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STRUCTURAL TRANSFORMATION AND SUSTAINABLE DEVELOPMENT IN AFRICA

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The $ sign refers to the United States dollar.

Sub-Saharan Africa: Except where otherwise stated, this includes South Africa.
North Africa: In this publication, Sudan is classified as part of sub-Saharan Africa, not North Africa.

A hyphen (-) indicates that the data are either not available or not applicable.

ABBREVIATIONS

AIS	agriculture innovation system
ANS	adjusted net savings
ARSCP	African Roundtable on Sustainable Consumption and Production
CIS	Commonwealth of Independent States
CO_2	carbon dioxide
DE	domestic extraction
DMC	domestic material consumption
DSM	demand sector management
ECA	Economic Commission for Africa
EITI	Extractive Industries Transparency Initiative
EKC	Environmental Kuznets Curve
EST	environmentally sound technologies
EU	European Union
FAO	Food and Agriculture Organization
FDI	foreign direct investment
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gases
GTP	Growth and Transformation Plan
HANPP	Human Appropriation of Net Primary Production
ICT	information and communication technology
IPAT	impact, population, affluence and technology
IPR	intellectual property rights
KWh	kilowatt hours
LDC	least developed country
MFA	Material Flow Accounting and Analysis
MVA	manufacturing value added

NCPC	National Cleaner and Production Centre
NEECP	National Energy Efficiency and Conservation Plans
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
NPP	net primary production
ODA	official development assistance
OECD	Organization for Economic Cooperation and Development
PES	payments for ecosystem services
PPI	private participation in infrastructure
PPP	public-private partnerships
PTB	physical trade balance
R&D	research and development
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing countries
RET	renewable energy technologies
SAIS	sustainable agricultural innovation system
SME	small and medium-sized enterprise
SNA	system of national accounts
SRI	System Rice Intensification
SST	sustainable structural transformation
tC/ha/yr	tons of carbon per hectare per year
TRIMS	Trade-Related Investment Measures
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WFP	World Food Programme
WIPO	World Intellectual Property Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

INTRODUCTION

THE RATIONALE FOR A NEW DEVELOPMENT PATH

African countries have been growing at a relatively fast rate since the beginning of the new millennium, which in turn has led to improvements in several areas such as trade, mobilization of government revenue, infrastructure development, and the provision of social services and vice versa. Indeed, over the period 2001–2008, Africa was among the fastest growing regions in the world economy, and it is interesting to note that this improvement in growth performance has been widespread across countries. Despite the progress that has been made by the region over the last decade, the current pattern of growth is neither inclusive nor sustainable. There are various reasons for this.

Firstly, African countries are heavily dependent on natural resources as drivers of economic growth. But most of these resources — fossil fuels, metallic and non-metallic minerals — are non-renewable and are being depleted at a very rapid rate with negative consequences for future growth and sustainability. The dependence on resource-based growth is also of concern to African policymakers because commodity prices are highly volatile and subject to the caprices of global demand. Such price instability has negative consequences for investment and makes macroeconomic planning challenging.

Secondly, per capita agricultural output and productivity in the region are still low compared to the global average, with dire consequences for food security and social stability. The African Development Bank estimates that Africa's per capita agricultural output is about 56 per cent of the global average. Furthermore, about 30 per cent of sub-Saharan Africa's total population is estimated to have been undernourished in 2010 (Food and Agriculture Organization of the United Nations (FAO) and World Food Programme (WFP), 2010). There have been some positive signs of rising agricultural productivity during the last decade (Block, 2010). But in the past, agricultural output growth has been driven largely by an expansion of cropped area rather than an increase in productivity. With rising rural population densities, farm sizes have been declining and more and more people have been compelled to move to more fragile lands. The sustainable intensification of agricultural production is necessary to boost agricultural productivity and output and enhance food security in the region.

A third feature of Africa's current pattern of growth is that it has been accompanied by deindustrialization, as evidenced by the fact that the share of manufacturing in

Africa's gross domestic product (GDP) fell from 15 per cent in 1990 to 10 per cent in 2008. The most significant decline was observed in Western Africa, where it fell from 13 per cent to 5 per cent over the same period. Nevertheless, there has also been substantial deindustrialisation in the other sub-regions of Africa. For example, in Eastern Africa the share of manufacturing in output fell from 13 per cent in 1990 to about 10 per cent in 2008 and in Central Africa it fell from 11 to 6 per cent over the same period. Furthermore, in Northern Africa it fell from about 13 to 11 per cent and in Southern Africa it fell from 23 to 18 per cent. The declining share of manufacturing in Africa's output is of concern because historically manufacturing has been the main engine of high, rapid and sustained economic growth (UNCTAD and the United Nations Industrial Development Organization (UNIDO), 2011).

Furthermore, Africa has experienced rapid urban growth. The share of the urban population in total population is currently about 40 per cent and is projected to rise to about 60 per cent by 2050.[1] Historically, industrialization and an industry-led agricultural transformation have been important drivers of urbanization, making it possible to absorb labour moving from the rural to the urban and modern sectors of the economy. However, Africa's urbanization has not been driven by either industrialization or an agricultural revolution. Jedwab (2012) shows that the dramatic urban growth observed in Africa over the past few decades has been driven by natural resource exports rather than an industrial or agricultural revolution. He argues that, because natural resource rent in Africa are spent mostly on urban goods and services, they make cities relatively more attractive and pull labour out of the rural areas.

The current pattern of Africa's economic growth is particularly worrisome given the fact that the region has a young and growing population and will, according to the United Nations Population Division, account for about 29 per cent of the world's population aged 15–24 by 2050. Furthermore, population projections indicate that the working age population in Africa is growing by 15.3 million people per annum, and this number is expected to increase over the coming decades. While having a young and growing population presents opportunities in terms of having an abundant labour supply with much creative potential, it also means that African countries will need to engage in growth paths that generate jobs on a large scale to absorb the additional labour. In particular, they will need to move away from jobless growth strategies and towards inclusive growth paths that are labour-intensive and create learning opportunities for young people. Recent events in North Africa have shown that a development pathway that generates growth without significant improvements in employment has the potential to create social and political unrest with dire consequences for efforts to promote sustainable development.

Recent evidence shows that Africa has experienced a process of structural change over the last 30 years, but that it has not been productivity-enhancing structural change. This is because it has been associated with the increasing importance of the commodity economy and also the rising importance of low-productivity informal economic activities in the service sector. Such structural change has actually slowed rather than enhanced the economic growth process, as it has not involved a shift from low-productivity to high-productivity sectors (McMillan and Rodrik, 2011). Consequently, if African countries want to achieve high and sustained economic growth, they have to go through the process of structural transformation involving an increase in the share of high productivity manufacturing and modern services in output, accompanied by an increase in agricultural productivity and output.

In recent years, African leaders have responded to the challenge of resource-based growth by renewing their political commitment to structural transformation and adopting several initiatives, at the national and regional levels, aimed at diversifying their production and export structures (UNCTAD and UNIDO, 2011). But structural transformation is a double-edged sword: while it is necessary for sustained growth and poverty reduction, it also imposes significant costs on ecological systems, especially when deliberate and appropriate actions are not taken by governments to reduce environmental damage to protect the environment. Fischer-Kowalski and Haberl (2007) argue that, historically, the transition from an agrarian to an industrial socio-ecological regime has been a major factor behind the rapid increase in environmental pressures. Resulting problems range from climate change, waste pollution, deforestation, desertification and degradation of freshwater resources, to the loss of biodiversity. It is crucial that the renewed focus on structural transformation in Africa is not achieved at the expense of social and environmental sustainability. Therefore, as they ratchet up efforts to transform their economies, African governments should also seek to improve resource use efficiency and address the adverse environmental impacts of structural transformation.

In summary, Africa needs to rethink its growth strategies and find ways and means to make them more compatible with the objective of sustainable development. Sustainable development as recognized in the Brundtland report amounts to "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". As acknowledged at the

United Nations World Summit in 2005, sustainable development consists of three interdependent and mutually reinforcing pillars: *economic development, social equity and environmental sustainability.* In particular, it requires that policymakers take into account the consequences of their choices and decisions on future generations and that social welfare is maximized inter-temporally rather than currently.

THE FOCUS AND MAIN MESSAGE OF THE REPORT

The *Economic Development in Africa Report 2012,* subtitled *"Structural Transformation and Sustainable Development in Africa"*, examines how African countries can promote sustainable development. The main message of the *Report* is that *achieving sustainable development in Africa requires deliberate, concerted and proactive measures to promote structural transformation and the relative decoupling of natural resource use and environmental impact from the growth process.* Sustainable structural transformation, as defined in the *Report*, is structural transformation with such decoupling.

The *Report* builds on the *Economic Development in Africa Report 2011* on *Fostering Industrial Development in Africa in the New Global Environment.* It also fits into UNCTAD's broader work on the development of productive capacities. The report is timely in the light of the United Nations Conference on Sustainable Development (Rio+20), 20–22 June 2012 and the renewed global focus on greening economies occasioned by the global financial and economic crisis of 2008–2009. The concept of sustainable structural transformation provides a dynamic understanding of the efforts which are involved in greening an economy, and also places such efforts into a development perspective.

The *Report* focuses directly on the economic and environmental pillars of sustainable development. However, to the extent that it stresses the need for structural transformation — which is crucial for inclusive growth and poverty reduction — it indirectly addresses the social pillar as well. The *Report* argues that, in the context of structural transformation, decoupling natural resource use and environmental impacts from economic growth is critical to addressing the environmental sustainability challenge in Africa. The United Nations Environment Programme (UNEP) defines decoupling as using less resource per unit of economic output (i.e. increasing resource productivity or resource efficiency) and reducing the environmental impact of any resources that are used or economic activities that are undertaken. Decoupling can be either absolute — requiring a decrease in the absolute quantity of resources used irrespective of output produced — or relative, which implies that resources may be increasingly used but at a rate lower than the rate of increase in output.

While absolute decoupling may be needed at the global level to address global environmental challenges (such as climate change), this *Report* argues that the focus of African policymakers should be on *relative decoupling* because the region has very low per capita resource use compared with the global average and is also not a major polluter. Furthermore, Africa currently has very low per capita income, has not gone through the normal process of structural transformation, and would need to achieve higher economic growth in the short-to-medium term in order to make significant progress in reducing poverty. Consequently, the region needs more policy space to promote structural transformation and address its current and emerging development challenges. Furthermore, decoupling should not be seen as an end in itself but rather as a part of a more expansive strategy of structural transformation.

Africa, however, does not stand alone in the need to achieve sustainable development. There is a general global movement for integrating environmental considerations into economic and social decision-making. The *Report* points out that these international efforts should be managed in a manner that does not reduce the policy space needed by African countries to promote sustainable structural transformation. Moreover, the international community has an important role to play in supporting sustainable structural transformation through action in the key areas of trade, finance and technology transfer.

STRUCTURE OF THE REPORT

The main body of the *Report* consists of four chapters.

Chapter 1 is on conceptual issues. It discusses different views of the relationship between the economy and the environment and of how resource use and environmental impacts typically change during the course of a development process. It raises some conceptual questions concerning “green economy” and “green growth”, and introduces and defines the concept of sustainable structural transformation as a way to operationalize the concept of the green economy in the context of sustainable development and poverty eradication.

Chapter 2 presents new stylized facts associated with resource use and productivity in Africa. Where possible, it discusses how these stylized facts could be linked to the structural transformation process. The chapter also provides information on Africa's contribution to global greenhouse gas emissions and the impact of climate change in the region.

Chapter 3 provides a strategic framework for sustainable structural transformation. It discusses the nature of the African challenge in a global context and why African governments should adopt policies of sustainable structural transformation rather than follow a policy of "Grow Now, Clean Up Later". It also identifies key drivers of sustainable structural transformation, its prioritization and financing. Finally, it discusses the role of government in promoting sustainable development, and the way in which the international community can support national efforts.

Chapter 4 identifies policies for sustainable structural transformation in Africa, with a focus on three key economic sectors: energy, industry and agriculture. Furthermore, it highlights the special role of trade and technology policies in promoting sustainable structural transformation in Africa.

The final chapter presents a summary of the main findings and policy recommendations of the *Report*.

CHAPTER 1

ENVIRONMENTAL SUSTAINABILITY, ECONOMIC GROWTH AND STRUCTURAL TRANSFORMATION: CONCEPTUAL ISSUES

There are important differences among economists, and also between economists and ecologists, regarding the relationship between economic growth and the environment, the meaning of sustainability, and the policies necessary to make growth consistent with environmental sustainability. Against this backdrop, this chapter examines some conceptual issues critical to understanding different approaches.

The chapter is organized in four parts. Section A summarizes some fundamental differences among scholars on what sustainability is, how it could be achieved, and the policies deemed necessary to make growth consistent with environmental sustainability. In this context, section B identifies some conceptual issues related to the notions of the green economy and green growth. A particular challenge is to operationalize the idea of a green economy in a development context. Section C builds on one of the approaches of section A to discuss how resource use and environmental impacts change during the course of economic development. This shows that for countries at low levels of development, there will necessarily be a trade-off between structural transformation, on the one hand, and environmental sustainability, on the other hand. Section D introduces the concept of *sustainable structural transformation* (SST) as an appropriate strategy for managing that trade-off and introducing a development-led approach to the green economy.

A. THE RELATIONSHIP BETWEEN THE ECONOMY AND THE ENVIRONMENT: ALTERNATIVE VIEWS

Traditionally, economists downplayed the importance of the natural environment for economic processes. They viewed the economic system in terms of the reciprocal circulation of income between producers and consumers, and focused on the problem of allocating resources efficiently between different uses to meet unlimited wants. Neoclassical environmental and resource economists consider the environment, along with the planet's resources, as a sub-part of the economic system. They have introduced natural capital into their analytical frameworks and examined problems of resource misallocation arising from the failure of markets to generate appropriate prices for natural resources. There is also increasing attention to natural capital within growth models (see, for example, Hallegatte *et al*., 2011). In general, mainstream economists have assumed that the expansion of the economy should allow societies to harness new technologies to conserve scarce resources, as well as to offset any adverse effects that increased economic activity might have on the environment (Grossman and Krueger, 1995). In other words, growth is conceptualized as a solution rather than as the cause of environmental problems. Moreover, the expansion of an economy can continue into the future following a balanced growth path without any apparent limits.

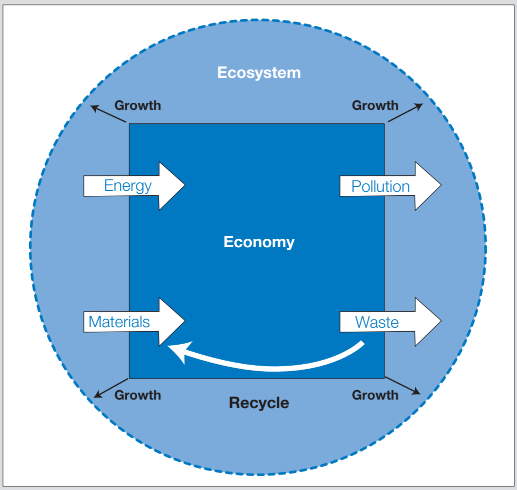
This view stems in part from the fact that neoclassical economists do not regard the scarcity of natural resources as a binding constraint. In their view, the scarcity of a natural resource should lead to an increase in its price and substitution away from that resource into other relatively less expensive factor inputs. The idea is that natural capital (such as renewable and non-renewable resources) and man-made or reproducible capital are substitutes, and so the depletion of natural capital should affect their supply price and induce substitution away from natural capital and into reproducible capital. Because of the assumption of substitutability between natural and reproducible capital, sustainability in mainstream economics requires *maintaining intact the value of a nation's total capital stock over time* (Heal, 2007). This notion of sustainability which is referred to as *weak sustainability* in the literature allows countries to compensate for the depletion of some kinds of capital by investing in other kinds of capital. It draws heavily from studies by Solow (1974) and Hartwick (1977), showing that a maximal level of consumption or welfare can be maintained over time if the rent from the use of exhaustible resources is reinvested in reproducible capital (the Hartwick rule). In this framework, what is important for sustainability is not the composition of a nation's capital, but the total value of its capital stock. Furthermore, it is assumed that there is a positive relationship between the total value of an economy's capital and long-run living standards — or there is a discounted value of welfare. Consequently, if a country wants to maintain its long-run living standards intact, it also has to maintain the total value of its capital stock intact.

Although the methodology adopted by mainstream economists in dealing with environmental issues is regarded as analytically rigorous and tractable, it suffers from several limitations. In particular, it treats the economy as if it is a self-contained system, with the planet, resources, animals and people existing as components of the economic system. This ignores the fact that in reality the economy is a part of the larger ecosystem, which is the source of natural resources used in an economy and is also a sink for the wastes produced in it. Vencatachalam (2007) argues that the narrowness of the neoclassical approach to environmental and ecological issues has made it difficult to understand and address environmental problems, such as global warming and the loss of biodiversity.

In contrast to environmental and resource economists, ecological economists view the economic system as a part of the larger ecosystem, which is the source of natural resources used in an economy and is also a sink for the wastes produced in it (Constanza, 1991; Daly 1996). That is, it receives inputs, such as energy and material resources, from the broader natural systems and produce wastes and pollution as outputs (see figure 1). These inputs and outputs from and to the ecosystem constitute what is known as the throughput of an economy.

This shift in vision has important consequences. Whilst environmental and resource economists within the neoclassical tradition focus on allocation issues, ecological economists emphasize the overall scale of the economy as a key policy issue. At the global level, as the economy grows bigger and bigger, it reduces the capacity of the ecosystem to perform its source and sink functions more and more. From this perspective, there are global limits to economic growth in the sense that, once the global economy passes a certain size, the benefits of consuming produced goods and services are outweighed by the costs in terms of destruction of ecosystem services on which the economy is based. This issue is not relevant when the material weight of the economic system on the ecological system is relatively small, but it becomes relevant in a "full world"[2], where the size of the global

Figure 1. The economy as a subsystem of the Earth system



Source: Based on Goodland and Daly (1996).

economy undermines the natural bases for economic processes and prosperity. Most ecological economists believe that we are now living in a full world.

Ecological economists are likewise sceptical about the substitutability between natural capital and man-made capital, as implied by the notion of weak sustainability. Consequently, they share the view that sustainability requires society maintaining intact its natural capital to ensure that future generations have the same production and consumption possibilities that are available to the current generation. This is the notion of *strong sustainability* in the literature on environmental and ecological economics (Daly 1990; 1996). It should be noted that, although proponents of strong sustainability emphasize the preservation of the stock of natural capital, some also assume that there is substitutability within natural capital, but not between natural and man-made capital. Other proponents, however, argue that there is the need to preserve the physical stocks of critical natural capital, because they provide life-support services and the loss of natural capital is irreversible. Furthermore, there is uncertainty about the impact of natural resource depletion and so society should adopt a cautious approach to the use of natural capital. Daly (1990) has identified four basic principles that economies could follow to ensure that natural capital is maintained at a sustainable level, namely: (a) the health of ecosystems and their life support services should be maintained; (b) renewable resources should be extracted at a rate that is not more than their rate of regeneration; (c) non-renewable resources should be consumed at a rate that is not more than the rate at which they can be replaced through discovery of renewable substitutes; and (d) waste disposal should be done at a rate not higher than the rate of absorption by the environment.

While ecological economists recognize the existence of limits to economic growth at a global scale, they also argue that developing countries still need to expand their economies. Levels of human well-being are very low, and people have legitimate aspirations to higher living standards which can only be achieved through high levels of economic growth maintained over a few generations. What this implies is that global distributional issues are at the heart of the concern to ensure environmental sustainability along with prosperity for all. This approach draws attention to major global inequities in terms of the distribution of both contributions to, and the costs of, environmental pressures. The work of ecological economists is also showing that international trade is acting as a powerful mechanism through which environmental constraints in one country are being circumvented, and environmental costs outsourced from countries of consumption to countries of production.

B. CONCEPTUAL ISSUES CONCERNING THE GREEN ECONOMY AND GREEN GROWTH

It is against the background of these alternative views of the relationship between the environment and the economy that the new policy concepts of the "green economy" and "green growth" have been introduced. There is no consensus on the meaning of these terms. But, rhetorically, being "green" connotes being good to the environment. UNEP (UNEP, 2011b) defines a green economy as one which is "low-carbon, resource-efficient and socially inclusive", or to put it in other words, a green economy is "one that results in improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities". The Organization for Economic Cooperation and Development (OECD, 2011) states that "green growth means fostering economic growth and development while ensuring that natural assets continue to provide resources and environmental services on which our well-being relies".

The major point of introducing these concepts has been to sharpen the focus on the relationship between the economy and the environment within a policy discourse, where the concept of sustainable development has been in long use. Neither UNEP nor OECD sees these concepts as replacements for the idea of sustainable development. According to OECD (2011), green growth is "a subset" of the idea of sustainable development, "narrower in scope, entailing an operational policy agenda that can help achieve concrete, measurable progress at the interface between economy and environment"; whilst UNEP (2011b) sees the usefulness of the concept of a green economy stemming from "a growing recognition that achieving sustainability rests almost entirely on getting the economy right".

However, there is also a significant difference between these new concepts and the old concept of sustainable development. In general terms, sustainable development has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". But such development rests on three pillars — economic growth, social equity and environmental sustainability — and it was explicitly recognized that in achieving sustainable development there would be potential trade-offs amongst them. In contrast, the concepts of green economy and green growth place greater emphasis on the potential synergies between economic growth and environmental sustainability. These synergies definitionally constitute what a green economy is in the UNEP Green Economy Report ((UNEP, 2011b). With regard to green growth, three basic positions have been identified in the literature (see Huberty *et al.*, 2011). The first, and weakest, argues that greening the economy does not inhibit economic growth and employment creation; the second argues that there are significant new opportunities for growth and jobs in green sectors; and the third, and strongest, argues that new environmental technologies and renewable energy systems will provide the basic sources of economic growth in the coming long-wave of economic growth.

The idea that economic growth and environmental sustainability are complementary objectives is certainly attractive. However, there is a danger that political enthusiasm undermines policy rigour. Huberty et al. (2011) go as far as to say that "to date, discussions of 'green growth' have been more religion than reality", adding that "the easiest arguments about green growth are not satisfactory". Dercon (2011) notes that "much of the discussion on green growth remains relatively vacuous in terms of specifics for poor settings", and says that the understanding of the interaction between green growth strategies and investments and poverty is particularly weak. He asks: "Is all green growth good for the poor, or do certain green growth strategies lead to unwelcome processes and even 'green poverty', creating societies that are greener but with higher poverty?" (p. 2). From another perspective, Hoffmann (2011) argues that current approaches to the green economy are simply insufficient to meet the challenge of reducing global emissions and thus mitigating climate change.

More research is definitely needed. But one review of the literature on green growth in the context of developed countries has concluded that "green growth arguments should be treated with cautious optimism" (Huberty *et al.*, 2011). The research shows that combining growth with emissions reductions is possible at low cost. But, in general, "none of the current prescriptions for green growth guarantee success" (Huberty *et al.*, 2011). In particular, the creation of green jobs and new green sectors in many cases may simply offset the destruction of brown jobs in declining sectors. Moreover, new opportunities for economic growth in developed countries based on the development of green sectors have particularly relied on exports and may not be replicable. In the context of developing countries, research is even scarcer. But Dercon (2011) carefully examines how internalizing environmental costs may change patterns of growth and concludes that "it is not very plausible that green growth will offer the rapid route out of poverty as it appears to promise, or even as rapid an exit with more conventional growth strategies" (Dercon, 2011).

Relating the concepts of green economy and green growth to processes of economic development is as yet a major weakness within the literature. IBON International (2011) states that “by focusing on ‘getting the economy right’, proponents of the green economy and green growth end up getting development wrong”. Khor (2011) is particularly sensitive to this issue. He cautions against a one-dimensional usage of the green economy concept, which promotes it in a purely environmental manner without fully considering the development dimension and equity issues, particularly at the international level, and against a one-size-fits-all approach, in which countries at different levels and stages of development, and in particular the priorities and conditions of developing countries, are not taken into account. He also argues that the meaning, use and usefulness of the notion of the green economy for policymakers in developing countries, and also in international negotiations, will depend on clarification of a number of difficult questions, notably (a) whether the attainment of a green economy constrains other objectives (growth, poverty eradication, job creation); (b) how to identify and deal with trade-offs; (c) what is the combination between these aspects at different stages of development as well as stages in the state of the environment; (d) what is the role of the State in building a green economy, its compatibility with free market and the role of the private sector; and (e) how to build an economy that is more environmentally friendly and how to handle the transition from the present to a greener economy.

It is clear that operationalizing the concept of the green economy in the context of sustainable development and poverty eradication in a way which is relevant to developing countries is a work in progress. More attention needs to be given to the nature of the relationship between the economy and the environment, the way in which such relationship evolves during the process of economic development, and the implications of that evolving relationship for the policy challenge of promoting development and poverty reduction in countries at different levels and stages of development.

C. THE DYNAMICS OF DEVELOPMENT, RESOURCE USE AND ENVIRONMENTAL IMPACTS

This section seeks to build a developmental approach to the relationship between the economy and the environment. It takes as its starting point the idea that the economy is best viewed as a subsystem of the Earth-system and then considers how, within this vision, resource use and environmental impacts change during the economic development process. This provides the basis for a strategic approach to sustainable development, which builds on the imperative of structural transformation for accelerated economic growth and poverty reduction.

It summarizes three major views of the dynamics of development, resource use and environmental impacts, namely:

- The IPAT equation;
- The Environmental Kuznets Curve (EKC) hypothesis; and
- Socioecological metabolism and structural change.

These views constitute a valuable framework to comprehend where countries at different levels of development stand in relation to their current and future use of natural resources and levels of environmental impact. They provide a basis for starting to think about a development-led approach to the green economy.

1. The IPAT equation

Economists have long tried to identify the factors that determine the degree of environmental impact registered throughout the different stages of the development process. One of these attempts is represented by the IPAT equation, formulated by Ehrlich and Holdren (1971) and Commoner (1972). In basic terms, it suggests that an environmental impact (I) depends on the levels of population (P), affluence (A) and technology (T).

Environmental impact = Population x Affluence x Technology

The equation is useful to express the extent to which each component contributes to an unsustainable situation, but it can also be interpreted as a way to assess an economy's pathway towards sustainability. By analysing each of its components, the identity implies that growing population rates lead to larger pressures on the environment. On the other hand, higher levels of affluence, which is generally measured in consumption per capita terms, entail a larger demand for natural resources and energy, as well as a rising generation of wastes and pollution. Finally, the level of technology, understood as the different ways in which societies use their productive resources, can have a significant effect on the degree of environmental impact, either reducing it or enlarging it. For example, the internal combustion technology has importantly contributed to the development of industrialized economies by using fossil fuels, but it has also significantly increased the levels of pollution in the atmosphere. Conversely, renewable energy technologies (RET) can crucially contribute to reduce atmospheric pollution and prevent the depletion of non-renewable resources.

