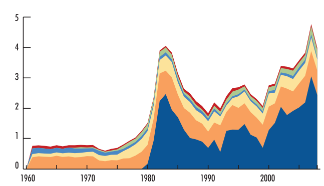
OCCUPIED PALESTINIAN TERRITORIES



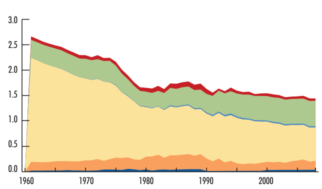
QATAR



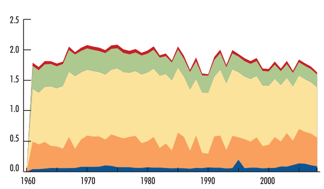
SAUDI ARABIA



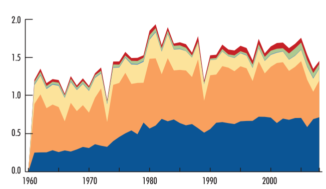
SOMALIA



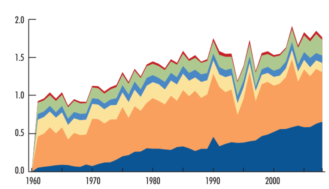
SUDAN



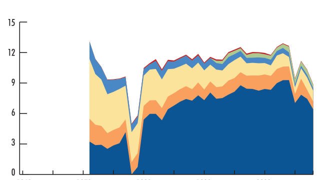
SYRIA



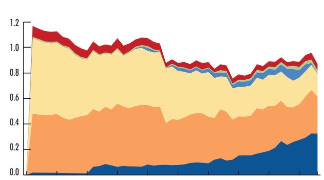
TUNISIA



UNITED ARAB EMIRATES



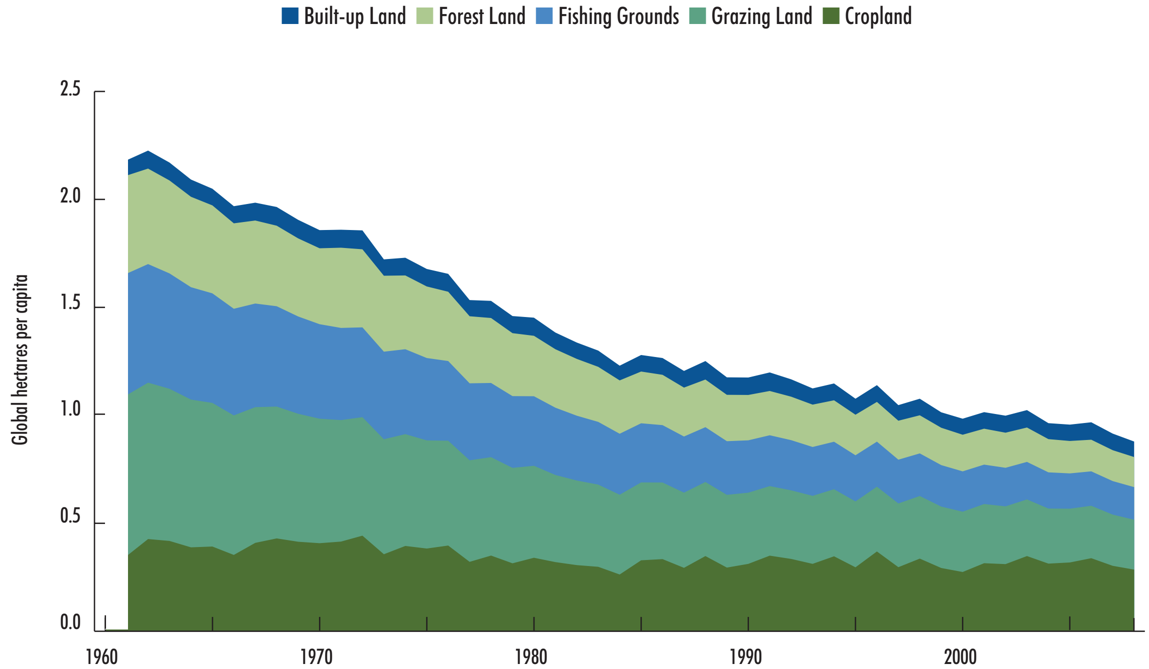
YEMEN



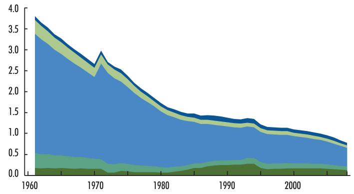
BIOCAPACITY BY LAND USE TYPE

The biocapacity, by land use type, of the League of Arab States and the countries and sub-regions of which it is comprised, 1961-2008. On average, biocapacity per capita has decreased significantly across all land use types, with the exception of cropland.

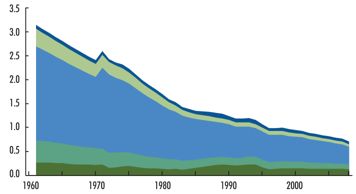
LEAGUE OF ARAB STATES AVERAGE



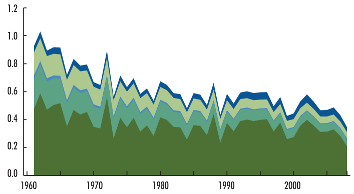
GCC



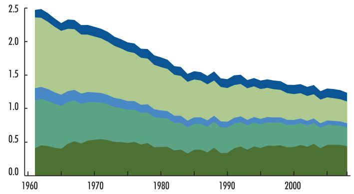
GCC PLUS YEMEN



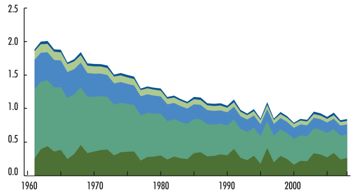
LEVANT



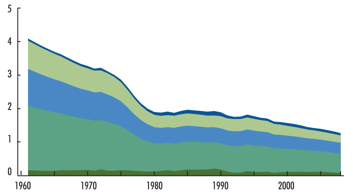
NILE VALLEY



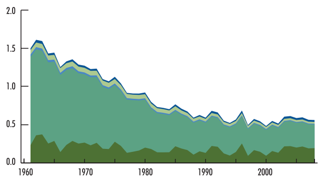
NORTH AFRICA



AFRICAN HORN



ALGERIA



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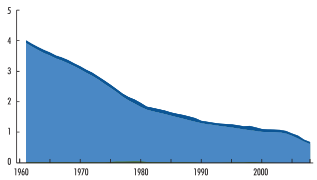