The IPAT equation is very simple and has been modified several times since its inception (Chertow, 2001). A common approach is to describe each of the factors with more detail.

$$\text{Impact} = \text{Population} \times \frac{\text{GDP}}{\text{Population}} \times \left(\frac{\text{Resource Use}}{\text{GDP}} + \frac{\text{Pollution/Waste}}{\text{GDP}} \right)$$

This form of the equation expresses affluence as GDP per capita, as had already been mentioned. However, the technology factor is now decomposed into two separate components, which relate to the throughput of an economy. On the one hand, resource intensity (i.e. resource use per unit of production) shows how efficiently the inputs are used; while, on the other hand, pollution or waste intensity (i.e. pollution/waste per unit of production) exhibits the degree of "cleanliness" of a certain technology in relation to the outputs. In this sense, improvements in environmental quality can be attained by minimizing resource intensity, as well as pollution intensity.

Important policy implications arise from the IPAT equation. In particular, the need to develop more efficient technologies is vital. Members of the Factor 10 Club (1994) believe that existing resource and pollution intensities must improve by a factor of 10 during the next three to five decades so as to significantly lower the environmental impacts, especially when it comes to the generation of greenhouse gases (GHG). Others, like von Weizsäcker *et al.* (1997), propose a factor 4 approach, according to which the global population could double its wealth, while halving the amount of used resources. This basically involves multiplying the affluence (A) component by two in the IPAT equation and reducing technological-induced (T) impacts by half. Nonetheless, whichever factor is chosen (whether 10, 4 or another number), the magnitude of the required tasks to transform the structure of the global economy involves enormous efforts.

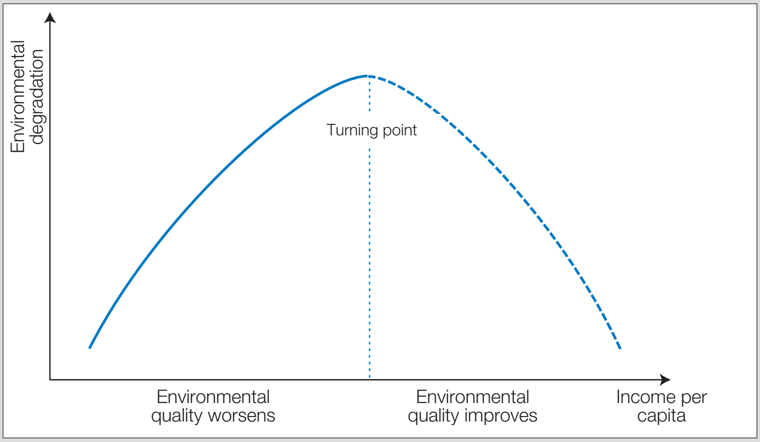
An important issue here is that, while rich industrialized countries might have the ability to generate technological innovations, many developing countries, and specifically most African countries, do not possess these capabilities. Many of them currently have access only to traditional technologies, which often are considered "dirty" or at least not efficient enough to offset the influence of the other factors in the equation. The plausibility for these countries to generate new technical innovations domestically and thus push the technological frontier is low, due to their lack of physical and human capital. Furthermore, it is important to keep in mind that the T-factor not only refers to technical innovations, but also to the institutional settings and the relationship between the different actors of a society. As recognized in the original Rio conference, changes in both technology and social organization are critical for sustainable development. This means that these countries face a complex situation, in which changes must take place at many different levels.

In relation to population, the IPAT has a harsh implication. As the number of people on the planet increases, the demand for resources will augment, generating severe consequences on the environment. However, the issue of curbing population growth depends on other developmental factors, such as reducing poverty and increasing women's rights, specifically in relation to access to education.

2. The Environmental Kuznets Curve (EKC)

Some researchers believe that the key to resolving environmental problems is the affluence factor. They argue that as economies grow and per capita income rises, environmental degradation increases but, after a certain threshold level of income, environmental quality improves. This relationship between growth and the environment is known as the EKC hypothesis (IBRD, 1992; Grossman and Krueger, 1993 and 1995). The EKC can be read following a similar logic to that applied to the original inverted-U curve formulated by Simon Kuznets (1955), which deals with income inequality and income per capita. In this fashion, the form of the EKC can be explained as a result of the process of structural change associated with economic development. In the early stages of development, there is a deterioration of environmental quality as the share of agriculture falls and the share of industry rises (see figure 2). This happens as a consequence of increasing physical capital intensive activities, rather than human capital intensive. Mass production, income per capita, and consumer expenditure grow gradually. As a society achieves a higher level of income, the share of industry starts declining and that of services increases, resulting in an expected improvement in environmental quality. At this "turning point", environmental indicators should start to display improvements. A related explanation is based on the sources of growth. For example, Copeland and Taylor (2004) argue that if capital accumulation is the source of growth in the early stage of development and if human capital acquisition is the source of growth in the advanced stage of development, then environmental quality will deteriorate at low

Figure 2. Stylized representation of the EKC hypothesis



Source: UNCTAD secretariat.

income levels and improve at very high income levels. In addition, there are other explanations for the EKC which rely on the assumption that environmental quality is a normal good whose demand increases with income. The idea being that, as income grows, environmental concerns increase, resulting in more environmental protection and better environmental quality. Yet another explanation for the EKC is that, as economies become richer, people tend to be more educated and have less children, leading to lower population growth rates. A decrease in population growth means less pressure on natural resources and hence less environmental degradation. The shape of the EKC can also be ascribed to the idea that poor countries do not have the means and capacity to adopt clean technologies and so, in the early stages of development, environmental quality tends to be low. However, as countries become richer and adopt clean technologies, environmental quality improves. This links the discussion back again to the T-factor in the IPAT equation.

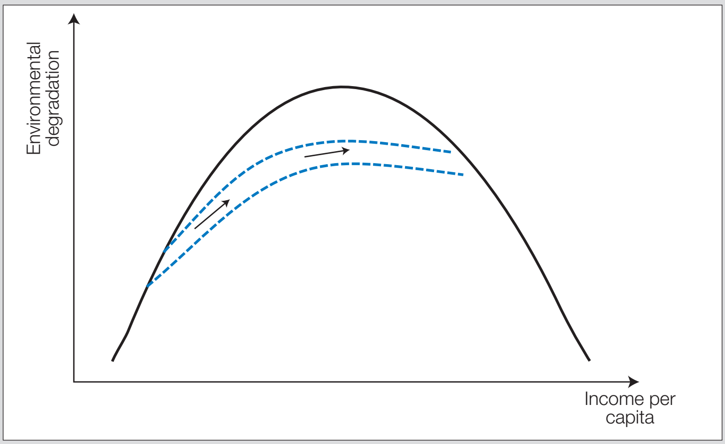
Empirical evidence has been used to assess the validity of the hypothesis. However, the empirical studies that have been carried out so far have yielded mixed results with regard to the existence of an automatic turning-point in environmental pressures. Van Alstine and Neumayer (2008) provide a critical review of the empirical literature on the EKC, arguing that the evidence is mixed. In particular, they show that the results of empirical tests of the EKC fall into three groups, depending on the indicator of environmental quality used. The first set, using indicators such as adequate sanitation and clean water, generally finds that environmental quality improves as income rises. The policy implication is that growth is good for the environment and so there is no need for environmental regulation. The second set of results, using indicators such as sulphur oxides and the rate of tropical deforestation, finds that environmental quality first deteriorates and then improves as income passes a certain threshold. This is consistent with the predictions of the EKC, and it implies that environmental quality depends on the level of development. It also implies that countries can grow out of their environmental problems over time (Beckerman, 1992). But the question arises as to the income level at which environmental quality begins to decline, whether it is automatic or due to government policy and whether any irreversible damage is done before the turning point. The final set of results, using indicators such as per capita carbon dioxide (CO_2) emissions and municipal waste, finds that there is no turning point; as income per capita rises, environmental pressures continue to rise.

One reason adduced for the sensitivity of the empirical results to the measure of environmental quality used is that some indicators such as sulphur oxide and nitrogen oxide are relatively easy to eliminate, while CO_2 and solid waste are more complicated to get rid of. Another explanation is that indicators that are “local public goods” (for example, clean water and adequate sanitation) tend to rise with income, while those that are “global public goods” (for example, CO_2 emissions) worsen as income rises.

A further complication in interpreting the EKC arises because of the implications of international trade. One group of researchers has suggested that as countries become richer, they start importing larger volumes of natural resources from other regions (Bringezu *et al.*, 2004; Ayres and van den Bergh, 2005; Rothman, 1998). Hence, the environmental burden is shifted away from their own territories towards those of other countries through international trade. This means that, if trade effects were taken into account, the EKC hypothesis would lose its validity, indicating that environmental quality does not decrease with increasing levels of income.

The mixed findings in the empirical literature present a challenge for policymakers because they have different policy implications. But in general, governments should not rely on pursuing economic growth as a measure of improving environmental conditions, especially when it comes to long-term and global problems, such as CO_2 emissions. An array of other actions, such as regulatory interventions or developing technological innovations, is important. For rich countries, what is imperative is that they must reduce their ecological footprint in absolute terms. That is to say, they should act to bring about the turning point. In the case of developing countries, it might be possible to avoid the resource-intensive and polluting development trajectory of their industrialised counterparts. They might “leapfrog”, or in other words “tunnel through” the EKC, accelerating their development processes by skipping inferior and less efficient stages and moving directly to more advanced ones (see figure 3). However, the ability to leapfrog and tunnel through the EKC in this way will depend upon effective technology transfer between richer and poorer countries, as well as increasing the ability of the latter to adapt and utilize these technologies.

Figure 3. Tunnelling through the EKC



Source: UNCTAD secretariat.

3. Socioecological metabolism and structural change

Although the affluence factor undoubtedly plays an important role, basing the transition towards a sustainable pathway solely on it may prove to be an overly simplistic approach. Several scholars consider that additional determinants exert a significant influence, and some of these can be rooted in the way the relationship between economies and the ecological system changes with the economic transformations associated with industrialization.

Socioecological metabolism is a term that has been steadily emerging in the sustainability literature, and specifically in the area of industrial ecology, to understand this relationship (Fischer-Kowalski and Haberl, 2007). *Metabolism* is a concept that originated in the biological sciences, and it essentially refers to the processes by which living organisms take nutrients from the environment, break them into smaller pieces so as to assimilate them, and then discard what is not required. In a way, this description is similar to the concept of throughput. Consequently, one can also conceive that societies carry out a metabolic process, by acquiring energy and extracting natural resources from the ecosystems, then processing them in order to be consumed, and finally generating wastes and other by-products, such as pollutant gases. The scale of this throughput is determined by the specific stage of development that an economy is going through. Societies have historically followed a trajectory that has clearly marked their changing interrelationship with the ecological sphere.

The primitive hunter–gatherer societies performed a basic metabolism, in which the scale of their throughput remained most of the time within the environment's carrying capacity. By not growing or farming their own food requirements, these societies just extracted from the natural realm the required amount of resources they required for subsistence, depending mostly on the sun's energy and biomass. They could only deplete the resources if their rate of consumption exceeded the ecosystem's natural regeneration rate. Meanwhile, the amount of wastes derived from their metabolic process was easily absorbed again by the ecosystem. However, over time, this socioecological regime evolved. The emergence of agriculture relied on the accumulation of knowledge about the natural world (e.g. climate patterns, soil and plants characteristics, etc.) and the development of new techniques. In this way, societies underwent a transition towards a new regime, in which they started "colonizing" nature and appropriating a larger amount of resources (Krausmann *et al.*, 2008). In other words, societies started to transform the natural ecosystems into man-made systems designed to maximize their productivity and social and economic usefulness. Animals and plants were domesticated, leading to an artificial selection of the genetic code. Moreover, populations started to expand, increasing the scale of their throughput and consequently exerting a larger pressure on the ecosystems. The main source of energy still remained solar-based, and these societies were completely reliant on the energy conversion provided by biomass sources. Their environmental impact varied according to the region, but environmental degradation and resource depletion started to emerge as problems in some areas. What is important to mention in this respect is that, although agrarian economies started to evolve thousands of years ago, this regime still exists today. Millions of people continue to subsist in agrarian economies, and specifically in Africa.

With industrialization, a new regime emerged, based on a revolutionary technological change and the use of non-renewable sources of energy. Fossil fuels and new production techniques allowed societies to “extend” their metabolism and overcome some of the problems associated with the agrarian societies, such as scarcity and its strong dependence on solar-based energy and climate. This facilitated an unprecedented productivity increase, driven by a significant expansion of population and per-capita material and energy consumption. Industrialization has allowed some countries to achieve higher levels of economic growth and elevate the standards of living of millions of people over the last century. However, at the same time, this transition has implied an even more severe pressure on ecosystems. The scale of throughput registered historical levels. The rate of resource extraction has surpassed the natural regeneration rates, resulting in depletion of natural capital, and the amount of wastes is larger than the amount that can be absorbed by the planet’s sink mechanisms (Haberl *et al.*, 2011).

The importance of the socioecological metabolism approach is that it takes into account resource use and environmental impacts, and illustrates how they change during the process of structural transformation. Table 1 shows some indicators that illustrate the transition between an agricultural and an industrial regime. These are presented in the third and fourth columns. Energy and material use per-capita increase significantly. The use of biomass as an energy source accounts for 10 per cent to 30 per cent of the total energy mix, while fossil fuels provide up to 80 per cent of the energy requirements. It is relevant to take these figures into account, since the transition from an agrarian to an industrial regime is still currently taking place in many economies. The three last columns present data for least developed countries (LDCs), developing countries (including LDCs) and developed countries. The metabolic profile of LDCs corresponds to that of a typical agrarian regime. Total energy and material use per capita and per unit of area are low, while they rely on traditional forms of biomass as their primary source of energy. Developing countries, on the other hand, present higher figures. However, on average, they seem to be closer to an agrarian profile, than to an industrial one, which indicates that they have still not managed to complete the transition. Their total energy and material use is still far from reaching the levels registered in the industrial regime. In

Table 1. Metabolic profiles of the agrarian and industrial regimes

	Unit	Agrarian society	Industrial society	LDCs	Developing	Developed*
Population density	cap/km^2	<40	100–300	40	76	116
Total energy use per capita	GJ/cap/year	50–70	150–400	33	64	205
Total energy use per unit area	GJ/ha/year	20–30	200–600	13	49	216
Biomass (share of energy use)	per cent	95–100	10–30	92	50	23
Fossil fuels	per cent	0–5	60–80	8	50	77
Use of materials per capita	ton/cap/year	2–5	15–25	4.2	6.8	16
Use of materials per unit area	ton/ha/year	1–2	20–50	1.3	4.8	18

Source: Fischer-Kowalski (2011) and Haberl *et al.* (2011).
Notes: * Based on European Union (EU) 15.
cap = capita; GJ = gigajoule; ha = hectare; km^2 = square kilometre

contrast, the figures corresponding to developed nations — which are based on the EU15 members — show a considerable use of energy and resources and a very strong dependency on fossil fuels.

The metabolic profiles of different types of economies are also profoundly influenced by trade. As countries begin to industrialise, their material and energy requirements augment significantly, and a diverse range of different types of materials are needed and utilised. Hence, these countries start relying not only on domestic sources, but also in foreign stocks of natural capital to fulfil their material requirements (Bringezu *et al.*, 2004). In general, there is an escalating dependency of domestic industries in industrialized countries on imports of natural resources, particularly regarding fossil fuels and metal ores (European Commission, 2006). In this way, industrialized countries shift the environmental burden away from their own territories through trade, and externalize it to other regions (Schütz *et al.*, 2003; Giljum *et al.,* 2008). Concomitantly, resource-exporting countries, which may be predominantly agricultural- or mineral-based, exhibit elevated material extraction rates and resource use. High levels of environmental pressure can, in such cases, be coupled with low levels of consumption.

The findings of the research based on socioecological metabolism are important as they show that structural transformation is going to exacerbate resource and in particular energy use. The challenge for developing countries in this context is how to reconcile the imperatives of structural transformation for improving human well-being with the imperatives of environmental sustainability, at both national and global levels.

D. THE CONCEPT OF SUSTAINABLE STRUCTURAL TRANSFORMATION

The challenge of achieving sustainable development is different in countries at different levels of development. For countries at low levels of development which are commodity-based and in which low-productivity agriculture is still the predominant source of livelihood, the challenge involves resolving a specific dilemma. On the one hand, structural transformation is necessary for achieving substantial and broad-based improvements in human well-being. On the other hand, structural transformation, together with rising affluence and growing population, will necessarily intensify environmental pressures, through the increasing demand for natural resources, including both material and energy inputs used in production, the increasing magnitude of waste and pollution, and the increasing relative reliance on non-renewable resources.

In this situation, the sustainable development dilemma facing governments is to promote structural transformation and increase human well-being without increasing the environmental pressure in an unsustainable manner. This *Report* argues that this dilemma can be resolved through a strategy of sustainable structural transformation (SST). This is a development strategy which promotes structural transformation but which adopts deliberate, concerted and proactive measures to improve resource efficiency and mitigate environmental impacts of the growth process. In short, they should promote sustainable structural transformation, which will be defined here as structural transformation accompanied by the relative decoupling of resource use and environmental impact from the economic growth process.

1. The meaning of structural transformation

The term "structural transformation" has been used regularly in the economic literature over several decades. However, different meanings have been given to this concept (Silva and Teixeira, 2008; Syrquin, 2010; Lin, 2011 and 2012). It will be used in this *Report* to refer to a process in which the relative importance of different sectors and activities within a national economy changes, in terms of both composition and factor utilization, with a relative decline of low-productivity agriculture and low value added extractive activities and a relative rise of manufacturing and high-productivity services. This process also involves upgrading within sectors as production becomes more skill-, technology- and capital-intensive. Moreover, the sectoral shifts also tend to increase the predominance of sectors and activities with a higher growth potential, both in terms of income elasticity of demand, the presence of increasing returns to scale and the potential of technological progress. The development of manufacturing activities has historically been at the heart of processes of structural transformation and, as argued in the *Economic Development in Africa Report 2011* (UNCTAD and UNIDO, 2011), will be critical to the success of such processes in Africa.

Structural transformation occurs through factor accumulation, factor re-allocation and innovation, which refers to the introduction of products and processes which are new to a national economy. In dynamic economies undergoing structural transformation, there is a continual process of creative destruction, as some activities wither away whilst others mushroom. In general, structural transformation is also associated with changes in the form of integration into the global economy, in terms of both export and import composition, and also the increasing urbanization of the population.

2. Decoupling as a basis for sustainable structural transformation

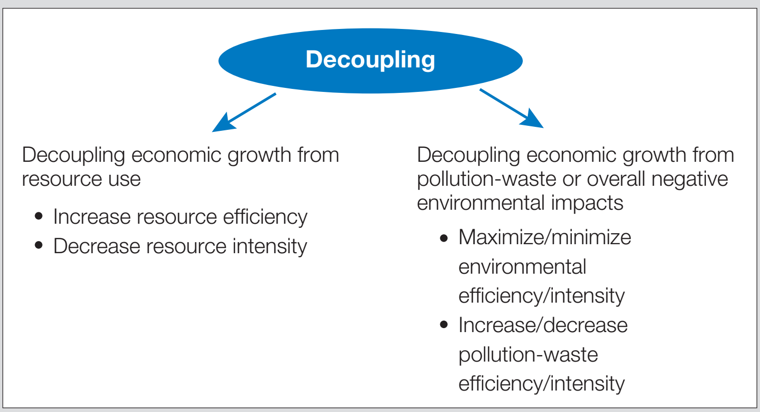
For developing countries, and especially for Africa, the priority is to achieve higher rates of economic growth by structural transformation. However, the transition to higher levels of development involves increasing the level of material throughput significantly. The policy challenge is therefore to transform the economic structure, while increasing human well-being and minimizing resource and pollution intensities. In other words, there is the need to attain *high-quality growth* by decoupling the increases in the level of material throughput — and consequently the pressure from the environment — from improvements in human well-being.

The term “decoupling” is used in the technical sense in which it is now being propagated in international policy debates on sustainability. The notion of decoupling was originally put forward by the Organization for Economic Cooperation and Development (OECD) in its policy paper, Environmental Strategy for the First Decade of the 21st Century (OECD, 2001), where it was first simply defined as breaking the links between environmental bads and economic goods. But in 2002, the World Summit on Sustainable Development (WSSD), hosted in South Africa, explicitly recognized the need to delink economic growth and environmental degradation — through improving efficiency and sustainability in the use of resources and production and reducing resource degradation, pollution and waste — as a key element of sustainable consumption and production (OECD, 2001: para. 15).

UNEP (2011a) has further developed the concept by distinguishing two separate components of decoupling: resource decoupling and impact decoupling. Resource decoupling can be achieved by increasing resource productivity or efficiency (GDP/resource use) or, conversely, by decreasing resource intensity (resource use/GDP). Impact decoupling might either refer to the pollution/waste intensity element of the technology factor in the IPAT equation or to the overall level of environmental impact. From an impact perspective, decoupling can be attained by mitigating the overall environmental impact per unit of production or by maximizing the level of production per unit of environmental impact. Figure 4 illustrates these options.

It is important to stress at this point that the concept of decoupling does not mean that production is somehow undertaken without using environmental inputs or creating waste. This is, strictly speaking, impossible. Resource decoupling (or increasing resource productivity) involves some "dematerialization" of extractive and

Figure 4. Components of decoupling



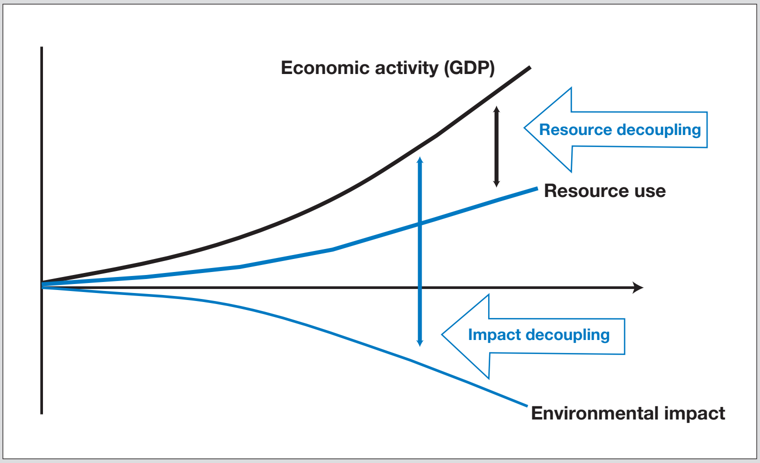
Source: UNCTAD secretariat.

productive processes, which means using less energy, water, land and minerals for a given amount of output. Impact decoupling (or increased eco-efficiency) requires that there are also less negative environmental impacts attached. These impacts can arise during the extraction of natural resources, during production in the form of pollution and emissions, during the use phase of commodities and in post-consumption stages in the form of wastes. With impact decoupling, not only the rate of use of natural resources is reduced, but environmental impacts (e.g. land degradation, water pollution, carbon emissions, etc.) are also mitigated (see figure 5). This form of decoupling may be achieved, for example, by reducing the carbon intensity of production in the case of CO_2 emissions.

Decoupling can further be classified in relative or absolute terms. Relative decoupling occurs when "the growth rate of the environmentally relevant parameter (resources used or some measure of environmental impact) is lower than the growth rate of a relevant economic indicator (for example, GDP)" (UNEP, 2011a). On the other hand, absolute decoupling takes place when resource use declines and the environmental impact of production and consumption decreases, even though the economy keeps growing.

Figure 5 illustrates a case where there is actually relative decoupling in resource use, but absolute decoupling in environmental impacts. This might be quite a rare

Figure 5. A stylized representation of resource decoupling and impact decoupling



Source: Based on UNEP (2011a), figure 1.1.

conjunction in practice, as the level of resource use is associated at an aggregate level with environmental pressure (van der Voet *et al.*, 2005). But it is possible and would occur, for example, if the reduction in the rate of resource use was associated with a shift in the mix of the resources utilized and the level of material throughput, away from priority materials and products which have particularly heavy environmental pressures. This might, for instance, include processes involving fossil fuel combustion, or activities which involve a significant loss of biodiversity, overexploitation of resources or a collapse of fish stocks (UNEP, 2010b).

3. Sustainable structural transformation as a development strategy

SST is defined here as structural transformation accompanied by the relative decoupling of resource use and environmental impact from the growth process. Understood in this sense, the notion of SST leads to an expanded vision of a traditional strategy of structural transformation. Without the environmental sustainability dimension, strategies of structural transformation are particularly concerned with increasing labour productivity, through rising capital accumulation, an acceleration of technological innovation, introduction of new economic activities, increasing economic linkages, development of markets, division of labour, and an increasing formalization of the economic activity. Strategies of SST, by contrast, would seek to do all this, but they are also concerned with increasing the productivity of natural resource use and mitigating negative environmental impacts of rising production and consumption.

As with structural transformation, SST occurs through factor accumulation, including investment in natural capital, factor re-allocation and also organizational and technological innovation. A central aspect of the process is structural change in which new economic activities emerge and others wither away. In SST, one aspect of this process is the emergence of new dynamic green activities and an increase in the relative importance of green sectors, such as organic agriculture, renewable energy and ecotourism, within a national economy. Ocampo (2011), who, just like this *Report*, notes that green growth should be best understood as a process of structural change, focuses precisely on this aspect and stresses the importance of facilitating the emergence of new green industries related to new green technologies. However, SST is understood in a broader sense here as it is not simply related to the emergence of specific green sectors but rather to the greening of the economy through relative decoupling. Improvements in resource productivity are pivotal to the whole process of SST.

The importance of resource productivity can be illustrated by simply separating the different components of the challenge of achieving a new development path with greater human well-being and lesser environmental impact. Essentially, as the following equation expresses it, there are three basic challenges involved. The first challenge (expressed by the first ratio) is to have a form of economic growth which delivers more human well-being (WB) for every extra unit of GDP. The second challenge (expressed in the second ratio) is to have more GDP growth for every unit of resource use (RU); that is, to improve resource productivity. The third challenge (expressed in the third ratio) is to mitigate the environmental pressure by increasing the resource use associated with each unit of environmental impact (EI).

$$\frac{\text{WB}}{\text{Unit of EI}} = \frac{\text{WB}}{\text{GDP}} \times \frac{\text{GDP}}{\text{RU}} \times \frac{\text{RU}}{\text{Unit of EI}}$$

This is quite a simple formulation as it ignores, for example, the direct contribution of the environment to human well-being. However, it underlines the central importance of resource productivity as the link between human well-being and environmental pressures. It also identifies the different policy challenges involved in improving the overall quality of economic growth.