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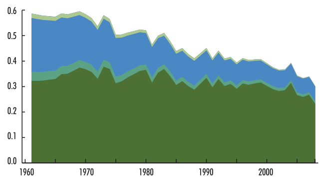
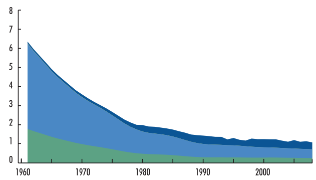


DJIBOUTI



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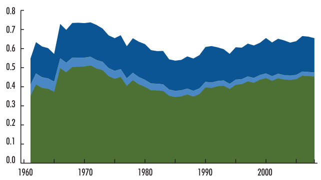

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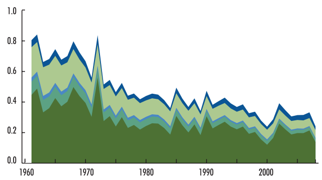
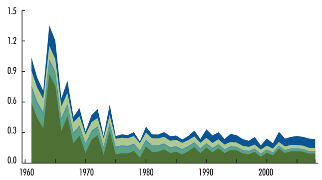


JORDAN



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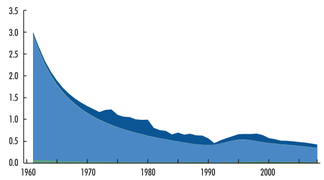

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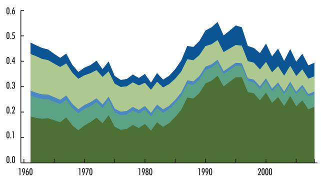

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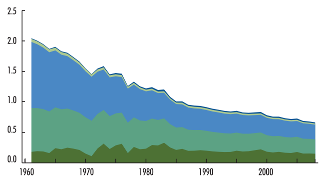

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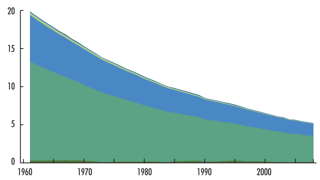

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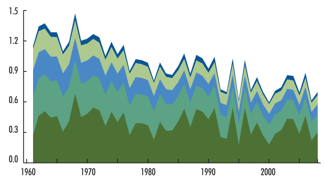

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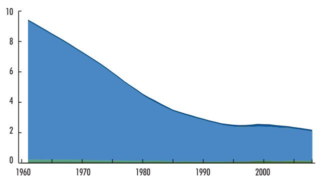
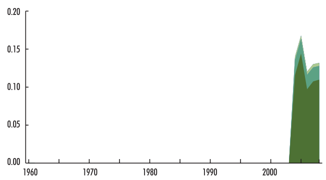
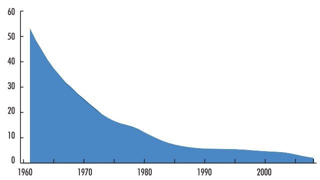


OCCUPIED PALESTINIAN TERRITORIES



QATAR



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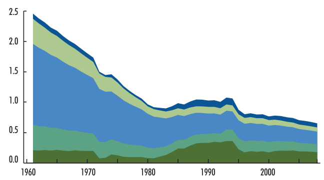

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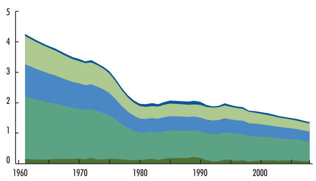

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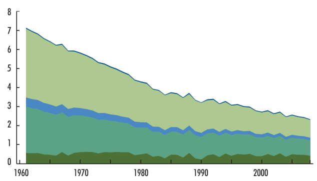
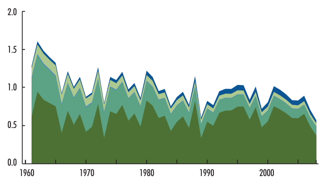


SYRIA



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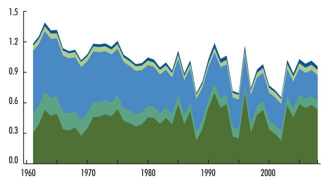
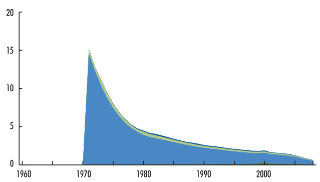
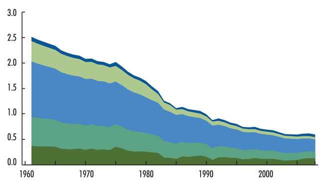


UNITED ARAB EMIRATES



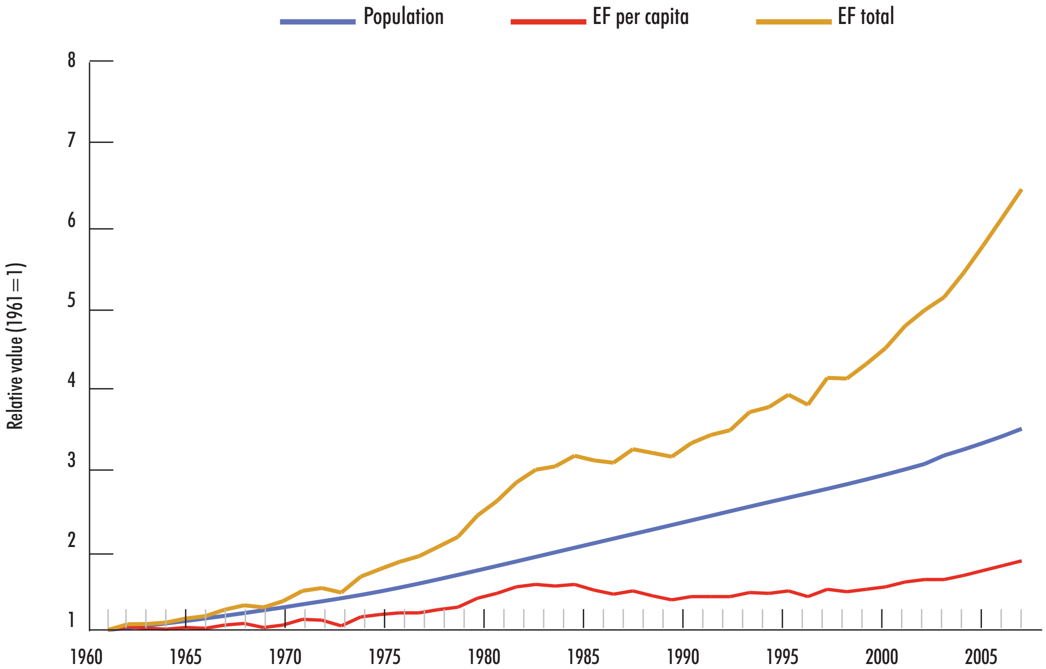
YEMEN

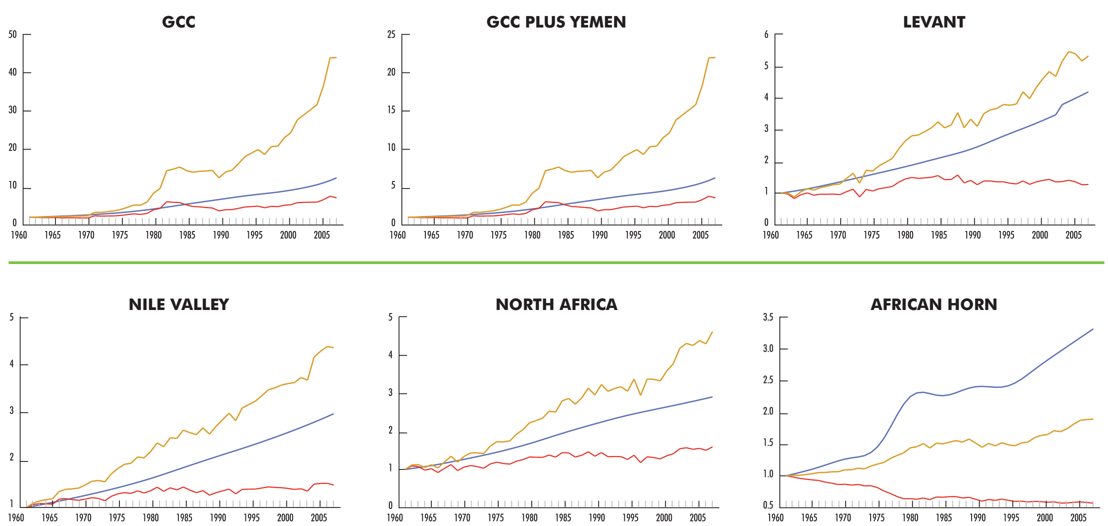


ECOLOGICAL FOOTPRINT DRIVERS

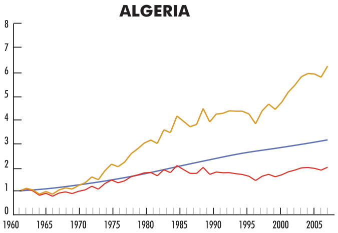
The drivers of the Ecological Footprint (population and individual consumption), of the League of Arab States and the countries and sub-regions of which it is comprised, 1961-2008. Population has been a greater driver of the total ecological demands of the region.

LEAGUE OF ARAB STATES AVERAGE

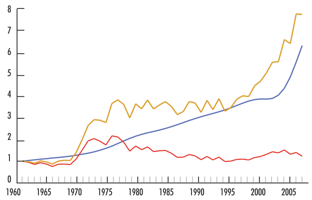




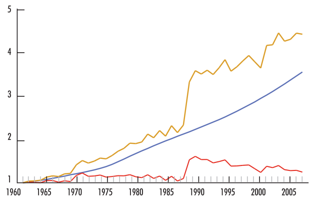
ALGERIA



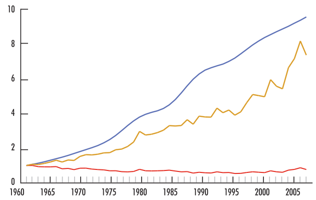
BAHRAIN



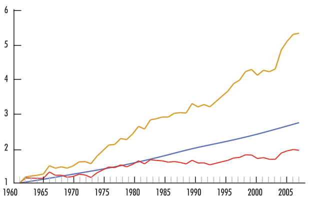
COMOROS



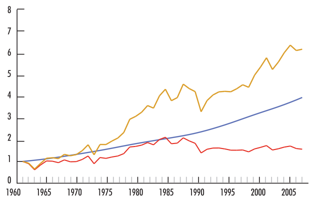
DJIBOUTI



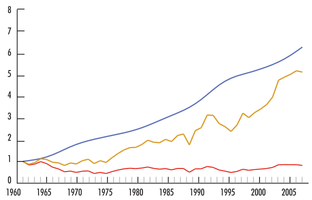
EGYPT



IRAQ



JORDAN



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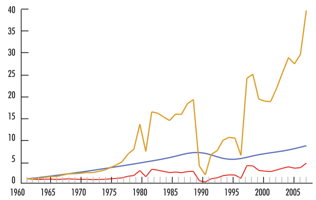

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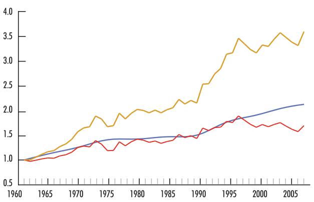

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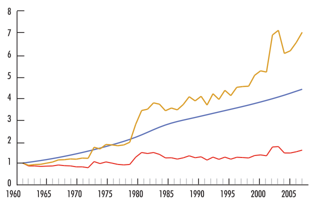

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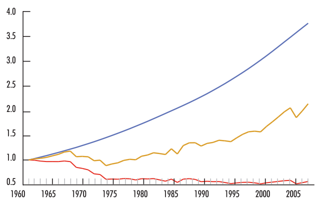

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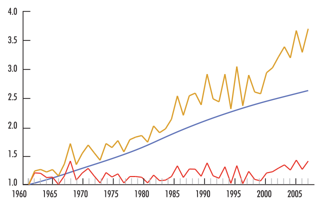

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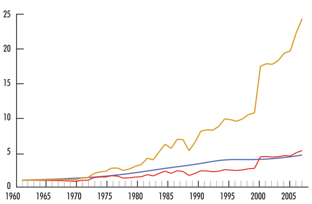
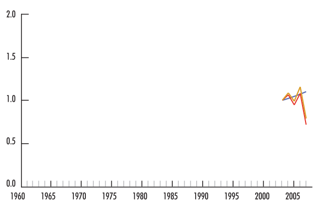


OCCUPIED PALESTINIAN TERRITORIES



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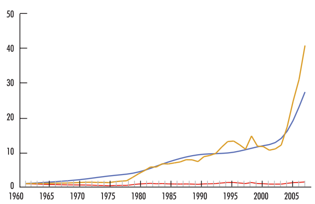
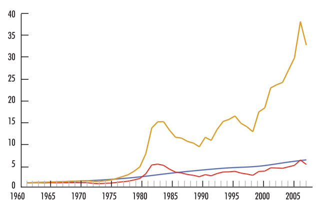
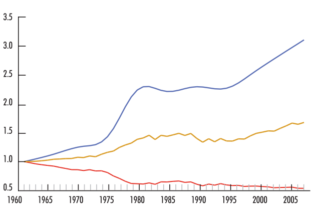