Essentially, a strategy of structural transformation can be expected to improve the quality of growth in the first sense. That is to say, when successful, it should result in a type of growth which leads to greater and more broad-based improvements in human well-being. Decoupling policies would seek to improve the environmental sustainability aspect of the growth process through addressing resource productivity and environmental impacts. The SST strategy, in addition, aims to improve the quality of growth in both the human well-being and environmental sustainability dimensions by enhancing the well-being aspect of economic growth and increasing resource productivity in a way which mitigates environmental impacts.

It should be stressed that improving resource productivity is not a magic bullet for resolving environmental problems in all contexts. Indeed, various researchers have pointed to the so-called “rebound effect”, in which improved resource efficiency lowers costs which, in turn, leads to increased resource use (Binswanger, 2001; Hertwich, 2005). Thus, improving resource productivity is not likely in itself to enable absolute decoupling. However, it can certainly support policies of relative decoupling, which seek to ensure that resource use and environmental pressures grow less rapidly than before as the economy grows.

In general, the concept of SST can be understood as a way to operationalize the concept of a green economy in the context of sustainable development and poverty eradication. The concept adds value because it provides a dynamic understanding of the efforts which are involved in greening the economy, and it places such efforts within a development perspective. It also provides a framework through which environmental issues can be articulated in the design of national development strategies. This avoids the danger of a one-dimensional approach in which environmental priorities are disconnected from development priorities.

The concept of SST can also bring new analytical and policy insights because it recognizes the central role of structural change in long-term economic growth processes. This goes beyond approaches to green growth which model growth in terms of an aggregate production function and ignore the dynamic forces associated with the emergence of new activities and the decline of others. As Ocampo (2011) argues, thinking of green growth as a process of structural change can provide a very fruitful basis for the formulation of developing countries' sustainable development strategies. The concept of SST enables this. It can also be applied and adapted to address the specific challenges facing developing countries at different stages in the process of structural transformation. Thus, a strategy of SST in economies which are dependent on agriculture and commodity exports and intend to promote economic diversification will be different from strategies in middle-income economies, which have managed to sustain growth for a number of years based on labour-intensive manufactures or services, but seek to upgrade towards more knowledge-, skill- and capital-intensive activities. In this way, the concept of SST can be used in a way which avoids the dangers of a one-size-fits-all approach.

Later chapters of this *Report* seek to apply the concept of SST to the challenge of achieving sustainable development in Africa. But first it is necessary to switch from conceptual issues and to get a better grasp of where Africa now stands in terms of resource use and efficiency. This is the subject of the next chapter.

CHAPTER 2

RESOURCE USE AND PRODUCTIVITY IN AFRICA: SOME STYLIZED FACTS

A. INTRODUCTION

This chapter presents key stylized facts on resource use and efficiency in Africa, which are crucial for understanding the nature and scale of the sustainable development challenges facing the region. The analysis is based primarily on the framework of Material Flow Accounting and Analysis (MFA), which measures resource flows in physical units — usually in metric tons per year — and tracks resource use from the extraction and production stages to the period of final use and waste disposal (see box 1). As discussed in chapter 1, MFA is increasingly being used for policy formulation and analysis, because it quantifies the interplay between economic activities and the environment in a manner that is comparable across countries and time (Haberl and Weisz, 2007). This Report is the first comprehensive, comparative and quantitative study on the levels, trends, and composition of resource use in Africa using this method. The analysis considers four major types of resources: biomass (from agriculture, forestry, fishery and hunting); fossil fuels (coal, oil and gas); metal ores; and non-metallic minerals (industrial and construction minerals).[3] As in most MFA studies, it does not consider water resource use and its impact on sustainability, though this is a very important issue for Africa (see the annex to this chapter). This chapter supplements the MFA with a land use indicator, namely the Human Appropriation of Net Primary Production (HANPP), as in Africa patterns of land use conversion are a key aspect of resource use. Finally, the chapter also provides facts on Africa's contribution to global GHG — a consequence of growing resource use — and on the impact of climate change in the region.

B. STYLIZED FACTS ON RESOURCE USE AND PRODUCTIVITY IN AFRICA

The key stylized facts on resource use and productivity in Africa identified in the data analysis are as follows:

The level of domestic material extraction per capita in Africa is very low compared to the global average.

In the period from 1980 to 2008, the levels of domestic material extraction per capita in Africa were very low (table 2). In 2008, the average domestic material extraction per capita in Africa was 5.4 tons, which is quite low compared to the global average of 10.2 tons. There are nevertheless major differences between

Box 1. Measuring sustainability: Material Flow Accounting and Analysis, and Human Appropriation of Net Primary Production

Several methods have been developed in order to understand the influence of economic activities on the environment, as well as to assess the magnitude and effects of an economy's throughput. These include Material Flow Accounting and Analysis (MFA) and Human Appropriation of Net Primary Production (HANPP). This Report presents some of the first Africa-wide applications of these methods.

Material Flow Accounting and Analysis

Material Flow Accounting and Analysis (MFA) is conceptually based on the notion that the economy is an open subsystem embedded within the larger Earth system. Its development was a response to the need to assess the scale of an economy's throughput and the negative environmental impacts (e.g. climate change) derived from material and energy consumption. The first material flow accounts started to be developed in the beginning of the 1990s in Austria and Japan. Since then, MFA has grown rapidly as a field of scientific and policy interest, and major efforts have been undertaken to harmonize methodological approaches (OECD, 2008).

In order to create economy-wide material flow accounts and undertake analysis on a national scale, two main boundaries are determined. The first boundary delimits the economic subsystem from the larger natural system. The second boundary sets the limits with respect to other national economies, thus distinguishing the flows of imported and exported materials.

In general, MFA considers four major types of resources, which are accounted in terms of their weight (measured in tons):

(a) Biomass (from agriculture, forestry, fishery and hunting)

(b) Fossil fuels (coal, oil, gas and peat)

(c) Minerals (industrial and construction minerals)

(d) Metal ores

In this fashion, different resource-use indicators can be constructed from material flow data:

(a) Domestic extraction (DE), which includes all the raw materials extracted within a country's territory

(b) Domestic Material Consumption (DMC), which is calculated as DE plus imports minus exports

(c) Physical Trade Balance (PTB), which is calculated as imports minus exports

Material flow data is consistent with the System of National Accounts (SNA). The relationship between material and economic variables allows quantifying, for example, resource efficiency (i.e. GDP/DMC). This is a suitable indicator to monitor decoupling processes.

Box 1 (contd.)

Human Appropriation of Net Primary Production

The Human Appropriation of Net Primary Production (HANPP) is another indicator that is often used to capture the impact of human activity on the ecosystem. It is defined for a given land area and is based on the notion that the amount of land, as well as the intensity of land use by humans, reduces the amount of resources (specifically biomass) left for other species in the food chain. This indicator is composed of two elements:

(a) Amount of harvested biomass

(b) Human-induced productivity changes derived from land conversion

HANPP, in this sense, measures the extent to which plant harvest and land conversion alter the availability of Net Primary Production (NPP) — the net amount of biomass produced each year by plants — in ecosystems (Haberl, Erb and Krausmann 2010). In other words, there are two ways through which NPP of biomass is appropriated by humans: directly through harvest, and indirectly through changes in productivity associated with processes of land conversion, such as land cover change and human-induced land degradation. Harvest is the fraction of HANPP which comprises all assets for human survival on earth, namely food, fodder, fibres, biofuels and wood products. In turn, the second component of HANPP — the amount of biomass appropriated through human-induced productivity changes — generally reflects productivity losses and hence inefficiency in land use. This second component represents the amount of appropriated NPP that does not enter the socio-economic system and has no further societal use. High fractions of productivity losses are generally associated with less efficient land use systems, often as a result of climatic constraints that go hand in hand with low agricultural inputs, such as fertilizers, irrigation and pesticides. Human-induced soil degradation is a crucial factor when it comes to productivity losses and is closely related to unsustainable land use practices.

The relationships between HANPP and its components are useful in various manners. The ratio of harvest per unit of HANPP serves as an indicator of efficiency. In turn, the ratio of productivity losses to harvest is a stringent indicator for the efficiency of the land use system. Increasing the harvested fraction and minimizing land change productivity losses can therefore help in limiting the expansion of agricultural systems into sensitive natural ecosystems (e.g. forests and drylands) by increasing the harvest output of already existing agricultural land. This is particularly crucial for countries where food security will be jeopardized in the coming decades and which are currently facing high productivity losses.

HANPP also allows accounting for trade. Embodied HANPP (or eHANPP) is the amount of net primary production consumed within a country. In this sense, it accounts for the domestic appropriation (extraction) plus imports minus exports. Embodied HANPP is a means for calculating the magnitude of all organic flows produced in the global production chain of traded biomass.

Table 2. Domestic material extraction per capita, 1980–2008

Country	1980	1985	1990	1995	2000	2005	2008
Algeria	7.5	8.7	7.9	7.8	8.5	10.0	10.4
Cameroon	4.9	5.4	4.9	4.4	4.7	4.5	4.2
Côte d'Ivoire	3.1	2.9	2.7	2.8	2.8	2.6	2.7
Egypt	3.5	5.0	5.0	5.5	6.2	6.2	7.3
Ethiopia	6.9	6.4	5.9	4.6	4.4	4.8	4.8
Kenya	5.4	5.1	5.2	4.3	3.5	3.8	3.4
Madagascar	7.2	6.6	6.0	5.3	4.6	4.0	3.7
Malawi	2.2	2.2	1.8	1.7	2.1	1.8	2.0
Mali	6.5	4.7	5.3	5.5	6.1	6.4	6.2
Morocco	5.9	5.7	5.2	4.6	5.1	7.2	6.9
Nigeria	3.8	3.3	3.6	3.7	3.7	3.8	3.6
Senegal	4.6	4.6	4.6	4.8	4.8	5.2	5.1
Seychelles	4.8	4.5	5.1	5.1	6.1	6.7	6.6
South Africa	16.5	16.9	16.1	15.0	14.0	14.2	14.4
Sudan	7.1	7.0	6.3	6.6	7.6	7.7	7.4
Togo	3.9	3.5	4.0	3.1	3.0	3.1	3.2
Africa	**5.9**	**5.7**	**5.4**	**5.2**	**5.2**	**5.4**	**5.4**
World	8.6	8.4	8.5	8.4	8.7	9.5	10.2

Source: UNCTAD (2012b).

African countries. For example, Algeria and South Africa had per capita extraction levels of 10.4 and 14.4 tons respectively, which are higher than both the African and the global average. However, countries such as Côte d'Ivoire and Malawi had per capita extraction levels of 2.7 and 2.0 tons respectively (lower than the African average).

Domestic material extraction in Africa has increased by 87 per cent over the past three decades, but has declined in per capita terms.

Although Africa has very low levels of domestic material extraction per capita, total domestic material extraction in the region increased from 2.8 billion tons in 1980 to 5.3 billion tons in 2008, representing an approximately 87 per cent increase in resource use over the past three decades (table 3).[4] It should be noted that a large part of this increase occurred after 1995. Furthermore, the increase in material extraction is evident in all material categories, as well as in most countries in the

Table 3. Global and African material extraction, 1980–2008

	Global extraction (billions of tons)	Global extraction (1980=100)	African extraction (billions of tons)	African extraction (1980=100)	Africa's share in global extraction (%)
1980	37.9	100.0	2.8	100.0	7.5
1985	40.5	106.8	3.2	111.7	7.8
1990	44.8	118.1	3.4	121.2	7.7
1995	47.9	126.3	3.7	130.9	7.7
2000	52.7	138.8	4.2	148.5	8.0
2005	61.6	162.3	4.9	173.8	8.0
2008	68.1	179.6	5.3	186.8	7.8

Source: UNCTAD (2012b).

region. It is interesting to note that the absolute increase in material extraction in Africa is in line with trends in material extraction at the global level, although the growth in extraction in the former has been slightly faster than in the latter. Consequently, Africa's share in global extraction increased marginally from 7.5 per cent in 1980 to 7.8 per cent in 2008.

While there has been an absolute increase in domestic material extraction in Africa, per capita extraction decreased by about 8 per cent over the past three decades due largely to high population growth. Interestingly, Africa also experienced deindustrialization during this period of declining per capita extraction. The share of manufacturing in Africa's GDP fell from 12 per cent in 1980 to about 10 per cent in 2008. The decline in the share of manufacturing in GDP is more pronounced in West Africa, where it fell from 17 per cent to 5 per cent. Central Africa also experienced a significant decline, from 12 per cent to 6 per cent over the same period (UNCTAD and UNIDO, 2011).

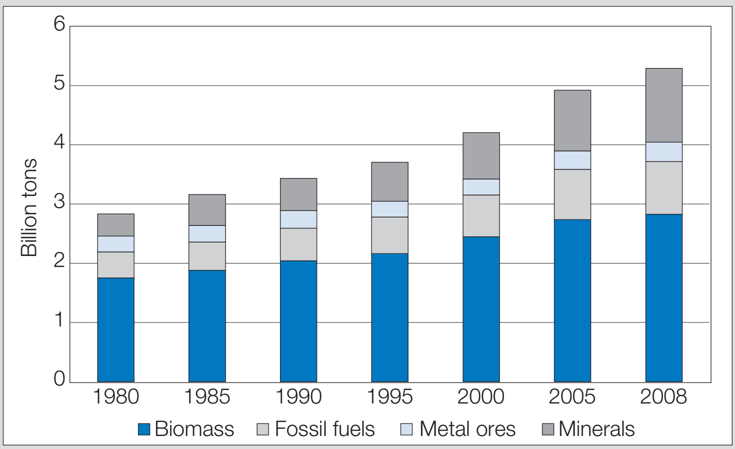
Biomass accounts for over half of the material extraction in Africa, but the share of non-renewable resources in total material extraction has increased from 38 per cent in 1980 to 47 per cent in 2008.

In terms of the categories of materials extracted, biomass (from agriculture, forestry and fishing) is the most dominant, accounting for 53 per cent of overall material extraction in Africa in 2008. However, there has been a significant change in the composition of material extraction in Africa in recent years, with non-renewable resources playing a relatively more important role in extraction than in the past.

Figure 6 illustrates the development of domestic extraction of used biomass, minerals, fossil fuels and metal ores in the region between 1980 and 2008. While there has been a significant increase in biomass extraction since 1980, its share in the total extraction fell from 62 per cent in 1980 to 53 per cent in 2008, due largely to a rapid increase in the extraction of minerals and fossil fuels in the region. As a result of this development, the share of non-renewable resources (fossil fuels, minerals and metals) in total extraction increased from 38 per cent in 1980 to 47 per cent in 2008. Despite the declining share of biomass in African domestic extraction, its share of 53 per cent is quite high when compared to the 28 per cent share of biomass in global material extraction, in 2008.

The increase in biomass extraction in Africa from 1.7 to 2.8 billion tons between 1980 and 2008 is mainly driven by an increase in the category of animal feed, particularly grazing activities, which accounted for 58 per cent of biomass extraction in 2008. The largest extractions for feed in absolute terms are in countries with savannah areas, where livestock breeding accounts for a high share in total land use. For example, Ethiopia, Nigeria and Sudan extracted 257, 133 and 228 million tons respectively in 2008, which is 36 per cent of total grazing and 21 per cent of total biomass extraction in Africa. Although biomass is the dominant form of

Figure 6. Material extraction in Africa, by category, 1980–2008



Source: UNCTAD (2012b).

domestic extraction in the region, its share of domestic extraction varies across African countries. For example, while biomass is the dominant form of extraction in Ethiopia, Kenya, Nigeria and Sudan, in countries such as Algeria, Egypt and Morocco, non-metallic minerals dominate other material categories in terms of domestic extraction (table 4).

Africa's share of global material trade fell, despite a significant increase in trade volume.

The volume of Africa's material trade in physical terms rose from almost 260 million tons in 1980 to 506 million tons in 2008 (table 5). During the same period, the physical trade volume of most of the other world regions rose more rapidly,

Table 4. Material extraction in selected African countries, by material category, 2008 (millions of tons)

	Biomass	Fossil fuels	Metals	Other minerals
Algeria	53.0	145.3	2.1	156.7
Cameroon	59.6	4.6	37.4	0.2
Côte d'Ivoire	37.4	3.4	1.1	10.3
Egypt	161.1	76.1	1.9	333.1
Ethiopia	358.0	0.0	0.9	20.7
Kenya	109.7	0.0	0.1	21.7
Madagascar	66.1	0.0	0.1	5.8
Malawi	24.2	0.1	0.0	4.5
Mali	72.8	0.0	10.3	6.8
Morocco	66.4	0.0	2.5	147.9
Nigeria	347.7	129.5	0.4	67.9
Senegal	37.6	0.0	0.2	22.5
Seychelles	0.1	0.0	0.0	0.5
South Africa	178.6	254.7	140.4	127.6
Sudan	261.5	23.9	0.7	19.9
Togo	12.7	0.0	3.0	2.8
Africa	**2,827.4**	**887.4**	**329.0**	**1,245.6**
World	18,827.3	12,710.4	6,614.2	29,966.8

Source: UNCTAD (2012b).

resulting in an increase in global trade volume by a factor of 2.6. Thus, Africa's share in global trade volume decreased from 6.5 per cent in 1980 to 4.9 per cent in 2008. It is interesting to note that Africa's share of global trade measured in physical terms is higher than its share measured in monetary terms, which was 3.3 per cent in 2008. Both imports and exports increased during the period, but imports grew by a factor of 2.6 while exports grew by a factor of 1.8. Furthermore, African countries imported around 301 million tons of biomass, fossil fuels, metals and non-metallic minerals, while they exported around 711 million tons of materials. Although physical imports as well as exports rose in absolute terms in all material categories, Africa lost global market shares in exports in all material categories and in imports — except biomass (which increased) and fossils fuels (which stagnated) — due to higher increases in trade in other world regions.

Fossil fuels are the dominant material export and import of Africa.

Fossil fuels, dominated by petroleum (crude oil), hard coal, and for a short time natural gas, are African countries' main exports in physical terms. After a decrease during the first half of the 1980s, exports of fossil fuels reached a peak in 2005, and amounted to 534 million tons in 2008 (figure 7a). The share of fossil fuels in total exports increased from 72 per cent in 1980 to 75 per cent in 2008, which is well above the global average of 50 per cent. In physical terms, all African countries account for about 10.5 per cent of fossil fuels supply to the world market. This represents a decline in Africa's share relative to the situation in 1980, when the region accounted for 13.2 per cent of global supply. Metals, clearly dominated by

Table 5. Physical trade volume in Africa and the world, 1980–2008

	Global trade volume (billions of tons)	Global trade volume (1980=100)	African trade volume (billions of tons)	African trade volume (1980=100)	Africa's share of global trade volume (%)
1980	4.0	100	0.3	100	6.5
1985	3.9	96	0.2	91	6.2
1990	5.0	124	0.3	102	5.2
1995	6.1	152	0.3	121	5.1
2000	7.6	189	0.4	156	5.3
2005	9.6	232	0.5	188	5.1
2008	10.3	257	0.5	195	4.9

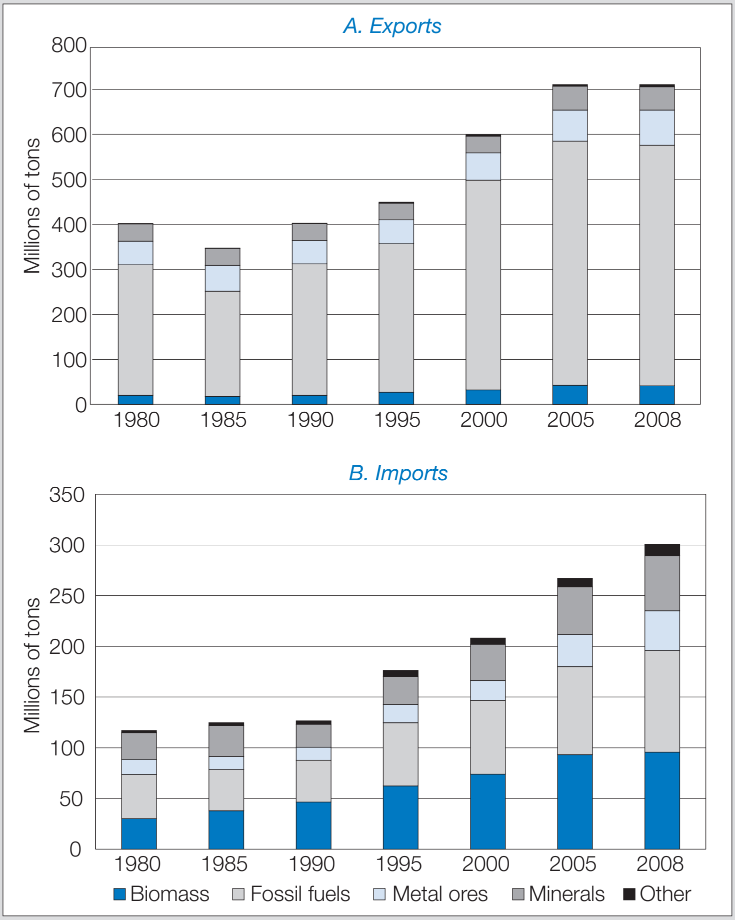
Source: UNCTAD (2012b).
Trade volume = (imports+exports)/2.

iron ores and concentrates, and followed by manganese and chromium ores and concentrates, are Africa's second-largest export flows, with around 78 million tons exported in 2008. South Africa is the dominant exporter, with around 55 million tons of exports in 2008. It is interesting to note that the share of metal exports in total exports declined from 13 per cent in 1980 to 11 per cent in 2008, due, in part, to rising exports of fossil fuels. Furthermore, Africa's share of global metal exports fell from 8 per cent in 1980 to 3.8 per cent in 2008.

Mineral exports are African countries' third-largest export group, with a volume of 52.3 million tons in 2008. The main exporter is Morocco, which mainly exports natural calcium phosphates and phosphatic chalk, followed by Egypt, Tunisia and South Africa. The share of mineral exports in Africa's total exports decreased from 10 per cent in 1980 to 7 per cent in 2008. At the global level, the share of minerals in total exports has been relatively constant, at around 12 per cent. In 2008, African countries accounted for around 4.4 per cent of global mineral exports, compared to 8.8 per cent in 1980. The last material category, biomass, has the lowest share of African exports. The region exported about 14.5 million tons in 2008, representing about 2 per cent of total exports. Fruits, timber, products made of biomass (e.g. paper and paperboards), and crops (e.g. coffee, cocoa and tobacco) are the main biomass exports.

In terms of material imports, fossil fuels are the dominant material imports of African countries, with a relatively constant share of between 33 and 37 per cent of total imports (figure 7b). This is low compared to the world average share of 50 to 55 per cent of fossil fuels in total imports. All African countries together import about 100 million tons of fossil fuels, which is around 2 per cent of global imports of fossil fuels. South Africa is the largest demander of fossil fuels in Africa, importing principally petroleum (crude oil), products such as hydrocarbons and plastics in primary forms, and, since 2005, increasingly natural gas too. Together with Morocco and Egypt, the second- and third-biggest demanders of fossil fuels in Africa, the three countries import around 57 million tons, representing about 57 per cent of Africa's imports of fossil fuels. Biomass is the second most important material import of African countries and has a rapidly growing share of imports. While in 1980 around 26 per cent of the imports of African countries were biomass, in 2008 the share was 32 per cent, which is high compared to a relatively constant world average share of biomass imports in total imports of around 16 per cent. Africa is currently demanding 6 per cent of globally traded biomass. Biomass includes a wide range of commodities and trade products, such as food and

Figure 7. Physical exports and imports of African countries, by material category, 1980–2008 (millions of tons)



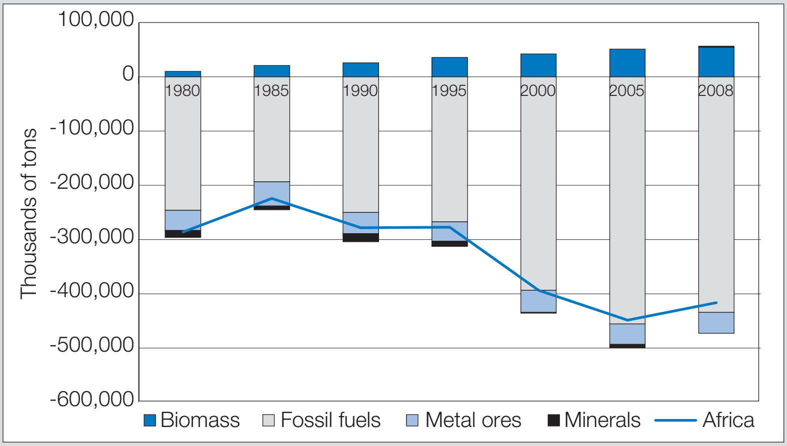
Source: UNCTAD (2012b).

beverages, animals including meat and products from animals, animal feedstuffs, forest products, fibres, fats and oils, and products mainly from biomass materials such as cellulose and paper. During the past three decades, Africa's main biomass imports in physical terms have been cereals, followed by biomass products (mainly vegetable fats and oils), timber and sugar crops. The dominant importers of cereals are the northern African countries, mainly Algeria, Egypt, Morocco and Tunisia. The third-largest material category in Africa's imports is non-metallic minerals. However, although the absolute amount of non-metallic mineral imports increased from 26 to 54 million tons, the share in total imports fell from 22 per cent to 18 per cent, which is still high compared to the world average share of non-metallic minerals in total imports of around 11–12 per cent. Africa is thus demanding around 4.6 per cent of globally traded non-metallic minerals. The main imported commodities in this category are cement and mineral fertilizers. Metals are the least important material in Africa's imports, although in absolute terms, imports of metals increased from 15 million to 39 million tons between 1980 and 2008, mainly due to increasing imports of iron and steel. Metal imports account for a fluctuating share of between 10 and 13 per cent, which is low compared to the world average share of metal imports in total imports of 20 per cent in 2008 and 16 per cent in 1980. In 2008, African countries imported about 1.9 per cent of globally traded metals.

Africa is a net exporter of non-renewable resources and a net importer of renewable resources.

An examination of physical trade balances (PTBs)— defined as imports minus exports — indicates that African countries are net suppliers of resources to the world. In 2008, net exports of materials by the region were 409 million tons, compared to 284 million tons in 1980. Figure 8 shows that the increase in net exports has been quite high since 2000, reflecting the significant increase in demand for Africa's resources by non-African developing countries such as Brazil, China and India (UNCTAD, 2010a). In terms of material composition, Africa is a net importer of renewable resources (biomass) and a net exporter of non-renewable resources. However, within the non-renewable resources material category, it is a net exporter for fossil fuels and metals and not for non-metallic minerals. In general, the PTBs of Africa is a reflection of its endowment, production and consumption structure. The region is endowed with significant amounts of fossil fuels and mineral resources, and so its production and exports are dominated by resources and resource-based products. The region accounts for 41 per cent of world reserves of cobalt, 56 per cent of reserves of diamond, 34 per cent of reserves of gold, 10 per cent of reserves of oil, 12 per cent of reserves of chromites, and 53 per cent of reserves of phosphate rock. It also accounts for significant amounts of the world output of other resources (table 6).