SAUDI ARABIA



SOMALIA



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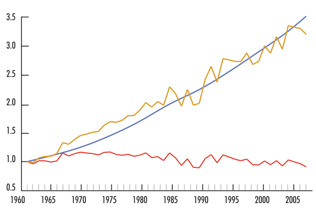
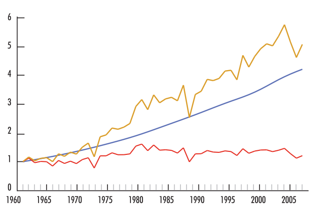


SYRIA



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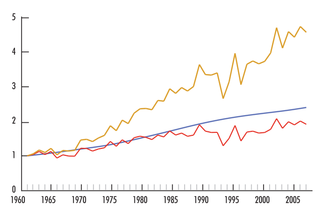
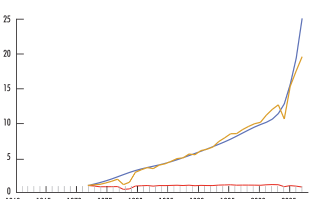
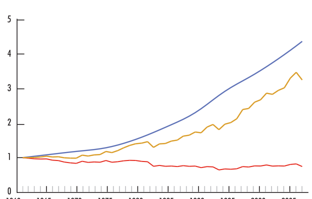