Figure 8. Physical trade balances of all African countries, 1980–2008



Source: UNCTAD (2012b).

The level of domestic material consumption (DMC) per capita in Africa is about half the global average (10.4 tons per capita), and has decreased slightly from 5.6 tons per capita in 1980 to 5.3 tons per capita in 2008.

DMC per capita in Africa is very low compared to the global average. In 2008, per capita DMC in the region was 5.3 tons, compared to the global average of 10.4 tons per capita. Furthermore, there has been no significant change in DMC per capita in the region, due largely to high population growth. While average per capita DMC in Asian and Latin American countries increased during the period under consideration, it decreased slightly in Africa — from 5.6 tons in 1980 to 5.3 tons in 2008. In fact, since 1995, Africa's average per capita DMC has been the lowest, compared to all other regions of the world. Within Africa, there are countries that have very high DMC per capita. For example, Seychelles and South Africa have higher DMC per capita than the global average. Figure 9a suggests that countries with a higher per capita income have higher DMC per capita. With regard to material categories, biomass accounts for a large part of the DMC per capita in most countries in the region. However, in countries such as Algeria, Egypt, Morocco and Seychelles, non-metallic minerals seem to dominate in terms of DMC per capita (figure 9b).

Table 6. Africa's share of global production and reserves of selected minerals

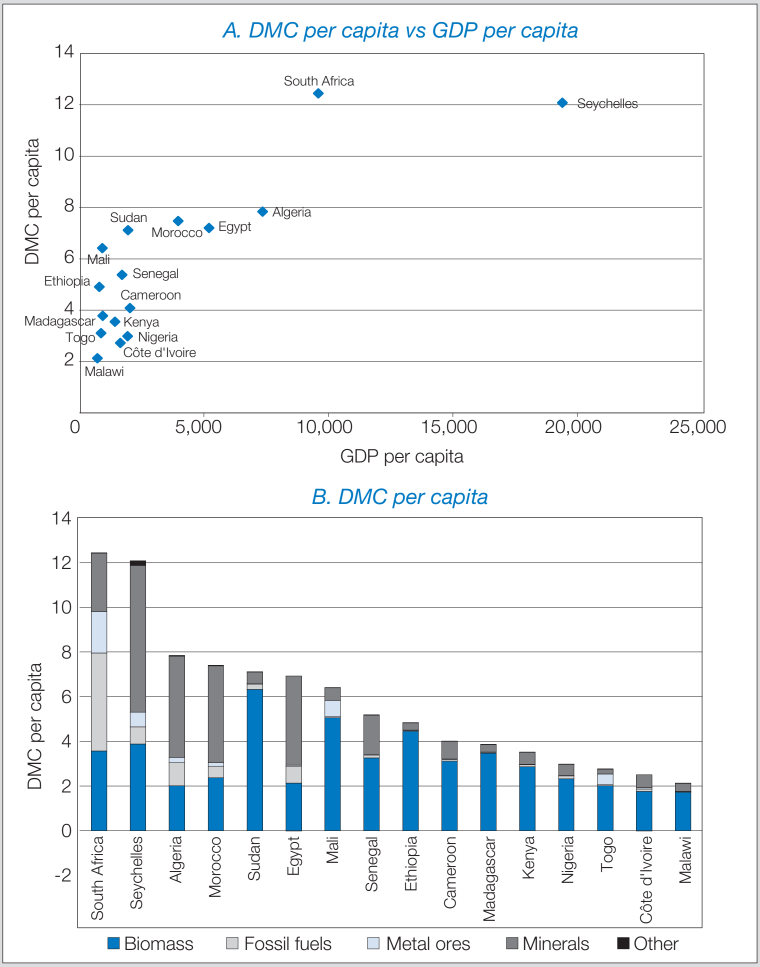
Mineral	Share of world reserves (%)	Share of world production (%)	Main African producers
Aluminium	3	4	Mozambique, Egypt, South Africa
Cement	-	4	Algeria, Egypt, Morocco, South Africa, Libya, Tunisia
Chromites	12	37	South Africa, Zimbabwe, Madagascar, Sudan
Coal	4	3	South Africa, Zimbabwe
Cobalt	41	60	Democratic Republic of the Congo, South Africa, Zambia
Copper	4	7	Zambia, South Africa, Democratic Republic of the Congo
Iron ore	1	3	South Africa, Algeria, Mauritania
Diamond	56	49	South Africa, Botswana, Democratic Republic of the Congo
Gold	34	18	South Africa, Ghana, Mali
Graphite	0.4	1	Zimbabwe, Madagascar
Lead	1	3	Namibia, South Africa
Natural gas	8	6	Algeria, Egypt, Libya
Manganese	-	23	South Africa, Ghana, Gabon
Oil	10	12	Nigeria, Angola, Algeria, Libya
Phosphate rock	53	25	Morocco, Tunisia, Egypt
Raw steel	-	1	South Africa, Egypt, Libya
Uranium	15	17	South Africa, Niger, Namibia

Source: Computed on the basis of data from U.S. Geological Survey, British Petroleum, and OECD.

Although domestic material consumption in Africa is increasing, the region accounts for only 7.2 per cent of global material consumption.

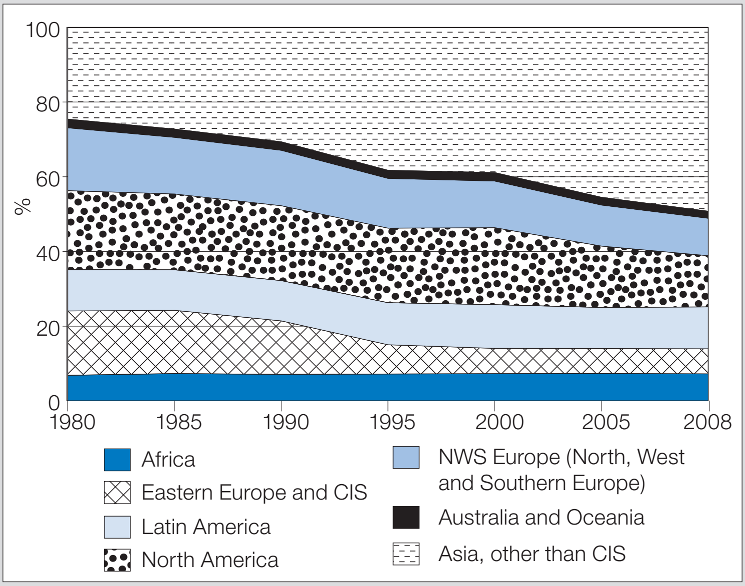
The absolute amount of DMC in Africa — defined as domestic material extraction plus imports minus exports — increased from 2.5 billion tons in 1980 to 4.9 billion tons in 2008, representing an approximately 90 per cent increase in material consumption over the period under consideration (figure 10). DMC is an indicator of potential environmental pressures associated with the disposal of residual materials

Figure 9. Domestic material consumption in selected African countries, 2008



Source: UNCTAD (2012b).
DMC is in tons and GDP is in constant 2005 dollars.

Figure 10. Material consumption by region, 1980–2008 (%)



Source: UNCTAD (2012b).

in the domestic environment. At the global level, absolute material consumption increased in all regions of the world, except in Eastern European countries and the Commonwealth of Independent States (CIS). In 2008 Africa accounted for about 7.2 per cent of global material consumption, compared to 6.8 per cent in 1980. Asian countries (excluding the CIS) have the highest share in global resource consumption, accounting for about 49 per cent in 2008. North America had a share of 14 per cent, Latin America 11 per cent, and Europe (Northern, Western and Southern) 10 per cent.

Within Africa, the absolute amount of domestic materials consumed varies significantly across countries (table 7). In 2008, the highest DMC was in the populous countries of Egypt, Ethiopia, Nigeria, South Africa and Sudan. The five countries as a group consumed around 2.3 billion tons in 2008, or 47 per cent of Africa's total consumption, and accounted for about 44 per cent of the region's

Table 7. Absolute amounts of domestic material consumption, 1980–2008 (millions of tons)

	1980	1985	1990	1995	2000	2005	2008
Algeria	96.3	161.6	140.0	163.4	160.2	210.0	269.8
Cameroon	42.2	49.8	53.1	55.6	70.1	76.8	76.5
Côte d'Ivoire	26.4	29.6	33.7	41.5	46.1	46.1	51.6
Egypt	157.5	268.7	294.1	347.3	433.9	461.2	563.9
Ethiopia	245.0	264.6	286.8	261.3	288.2	362.7	389.7
Kenya	89.5	101.0	124.6	118.7	114.1	138.3	136.3
Madagascar	62.3	64.8	67.9	70.7	71.9	72.7	73.8
Malawi	14.0	16.0	16.8	18.1	24.3	24.1	29.8
Mali	47.6	38.2	46.4	55.3	69.9	86.3	92.7
Morocco	104.1	119.2	125.0	128.6	154.9	229.5	234.0
Nigeria	210.5	218.0	276.9	332.9	342.4	432.3	449.7
Senegal	24.1	27.7	33.6	40.9	48.1	60.0	63.4
Seychelles	0.4	0.4	0.5	0.6	0.6	0.8	1.1
South Africa	422.4	494.7	527.9	541.8	516.6	552.5	607.0
Sudan	143.8	168.0	170.3	201.3	257.8	288.9	294.5
Togo	7.8	9.0	12.6	12.0	13.9	15.6	17.9
16 African countries	**1,693.7**	**2,032.2**	**2,209.9**	**2,390.0**	**2,613.1**	**3,057.8**	**3,351.7**
Africa	**2,547.0**	**2,938.5**	**3,115.9**	**3,432.1**	**3,813.4**	**4,478.0**	**4,879.8**

Source: UNCTAD (2012b).

population. Ranking all countries in the world according to their absolute material consumption in 2008, South Africa was 22nd, Egypt 26th and Nigeria 28th. In terms of growth of material consumption, Algeria, Senegal and Seychelles are some of the countries with the highest growth rates of absolute material consumption in the region.

Non-renewable resources account for a large share of domestic material consumption in African countries that are at a relatively higher level of industrial development.

Among the 16 African countries for which we have good-quality data by material category, the countries that have higher DMC per capita than the African average of 5.3 tons also have a relatively higher level of industrial development (table 8). For example, Algeria, Egypt, Morocco, Seychelles and South Africa have high per

Table 8. Industrial development and per capita resource use in Africa, 2008

	Domestic material consumption	Biomass	Fossil fuels	Metal ores	Minerals	Level of industrial development (MVA per capita)
	Tons per capita					
South Africa	12.4	3.6	4.4	1.9	2.6	948.5
Seychelles	12.1	3.9	0.8	0.7	6.6	880.3
Algeria	7.9	2.0	1.0	0.2	4.5	142.9
Morocco	7.4	2.4	0.5	0.2	4.3	311.0
Sudan	7.1	6.3	0.2	0.0	0.5	77.6
Egypt	6.9	2.1	0.8	0.1	4.0	239.9
Mali	6.4	5.1	0.1	0.7	0.6	26.2
Senegal	5.2	3.3	0.1	0.0	1.8	98.3
Ethiopia	4.8	4.5	0.0	0.0	0.3	8.7
Cameroon	4.0	3.1	0.1	0.0	0.8	156.4
Madagascar	3.9	3.5	0.0	0.0	0.3	40.4
Kenya	3.5	2.9	0.1	0.0	0.5	60.0
Nigeria	3.0	2.3	0.1	0.0	0.5	27.2
Togo	2.8	2.0	0.1	0.5	0.2	37.7
Côte d'Ivoire	2.5	1.8	0.1	0.1	0.6	142.8
Malawi	2.1	1.7	0.0	0.0	0.4	27.2

Source: UNCTAD (2012b).

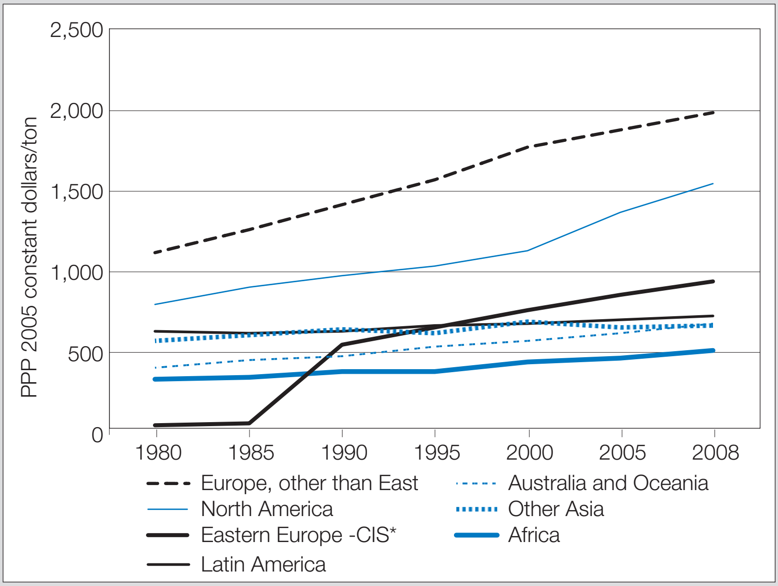
capita DMC and also have manufacturing value added (MVA) per capita above the regional average of $125. Mali and Sudan are exceptions in the sense that their per capita DMC is higher than the regional average but they have an MVA per capita level that is well below the regional average. It should be noted that the bulk of the per capita DMC in Mali and Sudan, as well as in other African countries at very low levels of industrial development, comes from biomass as opposed to non-renewable resources. In contrast, a large part of the per capita DMC in the African countries at a relatively high level of industrial development is accounted for by non-renewable resources. In the case of Algeria, Egypt, Morocco and Seychelles, non-metallic minerals are the most important non-renewable resources, whereas in South Africa, fossil fuels are the most dominant. Among the African countries at a relatively high level of industrial development, South Africa is the only country where consumption of fossil fuels per capita is quite high. This is not surprising, given that South Africa has the most advanced manufacturing sector in the region. These findings suggest that the industrial development process in African countries seems to be following the same pattern that was observed in currently developed countries, where fossil fuels and minerals played a critical role. In addition, these findings are in line with existing evidence indicating that the transition from an agrarian to an industrialized economy has historically involved greater use of non-renewable resources, particularly fossil fuels (Haberl and Weisz, 2007).

Material productivity in Africa is the lowest for any region in the world. Nevertheless, material productivity in Africa has improved over the past three decades.

Over the past three decades, the level of material productivity in Africa — defined as the ratio of real output to domestic material consumption (GDP/DMC) — has been very low compared to other regions (figure 11). For example, in 2008, the average level of material productivity in Africa was about $520 per ton of material, which is quite low relative to the global average of $950 per ton of material. Although the level of material productivity in Africa is low, it has increased significantly over the last three decades, from $338 per ton of material in 1980 to $520 per ton of material in 2008. To understand this change in material productivity in Africa, it is important to note that between 1980 and 2008, DMC almost doubled in Africa and exhibited similar trends to population over this period. Furthermore, the trend in GDP (at constant 2005 prices) was similar to the trends in population and DMC until 1995. After 1995, income increased significantly faster than material consumption and population in Africa, resulting in a 33 per cent rise in material productivity between 1995 and 2008.

The average figures for material productivity in Africa conceal important variations across African countries. Generally, industry- and service-oriented economies have higher material productivities than resource-based economies (Dittrich et al., 2011; Giljum et al., 2010). For example, Seychelles, which is a service-based economy, has the highest level of material productivity (above the global average), although there has been a decrease in its material productivity since 2000. It is important to note that most islands with a significant financial or tourism sector are net importers of resources, and the upstream flows of their imports outweigh those associated with exports.[5] It can be assumed that consideration of upstream flows would result in significantly lower material productivity values, as can be observed for other net importing countries (Dittrich, 2009).

Figure 11. Material productivity, by region, 1980–2008 (PPP 2005 constant dollars per ton)



Source: UNCTAD (2012b).

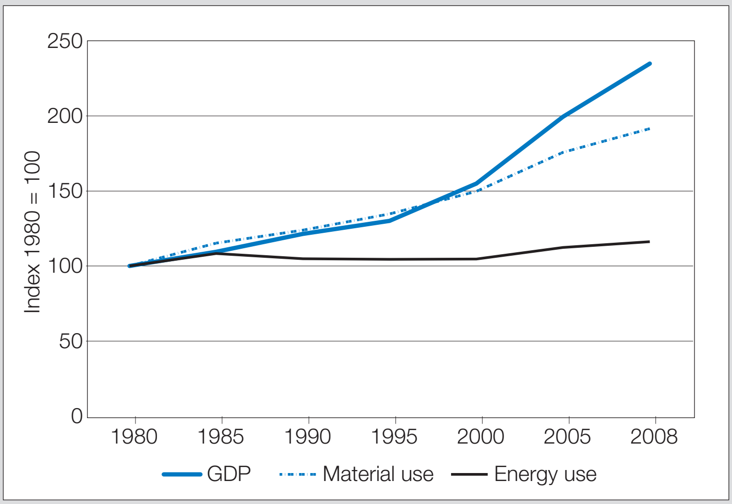
* Before 1990 no data were available for GDP of Soviet Union.

The second-highest level of material productivity can be found in Algeria, followed mainly by other oil- and metal-exporting countries such as Nigeria and South Africa, while countries with a high share of agriculture (which goes along with high extraction of biomass) have a comparably lower level of material productivity. This feature has also been observed in Asian countries (Giljum et al., 2010). Among the countries with high levels of biomass extraction, those with high shares of extraction for livestock-breeding generally have lower material productivities than countries with higher shares of intensive land use or crop-growing: typical examples are Ethiopia and Sudan, with material productivities of $166 and $276/ton, respectively, compared to Côte d’Ivoire and Malawi, which had $610 and $343/ton respectively, in 2008.

Energy use in Africa is low and has been increasing much less rapidly than material use.

Energy use in Africa is quite low relative to other regions of the world. For example, in 2009, per capita electricity consumption in Africa was only 561 kilowatt-hours (KWh), compared to 741 KWh for Asia, 1,884 KWh for Latin America, and 2,730 KWh for the world (IEA 2011). Although the level of energy use in Africa is low, it increased by about 16.3 per cent in the period from 1980 to 2008. Interestingly, the increase in energy use observed in Africa in 1980–2008 is far below the 92 per cent increase in material use over the same period (figure 12). It should be noted, however, that the low energy use observed in Africa reflects the fact that the region has a very low level of industrial development. The experience of industrialized economies suggests that industrialization is typically associated with high use of modern energy. This implies that if African countries want to successfully promote industrial development, they will have to improve access to modern energy and increase its use. This issue will be discussed in more detail in chapter 4.

Figure 12. Trends in GDP, material use and energy use, in Africa, 1980–2008 (Index 1980 = 100)



Source: UNCTAD (2012), U.S Energy Information Administration (2011) and United Nations Statistics (2011).

Africa has contributed the least to global greenhouse gas emissions but is the region most affected by climate change.

Africa's contribution to GHG in the atmosphere has been relatively small. In 2009, the total of CO_2 emissions in the region was 928 million tons compared to 10,030 million tons and 12,045 million tons for Asia and the OECD countries respectively (table 9). In fact, Africa accounted for only 3.2 per cent of global CO_2 emissions in 2009, reflecting the fact that it is at a much lower level of industrial development, and so has lower levels of income and of energy consumption. In per capita terms, the region emitted 0.9 tons of CO_2 per capita in 2009. This compares with 4.3, 9.8, 2.8 and 2.2 for the world, the OECD countries, Asia, and Latin America, respectively (IEA 2011). That said, the carbon intensity of output in Africa is higher than the average for the OECD countries and the world, but less than for Asia and the Middle East. Within Africa, Libya and South Africa have the highest per capita emissions of CO_2. In 2009, they had 7.9 and 7.5 tons per capita respectively, which is higher than the global average of 4.3 but less than the OECD countries' average of 9.8. Other African countries that have per capita emissions that are higher than the African average of 0.9 include Algeria, Botswana, Egypt, Gabon, Morocco, Namibia and Tunisia.

With regard to the impact of climate change, recent research indicates that this has and may continue to have a more severe impact in the region because of Africa's geography, its high level of dependence on agriculture, and the fact that it has less capacity to adapt. Boko et al. (2007) suggest that the projected reduction

Table 9. Population, output and carbon emissions, across regions, in 2009

	Population (millions)	GDP (billions of 2000 dollars)	CO_2 emissions (Mt of CO_2)	CO_2 per capita (t CO_2/capita)	CO_2/GDP (kg CO_2/ 2000 dollars)
World	6,761	39,674	28,999	4.3	0.7
OECD countries	1,225	29,633	12,045	9.8	0.4
Middle East	195	782	1,509	7.8	1.9
Asia	3,546	5,655	10,030	2.8	1.8
Latin America	451	1,957	975	2.2	0.5
Africa	**1,009**	**896**	**928**	**0.9**	**1.0**
Africa (share of global)	15 %	2.3 %	3.2 %		

Source: International Energy Agency (2011), *Key World Energy Statistics*.
Notes: Mt = million tons; t = metric ton; kg = kilogram

in agricultural yields in some African countries is likely to be as high as 50 per cent by 2020, and that net crop revenue could decline by as much as 90 per cent by 2100. It is also estimated that the proportion of arid and semi-arid lands in the region may increase by 5–8 per cent by 2080. Furthermore, the study suggests that between 75 and 250 million people in Africa are expected to be at risk of increased water stress by 2020. Other studies have estimated the impact of climate change in Africa too, and have arrived at qualitatively similar results (Boyd and Tompkins, 2009). For example, Wheeler (2011) provides an estimate of the vulnerability of countries to climate change resulting from increasing weather-related disasters, sea-level rise, and loss of agricultural productivity. The results show that the loss of agricultural productivity will be higher in Africa compared to other regions. In particular, the loss is expected to be higher in Central Africa, with a loss in agricultural productivity over the period 2008–2050 of as much as 20 per cent. Collier, Conway and Venables (2008) have also argued that Africa is likely to be affected more severely by climate change than other regions.

The human impact on natural ecosystems in Africa is generally low but increasing at a rapid rate.

The Human Appropriation of Net Primary Production (HANPP) is an indicator that measures the human impact on the yearly availability of energy (biomass) in ecosystems (see box 2). By appropriating a certain percentage of accumulated net primary production (biomass), humans cause transformations in the productivity of natural ecosystems by reducing the amount of biomass that is left in the system. There are two ways in which human beings appropriate biomass in an ecosystem — directly, through harvest; and indirectly, through changes in productivity associated with processes of land conversion, such as land cover change and human-induced land degradation. The harvest component of HANPP is made up of used extraction and unused extraction (harvest losses).

In Africa, the level of HANPP at the national scale ranges from close to zero to 10 tons of carbon per hectare per year (tC/ha/yr), with an average of 0.7 tC/ha/yr which is quite low compared to other regions of the world.[6] Nevertheless, there are a few countries in the region with very high HANPP levels. For example, countries in East Africa (Burundi, Rwanda and Uganda) have levels of between 4 and 10 tC/ha/yr. Also, some West African countries, particularly Côte d'Ivoire, Nigeria and Togo, have moderate levels of HANPP — between 2 and 4 tC/ha/yr. High levels of HANPP can be observed in African countries with high population densities. Although HANPP levels in Africa are generally low, they are increasing

Box 2. Land degradation, deforestation, and loss of biodiversity in Africa

Land degradation — defined as a reduction in the capacity of the land to provide ecosystem goods and services over a period of time — is one of the key environmental sustainability challenges facing the Africa region. UNEP (2008) argues that 65 per cent of Africa's agricultural land, 31 per cent of its pasture lands, and 19 per cent of its forests and woodlands are degraded. Furthermore, Requier-Desjardins (2006) shows that the economic cost of land degradation in Africa ranges from 1 to 18 per cent of GDP. Land degradation has very serious consequences for Africa, given its heavy dependence on its natural resource base. Although natural events (such as droughts) can exacerbate land degradation, it is generally assumed that the main causes are deforestation, desertification, erosion (water and wind), and poor agricultural practices such as the unbridled use of irrigation and fertilizers. However, it should be noted that high population growth (and hence density) are important drivers of these human activities associated with land degradation.

Although Africa has a significant amount of forest resources, it also has a very high rate of *deforestation*. In 2010, Africa's forest area was 674 million hectares, representing 16.7 per cent of the world's total forest area of about 4 billion hectares. However, the region lost about 10 per cent of its forest area between 1990 and 2010. A large part of this loss occurred in the period 1990–2000 when the total forest area declined by 4.1 million hectares per year, compared with a decline of 3.4 million hectares per year in the period 2000–2010. In fact, Africa and South America are the only regions in the world where forests are disappearing at a rapid rate. South America lost about 4 million hectares of forest area per year between 2000 and 2010 (United Nations, 2011). Within Africa, Burundi, Comoros, Ghana, Mauritania, Niger, Nigeria, Togo and Uganda are the countries with the highest net loss of forest area in percentage terms (box table 1). However, in absolute terms, the most significant losses were observed in Cameroon, the Democratic Republic of the Congo, Mozambique, Nigeria, Sudan, the United Republic of Tanzania, and Zimbabwe. The main causes of deforestation in Africa are logging, land conversion for agriculture and settlements, wildfires, cutting for firewood and charcoal, and civil unrest (UNEP, 2008).

The rapid depletion of Africa's forest resources is a source of concern because forests play an important role in the ecosystem. They are useful for the provision of food, fuel, and medicines. They also protect the soil, reduce the amount of CO_2 in the atmosphere, and are needed for the regeneration and survival of plant and animal species. Five countries — Angola, the Democratic Republic of the Congo, Mozambique, Sudan and Zambia — account for about 55 per cent of the region's forest area. Furthermore, Congo, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, Guinea-Bissau, Seychelles and Zambia are the African countries with a very high percentage of total land area covered by forests (more than 50 per cent).

Desertification is another form of land degradation and a major environmental challenge facing Africa. It is associated with loss of vegetation cover, reduction of the soil's organic matter, and diminished water-holding capacity of the soil. It is common in the arid and semi-arid areas of Africa with low and unpredictable rainfall. Africa is the region of the world most vulnerable to desertification, because two thirds of its land is either desert

Box 2 (contd.)

Box table 1. Forest area and depletion in Africa

	Forest area in 2010 (Km²)	Percentage change between 1990 and 2010	Percentage of land area covered by forests in 2010
Algeria	14 920	-10.5	1.0
Angola	584 800	-4.1	47.0
Benin	45 610	-20.8	41.0
Botswana	113 510	-17.3	20.0
Burkina Faso	56 490	-17.5	21.0
Burundi	1 720	-40.5	7.0
Cameroon	199 160	-18.1	42.0
Cape Verde	850	46.6	21.0
Central African Republic	226 050	-2.6	36.0
Chad	115 250	-12.1	9.0
Comoros	30	-75.0	2.0
Congo	224 110	-1.4	66.0
Côte d'Ivoire	104 030	1.8	33.0
Dem. Rep. of the Congo	1 541 350	-3.9	68.0
Djibouti	60	0.0	0.0
Egypt	700	59.1	0.0
Equatorial Guinea	16 260	-12.6	58.0
Eritrea	15 320	-5.5	15.0
Ethiopia	122 960	-18.6	11.0
Gabon	220 000	0.0	85.0
Gambia	4 800	8.6	48.0
Ghana	49 400	-33.7	22.0
Guinea	65 440	-9.9	27.0
Guinea-Bissau	20 220	-8.8	72.0
Kenya	34 670	-6.5	6.0
Lesotho	440	10.0	1.0
Liberia	43 290	-12.2	45.0
Libya	2 170	0.0	0.0
Madagascar	125 530	-8.3	22.0
Malawi	32 370	-16.9	34.0
Mali	124 900	-11.2	10.0
Mauritania	2 420	-41.7	0.0
Mauritius	350	-10.3	17.0
Morocco	51 310	1.6	11.0
Mozambique	390 220	-10.0	50.0
Namibia	72 900	-16.8	9.0
Niger	12 040	-38.1	1.0
Nigeria	90 410	-47.5	10.0
Rwanda	4 350	36.8	18.0
Sao Tome and Principe	270	0.0	28.0
Senegal	84 730	-9.4	44.0
Seychelles	410	0.0	88.0
Sierra Leone	27 260	-12.6	38.0
Somalia	67 470	-18.5	11.0
South Africa	92 410	0.0	8.0
Sudan	699 490	-8.4	29.0
Swaziland	5 630	19.3	33.0
Togo	2 870	-58.1	5.0
Tunisia	10 060	56.5	6.0
Uganda	29 880	-37.1	15.0
United Republic of Tanzania	334 280	-19.4	38.0
Zambia	494 680	-6.3	67.0
Zimbabwe	156 240	-29.5	40.0

Source: UNCTAD computation on the basis of data from United Nations Statistics Division.

Box 2 (contd.)

or drylands. The African countries facing very high risk of desertification include: Algeria, Botswana, Burkina Faso, Chad, Eritrea, Gambia, Guinea-Bissau, Kenya, Malawi, Mali, Mauritania, Morocco, Namibia, Niger, Senegal, Somalia, Sudan, Zambia and Zimbabwe. The primary causes of desertification are overgrazing, deforestation, intensive cropping, and climatic variability. Deblij, Murphy and Fouberg (2007) suggest that over 270,000 miles of farming and grazing lands in sub-Saharan Africa have been turned into desert over the past fifty years. Desertification has a significant negative impact on land productivity, with severe consequences for agricultural production and food security.

The loss of biological diversity — encompassing the total variety of plant and animal species — is increasingly a major concern for African governments and the international community. Africa's social and economic systems depend heavily on the continent's rich and varied biological resources. These resources are important sources of food, energy, medicines, and clean air and water. They also contribute to industrial production, construction, tourism and psychological well-being. Africa accounts for one third of global biodiversity. In particular, one quarter of the world's mammal species and one fifth of the existing species of birds are in Africa. Furthermore, the region is home to between 40,000 and 60,000 plant species. Despite its rich biological resources, there are indications that human activities have led to significant declines in biodiversity in Africa. It is estimated that over 120 plant species in the region are extinct, and that about 1,771 are under threat. African forests are also disappearing at an alarming rate, and several birds and animal species are either under threat or have been driven to extinction (UNEP, 2008 and 2010c). For example, in Egypt, the expansion of economic activities is creating significant hazards to birds. In Comoros and Seychelles, large numbers of bird species are now classified as endangered. In Somalia, overhunting, drought and loss of habitat have resulted in a significant reduction in the species of long-necked antelopes (gerenuks). Africa is also experiencing a decline in its fish stocks, because of illegal fishing by foreign vessels coupled with excessive fishing by local fishermen and legal commercial fleets. It is estimated that illegal fishing costs Africa about $1 billion every year (United Nations, 2009). In recent years, efforts have been made at different levels to protect Africa's biodiversity through an increase in the number of protected areas. However, the percentage of protected areas remains low in a large number of countries. In 2009, the proportion of terrestrial and marine areas protected to total territorial area was less than 10 per cent in 31 of the 54 African countries. In particular, the ratio of protected to total area was less than 1 per cent in Djibouti, Lesotho, Libya, Mauritius, Seychelles and Somalia.

at a rapid rate. Between 1980 and 2005, HANPP grew by about 53 per cent in Africa. The highest growth rate was in West Africa (84 per cent), and the lowest was in Southern Africa (10 per cent). Increasing HANPP in Africa is due in part to the expansion of agricultural land area through land conversion (for example, the replacement of forests by pasture or cropland) and through land degradation.

Land use processes are found to be largely inefficient over large parts of Africa.

Land use efficiency — analysed in terms of the ratio between (a) used extraction (i.e. the used fraction of harvest) and total HANPP and (b) used extraction per harvest — is very low in sub-Saharan Africa. Table 10 shows that the ratio of used extraction to total HANPP is below 20 per cent in Angola, Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, Liberia and Madagascar. Furthermore, the share of unused extraction (i.e. unused crop residues, felling losses and livestock feces) in total harvest is above 30 per cent in 15 African countries. Low land use efficiency in sub-Saharan Africa is due largely to large-scale land cover changes (deforestation) and degradation (see box 2). In these countries, the productivity losses associated with human land use are much higher than the harvested biomass. In contrast to many European and Asian countries, many African countries were not able to improve land use efficiency (e.g. increase crop yields per land area) over time. In several countries, such as the Democratic Republic of the Congo, Senegal, and Uganda, land use efficiency has even declined in the past decades. Egypt and South Africa, which both have relatively advanced agricultural production systems, are the few countries in the region that do not follow this trend. A crucial factor is human-induced soil degradation in dry lands, a phenomenon that is responsible for a large share of the low land use efficiency. The countries heavily prone to dry land degradation include Botswana, Burkina Faso, Cameroon, Eritrea, Madagascar, Senegal, Swaziland, Togo and Uganda. In these countries, which are characterized by high fractions of dry land areas, livestock overstocking, forest depletion for fuel wood consumption or overexploitation of soils due to short fallow periods are the main causes of soil degradation. Combating and mitigating degradation is therefore a prerequisite for increasing land use efficiency in the above-mentioned countries.

Unlike in sub-Saharan Africa, the countries in the Northern African and Western Asian desert and the Gulf States have been able to cultivate parts of the naturally arid areas by means of advanced cultivation techniques in the last decades (e.g. through irrigation and fertilizer application) and have thus achieved productivity gains (i.e. negative productivity losses). Regions where agriculture has been highly industrialized in the last decades and where advanced means of cultivation are applied (mostly agrochemicals and irrigation) tend to show very high levels of harvest compared to low fractions of productivity losses associated with land use. Similar patterns can be found in South Asia, East Asia, Europe and North America. However, these regions often rely heavily on fossil energy carriers in order

Table 10. HANPP levels and composition in African countries

	HANPP (tC/ha/yr)	Used extraction (% of HANPP)	Unused extraction (% harvest)	Productivity loss (% of HANPP)
Algeria	1.1	49	24.6	35
Angola	0.7	10	16.7	88
Benin	1.9	27	34.1	59
Botswana	0.2	50	5.7	47
Burkina Faso	1.9	37	22.9	52
Burundi	6.2	24	27.3	67
Cameroon	1.8	24	27.3	67
Cape Verde	-	58	-	23
Central African Republic	0.4	39	15.2	54
Chad	0.5	52	17.5	37
Comoros	0.0	27	-	63
Congo	0.7	6	45.5	89
Dem.Rep. of Congo	0.5	15	37.5	76
Côte d'Ivoire	2.5	16	33.3	76
Djibouti	0.4	92	9.8	-2
Egypt	-0.5	4,473	37.4	-7,047
Equatorial Guinea	0.9	16	50.0	68
Eritrea	0.7	-	-	-
Ethiopia	1.9	41	18.0	50
Gabon	0.4	14	50.0	72
Ghana	2.4	27	35.7	58
Gambia	1.8	51	25.0	32
Guinea	1.1	27	30.8	61
Guinea-Bissau	1.1	27	22.9	65
Kenya	1.5	39	22.0	50
Lesotho	2.5	30	14.3	65
Liberia	1.1	18	41.9	69
Libya	0.4	114	13.6	-32
Madagascar	2.2	16	15.8	81
Malawi	1.6	38	30.9	45
Mali	0.7	52	17.5	37
Mauritania	0.5	79	3.7	18
Morocco	1.3	64	15.8	24
Mozambique	0.7	20	35.5	69
Niger	0.9	54	18.2	34
Nigeria	3.2	39	27.8	46
Rwanda	7.4	29	25.6	61
Senegal	1.5	50	19.4	38
Sierra Leone	1.4	23	34.3	65
Somalia	0.6	84	5.6	11
South Africa	1.6	57	26.0	23
Sudan	1.1	54	12.9	38
Swaziland	1.5	78	25.7	-5
Togo	3.4	25	35.9	61
Tunisia	2.0	42	20.8	47
Uganda	4.8	27	32.5	60
United Rep. of Tanzania	1.1	36	23.4	53
Zambia	0.6	20	25.9	73
Zimbabwe	1.0	56	21.1	29

Source: UNCTAD (2012a).

to increase harvest outputs and minimize productivity losses. Hence, agricultural production in these parts of the world results in substantial sustainability challenges, in particular regarding their role in the global climate change debate. Furthermore, these regions will have to deal with issues of scarcity of non-renewable resources, such as water and fossil fuels, which are likely to have major impacts on the welfare of entire economies. Constantly rising global oil prices are a stringent indicator for this scenario.

C. CONCLUSION

The analysis of resource use presented in this chapter indicates that African countries have very low levels of material extraction and material consumption, both as a share of the global total and also in per capita terms. Levels of energy use are particularly low, and there is a major gap between GDP growth and the growth in energy use. It also indicates that average material productivity (which measures resource efficiency) is roughly half the global average. There is low land use efficiency in the region, due mainly to large-scale land cover changes (deforestation) and land degradation. Despite major reserves, the region's stock of non-renewable resources is being depleted, particularly through international trade, and the overuse of and lack of investment in non-renewable resources means that the renewable natural capital stock is depreciating.

The low level of resource use in Africa reflects the very low levels of consumption and the fact that the region has not successfully gone through the transition from a predominantly agrarian to an industrial economy, which generally involves more resource use. As the region goes through this structural transformation process, there will be a significant increase in resource use, particularly energy. The stylized facts presented in this chapter indicate that there is already an ongoing shift from renewable to non-renewable resources in Africa, and this is likely to intensify as the structural transformation process gathers momentum. Structural transformation in Africa will also have adverse environmental impacts. For example, it will increase waste generation as well as pollution, and thus will have important implications for environmental sustainability. In this regard, the challenge facing African countries is how to promote structural transformation while mitigating the associated environmental impacts. In this regard, the analysis suggests that there are major opportunities to improve resource use efficiency. The next chapter presents a framework and strategies that African countries can adopt in order to respond to this challenge.

ANNEX

Water use and sustainability in African countries

Water scarcity and stress are major environmental sustainability challenges in Africa. UNEP (2008) suggests that over 300 million people in Africa experience water scarcity and that by 2025, eighteen countries in the region will experience water stress. A country is considered to face water scarcity if it has less than 1,000 cubic meters of water available per person in a given year. In the case of water stress, the threshold is 1,700 cubic meters. In 2007, renewable internal freshwater resources per capita were less than 1,000 cubic metres in the following African countries: Algeria, Burkina Faso, Cape Verde, Djibouti, Egypt, Eritrea, Kenya, Libya, Mauritania, Morocco, Niger, Somalia, South Africa, Sudan, Tunisia and Zimbabwe. In terms of absolute water withdrawals, Egypt, Madagascar, Nigeria and Sudan are the African countries with annual freshwater withdrawals of more than 10 billion cubic metres over the period 2000–2005. Furthermore, in 2008, only 60 per cent of the population of sub-Saharan Africa had sustainable access to an improved water source, compared with 92 per cent in North Africa. An increase in water consumption and withdrawal, due largely to population growth and decreasing water supply, are the main reasons for water scarcity and stress in Africa. In general, water consumption and withdrawal could be for agriculture, industrial or domestic use. However, given Africa's low level of industrial development, a large part of water use is for agriculture (annex table 1). Nevertheless, there are differences across countries in terms of the importance of these sectors in water use. For example, in Lesotho 40 per cent of water use is in industry, and in Seychelles and Togo, domestic use accounts for 65 per cent and 53 per cent of water use respectively.

Annex table 1. Share of sectors in water use in Africa, 1998–2007 (%)

	Agricultural	Industrial	Domestic
Algeria	64.9	13.2	21.9
Angola	60.0	17.1	22.9
Benin	45.4	23.1	31.5
Botswana	41.2	18.0	40.7
Burkina Faso	86.3	0.8	13.0
Burundi	77.1	5.9	17.0
Cameroon	73.7	8.1	18.2
Cape Verde	90.9	1.8	7.3
Central African Republic	4.0	16.0	80.0
Chad	82.6	-	17.4
Comoros	47.0	5.0	48.0
Congo	8.7	21.7	69.6
Dem. Rep. of Congo	30.6	16.7	52.8
Côte d'Ivoire	64.5	11.8	23.7
Egypt	86.4	5.9	7.8
Equatorial Guinea	0.9	15.7	83.3
Eritrea	94.5	0.2	5.3
Ethiopia	93.6	0.4	6.0
Gabon	41.7	8.3	50.0
Gambia	65.4	11.8	22.9
Ghana	66.4	9.7	23.9
Guinea	90.1	2.0	7.9
Guinea-Bissau	82.3	4.6	13.1
Kenya	79.2	3.7	17.2
Lesotho	20.0	40.0	40.0
Liberia	54.5	18.2	27.3
Libya	82.8	3.1	14.1
Madagascar	95.7	1.5	2.8
Malawi	80.2	5.0	14.9
Mali	90.1	0.9	9.0
Mauritania	88.2	2.9	8.8
Mauritius	67.7	2.8	29.5
Morocco	87.4	2.9	9.8
Mozambique	87.3	1.6	11.1
Namibia	71.0	4.7	24.3
Niger	95.4	0.5	4.1
Nigeria	68.8	10.1	21.1
Rwanda	68.0	8.0	24.0
Senegal	93.0	2.6	4.4
Seychelles	7.3	27.6	65.0
Sierra Leone	92.1	2.6	5.3
Somalia	99.5	0.1	0.5
South Africa	62.7	6.0	31.2
Sudan	96.7	0.7	2.7
Swaziland	96.5	1.2	2.3
Togo	45.0	2.4	52.7
Tunisia	76.0	3.9	12.8
Uganda	40.0	16.7	43.3
United Rep. of Tanzania	89.4	0.5	10.2
Zambia	75.9	7.5	16.7
Zimbabwe	78.9	7.1	14.0
World	70.0	20.0	10.0

Source: FAO, *Statistical Yearbook 2010*.

CHAPTER 3

A STRATEGIC FRAMEWORK FOR SUSTAINABLE STRUCTURAL TRANSFORMATION

It is a major challenge for Africa to achieve a development path that can reduce poverty and improve the living standards of its population while ensuring environmental sustainability. The basic argument of this *Report* is that there is a need for a strategy of sustainable structural transformation (SST). This involves the adoption of deliberate, concerted and proactive policies to promote structural transformation and the relative decoupling of natural resource use and environmental impacts from the economic growth process. However, putting this into practice is not easy. The specification of the policy framework and required instruments for decoupling are still at early stages both in international policy debates (see United Nations Environment Programme (UNEP, 2011a) and in Africa (see box 3).

In this context, this chapter puts forward a strategic framework for thinking about SST as a central thrust for African development strategies. The chapter is organized into four sections. Section A discusses why African countries should adopt a sustainable structural transformation strategy, rather than a "grow now, clean up later" approach. Section B discusses strategic priorities for increasing resource efficiency and mitigating environmental impacts and strategic issues related to investment and technological development as the key drivers of decoupling. Section C focuses on the role of the State, while section D identifies key areas in which the international community could support African policy makers to promote SST. The next chapter completes the analysis by discussing specific policies to promote SST, focusing on national policies that will develop productive capacities and relative decoupling in the key sectors of energy, industry and agriculture.

A. WHY SHOULD AFRICA PROMOTE SUSTAINABLE STRUCTURAL TRANSFORMATION?

1. The imperative of decoupling

While there are now many studies that make projections of climate change associated with CO_2 emissions and other sources of global warming, assessments of global levels of resource use and material throughput and their implications are only now being made (UNEP, 2011a; Dittrich *et al*., 2012). The work of the Working Group of the International Resource Panel is particularly useful from a policy standpoint, as it sets out scenarios of future material resource use based on different assumptions and considers their implications. Its three scenarios are as follows:

(a) *Scenario 1:* Freeze (industrial countries) and catching up (rest of the world). In this scenario, per capita levels of material resource use in industrial countries remain stable at year 2000 levels, while developing countries gradually build up the same per capita level by 2050;

(b) *Scenario 2:* Reduction by a factor of 2 (industrial countries) and catching up (rest of the world). In this scenario, industrial countries commit to an absolute reduction of per capita levels of resource use by a factor of 2, while developing countries catch up to these reduced levels of material resource use by 2050;

(c) *Scenario 3:* Freeze global consumption at 2000 level and converge (industrial countries and developing countries). In this scenario, there is no increase in total global material resource use, and there is also convergence in per capita levels of resource use between industrial countries and developing countries. This would be achieved by the reduction of per capita levels of resource use in industrialized countries by a factor of 3 to 5, and developing countries catching up to these levels by 2050, which would imply an even slower rate of increase of material resource use in developing countries and even a 10–20 per cent absolute reduction in resource use in some developing countries (UNEP, 2011a).

The important point about the first scenario, in which developed countries make no effort to reduce their level of resource use in absolute terms and developing countries catch up to that level, is that if this were to occur, there would be a more than tripling of annual global resource extraction and the globalization of developed countries' levels of material resource use per capita. According to the UNEP report, *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth* (UNEP, 2011a), this "represents an unsustainable future in terms of both resource use and emissions, probably exceeding all possible measures of available resources and assessment of limits to the capacity to absorb impacts" (p. 29). By 2050, there would be a doubling of biomass use, a quadrupling of fossil fuel use and a tripling annual use of metals (ores) and construction materials. Essentially "this scenario would place an equivalent burden on the planet as if the human population tripled by the year 2050 to 18 billion people, while maintaining the resource consumption patterns of the year 2000" (pp. 30–31).

It is against this background that the UNEP Report identifies decoupling natural resource use and environmental impacts from economic growth as a global

Box 3. Some African initiatives relating to decoupling

In Africa, there are a number of initiatives relevant to the promotion of decoupling with structural transformation. An important one is the African 10-year Framework of Programmes on Sustainable Consumption and Production (UNEP, 2005). This framework is part of the Marrakech Process, a global effort to support the development of a 10-year framework of programmes on sustainable consumption and production, as called for by the Johannesburg World Summit on Sustainable Development Plan of Implementation. The Sixth African Roundtable on Sustainable Consumption and Production (ARSCP) was held in 2010 in Cairo, and its main objective was to promote structural transformation and green development in Africa through the integrated implementation of cleaner and more efficient industrial practices, as well as through the promotion of sustainable lifestyles (ARSCP, 2010). Their members have agreed to implement several sustainable consumption and production initiatives that can promote resource and impact decoupling.

As part of the Marrakech Process, and with the support of the United Nations Industrial Development Organization (UNIDO) and UNEP, national cleaner production centres have been established in Egypt, Ethiopia, Kenya, Morocco, Mozambique, Rwanda (under establishment), South Africa, the United Republic of Tanzania, Tunisia, Uganda and Zimbabwe.[a] Among their objectives, these centres help developing countries in the region to increase their efficient use of water, energy and raw materials, improving the competitiveness of African industries and opening new access routes to the global market. Additionally, they stimulate the creation of public and private partnerships and promote the development and transfer of novel technologies. They can provide an important impetus to decoupling efforts.

Another key activity recognized by the African 10-year Framework of Programmes on Sustainable Consumption and Production is the creation of regional ecolabelling mechanisms to enhance the marketability of African products and ensure a lower environmental impact throughout their production process. As a market instrument, the main aim of an ecolabel is to increase consumer awareness and ensure that the design and production of products meets appropriate environmental standards. In this sense, these instruments encourage producers to adopt more resource-efficient and sustainability-friendly production processes, which can lead to some degree of decoupling. Currently, there are a number of existing ecolabelling initiatives in the region, and most of them apply to specific sectors, such as organic agriculture, fisheries, forestry and energy. In addition, the majority are international schemes. The East African organic products standard and the West African organic cotton ecolabels, however, are examples of initiatives operating on a regional scale.

Despite some progress, efforts to promote sustainable production and consumption are limited in most countries. The United Nations Economic Commission for Africa (ECA, 2009a) states that “sustainable production in Africa may be described as a ‘work in progress’ that has a long way to go before becoming widely adopted and fully integrated as an everyday practice” and “the regional capacity for promoting sustainable consumption is far less developed than for sustainable production” (p.13).

Box 3 (contd.)

Many African governments have prepared and implemented national strategies for sustainable development as a follow-up to the United Nations Conference on Environment and Development in 1992. Recently, ECA appraised the progress made during the last two decades in the African continent (ECA, 2011a). The review indicates that most ECA member States have developed and are implementing their national strategies for sustainable development. These national strategies differ according to the countries' specific understanding of the concept of sustainable development and their developmental stage. Some of them place a special emphasis on the economic dimension, while others focus more on environmental or poverty-reduction-related issues. However, in many cases, the strategies just include general directives and do not clearly consider decoupling measures focused on the efficient use of land and natural resources, the utilization of alternative sources of energy, pollution mitigation and waste/pollution management. The concept of decoupling has been recognized and proposed explicitly as a policy objective in only a few. Notably, South Africa's National Framework for Sustainable Development calls for resource and impact decoupling.

a For a list of national cleaner production centres in Africa, see http://esa.un.org/marrakechprocess/ncpcs.shtml.

imperative. Scenarios 2 and 3 suggest the parameters of different ways to do this. Scenario 2 ("moderate contraction and convergence") is a global strategy in which absolute decoupling takes place in industrialized countries, while developing countries pursue relative decoupling together with catch-up growth. This would require "substantial economic structural change and massive investments in innovations and resource decoupling" (p.31). Scenario 3 ("tough contraction and convergence") is a global strategy that would require even more investment and innovation, and absolute decoupling in some developing countries as well as in industrialized countries. The technological, social and political requirements for effective collective action to agree and implement this global strategy are hardest for this scenario. However, Scenario 3 is the scenario that "would be most compatible with the existing (if unknown) limits to the Earth's resource base" and also "more or less consistent with the assessments of the Intergovernmental Panel on Climate Change of what would be required to prevent global warming beyond 2 degrees" (p. 32).

2. Africa in the global context

Where should Africa fit into this global context? How should African policymakers position themselves in relation to negotiation of such a global consensus on material resource use? What national policies should they adopt in relation to the decoupling of natural resource use and environmental impacts from economic growth?

From the outset, it must be stressed that given the current living standards of the majority of the population in Africa and also the urgency of creating jobs for its growing young labour force, it is critical that African countries seek to achieve accelerated economic growth and a type of economic growth that maximizes broad-based improvements in human well-being. Notions of no growth or degrowth, which are sometimes put forward in sustainability debates, are simply not relevant in Africa.

Given this development imperative, one option for African countries would be to prioritize economic growth, catching up and structural transformation, ignoring environmental constraints, a strategy some describe as “grow now, clean up later”. Not only are the living standards of the majority of the population in Africa extremely low but, as shown in Chapter 2, levels of material consumption are too. It could be argued therefore that there is scope for Africa to go for economic growth without the continent impinging unfairly on global ecological sustainability. The evidence in this *Report* shows that DMC per capita has been falling in Africa and its share of global material consumption, around 7 per cent of globally consumed resources in 2008, is well below its share of the global population (around 15 per cent). Thus, Africa could aim for growth without impinging unfairly on the global ecological footprint.

Further, taking account of the environment now may be costly and thus could slow down economic growth and poverty reduction. This would occur, for example, if the adoption of decoupling policies forces producers to use more expensive or less productive technologies. It is difficult to make estimates of the additional costs associated with structural transformation with decoupling policies, compared with structural transformation with no decoupling. However, such costs are recognized as significant in the economic debate on climate change mitigation, which is conceptualized in terms of the additional short-term investment costs required to offset the long-term costs of different degrees of climate change. The United Nations Department of Economic and Social Affairs (DESA, 2009), for example, estimates that the additional upfront investment costs of promoting a low-carbon-energy transition in order to mitigate climate change are at least twice the current levels of investment.

African policymakers will have to consider the alternatives carefully. However, there are a number of valid reasons as to why they should promote SST now rather than follow a policy of “grow now, clean up later”.

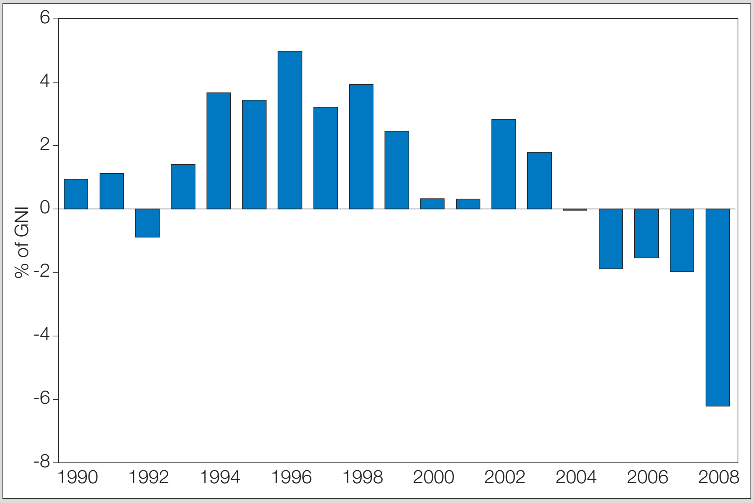
Firstly, it is clear that despite low levels of DMC per capita, there are already strong environmental pressures emerging in Africa. As discussed in the previous chapter, this is particularly evident in relation to land degradation, and there is also an ongoing shift in which the share of non-renewable resources in total resource use is increasing. However, the adverse economic effects of environmental degradation are also apparent in estimates of adjusted net savings (ANS). This indicator shows the rate of savings in an economy after adding to the gross national savings the expenditures on education (human capital) and subtracting the costs of resource depletion and the damage caused by pollution. As shown in figure 13, ANS rates in sub-Saharan Africa have been negative since 2004, and in 2008, they represented a negative percentage rate of 6.2 per cent of the region's gross national income.