UNITED ARAB EMIRATES

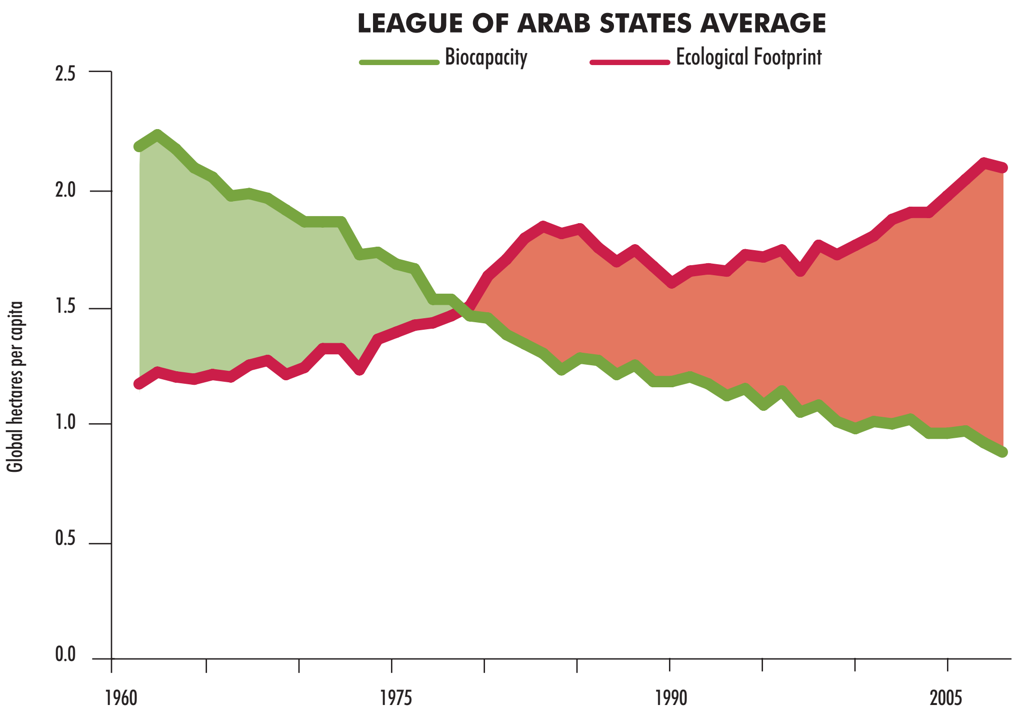


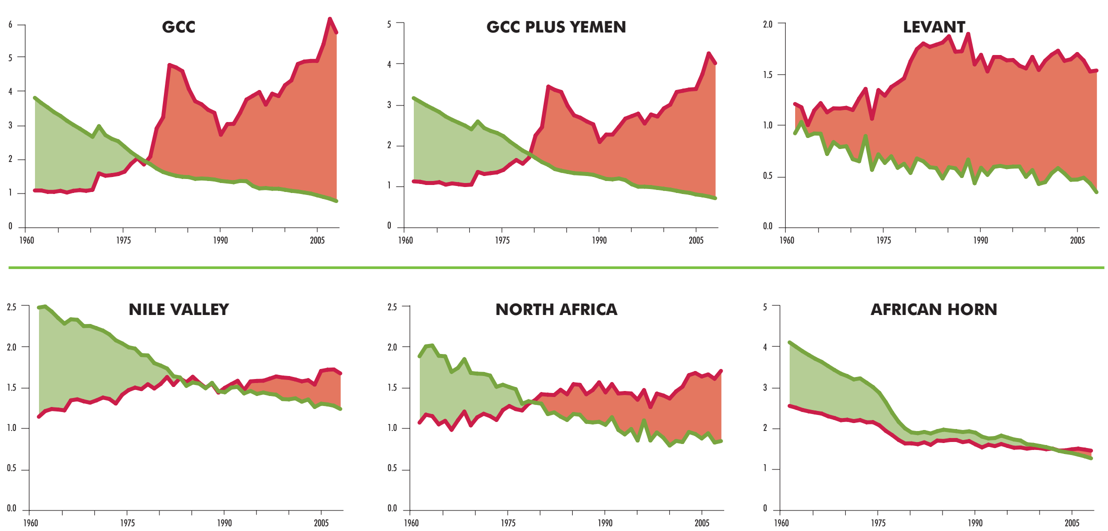
YEMEN

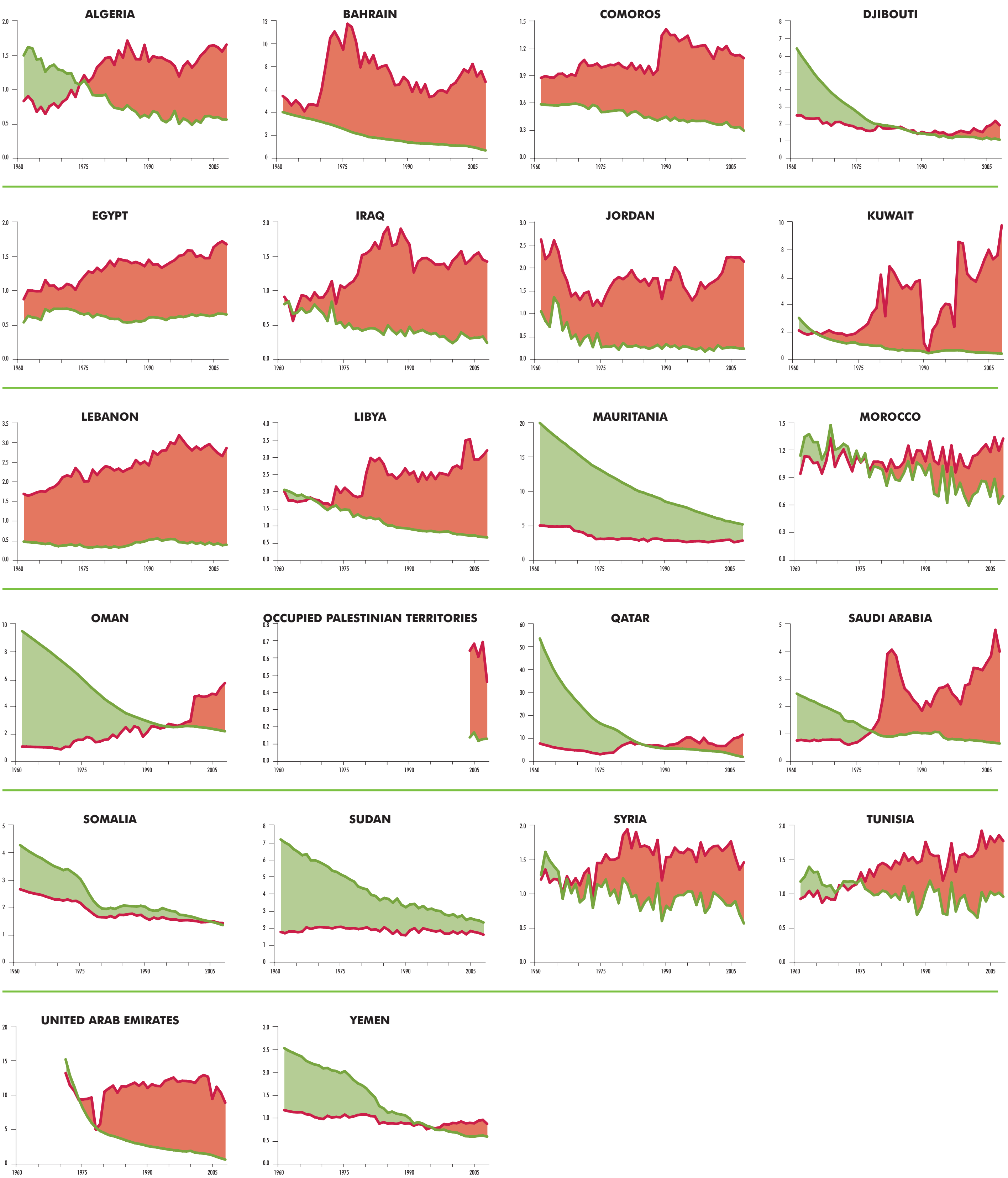


BIOCAPACITY DEFICIT

The Ecological Footprint and biocapacity of the League of Arab States and the countries and sub-regions of which it is comprised, 1961-2008.

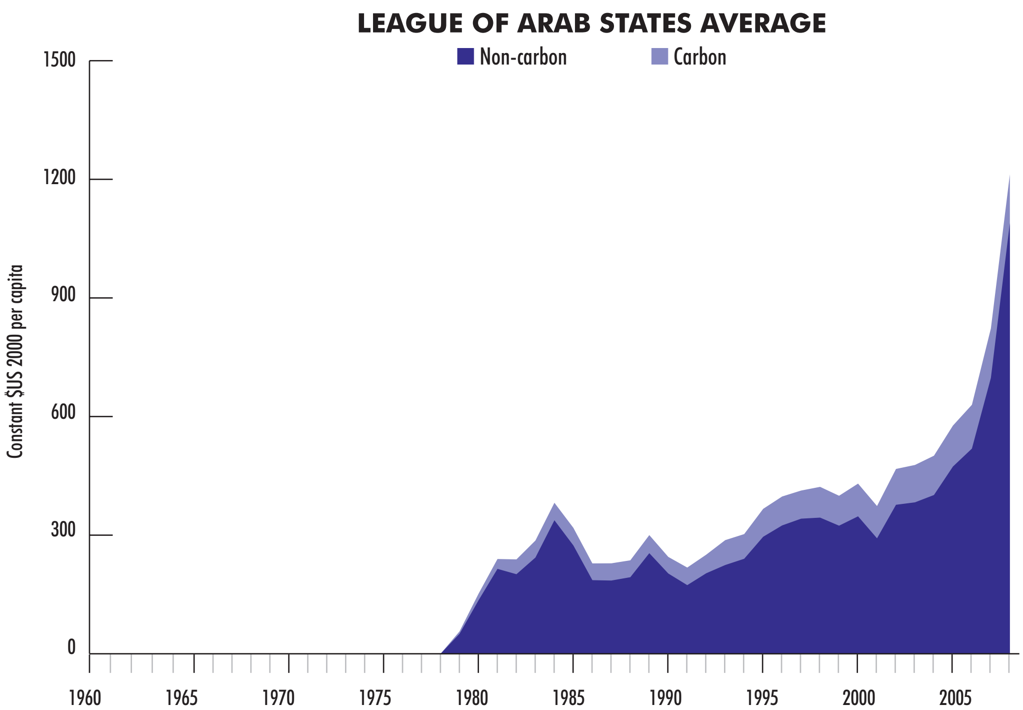


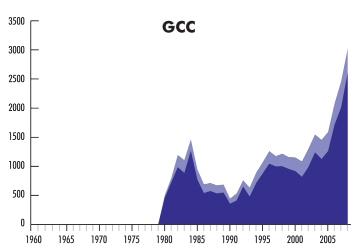


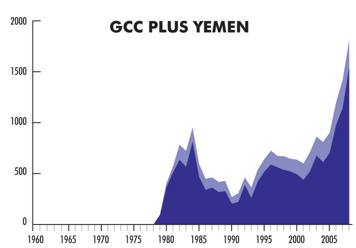

ALGERIA
BAHRAIN
COMOROS
DJIBOUTI
EGYPT
IRAQ
JORDAN
KUWAIT
LEBANON
LIBYA
MAURITANIA
MOROCCO
OMAN
OCCUPIED PALESTINIAN TERRITORIES
QATAR
SAUDI ARABIA
SOMALIA
SUDAN
SYRIA
TUNISIA
UNITED ARAB EMIRATES
YEMEN
1960
1975
1990
2005

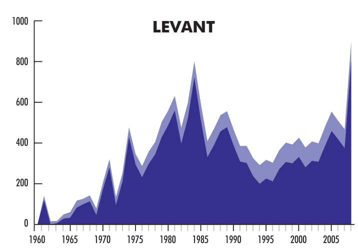
PRICE OF BIOCAPACITY DEFICIT

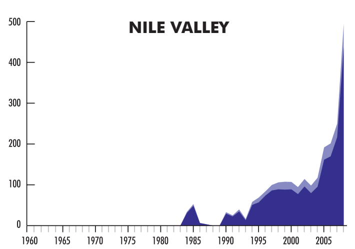
The value of the biocapacity deficit, in constant $US 2000, for the League of Arab States and the countries and sub-regions of which it is comprised. Currently, no actual monetary transfers take place for carbon emissions. However, countries pay for the fossil fuel (a cost not included in this assessment).