This current pattern of economic growth is unsustainable over the medium and longer term. It is a cause for concern, particularly because, as Dasgupta (2008) has put it: "Ecosystems are capital assets. Like reproducible capital assets (roads, buildings, machinery), ecosystems depreciate if they are misused or overused. However, they differ from reproducible capital assets in three ways: (a) depreciation of natural capital is frequently irreversible (or at best the systems take a long time to recover); (b) except in a very limited sense, it isn't possible to replace a depleted or degraded ecosystem by a new one; and (c) ecosystems can collapse abruptly, without prior warning".

Secondly, this growth pattern is path dependent. Once established, these trends are likely to accelerate in the future with increasing population, rising living standards and structural transformation. If African economies are able to grow at least by 7 per cent per annum, which is the minimum required to generate sufficient employment opportunities to reduce poverty, their GDP would expand 2.1 times in 2020. If this performance is maintained, their GDP in 2050 would be 15 times greater than in 2010. Without any decoupling, material and energy use would increase concomitantly, exerting an impossible stress on resource stocks and environmental quality. In absolute terms, DMC would increase from 4.8 billion tons in 2010 to 10 billion tons in 2020 and 72 billion tons in 2050. If a "grow now, clean up later" approach is adopted, the increased consumption, greater exploitation of natural resources and energy use, as well as more pollution, atmospheric emissions and waste production, associated with the growth process, are likely in the long run to jeopardize the sustainability of the growth process itself.

Thirdly, delaying the implementation of a SST may become extremely costly in the future, if worsening environmental conditions force the early replacement

Figure 13. Adjusted net savings, including particulate emission damage in sub-Saharan Africa (% of gross national income)



Source: World Bank, *World Development Indicators* (2011).

of past investments (Liebowitz and Margolis, 1995; Hallegatte et al., 2011). This is because infrastructure and technology choices have a "lock-in" effect, in which countries get stuck on a particular development path, owing to the long life of physical capital investments. African structural transformation must necessarily involve massive new capital investments in infrastructure and this should be done in a way that promotes sustainability. If Africa becomes locked in due to traditional infrastructures, the future costs of dematerialization and waste/pollution abatement will become higher. Since most of Africa's infrastructure will be built in the next decades, the continent faces today the chance of developing in a clean and efficient manner.

Finally, decoupling can contribute to the creation of a virtuous development circle. The concept of decoupling actually means producing more with fewer resources and less pollution. In this sense, productivity gains can lead to larger amounts of value added in the economic system. This, along with the implementation of better technologies, helps expand the production possibilities of the economy and results in an efficient rearrangement of the factors of production. At the firm level, improved resource efficiency should enhance profitability, while some researchers suggest that increased material productivity is also associated with improved competitiveness (Bleischwitz and Bringezu, 2011). On a global scale, the movement towards environmental sustainability is also likely to create new markets for sustainability technologies (Walz, 2011). For some African countries, there may also be first-mover advantages.

In short, by intervening early in the way in which resources are used in the context of SST, it is possible to alter the growth prospects of African countries, connect up with sustainability transitions occurring in other parts of the world and avoid locking Africa into development paths that will become unsustainable in the future. Within this perspective, resource and impact decoupling are not seen as ends in themselves, but rather as means by which the necessary process of structural transformation is made sustainable.

The pertinent question then is not whether — but how — Africa can implement a strategy of SST. The next section discusses questions related to the degree of decoupling, how priorities can be identified and some strategic issues related to the two key drivers of SST – investment and technology.

B. STRATEGIC PRIORITIES AND DRIVERS

1. The degree of decoupling

A first strategic issue is the degree of decoupling that African governments should aim for. This *Report* argues that African countries should aim for relative decoupling, rather than absolute decoupling. This means they still need to keep consuming more resources and energy to improve their levels of prosperity and quality of life. However, it also means that they should focus on improving resource productivity and seek to mitigate the environmental impacts of resource use.

The scale of the challenge can be roughly estimated using the simple IPAT equation (see chapter 1). Table 11 shows population projections for 2020 and 2050, as well as projections of GDP, assuming that African economies grow at least by 7 per cent per annum, which is the minimum required to generate sufficient employment opportunities to reduce poverty. If this were to occur, African GDP per capita in 2020 would be double that of 2010, and it would be seven times higher in 2050 than in 2010 (see table 11). As discussed earlier, however, this would imply a massive increase in resource use and environmental impacts. In order to maintain the same level of material throughput with these higher incomes, resource productivity would have to double by 2020 and to improve more than 10 times compared with the one that existed in 2010 (figure 14).

Against this background, relative decoupling is a much more realistic option for Africa than absolute decoupling, as well as being fairer, given the continent's relatively small contribution to global material flows. The figures also indicate that population growth is an important variable that affects the scale of the challenge of SST. It is likely that rising prosperity and structural transformation will bring down population growth rates. It is worth noting, however, that the promotion of an early demographic transition by a faster decline in fertility rates has been a characteristic of successful cases of structural transformation in Asia, reducing the scale of the job creation challenge in the growth process.

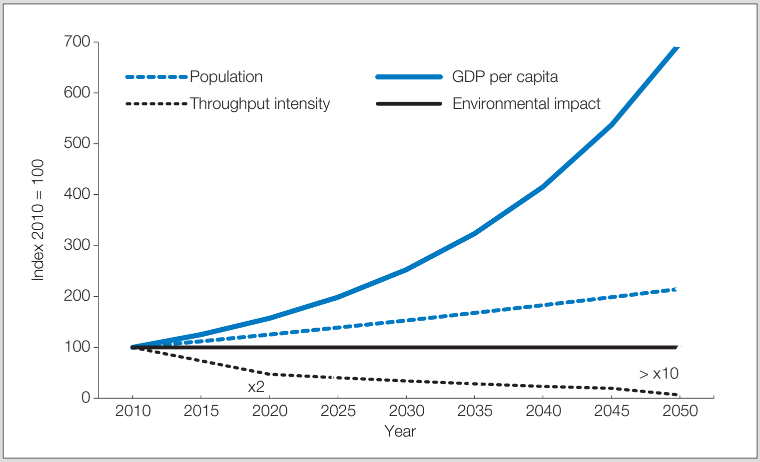
Table 11. Projected growth for population, GDP, GDP per capita and material, energy and carbon intensities by 2020 and 2050

Indicator	2010	2020	2050
Population	1.0 billion people	1.3 billion people (1.2 times that of 2010)	2.2 billion people (2.1 times that of 2010)
GDP	1.2 trillion[a]	2.6 trillion (2.1 times that of 2010)[a]	18.6 trillion (15 times that of 2010)[a]
GDP per capita	1,219[a]	$2,049 (1.7 times that of 2010)[a]	$8,500 (7 times that of 2010)[a]
Material intensity	4.1 (2008)[b]	Combined reductions of 2 times that of 2008	Combined reductions of more than 10 times that of 2008
Energy intensity	13,715 (2008)[c]		
Carbon intensity	0.9 (2009)[d]		

Source: Dittrich *et al.* (2011), United States Energy Information Administration and United Nations Statistics Division.

Notes: *a* Constant 2005 dollars;
b Domestic material consumption (tons)/GDP (thousands of 2005 dollars);
c Btu (British thermal unit) per 2005 dollars;
d Metric tons of carbon dioxide per thousands of 2005 dollars.

Figure 14. Projected population, GDP per capita and the required throughput intensity* to maintain 2010 levels of environmental impact



Source: Dittrich, *et al.* (2011). United States Energy Information Administration and United Nations Statistics Division.

* Throughput intensity was calculated as an average of material, energy and carbon intensities.

2. Sectoral and resource priorities

A critical strategic issue that governments face in the design of strategies of SST is the question of priorities. In any economy, particular sectors are more or less important in terms of resource use, and specific resources are associated with higher or lower levels of environmental impact. Effective relative decoupling policies would seek to identify the sectors and resources that offer the greatest opportunities for resource productivity and the mitigation of environmental pressures. However, a strategy of SST should seek to do this in such a way that economic growth rates are least constrained, and human well-being gains from economic growth, most enhanced.

This is a difficult task. However, strategic choices may be identified by assessing the relative merits of relative decoupling measures at a sectoral level, targeting economic sectors where resource use has been found to be more intensive, such as agriculture, industry, energy and construction. Concurrently, governments can assess the relative merits of relative decoupling measures to enhance a sustainable use of specific renewable and non-renewable resources, such as water, land and soils, fossil fuels, materials, and metal and mineral ores. Figure 15 summarizes such an integrated approach. In addition, it is important for policymakers to bear in mind the life-cycle phases attached to economic resources and activities. Such a life cycle begins with the resource getting extracted, its transportation to the factory or manufacturing centre, followed by its conversion into commodities, the consumption of such commodities and finally the disposal of these commodities after use. Relative decoupling measures must thus aim to improve resource productivity and mitigate negative environmental impacts during each of these life-cycle phases, targeted at the end user, whether in the corporate or household sector.

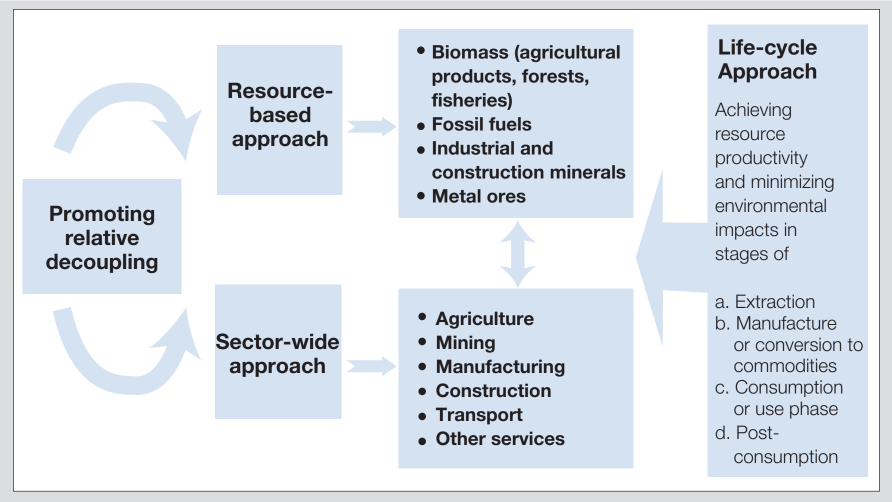
Sectoral and resource priorities are necessarily country specific. In general, it is likely that there will be major opportunities in many African countries to increase resource productivity and mitigate environmental impacts in energy, industry and agriculture.

The development of manufacturing activities, on both national and regional scales, will be critical for structural transformation processes in Africa. However, industrialization is likely to exacerbate environmental pressures by more intensive use of materials, water and energy, increased air emissions and pollution, greater discharge of effluents and more waste production. African countries must therefore aim not simply to achieve industrial development, but also to improve efficiency of resource use and mitigate pollution and waste.

A focus on agriculture is equally necessary, because it is clear that successful structural transformation usually begins with agricultural productivity improvements and an increase in reliable food supplies. This is particularly important in Africa, as the majority of the population still earns its livelihood from agriculture. However, a major finding of chapter 2 was the inefficiency of prevailing land use practices in terms of biological productivity. Thus, a major focus of policy must be the intensification of sustainable agriculture, which involves producing more output from the same area of land, while mitigating the negative environmental impacts and sustaining natural capital.

Finally, energy will be critical to SST. In this regard, the findings of chapter 2 imply that there is a need not simply for higher energy efficiency and a shift towards renewable energy sources, but also a substantial increase in energy supply. Greater

Figure 15. An integrated framework for relative decoupling in Africa



Source: UNCTAD (2012).

access to energy, and in particular electricity, is a key enabler of increased resource efficiency. It is essential to enable productive activities to take place by means of small and microenterprises, for instance, relying on the use of machinery and electrical equipment, and to ensure productivity gains by allowing these enterprises to operate beyond daylight hours.

Specific sectoral policies in each of these three sectors will be discussed in the next chapter.

3. Drivers of sustainable structural transformation: Investment

The two key drivers of structural transformation are investment and technology. SST is driven by exactly the same processes. Investment is the vehicle by which new productive capacities are created. Technology, understood in the broadest sense to mean new products, production processes and ways of organizing production, is the vehicle through which the development of productive capacities becomes greener. SST in Africa will be driven by massive capital investments and also the acquisition, adaptation and deployment of technologies that facilitate greater resource efficiency and mitigate the environmental impacts of resource use.

With regard to capital investment, the experience of successful developing countries indicates that structural transformation generally requires investment rates as a share of GDP to rise to at least 25–30 per cent, and public investment to reach at least 7 per cent of GDP (Commission on Growth and Development, 2008). Successful cases also increasingly rely on domestic savings to finance investment growth. The very process of structural transformation thus requires that current generations make sacrifices to improve the lives of future generations. SST would simply extend this principle by taking account of the environmental bads undermining environmental sustainability that are associated with the growth process.

Within structural transformation per se, the focus of the investment process has been on the productivity-enhancing effects of man-made (physical) capital, in particular machinery, equipment and structures. Public investment in infrastructure has been vital, acting both in terms of delivering required services and in crowding in private investment in underdeveloped economies. This must remain central to SST. Box 4 provides some estimates of the costs involved in building the energy infrastructure, which will be at the heart of SST. However, greater attention must also be paid to investing in natural capital. Natural capital can be preserved by re-using certain resources, recycling by-products and finding renewable substitutes for non-renewable resources.

Resource rent can play a significant role in financing SST in Africa. Many African countries are endowed with significant amounts of natural resources. This rich resource base has been a major driver and engine of economic growth in the region. Foreign exchange from resource exports has made it possible for African countries to import important intermediate inputs and also finance national development programmes. While African countries have benefited from their resource endowments, some of these resources are non-renewable, meaning that their rapid depletion by the current generation will limit the capacity of future generations to meet their consumption needs, particularly if the rent from these resources is not invested in assets that support future growth.

In the past, most governments in the region used resource rent to increase domestic consumption, with very little going into productive investments needed for long-term growth. Further, poor management of resource rent has often exacerbated economic instability, social conflicts and environmental problems in the region. Against this backdrop, one of the challenges facing African governments

Box 4. The investment costs of African energy infrastructure

Investment in energy infrastructure should be a critical element of sustainable structural transformation in Africa. The African Development Bank (2010) has estimated that 7,000 megawatts of new generation capacity must be installed annually so as to extend access and keep up with projected economic growth. There are various estimates of the costs of achieving this. According to the African Development Bank, the total capital investment requirements to provide universal access to reliable and increasingly cleaner electric power in all the countries in Africa by 2030 are close to $547 billion (see box table 2). This averages out to $23.8 billion per year starting from 2008. For sub-Saharan African countries and island States, the total capital requirements are estimated at $282 billion or, on average, $12.3 billion per year (for more information, see African Development Bank, 2008).

Box table 2. Indicative capital investment requirements of the African Development Bank to attain universal access to reliable electric power by 2030

	Total capital investment (billions of 2005 dollars)				Indicative average investment (billions of dollars per year)
	Generation	Transmission	Distribution	Total	
Northern Africa	82	29	62	173	7.5
South Africa	77	5	10	92	4.0
Sub-Saharan Africa: 41 countries	102	54	119	275	12.0
Island States: 6 countries	4	1	2	7	0.3
Africa	265	89	194	547	23.8

Source: African Development Bank (2008).

World Bank estimates of the costs of meeting sub-Saharan Africa's energy needs are somewhat higher. Foster and Briceno-Garmendia (2010) indicate that the overall costs for the power sector in sub-Saharan Africa are nearly $41 billion a year. Roughly 65 per cent are required as capital investment and the rest for operations and maintenance. These authors estimate that 44 per cent of sub-Saharan Africa overall infrastructure investment needs, including operations and maintenance, are in the power sector.

is how to put resource rent to productive use and to manage them in a manner that improves living standards for both current and future generations.

Following the Hartwick rule, it has been suggested that one way in which resource-rich countries could use their resources in support of development and achieve intergenerational equity is to invest resource rent in reproducible (physical, human or financial) capital (Hartwick, 1977). However, in African countries with very high poverty levels, a strict application of the Hartwick rule, which involves investing all resource rent in reproducible capital, does not seem appropriate. What makes sense from the African perspective is for a certain percentage of the resource rent to be invested in reproducible capital, while the rest is used to finance current consumption and other poverty-reduction programs.

This *Report* recommends that African governments earmark a certain percentage of their annual resource rent for promoting SST. The exact percentage of resource rent to be used for this purpose will vary across countries, but should be arrived at through consultations with parliament and other local stakeholders. The allocated amount should be kept in a special fund and used to promote domestic investment in the priority areas deemed crucial for SST in Africa, namely, energy, industry and agriculture. African countries can also impose environmental taxes on their primary commodity sectors in order to internalize the costs of environmental harm in the production costs of firms in those sectors. Such taxes can also raise revenues that can feed into the special fund. The fund proposed here differs in at least two ways from the sovereign wealth funds that have been created by several resource-rich developing countries. First, it is not meant primarily to be a stabilization fund. Second, unlike existing sovereign wealth funds that are predominantly invested in foreign assets, the focus of the special fund will be on domestic investment.

A relevant issue in managing the special fund is how to ensure that African governments will indeed use the allocated amount for the purpose for which it was intended. Transparency and accountability are critical for addressing this challenge effectively. One mechanism for ensuring that there is domestic accountability is for the executive branch of government to sign an agreement with parliament and other local stakeholders indicating that each year it will publish in the national newspapers the amount allocated to the special fund, as well as how it is spent. An independent committee chosen by parliament and other local stakeholders should also be set up to monitor and verify information provided by the executive branch. The Extractive Industries Transparency Initiative (EITI) can also play a role in enhancing domestic accountability by monitoring whether African governments observe and implement its rules. So far, 20 countries in the region have joined the Initiative: the Central African Republic, Ghana, Liberia, Mali, Mauritania, Niger, Nigeria, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, the Democratic Republic of the Congo, Gabon, Guinea, Mozambique, the Republic of the Congo, Sierra Leone, the United Republic of Tanzania, Togo and Zambia.

Africa's development partners should also contribute to domestic efforts to promote accountability by joining the EITI and ensuring that firms registered in their countries and doing business in Africa publish the amount of money they pay to African governments for resource extraction. This will make more information available to the African public and compel them to hold their leaders accountable for misappropriation or inefficient spending of resource rent.

4. Drivers of sustainable structural transformation: Technology

Technological change and innovation are the second key driver of SST. Innovation is broadly understood here to mean the introduction of products, processes and organizational systems that are new to a country or firm, rather than new to the world. In this domain, the experience of successful developing countries shows that importing foreign technologies is critical in the early stages of the development process. However, this is best achieved when there are existing absorptive capabilities in a country, in the sense of the ability to acquire, use and adapt foreign technologies. This depends on the presence of general and specific human capital skills, such as engineers, as well as the technological capabilities of domestic firms. In successful cases of structural transformation, there is a progressive build-up of technological capabilities in specific sectors. Eventually, capabilities are formed to develop and commercially introduce products and processes that are new to the world.

Technological change is central to the process of structural transformation because it is through innovation in the broad sense that new sectors emerge and upgrading within sectors takes place. This applies to SST as much as to structural transformation in general. However innovation in the case of SST would be more oriented to improving resource productivity, mitigating environmental impacts and promoting a more sustainable development pathway (see Berkhout, Angel and Wieczorek, 2009).

An important issue is whether African countries can engage in "technological leapfrogging", in which they adopt clean and resource-efficient technologies right from the start as they embark on structural transformation and thereby skip the dirty stages of development experienced by now-rich countries. This is certainly an opportunity for some countries. South Africa, for example, already has some medium-level technological competences in sustainability technologies and material efficiency (Walz, 2011). However, the possibilities for technological leapfrogging will be limited in many African countries because the level of technological capabilities of their domestic firms and farms are weak (see Lall and Petrobelli, 2003; Oyelaran-Oyeyinka, 2006).

It is clear, therefore, that African governments must pay particular attention to improving capabilities relating to science, technology and innovation as a central part of their policies to promote SST. In this regard, it is encouraging that there is much interest in policies relating to science, technology and innovation in many African governments, a trend that has been encouraged by the New Partnership for Africa's Development (NEPAD). However, it is important that these new technology policies do not simply adopt a science-push approach to innovation, but rather focus on building the technological learning capabilities of firms and farms. It is also good practice to adopt a systemic approach that supports the development of the local and national innovation systems within which they are embedded. This implies fostering greater linkages between enterprises and research institutes, as well as linkages among firms, for example by encouraging the formation of technological clusters (Oyelaran-Oyeyinka and McCormick, 2007) The requirements for the emergence of "sustainability-oriented innovation systems", to use the concept of Stamm et al. (2009), should be further explored in the African context.

C. THE ROLE OF THE STATE

In successful developing countries, structural transformation is carried out by an effective developmental State. Such a State is one which adopts long-term growth and structural transformation as its basic objective and seeks to devise policies and institutions that facilitate the evolution of the economic system so that the goals of economic development are achieved. For SST, the State will have to take on not only a development role but a broader sustainable development role.

Promoting economic development is not a simple task and not all developmental States have successfully met that end. Successful developmental States have a common approach towards governance. Perhaps the most basic, and one which is often misunderstood, is that they have not sought to replace the private sector through State ownership or to directly control large parts of the economy. Rather they have sought to fulfil the vision through design policies and institutions that harness private ownership, the animal spirits of entrepreneurs and the drive for profits to achieve national economic development goals. Thus the creation of a dynamic and development-focused private sector should be at the heart of policies to promote SST by a developmental State. Key elements of the strategy are public investment to crowd in private investment as well as production sector policies designed to generate a strong private-sector response geared towards increasing investment and technological change in the development directions the government is seeking to achieve (UNCTAD, 2009).

Successful developmental States have also had a number of other common features. Firstly, they have formulated a clear vision for the developmental future of the economy, which has provided a common-sense approach to coordinating the evolution of different parts of the economic system. Secondly, they have sometimes encouraged the emergence of political elites who are not committed first and foremost to the enhancement and perpetuation of their own privileges. Thirdly, they have built technically competent bureaucracies which have been relatively insulated from sectional interests and been able to act in the general interest. In addition, they have established institutions for dialogue, particularly for government-business relations, to support the formulation and implementation of policies that can support the general interest of business. They have also made sure that any incentives and resources provided to lead and guide the activities of the private sector are contingent on performance and are time bound. Further, they have undertaken policy experimentation, policy learning and institutional adaptation and innovation based on the constant monitoring of what works and what does not. Finally, successful developmental States have built their legitimacy on development results, ensuring that the benefits of development are widely shared and that the population is actively engaged in the common national project of development (UNCTAD, 2009).

All these characteristics of development governance are also relevant for promoting SST. However, the State should also view the environment as an intrinsic component of the development strategy. The State would thus play a leadership role in formulating a vision that sets clear and plausible goals to change the structure of the economy, engage in a relative decoupling of resource use and environmental impacts, and increase human well-being in the short-, medium- and long-term. It should also formulate a set of appropriate policies, regulations and incentives to ensure the successful fulfilment of SST objectives and take necessary measures, working with and through key stakeholders, and in particular the private sector, to ensure their effective implementation. Significantly, policy instruments and this vision should not be expressed in a special document that is separate from the main policy process. SST should be a key component of national development strategies.

An important feature of the types of policies successful developmental States have adopted is that they have not simply involved macroeconomic policy or a framework approach such as getting the overall investment climate right. Instead they have involved a combination of macroeconomic, mesoeconomic and microeconomic policies. Thus economic governance has invariably involved some kind of industrial policy or more broadly, some kind of production sector policy. As Ocampo (2011) points out, once the process of economic growth is seen as a process of structural change, such policies become a central element of national development strategies. Such policies should be at the heart of national strategies to promote SST.

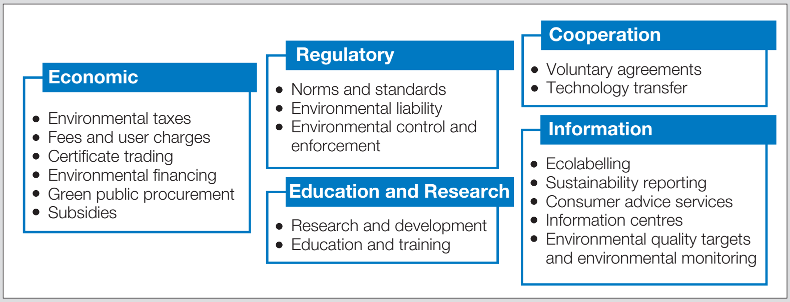
As indicated above, investment and technological change are key drivers of SST; therefore, policies and institutions should be designed to lead these drivers in the desired way. It is possible to do this with a range of policy instruments that include command-and-control approaches, market-based tools, information, cooperation, education and research (see box 5).

Selecting the optimal mix of policy instruments is crucial. The challenge is to design an appropriate and balanced combination that is sound enough to achieve the required objectives. Such a policy mix should provide both incentives and penalties. In addition, hard measures should be complemented with softer instruments, since implementing just one of these two types in isolation would be insufficient to deliver the expected results. For example, the objective of an environmental tax responds to the need of incentivizing changes in behavioural patterns among economic agents. Consequently, the latter require access to financial, technological and information resources in order to adequately modify their actions. In the absence of these complementary measures, the tax would just hinder their efficiency, and thus their ability to change. Finally, it is also important to consider the costs and benefits associated with the intended policies. It is up to each African country to conduct cost–benefit analyses to decide on the optimal mix of policy instruments to use by selecting instruments that prove to be the least-cost option available. The potential benefits to be gained from resource- and impact decoupling (lesser environmental costs, savings from resource use, for example) and in the form of revenues from fiscal instruments should be weighed against potential costs derived from administering the instrument, disincentive effects on labour and capital, switching costs induced by the instrument and losses in competitiveness. Moreover, factors that may influence the suitability of one instrument over the other for a given country include institutional and human capacities, social capital, economic structure and level of development governance.

Box 5. Policy instruments for promoting sustainable structural transformation

Box figure 1 summarizes the different types of policy instruments that can be used to promote resource and impact decoupling.

Box figure 1. Overview of policy instruments that promote resource and impact decoupling



Source: GTZ (2006).

- **Regulatory or command and control:** These are rules and targets that are set up by the State and are legally enforced. They can achieve numerous aims, such as increasing resource or energy efficiency; reducing emissions, waste and the use of toxic substances; and protecting ecosystems. They may also aim to incentivize the use of certain technologies, address the polluter-pay principle and monitor the compliance of existing regulations.
- **Market-based:** These instruments make use of market mechanisms to incentivize a positive behaviour among economic agents. These encompass a broad array of policy tools, ranging from environmental taxes and marketable certificates to subsidies. They might be applied across a similarly wide-ranging set of policy areas, such as land, water and air management. They allow economic agents a larger flexibility in deciding how and when to meet their targets, while encouraging the implementation of new and improved technologies. These instruments can also lower regulatory expenditures, as less monitoring and surveillance is often required. In addition, some of these instruments help raise public revenue (see UNEP, 2004).
- **Information:** These measures positively affect environmental quality by promoting changes in consumer and producer behaviour. They often do not involve direct governmental intervention and thus may not involve the use of public funds to put them into operation. Some of these measures allow stakeholders to make better-informed choices, such as in the case of ecolabels and consumer advice services. Other types encourage organizations to enhance their public reputation by disclosing or reporting information about their sustainability performance. Information centres,

Box 5 (contd.)

however, can provide information on resource efficiency and related topics to small and medium-sized enterprises, which do not usually have access to this kind of knowledge.

- **Cooperation:** These include measures implemented by governments to promote cooperation between the private sector and civil society, as well as with public and private foreign parties. They might be designed to facilitate technology transfer focused on resource efficiency, or to improve voluntarily the performance of public and non-State actors beyond existing environmental legislation.
- **Education and research:** These measures promote public education and training, as well as R&D focused on resource and environmental efficiency. These aspects are key activities in any country and are an essential part of economic and human development. African States should thus encourage an increase in applied and experimental research activities among governmental departments, universities, research institutes, private companies and non-governmental research bodies. Furthermore, they should carry out the continuous task of educating local populations about the benefits derived from environmental protection and resource efficiency measures.

Within the African context, a major negative side effect of the structural adjustment phase was the erosion of State capacities. Building up developmental States' capabilities to formulate and implement structural transformation policies will thus be an important challenge. In this regard, it is important to realize that when successful developing countries such as those in East Asia embarked on their development process, the technical capacities of their governments were not strong. These capacities were built up slowly through policies of meritocratic recruitment and policy learning. It is also clear that improving government effectiveness across the board, a very difficult task, is not a necessary condition for success; rather it is necessary to initiate positive change within a few strategically important agencies (see UNCTAD, 2009).

One important area where much more work is needed is for governments to establish a system for monitoring and evaluating progress towards relative decoupling. This will involve strengthening statistical capacities in designing sustainability indicators, in using a national system of accounts to keep track of the environmental state and to monitor resource productivity (green national accounts, MFA and so forth), strengthening institutional capacities to set and monitor sustainable development targets over a given period of time and acting on progress made towards these indicators to review policymaking. In addition, the current institutional setting for implementing, monitoring and evaluating environmental measures should be reviewed in terms of assessing the needs for new institutions and revising legal, regulatory and supervisory frameworks. Moreover, it needs to be revised in relation to the need for building the capacities of existing institutions and agents, and delineating their respective roles and responsibilities for greater transparency and accountability.

A national development vision is particularly effective when it becomes a shared national project and there is societal mobilization behind the goals of the project. In this regard, some non-governmental organizations (NGOs) can be influential in promoting societal mobilization of environmental sustainability. The number of NGOs in Africa has risen sharply during the last two decades. Some of them advocate measures that can contribute to relative resource and impact decoupling by promoting the preservation and restoration of natural resources, such as forests or fisheries. For example, the Green Belt Movement in Kenya, founded by Nobel laureate Wangari Maathai, engages communities in setting up tree nurseries and planting seedlings on public lands, degraded forest areas and private farms. Other NGOs promote the use of sustainable energy sources, such as Africa's International Network for Sustainable Energy, whose more than 35 NGOs operating in 18 African countries strive to produce sustainable energy solutions to protect the environment and reduce poverty.

D. THE ROLE OF THE INTERNATIONAL COMMUNITY

While African governments must play the leadership role in formulating and implementing strategies of SST, it is essential that an appropriate enabling environment, including support measures, should be established at the international level. The international enabling environment should seek to apply the principle of common and differentiated responsibilities which was articulated at the 1992 United Nations Conference on Environment and Development. This can be interpreted in various ways. However, in broad terms, it implies an approach whereby (a) African countries should not be hindered in their pursuit of accelerated economic growth and structural transformation and should seek to enhance environmental sustainability by means of relative, rather than absolute, decoupling, the latter being much more relevant for developed countries that have already achieved high living standards; and (b) developed countries provide financial support and facilitate technology transfer to support SST and design the international trade regime and intellectual property rights regime in a way that facilitates the sustainable development process.

The policy agenda is a broad one and the purpose of this section is to identify a few areas in which increased policy attention would be desirable. These relate to: (a) the financing of SST; (b) technology transfer and development; (c) the international trade regime; and (d) South–South Cooperation.

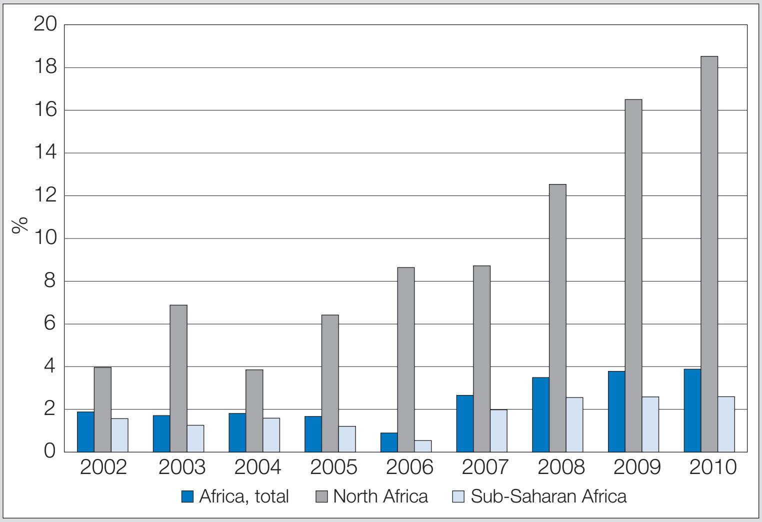
1. Finance

African countries need long-term development finance to support structural transformation. A critical issue in this regard is to shift the balance of development aid so that a higher proportion is devoted to building productive capacities. For example, Aid for Trade in Africa should be used to facilitate increased value-added from commodity exports and the diversification into new sectors. For SST, the energy sector is critical. As indicated previously, this is the major component of Africa's infrastructure financing needs; the investment costs to provide energy access for all and increase the share of renewables is substantial. These needs cannot be met through domestic sources, and past experience suggests that the private sector is unwilling to undertake the risks. Development aid can play an important role in enhancing public investment in energy. Although the share of the energy sector in total official development assistance (ODA) disbursements has been increasing in North Africa, only around 2 per cent of total ODA to sub-Saharan Africa went to the energy sector from 2005 to 2010 (see figure 16). In absolute terms, the amount of ODA disbursements to the energy sector in Africa actually doubled in real terms between 2007 and 2010. Yet in practice, ODA disbursements to the energy sector in 2010 were only $806 million, compared with World Bank estimates of infrastructure investment needs of $41 billion per year. Increasing the share of aid to the energy sector in sub-Saharan Africa should be a priority for the international community. However, it is important that this aid, and development aid in general, should not be made conditional on the achievement of externally required environmental sustainability targets.

Another area where ODA will be important is technical assistance. This should support improved governance of sustainable development. Technical assistance to build statistical capacities to integrate development and environmental concerns is a priority in this regard.

Within the last few years, various innovative international mechanisms for financing environmental issues have been developed that should offer a source of financing for SST additional to ODA. However, it is important that these mechanisms be designed in such a way that they are accessible to African countries. The Global

Figure 16. Official development assistance disbursements to the energy sector, 2002–2010 (%)



Source: OECD DAC, Creditor Reporting System database, online, March 2012.

Environment Facility (GEF), for example, is a multi-partnership financing facility that provides grants to developing countries for projects in a range of environmental areas such as climate change and is the financing mechanism behind several multilateral environmental agreements. Numerous concerns have been expressed by developing countries about the manner of governance of the Facility, and difficulties in accessing the funds. African countries should continue to push for governance reforms at the Facility (ECA and Africa Partnership Forum, 2009), while seeking technical assistance from the United Nations and NGOs to increase their utilization of funds from the Facility. Similarly, governance reforms could help increase the relevance of the LDC Trust Fund for Climate Change, given that the Fund is designed to help these countries adapt to climate change (see UNCTAD, 2010b).

Payments for ecosystem services (PES) are an innovative source of financing that may be particularly relevant for Africa. They could support various areas, such as the conservation of biodiversity, carbon sequestration, watershed protection and sustainable agriculture. The basic idea behind the PES scheme is to provide incentives, by means of payments to farmers, local communities, landowners and resource owners for sustainably managing their resources in exchange for the provision of ecosystem services. The East African Forum for Payment for Ecosystem Services is a regional initiative to promote PES schemes. The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) is an international PES scheme from which Africa can benefit enormously, given the richness of its forest resources. REDD+ strategies are being developed in several African countries, notably Ghana, Liberia, Madagascar, the United Republic of Tanzania, Zambia and the Congo Basin countries.

Another important source of external development finance in Africa is FDI. How it can contribute to sustainable development is the subject of other UNCTAD work, which is forthcoming. However, this *Report* suggests that African governments should seek to use innovative ways to leverage support for SST from multinational corporations investing in Africa. For example, multinational corporations involved in the natural resource extractive industries may be legally mandated to hold interest-bearing deposits, equivalent to a share of their initial investment, at the national Central Bank of the country, as collateral warranty against potential environmental damage. Such an initiative can take place under a sustainable corporate social responsibility programme initiated by the government. If no major environmental damage is associated with their activities, the multinational corporations can then retrieve from the Central Bank such deposits in full with interest at the end of their operations in the country. In cases where environmental impact assessments conducted regularly throughout the operating period reveal that their activities caused environmental harm, then penalties can be applied to the environmental collateral to pay for environmental damages. Such an initiative not only gives incentives to multinational corporations to minimize environmental impacts from their activities, but it also provides the national banking system with additional loaning capacities that can be deployed to finance sustainable development projects in the economy. For multinational corporations, participation in such an initiative can help them build good reputations by means of sustainable corporate social responsibility on the international scene.

2. Technology transfer and technology development

Most African countries will be technology followers rather than technology leaders. It is thus necessary to develop global institutional arrangements that increase international cooperation and collaboration in all areas relevant to SST and to accelerate the transfer, adoption and adaptation of relevant technologies in African countries. This is how leapfrogging can become possible.

There are various ways international cooperation can take place to promote technology transfer and development as part of supporting SST. Firstly, as recognized in Agenda 21 (para. 34.9), a large body of technological knowledge lies in the public domain. Many of the environmental technologies that developing countries are seeking to access are off patent (UNCTAD, 2011b). In this case, there is a need for improved access to such technologies as well as the know-how required to use them. A technology bank could facilitate search and access. Lack of financial resources may be a key barrier to use licensed technology; therefore, there may be a case for establishing international funds to enable developing countries to purchase and manufacture relevant technologies.

Secondly, major efforts should be made to expand the space for technologies in the public domain and to stimulate the transfer of publicly funded technologies to developing countries in general, and African countries in particular (Ocampo, 2011). In this regard, increased international cooperation for public funding and joint planning of research and development (R&D) programmes, based for example on the model of the Consultative Group on International Agricultural Research, should be considered. Within Africa, the establishment of regional research centres to support science, technology and innovation would be relevant.

Thirdly, attention must be paid to ways in which the intellectual property rights (IPR) regime affects the transfer of technologies that support environmental sustainability objectives. It is important in particular that IPR facilitate technological development and do not act as a barrier preventing African countries from accessing and using the technologies necessary for leapfrogging. This is a complex issue. According to Ocampo (2011), “a delicate balance must be struck between the advantages and costs IPR have for technologically dependent countries”, and the following reforms to the global IPR regime could be supportive: (a) broader room for compulsory licensing (replicating in the area of environmental sustainability the agreement on Trade-Related Aspects of Intellectual Property Rights and on public health of the World Trade Organization (WTO)); (b) strengthening patenting standards, particularly standards of breadth and novelty; (c) limiting the length of patent protection; and (d) allowing innovators to use existing patented knowledge to generate new innovations.

Finally, there is an important role ODA can play in building the technological capabilities of African firms and farms. This is currently a major blind spot in development assistance (see UNCTAD, 2007). Particular attention should be given to use aid to support agricultural R&D and the extension of sustainable agricultural intensification in Africa.

3. International trade regime

There are number of key considerations with regard to the international trade regime. Firstly, it is important that the increased interest of the international community in global environmental sustainability does not translate into protectionist measures in Africa's trading partners, which could damage export growth.

Secondly, increased domestic value added for commodity exports contributes to GDP growth. This is tantamount to relative decoupling in the sense that the country is gaining and retaining more for each unit of domestic resource extraction. Therefore, any aspects of trade regime that constrain increased domestic value added from commodity exports also constrain relative decoupling. Thus, for example, tariff escalation in importing countries should be reduced, as it acts as a disincentive for countries to make greater use of their domestic resources.

Given the state of their human, institutional and technological capacities, African countries need policy space to enable infant economic activities to develop. This is necessary to enable economic diversification in general, to make the leap to low-carbon economies and to achieve competitiveness in producing environmentally friendly goods and services. African countries should thus be allowed the policy space to apply measures that will help them achieve economic diversification and relative decoupling. In the multilateral arena, African countries must remain vigilant in preserving policy space to pursue SST in order to meet their sustainable development objectives, when negotiating on rules under WTO agreements and bilateral and regional free trade and investment agreements. African countries must also ensure that agreements signed at the bilateral, regional and international levels facilitate rather than hinder their abilities to engage in SST processes, including green industrial development.

Finally, African countries should work towards ensuring policy coherence and policy synergies at the national, regional and international levels (Chaytor, 2009) with regard to trade, investment and environment. For instance, at the national level, the preservation of fossil-fuel subsidies is incoherent with the objective of fostering a transition to a low-carbon, sustainable economy. At the international level, unless talks on climate change mitigation and adaptation are followed by actual disbursements of resources and transfers of clean technologies from developed to developing countries, no significant results can be achieved in terms of protecting the global environment. African countries need to remain vigilant on such kinds of policy incoherence and heighten the awareness of the development community about the need to iron out policy inconsistencies relating to trade, investment and the environment.

4. South–South cooperation

South–South cooperation and triangular cooperation mechanisms for accelerating the transfer, assimilation and deployment of environmentally sound technologies (EST) in Africa should be considered. Such cooperation can involve the provision of technical assistance to African countries on the use and deployment of EST, grants for the purchase of patented EST, training of African nationals abroad in the area of green technology use and adaptation, and support to African technological research institutions and universities. Recent research suggests that the EST sector is growing, and that many large developing countries, namely Brazil, China and India, are participating in EST transfer. It also argues that EST transfer is not necessarily a unidirectional process from developed to developing countries (World Intellectual Property Organization (WIPO), 2011), suggesting that triangular cooperation mechanisms should be fostered.

CHAPTER 4

POLICIES FOR SUSTAINABLE STRUCTURAL TRANSFORMATION

The purpose of this chapter is to illustrate selected sectoral policies that can be implemented, at a national level, to promote SST in Africa. The chapter is based on the view elaborated in the last chapter that production sector policies, such as industrial, should be at the heart of efforts to promote relative resource and impact decoupling. The chapter focuses on three sectors: energy, industry and agriculture. These sectors have been identified as critically important for Africa's structural transformation and sustainable development (New Partnership for Africa's Development (NEPAD), 2001; AU/NEPAD African Action Plan 2010-2015; ECA, 2011b). Building on last year's *Economic Development in Africa Report,* this chapter argues that a green industrial policy should lie at the heart of strategies of SST in Africa. However, given the findings in chapter 2 on the low levels of land-use efficiency, the scale of land productivity losses and the prevalence of energy poverty in Africa, it is also necessary to have policies which promote sustainable agricultural intensification and increased access to energy, particularly sustainable energy. The chapter highlights policies which can promote the development of productive capacities in these areas as well as relative resource and impact decoupling.

The chapter shows the role that technology and innovation plays in promoting SST. The application of technology is critical in order to deliver on the supply side the building of sustainable production capabilities. National trade policy and national trade strategies can be formulated in such a way as to tip the demand in favour of more sustainable consumption and production patterns among households and firms and favour the building of competitiveness in producing and exporting environmentally-friendly goods and services. As discussed in chapter 3, the provision of finance for investment is also critically important.

The remainder of this chapter is articulated around the following sections:

(a) The development of sustainable energy in Africa;

(b) Green industrial policies in Africa; and

(c) The promotion of a truly green agricultural revolution in Africa.

It has to be borne in mind that important intersectoral linkages exist when promoting SST. For example, the fostering of green industrial development and agricultural productivity necessitate policies to increase sustainable energy use. This calls for an integrated approach in formulating and applying relative decoupling policies to advance SST in Africa.

A. THE DEVELOPMENT OF SUSTAINABLE ENERGY IN AFRICA

Relative decoupling for promoting SST should in Africa encompass three types of policies in the energy sector: (a) policies that will increase access to energy by firms and households both in rural and urban areas; (b) policies for promoting efficiency in energy use both by households and firms; and (c) policies for promoting the gradual phase-in of Renewable Energy Technologies (RET) in the national energy grid.

(a) Policies to increase access to energy for all

Increasing access to energy is critical both for powering resource productivity increases, be it in industry and agriculture, and for limiting environmental damage. For instance, it is widely recognized that poor people, in the face of energy poverty, tend to rely heavily on traditional biomass fuels such as wood, charcoal and agricultural residues that can be environmentally harmful. In sub-Saharan Africa, it is estimated that about 70 to 90 per cent of the population resorts to biomass use and that half a million Africans die every year due to indoor air pollution arising from use of solid biomass fuels (VENRO *et al.*, 2009). On the other hand, without access to mechanized equipment, farmers' land productivities may remain low in African rural areas, inciting farmers to more intensive use of chemical fertilizers that can aggravate land degradation. Without access to cheap, stable energy supplies, industries in urban areas may lack incentives in acquiring and applying resource-productive technologies such as waste-water recycling technologies.

Policies for increasing access to energy in Africa must target both households in their consumptive uses and local enterprises in their productive uses. They must also target both urban areas, where economic activities tend to be concentrated, and rural areas, where a large part of agricultural production occurs.

This *Report* argues that a first policy component for relative decoupling in the energy sector lies in getting households and firms to switch away from traditional biomass fuels such as wood to more modern and energy-efficient solid, liquid and gaseous fuels such as electricity as part of increasing access to energy. Governments can, for instance, induce households and rural enterprises to make such a switch through fiscal-based policy instruments that include providing subsidies, tax breaks on and small grants for purchases of kerosene and electricity.

This has to be accompanied by intensification and upscaling of rural and urban electrification programmes whereby African governments develop partnerships with the private sector to develop a range of off-grid, mini-grid and grid-connected options for rural and urban populations. Such options may include expanding the national electricity grid to rural and peri-urban areas and/or promoting decentralized electricity generation through the expansion of RET (ECA, 2009b).

As an example of the latter option, in countries where agro-based industries are significantly present, the potential of co-generation projects can be developed. Industries in the sugar, paper, pulp and wood sectors can, for instance, harness their agricultural by-products or wastes to meet their own heating and electricity needs and sell their excess electricity to the national grid. Countries such as Mauritius and Kenya have significant installed capacities of co-generation electricity production (VENRO *et al*., 2009). These countries have resorted to a combination of policy instruments involving feed-in tariffs and legislative and regulatory instruments to develop co-generation (see box 6).

A second important policy component in the energy sector is increasing investment in energy generation. This will mainly involve public investment, but the State should also seek to encourage private investment through such policy instruments as feed-in tariffs, public procurement and removal of tariffs on imported energy technologies, in addition to the maintenance of a stable and predictable legal and regulatory environment in the energy sector, a sound investment climate and support from the State in accessing finance from banks. Public–private partnerships (PPP) such as Private Participation in Infrastructure (PPI) have the potential to play an important role in boosting private sector investment in energy generation in Africa (ECA *et al.*, 2011). However, the potential of PPI should be realistically assessed. African governments must also fundamentally improve their systems for dealing with the private sector in order to make PPP deliver on their promised goals by, for instance, ensuring thorough planning, good communication, strong commitment from both parties and effective monitoring, regulation and enforcement (Farlam, 2005).

Regional integration can play a critical role in augmenting access of African populations to more modern and efficient energy systems, away from traditional biomass-based systems. Small domestic market size and huge transaction costs continue to hinder the full development of Africa’s huge energy reserves. In order to tap into that potential and connect Africa’s populations to its energy resources, significant investment will be needed, not only for converting these resources into

Box 6. Bagasse co-generation in Mauritius: An African success story

Mauritius is an African success story in co-generation. The sugar industry in Mauritius is currently self-sufficient in electricity and sells the excess it generates to the national electricity grid. The sugar industry generates electricity from bagasse, a by-product of sugar cane. Bagasse can be an environmental hazard if unused since, during decomposition, it releases methane which is a more potent greenhouse gas than carbon dioxide. The sugar industry now contributes over half of the electricity supply on the island. The Mauritian Government has played an instrumental role in the development of bagasse co-generation. In 1985, the Sugar Sector Package Deal Act (1985) was enacted to encourage the production of bagasse for the generation of electricity. The Sugar Industry Efficiency Act (1988) provided tax incentives for investments in electricity generation and incentives to encourage small planters to provide bagasse for electricity generation. The Bagasse Energy Development Programme was initiated in 1991 for the sugar industry. In 1994, the Government of Mauritius abolished the sugar export duty as an incentive for the industry. A year later, foreign exchange controls were removed and the centralization of the sugar industry was accelerated. Specific incentives in the past have included :

(a) Performance-linked rebates on export duty payable by millers for efficiency in energy conservation to generate surplus bagasse and in energy generation, preferably, firm power; (b) income tax exemption on revenue derived from sale of power, and capital allowances in such investment; (c) raising of tax-free debentures; and (d) bagasse energy pricing. Bagasse-based co-generation development in Mauritius has delivered a number of benefits, including reduced dependence on imported oil, diversification in electricity generation, improved efficiency in the power sector in general, and increased incomes for smallholder sugar farmers. In recent years, the revenue from the sale of excess electricity from co-generation has enabled Mauritian sugar factories to remain profitable. A notable achievement has been the use of a wide variety of innovative revenue sharing measures. For example, the Mauritian co-generation industry has worked closely with the Government to ensure that substantial monetary benefits from the sale of electricity from co-generation flow to all key stakeholders of the sugar economy, including the poor, smallholder, sugar farmers. Based on current sugar production in sub-Saharan Africa, it is estimated that bagasse-based cogeneration from sugar industries can meet about 5 per cent of the total electricity demand in the region. If biomass waste from other agro-industries and from forestry industries is included, about 10 per cent of electricity in the region could be generated through co-generation. Several other sub-Saharan African countries have already begun to follow in the footsteps of Mauritius, including Ethiopia, Kenya, Malawi, Sudan, Swaziland, Uganda, and the United Republic of Tanzania.

Sources: Reproduced from Karekezi and Kimani, 2010; VENRO *et al.*, 2009; WADE, 2004.

commercial energy but also for distributing the produced energy to wherever it is needed most. In that respect, the intensification of regional development energy projects may be considered as a policy option. The West African Gas Pipeline, for instance, is a natural gas pipeline that supplies natural gas from Nigeria to Benin, Ghana and Togo. This type of regional development projects can allow African countries to pool their resources to develop the necessary infrastructure and create the larger regional demand markets that can make energy production commercially viable and accessible to more in Africa. In developing such regional projects, however, due consideration must also be given to the social and environmental impact of the projects.

In the short-to-medium term, due to capacity, technological and cost constraints, African governments may have no choice but to target increased energy access through an expansion of fossil fuel-based production and consumption, especially in countries that are endowed with fossil fuels. However, this *Report* argues for the legal, regulatory, institutional and incentive frameworks in African countries to be designed in such a way as to encourage a gradual phase-in of sustainable energy from diverse sources in the energy mix.

(b) Policies for promoting efficiency in energy use at a national level

The promotion of efficiency in energy use can benefit Africa's SST in multiple ways. Increasing efficiency in national energy use can allow net energy-importing African countries to save on their energy consumption bills, thereby releasing resources to finance other critical areas of SST. The promotion of energy efficiency in multiple economic sectors such as industry, transport and agriculture can contribute to some extent to reducing production costs and raising Africa's competitiveness at a firm-level in the export of goods and services (African Development Bank (AfDB) *et al.*, 2009). Increased domestic energy efficiency in energy-abundant African countries can free up more energy resources as exports. Owing to the linkages between energy and the multiple drivers of SST, a third policy component for relative decoupling in African countries should involve mainstreaming the promotion of energy efficiency in various sectoral development plans as part of a holistic approach towards SST, as is the case in South Africa (box 7).

A possible starting point for African countries will be to utilize legislative and regulatory instruments such as developing National Energy Efficiency and Conservation Plans (NEECP), based on the participation of stakeholders from several economic sectors and civil society. The objective of such national plans will be to identify clearly the national priorities in terms of improving on energy access and efficiency, situate what the policy options are and what is needed in terms of regulatory, incentive and institutional frameworks. For example, Tunisia, at

Box 7. Improving energy efficiency at a national level: The adoption of an Energy Efficiency Strategy in South Africa

The Ministry of Minerals and Energy of the Republic of South Africa published in 2005 the Energy Efficiency Strategy for South Africa, which was reviewed in 2008. The objective of the Strategy is to provide clear and practical guidelines for the implementation of energy-efficient practices throughout the South African economy. The Strategy sets a national long-term target for energy efficiency improvement of 12 per cent by 2015. The Strategy states that energy efficiency improvements will be achieved largely via enabling instruments and interventions, which will include *inter alia* economic and legislative means, efficiency labels and performance standards, energy management activities, energy audits, as well as the promotion of efficient practices. The Strategy will cover all energy-using sectors and will be implemented through Sectoral Implementation Plans. Four Sector Programmes were identified in the strategy and consist of an Industry and Mining Sector Programme, a Commercial and Public Buildings Sector Programme, a Residential Sector Programme and a Transport Sector Programme. A National Energy Efficiency Agency was created in 2006. Among others, the Agency has as its main tasks: (a) prioritize and recommend energy efficiency and Demand Sector Management (DSM) projects to be undertaken in the country; (b) identify and develop key strategies to address the growing demand for energy in the country including gas, electricity, liquid petroleum, etc.; (c) develop and implement annual "energy efficiency and DSM" awareness campaigns to assist the general public in making wise choices when purchasing energy-consuming equipment and appliances; and (d) cooperate with others undertaking energy efficiency programmes in other countries to ensure that international best practices are adopted and applied in South Africa.

Sources: Excerpts from Energy Efficiency Strategy of South Africa, 2009; CEF Group of Companies Website.

the start of 1980 initiated a National Energy Conservation Plan, whose objectives were to limit increasing energy demand and stimulate increased energy supply through the development of natural gas and renewables. The Tunisian Agency for Energy Management was created to develop and implement the measures that were needed to achieve the objectives of the plan (Karekezi *et al*., 2004).