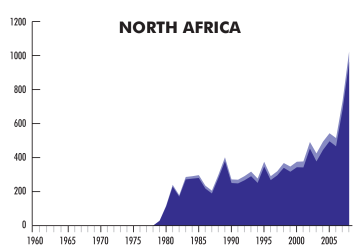


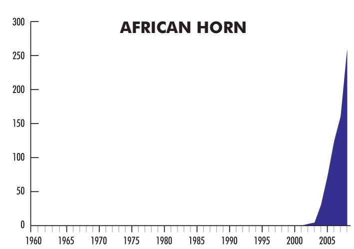




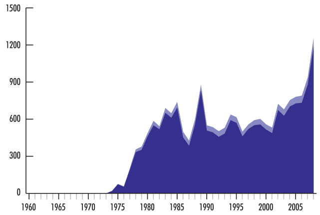




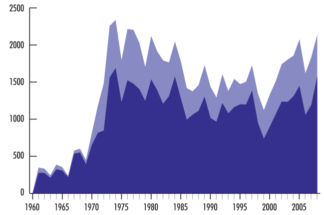




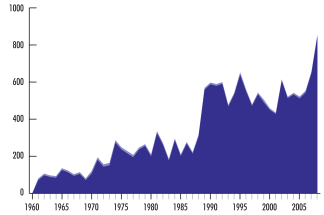
ALGERIA



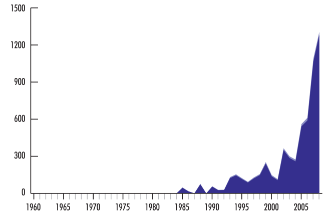
BAHRAIN



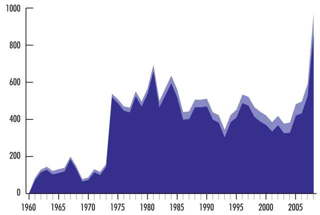
COMOROS



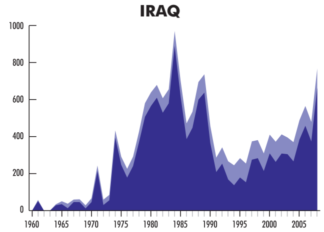
DJIBOUTI



EGYPT



IRAQ



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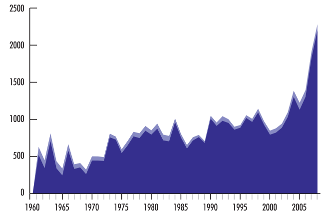
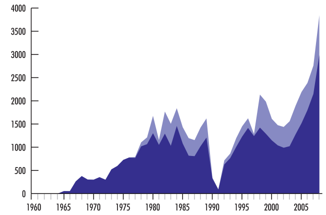
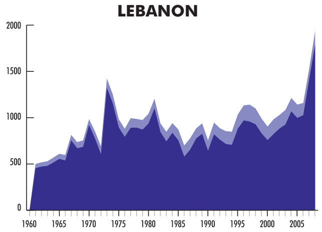


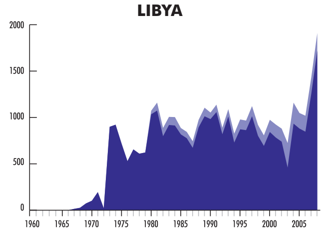
KUWAIT



LEBANON

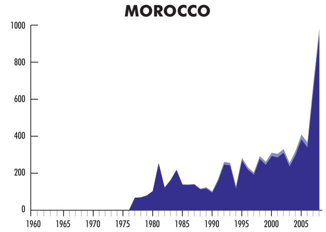


LIBYA



MAURITANIA

MOROCCO



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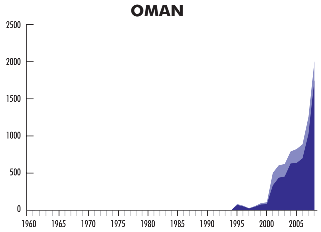
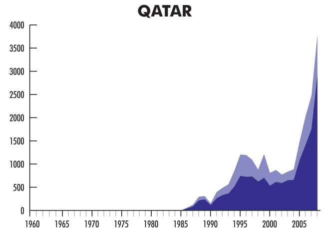
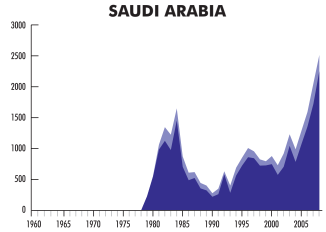


OCCUPIED PALESTINIAN TERRITORIES

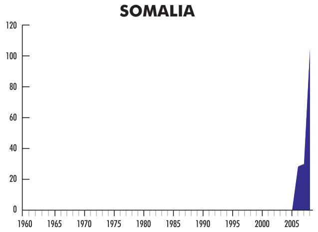
QATAR



SAUDI ARABIA

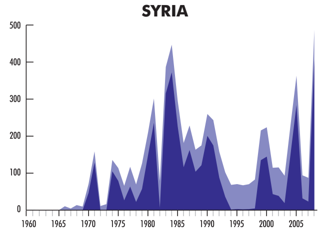


SOMALIA



SUDAN

SYRIA



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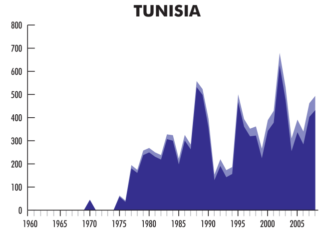
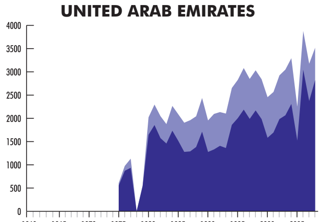
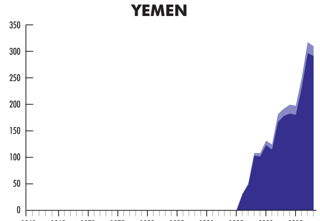


UNITED ARAB EMIRATES



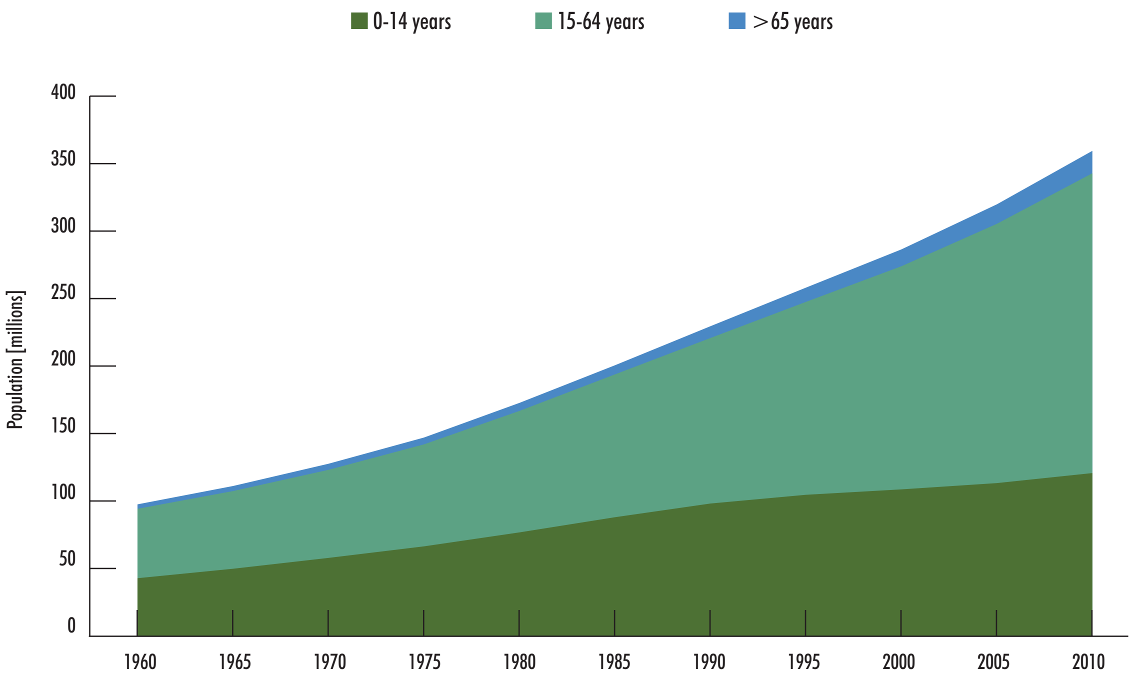
YEMEN



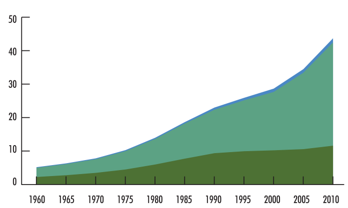
POPULATION BY AGE GROUP

The total population, by age group, of the League of Arab States and the countries and sub-regions of which it is comprised, 1960-2010.

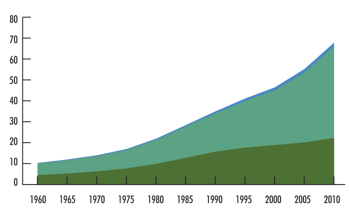
LEAGUE OF ARAB STATES AVERAGE



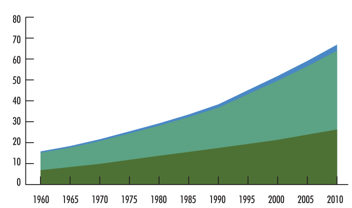
GCC



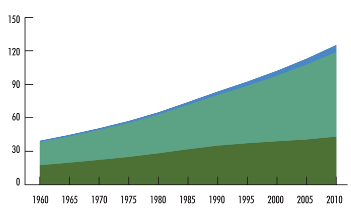
GCC PLUS YEMEN



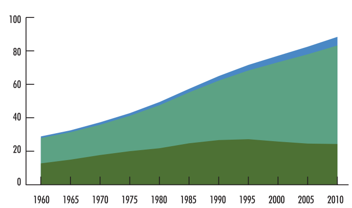
LEVANT



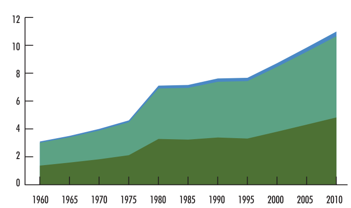
NILE VALLEY



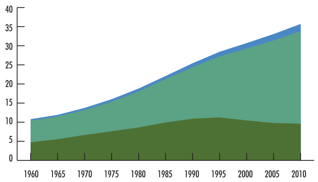
NORTH AFRICA



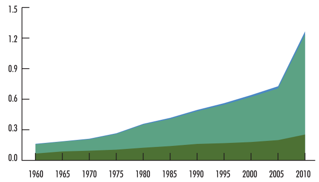
AFRICAN HORN



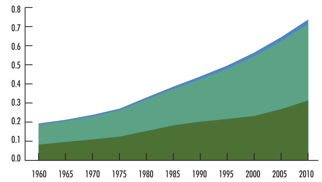
ALGERIA



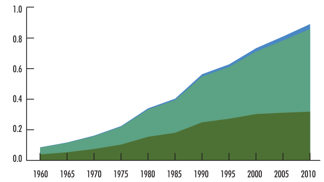
BAHRAIN



COMOROS



DJIBOUTI



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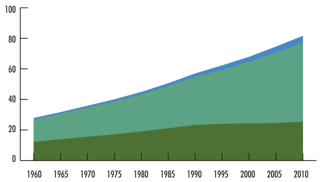
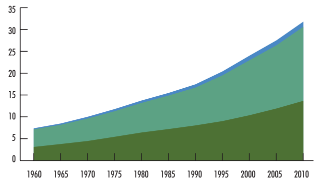
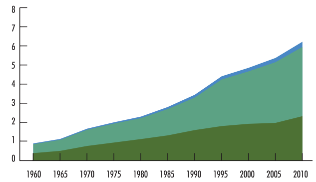


IRAQ



JORDAN



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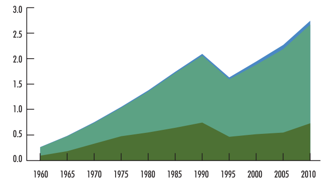
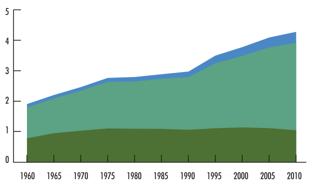
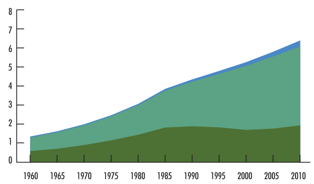


LEBANON



LIBYA



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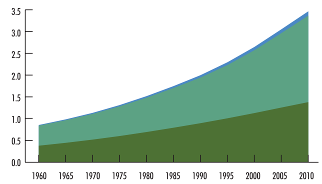
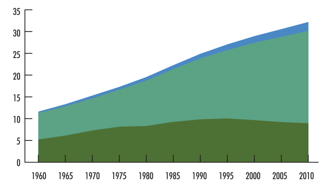
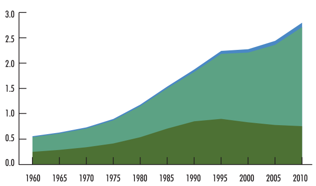


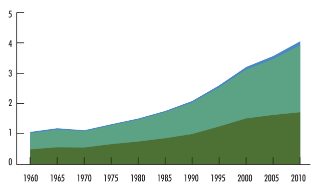
MOROCCO



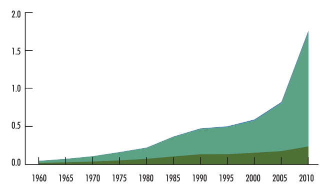
OMAN



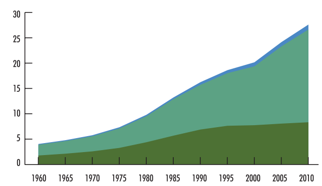
OCCUPIED PALESTINIAN TERRITORIES



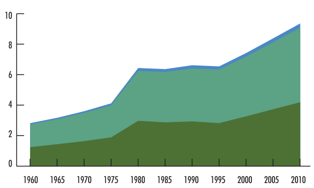
QATAR



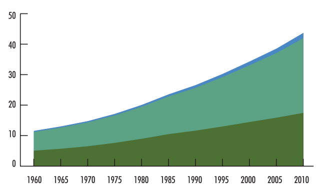
SAUDI ARABIA



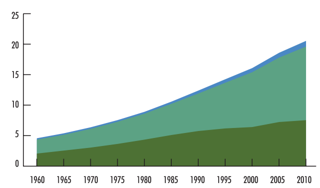
SOMALIA



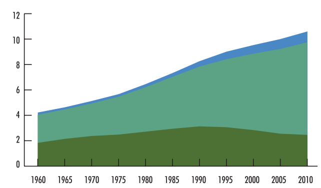
SUDAN



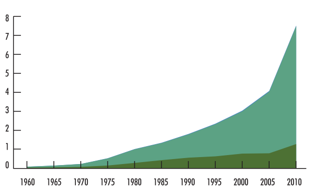
SYRIA



TUNISIA



UNITED ARAB EMIRATES



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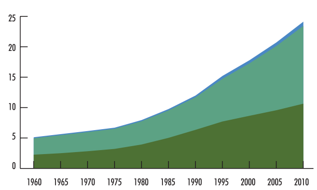

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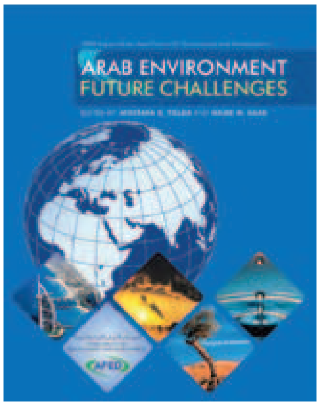
Note: Population data for the United Arab Emirates were provided directly from government sources.

Notes

Arab Environment: Future Challenges

2008 Report of the Arab Forum for Environment and Development

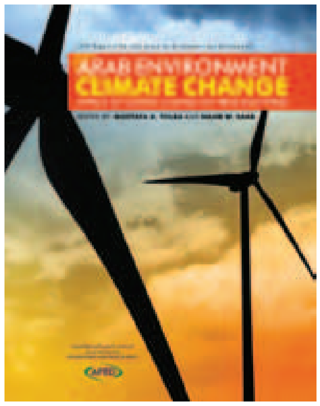


For the first time, a comprehensive independent expert report on Arab environment is released for public debate. Entitled *Arab Environment: Future Challenges*, this ground-breaking report has been commissioned by Arab Forum for Environment and Development (AFED), and written by some of the most prominent Arab experts, including authors, researchers and reviewers. Beyond appraising the state of the environment, based on the most recent data, the policy-oriented report also evaluates the progress towards the realization of sustainable development targets, assesses current policies and examines Arab contribution to global environmental endeavors. Ultimately, the report proposes alternative policies and remedial action.

www.afedonline.org
info@afedonline.org

Arab Environment: Climate Change

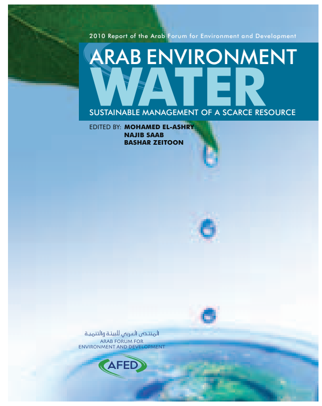
2009 Report of the Arab Forum for Environment and Development



Impact of Climate Change on the Arab Countries is the second of a series of annual reports produced by the Arab Forum for Environment and Development (AFED). The report has been designed to provide information to governments, business, academia and the public about the impact of climate change on the Arab countries, and encourage concrete action to face the challenge.
The report analyzes the Arab response to the urgent need for adaptation measures, and uses the latest research findings to describe the vulnerabilities of natural and human systems in the Arab world to climate change and the impacts on different sectors. In an attempt to help shape adequate policies, the report discusses options for a post-Kyoto regime and outlines the state of international negotiations in this regard.

Arab Environment: Water

2010 Report of the Arab Forum for Environment and Development



Water: Sustainable Management of a Scarce Resource is the third of a series of annual reports produced by the Arab Forum for Environment and Development (AFED). It follows the publication of two reports, Arab Environment: Future Challenges in 2008 and Impact of Climate Change on Arab countries in 2009.
The 2010 report is designed to contribute to the discourse on the sustainable management of water resources in the arab world and provides critical understanding of water in the region without being overly technical or academic in nature.
The unifying theme is presenting reforms in policies and management to develop a sustainable water sector in Arab countries. Case studies, with stories of successes and failures, are highlighted to disseminate learning.
This report contributes to the ongoing dialogue on the future of water and catalyzes institutional reforms, leading to determined action for sustainable water policies in Arab countries.

Arab Environment: Green Economy

2011 Report of the Arab Forum for Environment and Development

Green Economy: Sustainable Transition in a Changing Arab World is the fourth of a series of annual reports on the state of Arab environment, produced by the Arab Forum for Environment and Development (AFED).
This report on options of green economy in Arab countries represents the first phase of the AFED green economy initiative. Over one hundred experts have contributed to the report, and discussed its drafts in a series of consultation meetings.
The report is intended to motivate and assist governments and businesses in making a transition to the green economy. It articulates enabling public policies, business models, green investment opportunities, innovative approaches, and case studies, and addresses eight sectors: agriculture, water, energy, industry, cities and buildings, transportation, tourism, and waste management.