In sub-Saharan Africa, an important component of increased energy efficiency should consist in providing incentives to households and firms to switch away from traditional biomass towards more energy-efficient technologies such as kerosene, liquefied petroleum gas, natural gas and biogas. Some oil-producing African countries are in a situation where they export crude oil without any value addition to then import refined oil at much higher prices on international markets. Government measures to stimulate domestic and regional refining of crude oil can contribute towards facilitating the shift from traditional biomass to more energy-efficient technologies in some parts of Africa. Examples of policy instruments include providing accelerated depreciation allowances to oil and gas companies that invest in oil refining capacities, and forging cooperative arrangements with such companies under sustainable corporate social responsibility programmes for them to participate in the NEECP. However, such a switch can increase reliance on fossil fuels use, thereby compromising on environmental sustainability. This *Report* advocates for African countries to consider leapfrogging directly from traditional biomass and fossil-based energy into RET to the extent possible. Whether such leapfrogging can happen and the speed at which it can take place, however, will depend on the ability of African countries to overcome barriers in the acquisition, production, use and deployment of RET. This issue is treated in the following section.

Trade-based policy instruments can be deployed for stimulating energy efficiency in Africa. Through trade policy, African governments can influence the behaviour of households and firms in producing and consuming energy. In the transport sector, for instance, the removal of import tariffs on new, energy-efficient cars can stimulate demand for energy-efficient modes of transport. By granting, in general, lower tariffs on imported energy-efficient goods and technologies such as energy-saving light bulbs, energy-efficient appliances, renewable energy equipment and modern biomass energy technologies, African governments can stimulate demand by households and firms for energy-efficient goods and stimulate the displacement of traditional biomass technologies by energy-efficient technologies in industry and agriculture. African governments should also consider promoting the use of energy-efficiency standards and labelling in order to stimulate investment in the supply of energy-efficient goods and services.

Other examples of how policy instruments can be applied to foster energy efficiency include:

- Providing tax breaks or subsidies to oil and gas companies to invest in reducing losses from flaring and venting;
- Imposing energy taxes on oil and gas companies and large industries to feed the revenues into an Energy Efficiency Fund, aimed at supporting local R&D on energy efficiency;
- Increasing public investments in mass public transport systems and subsidizing use of such systems by targeted consumer groups;
- Imposing mandatory regular vehicle maintenance as a way to reduce energy consumption and mandatory energy audits, savings and obligations for large industries;

- Imposing and monitoring the implementation of energy-efficient building standards and codes in large public buildings; and
- Undertaking awareness and sensitization campaigns on television and radio on the need for energy efficiency.

(c) Policies for promoting the gradual phase-in of Renewable Energy Technologies

RET, as argued in UNCTAD's *Technology and Innovation Report 2011* (UNCTAD, 2011), can be highly attractive and feasible options for countries to increase their access to energy in an environmentally sustainable manner. RET can be developed and used as part of a national energy policy that in the short-to-medium term combines conventional sources of energy with renewable sources, while aiming for full conversion to renewable energy in the long term. RET have the practical advantage of versatility; not only can they be deployed either alone or in tandem with conventional sources, but they can also be accessed on the grid, off the grid or in semi-grid configurations (UNCTAD, 2011). In rural areas, where extending the energy grid infrastructure can be costly due to remoteness and poor accessibility, the application of RET in off-grid configurations can significantly enhance access by the poor to energy and in so doing reduce reliance on polluting and energy-inefficient traditional biomass sources.

The increased deployment of RET in economic sectors such as transport, industry and agriculture will be critical as part of Africa's SST process. African countries, as latecomers to the structural transformation and industrialization stage, have unique opportunities to leapfrog directly into clean, energy-efficient renewable energy. African capacities for leapfrogging, however, as mentioned in chapter 3, will critically depend both on international support in the form of finance and technology transfer from the international community, as well as on the set-up of adequate national and regional legislative, regulatory, institutional and policy frameworks by African countries and the Regional Economic Communities they belong to.

Significant technological, financial and cost barriers exist to the adoption and deployment of RET, as outlined in UNCTAD (2011), and African countries will no doubt be facing challenges in overcoming them. RET are also a diverse group of technologies, with some technologies at more advanced stages of commercial viability and deployment than others. RET such as solar pumps, solar PV installations, small wind and biomass mini-grids, for instance, can already offer higher potential and cost advantages than traditional grid extension (UNCTAD, 2011). Africa's significant competitive advantage in developing and using RET relies on its immediate vast reserves of renewable energy and growing international interest in commercially exploiting them as the world accelerates its transition to a green economy, and as the costs of some of these technologies continue to tumble down, thereby reducing the costs of switching into them. In 2010, global investment in renewable energy broke a new record at $210 billion, despite the global recession. Africa actually achieved the largest percentage increase in renewable energy investment in 2010 among developing country regions apart from China, India, and Brazil. Total investment rose from $750 million to $3.6 billion, largely as a result of strong performances in Egypt and Kenya (REN21, 2011). However, this is still a very low proportion of Africa's total energy sector investment needs using the estimates presented in chapter 3.

This *Report* echoes the recommendations of UNCTAD's *Technology and Innovation Report 2011* by advocating for African governments to strengthen their national policy frameworks for technology and innovation in order to promote the acquisition, development and use of RET, while complementing such frameworks by national energy policies that promote the gradual integration of RET into sectoral development policies. These policy frameworks should serve five important functions: (a) set out clearly strategies and goals for RET's development and use; (b) enact policy incentives for R&D, innovation and production of RET; (c) enact policy incentives for developing greater technological absorptive capacity, needed for adaptation and use of available RET; (d) promote domestic resource mobilization for RET; and (e) explore newer means of improving innovation capacity in RET through, among others, South–South collaboration (UNCTAD, 2011).

As noted in UNCTAD's *Technology and Innovation Report 2011,* governments should approach the development of policies for RET in an integrated manner that involves a large number of potential stakeholders, with a long-term perspective and clearly defined roles and responsibilities (UNCTAD, 2011). Such policies must contain both measures for stimulating on the supply side the acquisition and adaptation of RET to feed into the production of renewable energy, and on the demand side measures for creating a stable, predictable, long-term demand for renewable energy by households, firms and the public sector. For example, in order to stimulate private investment in the commercialization of Africa's vast renewable energy reserves, on the supply side, African governments would need to create a stable and predictable investment climate enriched with targeted incentives for investors in the renewable energy sector. These incentives may include public procurement programmes for renewable energy, feed-in tariffs, reduced import tariffs on RET equipment, creation of low-carbon special economic zones, and provision of investment guarantees and use of renewable portfolio standards to create a stable, profitable market for investors in renewable energy. On the demand side, African governments can use economic incentives and legislative and regulatory instruments to generate switching to renewable energy among users. Such incentives may include a gradual phase-out of fossil fuel subsidies, provision of tax breaks for enterprises that use a certain percentage of renewable energy in production, mandatory use of renewables, and financial support in the form of small loans to purchase RET equipment. Table 12 lists some of the incentives that are currently being used by African countries in their renewable energy policies.

The ability of African countries to acquire RET and adapt them to local conditions through indigenous innovations will be a critical policy component for relative decoupling in Africa as part of diffusing the utilization of RET. Policy instruments for stimulating national and regional R&D and innovation capabilities in RET (UNCTAD, 2011) may include:

- Public research grants to universities and public support in establishing national scientific and technological energy research centres that have ties to international research networks, as part of building sustainability-oriented innovations systems;
- Set-up of RET cluster centres and RET-based industrial parks that foster linkages between R&D institutes and industry;
- Set-up of collaboration and joint ventures with international research centres and facilitate FDI by multinational companies in the renewable sector in order to stimulate transfer of skills and knowledge to local stakeholders;
- Establishing RET-specific training centres that run training platforms on RET use and adaptation.

National and regional trade policies and trade strategies can have critical roles to play in the diffusion of renewable energy in Africa. Trade-based instruments can affect households' and firms' incentives for producing, using and researching RET. For example, taxes imposed on exports of primary commodities can be used to set up a Renewable Energy Fund to finance advisory and support services on the use and local adaptation of RET. In addition, the diffusion of RET to as many economic

Table 12. Renewable energy support policies in Africa

	Regulatory policies						Fiscal incentives				Public financing	
In order of income category	Feed-in tariff (including premium payment)	Electric utility quota obliga-tion/RPS	Net metering	Biofuels obligation/ mandate	Heat oblgation/ mandate	Tradable REC	Capital subsidy, grant, or rebate	Investment or produc-tion tax credits	Reductions in sales, energy, CO_2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants	Public competitive bidding
Algeria	X											
Botswana									X			
Mauritius							X					
South Africa	X					X	X					X
Egypt							X		X		X	X
Morocco											X	
Tunisia							X		X		X	
Ethiopia				X					X		X	
Gambia									X			
Ghana						X			X			
Kenya	X								X			
Mali									X			
Mozambique				X							X	
Rwanda									X		X	
United Rep. of Tanzania	X						X		X			
Uganda	X						X		X			
Zambia									X			

Source:REN21, 2011.
REC = Renewable Energy Certificate; RPS = Renewable Portfolio Standard.

sectors as possible — especially industry, agriculture, construction and transport — could be encouraged, among others, by trade-based instruments. The payment of export taxes and import tariffs by enterprises can, for instance, be linked to their performance in using renewable energy and meeting energy-efficiency standards. When signing investment and trade agreements with its partners, African governments could negotiate for the inclusion of cooperation mechanisms that will induce research cooperation on the development and adaptation of RET between African countries and their trading and investment partners.

The production and exports of renewable energy in of themselves can be an important component of sustainable trade strategies in Africa. Furthermore, the building of competitiveness in producing and exporting goods and services of a low-carbon content should be an integral component of strategic trade policymaking in Africa, in the face of growing external markets for "low-carbon" goods and services. Energy is an important input into the production of goods and services. The production of low-carbon goods and services requires the utilization of energy sources of low-carbon content, that is, a preference for renewable energy sources over fossil-based ones. As part of their plans to push forward their structural transformation process through accelerated industrialization,

Table 13. Share of primary and final energy from renewables in selected African countries, future targets

Country	Primary energy	Final energy
Botswana	-	1% by 2016
Egypt	14% by 2020	-
Gabon	-	80% by 2020
Madagascar	-	54% by 2020
Malawi	7% by 2020	-
Mali	15% by 2020	-
Mauritius	35% by 2025	-
Morocco	8% by 2012	10% by 2012
Niger	10% by 2020	-
Senegal	15% by 2025	-
Uganda	61% by 2017	-

Source: REN21, 2011.

Box 8. Renewable energy in export strategies in Africa: The case of Ethiopia

The Government of Ethiopia, through its 2025 Energy Vision, has expressed a clear commitment to developing and exporting renewable energy resources. The Government has defined its goal to transform Ethiopia into a middle-income country by 2025 with zero-net carbon emissions, and recognizes that Ethiopia's contribution to greenhouse gas emissions may grow with the acceleration of industrialization should business as usual continue. The development of renewable energy is also an important component of Ethiopia's strategy for reducing energy poverty. Under the Growth and Transformation Plan (GTP) of Ethiopia, the targets set for the period 2011–2015 are to generate 8,000 megawatts from clean and renewable energy sources for multiple purposes, generate and avail for market at least 35 million liters of ethanol and bio-diesel for transport and household use, and recover methane from a total of 20 million cubic meters of deposited waste within existing or new landfills. The Ethiopia Electric Power Corporation estimates that Ethiopia has a hydropower potential of 45,000 megawatts from dozens of its river basins. Several Chinese and Italian firms are working on these dams. It is projected that, once Ethiopia is able to harness its potential, it would be able to export electricity to neighbouring countries through transmission lines being built to connect the country with Djibouti and Sudan. Ethiopia has already signed an agreement to supply electricity to Kenya.

Sources: Dessalegne Mesfin, 2010; excerpt from www.Ezega.com.

agricultural development and deeper integration in the global trading system, African policymakers should target the exports of renewable energy and renewable energy-based products as niches to exploit in their export trade strategies. Regional cooperation can also provide an impetus to the development of renewable energy as an export sector in Africa through the forging of regional development projects in commercializing renewable energy as the case study in Ethiopia demonstrates.

B. GREEN INDUSTRIAL POLICIES IN AFRICA

Green industrial development, guided by green industrial policies, should lie at the heart of SST in Africa.[7] Green industrial development, according to the United Nations Industrial Development Organization (UNIDO), consists of building industries that are "resource and energy efficient, non-polluting, low-carbon, low-waste, safe, and that produce products that are responsibly managed throughout the life-cycle" (UNIDO, 2011). One component in the development of green or sustainable industries involves the *greening of industries,* whereby industries adopt more resource-efficient and environmentally friendly processes and technologies. A second component involves the *creation of new green industries* that supply industrial environmental goods and services, such as renewable energy technologies, waste and recycling products and environmental advisory services. As noted by UNIDO, the concept of decoupling lies at the centre of green industrial development (UNIDO, 2011).

Building on last year's *Economic Development in Africa Report,* UNCTAD advocates for African countries to pursue green industrial development, through a set of green industrial policies that comprise mainly of policies aimed at developing resource-efficient and clean, non-polluting, low-carbon, low-waste industries. As was argued in last year's *Report*, UNCTAD views the State as playing a central role in shaping and implementing such policies, in close collaboration with the private sector as part of learning, search and experimentation processes that integrate lessons learnt from past mistakes. In that context, the strengthening of government capabilities and building of developmental States in Africa are key to fostering green industrial development as part of SST. In coherence with what was argued in the *Economic Development in Africa Report 2011*, green (vertical) industrial policies have to be complemented with a range of other supportive horizontal and functional policies such as trade policy, appropriate monetary and fiscal policies, infrastructure provision, sound investment climate and South–South cooperation (UNCTAD and UNIDO, 2011). As the *Report* made clear last year, industrial development in Africa should be supported by the development of complementary competitive sectors such as agriculture and services and in a manner that emphasizes the building of forward and backward linkages across sectors.

In what follows, focus is laid only on selected aspects of green industrial policies. Three types of green industrial policies in Africa are examined in this section:

(a) Policies for increasing industrial resource efficiency as part of greening industries;

(b) Policies for mitigating adverse environmental impact as part of greening industries; and

(c) Policies for building export and productive capacities in new green industries.

(a) Policies for increasing industrial resource efficiency as part of greening industries

There are three major challenges for African countries in the context of increasing resource productivity as industrialization is fostered to accelerate structural transformation. First, there is the challenge for investing in, adapting to and innovating in the so-called Environmentally-Sound Technologies (EST)[8] that are needed to drive improvements in energy, water and material use. Second, there is the challenge of developing human capacities for driving the changes needed in managerial, organizational and behavioural structures and practices to achieve efficiency gains in industries. Third, there is the financial challenge, regarding how the State and enterprises, consisting mostly of small and medium-sized enterprises (SMEs) in Africa, can mobilize resources for accessing the needed technologies and infrastructure for investing in industrial resource productivity.

There is no simple solution to any of these challenges. Instead, African industries and governments will need to aim for incremental improvements in industrial resource productivity over time by making use of (a) incentives and standards; (b) strategic visioning, planning and monitoring tools; (c) investments in technologies, institutional and human capacity-building; (d) set-up of financial facilities; and (d) an intensification of public-private partnerships (PPP). For instance, in large-scale industries dominated by multinational corporations such as the mining sector, African governments can legislate to make it mandatory for these industries to develop and implement Resource-Efficiency Action Plans, undertake regular resource use audits and invest a certain share of their profits in energy-efficient and recycling technologies. In countries where water scarcity is a pressing issue, the national or subnational water utility company, in collaboration with the concerned ministry, can work with municipalities, the private sector and relevant stakeholders such as regional development banks and multilaterals in multi PPP to develop plans to invest in waste-water recycling plants as was the case in Durban in South Africa (box 9).

Based on the policy pyramid methodology (see box 10), specific examples of how industrial efficiency can be encouraged in African industries include (IIP, 2011):

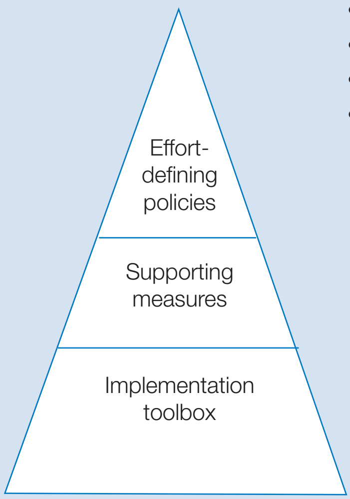
- Development of National Industry Efficiency Strategies, backed with national targets, monitoring of progress on targets and guidelines for firms to comply with;
- Set-up of mandatory targets on industrial efficiency such as energy efficiency targets, along with development of monitoring, reporting, verification and enforcement regimes;
- Set-up of voluntary and negotiated agreements between the State and firms on industrial efficiency targets, with a levy for non-participation and

Box 9. Wastewater recycling in Africa: The Durban Water Recycling Project

In 1999, after a formal tender process, Durban Water Recycling (Pty) Ltd. was awarded a 20-year concession contract for the production of high-quality reclaimed water. Construction commenced in 2000 and was completed in 14 months. The R74m sewage-to-clean-water recycling plant, commissioned in 2001, would treat 47.5 million litres of domestic and industrial wastewater to a near-potable standard for sale to industrial customers for direct use in their processes in a region that produces about 450 million litres of wastewater per day. A considerable benefit to industries is the lower tariff when compared to the normal tariff paid by industries for potable water. The first private water-recycling project in South Africa, this plant is the culmination of a 20-year Build Own Operate and Transfer contract awarded to treat 10 per cent of the city's wastewater. The plant is expected to free up sufficient drinking water for approximately 300,000 people in a city that has historically been water-stressed and has sewage capacity constraints.

Source: Excerpt from the Official website of eThekwini Municipality.

Box 10. Policy pyramid methodology for industrial energy efficiency



- Mandatory targets
- Negotiated agreements
- Voluntary targets
- Minimum energy norms and standards

- Financial incentives/disincentives
- Energy management obligations (incl. audits)
- Equipment standards

- Energy management audit protocols
- Benchmarking manuals
- Technology lists
- Networking, workshops, trainings
- Etc.

The policy pyramid methodology distinguishes between three levels of policymaking: effort-defining policies that determine energy-efficiency efforts; complementary or supporting measures that help deliver their effort and address specific barriers identified (in the form of either carrots or sticks) and tools and guidelines that help define and establish the policy implementation framework.

Source: Institute for Industrial Productivity (IIP, 2011).

non-compliance along with financial and technical support for meeting the targets;

- Bans on inefficient technologies and setting efficiency-standards and norms on industrial raw materials, infrastructure and technologies;
- Mandatory resource-efficiency assessments in investment programmes and large-scale projects;
- Development of an implementation toolbox for industry comprising of guidelines and tools such as manuals, standards, training workshops; and
- Set-up of Industrial Efficiency Funds to support industry in meeting targets, aided by donors, development banks and climate funds such as the Adaptation Fund.

African governments can, through regional and international cooperation, strengthen the capacities of their National Standards Bureaus in developing national resource efficiency or national industrial management system standards and regulations for industry to comply with. Governments can also support SMEs through funding and business advisory centres in complying with international environmental management standards such as ISO14000 and ISO9000, which emulate enterprises to achieve greater efficiency. Technical assistance in these cases can be sought from specialized agencies, and United Nations agencies such as UNEP, UNIDO National Cleaner and Production Centres (NCPCs) and UNCTAD Empretec Centres. International and regional collaboration and exchange on best practices on how to improve industrial resource productivity can be promoted via knowledge databases and networks, exchange programmes and study tours, and regular participation of African national industrial associations to international and regional business forums.

In order to achieve resource productivity improvements, African governments, the private sector and academia will have to strengthen their collaboration to harness EST and intensify the utilization of productivity-enhancing information and communications technology (ICT)-based technologies at the industrial workplace. In this context, specific measures for promoting the utilization and innovation of technologies at the workplace include:

- Provision of economic incentives to the private sector such as grants, small loans, tax breaks for investing in efficient technologies such as energy-saving light bulbs, and wastewater recycling plants;

- Set-up of national funds, with support from multilaterals and regional development banks, to ease firms' access to finance to purchase technologies;
- Set up of industrial technical and vocational institutes providing education and training to managers and workers in industry on material flow processes and costing;
- Promotion of partnerships and linkages between industries and scientific and technological institutes to foster indigenous improvements in industrial efficiency through adaptation of EST;
- Set-up of eco-industrial national and regional parks, through, *inter alia,* FDI, where industries are regrouped and provided incentives to use each other by-products as inputs;
- Set-up of skills formation policies that emphasize scientific and technological learning in the industrial work force;
- Running sensitization and awareness campaigns with firms on the economic and environmental benefits of enhancing industrial efficiency.

(b) Policies for mitigating adverse environmental impact as part of greening industries

A second type of green industrial policies consists in fostering the "greening" of industries; that is, promoting environmentally sustainable processes and practices in industrial development. This will consist, *inter alia*, of policies to sensitize, incentivize and reward/penalize industries to mitigate the environmental impact of their production activities at each stage of their production life cycle.

A central component of greening industries consists of relatively decoupling industrial development from increased carbon emissions and release of harmful pollutants and effluents in the environment. Yet again, the harnessing of EST such as treatment (end of pipe), recycling and clean technologies by industries will be critical in achieving such relative decoupling as part of Africa's efforts towards green industrial development. Treatment and recycling technologies do not by themselves reduce pollution and wastes; on the other hand, clean technologies such as RET are superior technologies that can reduce pollutants and wastes at the source, lower production costs and deliver better quality products (ECA and UNIDO, 2006).

Most of the EST that are currently applied in Africa fall in the first two categories (treatment and recycling) rather than the third, which means that the utilization and deployment of clean technologies in African industry remains a goal to be achieved, backed by significant international support in technology use and transfer.

As mentioned in the previous section, this *Report* advocates for African countries to accelerate the deployment of RET in powering their sectoral development, including industry. For those African countries that are in their early stages of industrialization, leapfrogging into renewable energy use will provide them with a unique opportunity to position themselves early in the growing market for low-carbon content goods as the world accelerates its transition to green economies.

Policies should hence be designed to encourage enterprises to switch to powering their production with renewable energy, investing in clean technologies and minimizing the environmental impact of their activities throughout the entire production cycle. Examples of policy instruments include:

- Legislation to mandate the conduct of regular environmental impact assessments and environmental audits by enterprises, backed by monitoring, verification and enforcement regimes;
- Enactment of environmental laws and regulations that sanction companies that harm the environment, accompanied by a strengthening of the Environmental Protection Agency or its creation if it does not exist;
- Provision of subsidies or tax breaks to enterprises in return for adopting renewable energy and environmentally-friendly production processes;
- Green industrial public procurement programmes;
- Incorporation of green requirements in public bidding awards;
- Support to SMEs, backed by international technical assistance, in participating in environmental standards accreditation such as eco-labelling schemes (see box 11);
- Provision of economic incentives such as accelerated depreciation allowances, tax breaks or reduced import tariffs on purchase and use of abatement technologies;
- Information campaigns targeting SMEs on the economic benefits of shifting to green business models and export opportunities arising from a global green economy; and

- Cooperation agreements with trade and investment partners that can provide access to EST and technical assistance in using them.

On the issue of promoting the deployment of clean technologies to enterprises, especially SMEs, the State can, for instance, implement low-carbon FDI policies and low-carbon special industrial zones that target investment from multinationals employing environmental technologies, and encourage the transfer of knowledge and technologies from such multinational companies to local suppliers through contractual arrangements and joint ventures. SMEs in Africa can have their technological capacities and access to EST strengthened through targeted measures that include, *inter alia,* the facilitation of their insertion into green global value chains where opportunities for technological acquisition, learning and upgrading exist, set-up of business advisory services specializing in greening SMEs, and the provision of financial support by the State for purchase of EST. The set-up of technology funds by national and regional development banks can ease financial barriers faced by SMEs in importing and adapting technologies.

The adaptation of foreign EST to local industrial conditions will necessitate the building of a strong scientific and technological base in Africa, good domestic absorptive capacities and innovation capabilities. Specific measures include (a) increasing the quality of science and technology education in schools and universities; (b) creating technical and vocational institutes that work directly with industry; (c) creating job programmes for scientists and engineers; (d) giving scholarships to students to study science and technology at good universities; (e)

Box 11. Use of eco-labels in African Industry: The case of leather sandals in Kenya and Ethiopia

"Enabling Developing Countries to Seize Eco-label Opportunities" is a UNEP-led project that aims to assist developing countries and transition economies to delink economic growth and environmental degradation through eco-labelling. Under this program, Kenya and Ethiopia hope to attach a European Union (EU) flower on the Maasai Leather Sandal (for Kenya) and also a locally manufactured Leather Sandal (for Ethiopia) for purposes of enabling them to penetrate the EU market at premium prices. In Kenya, the project is being implemented by the Kenya National Cleaner Production Center (NCPC) in collaboration with UNEP, the Leather Development Council, Kenya Industrial Research and Development Institute, Ministry of Livestock, Kenya Leather Tanneries Association, Ministry of Industrialization, Association of Leather Footwear Manufacturers, Ministry of Trade, Kenya Bureau of Standards, and the Ministry of Environment and Mineral resources.

Source: excerpt from the website of Kenya NCPC.

fostering linkages between the entrepreneurial class and universities and scientific and technological centres, through the creation of green industrial clusters and technology parks; (f) supporting through public and private research grants Technology Centers of Excellence; and (g) accelerating use of ICT in industry though investments in ICT infrastructure.

In order to elicit an uptake by industry for adopting green business models, the State should proactively and deliberately support African industry in accessing the new emerging markets for green goods and services. Trade strategies in Africa should include building competitiveness in producing and exporting low-carbon content goods and environmentally-friendly “green” products. Specific measures can involve linking local SMEs to green buyers through participation in business fairs, export promotion activities and technical and financial support for adopting environmental labelling.

(c) Policies for building export and productive capacities in new green industries

As other countries accelerate their transition to green economies, African countries must stand ready to exploit the opportunities that such a transition creates by building dynamic comparative advantages in producing and exporting in new green industries. National trade strategies in Africa should be forward-looking. It should start with an identification of potential export niches located in future growing “green” market segments and be complemented with a set of policies, including trade policies, for building competitiveness in the targeted niches that are likely to vary in technology-intensity. Which export niches to target will depend on each country’s initial industrial and technological conditions, the ease with which binding constraints can be removed, the scale and type of international support received and the types of partnerships countries can forge with the private sector at national and international levels.

Examples of new green industries include renewable energy equipment such as solar water heaters and wind pumps, recycling products, biotechnology products, vegetable fertilizers, natural soaps and waxes, fluorescent lamps and many others. The growth of the environmental goods market will also be accompanied by growing demand for environmental services related to the installation, maintenance and disposal of environmental products.

African trade strategies should also aim at building capacities and competitiveness in supplying the environmental services segment. Breaking into these emerging export sectors, as part of green industrial policy development, represents enormous challenges for African countries, in terms of achieving international cost competitiveness, product quality delivery, use of relevant technologies and availability of skills, know-how and finance, to name a few. However, African governments cannot afford to ignore the opportunities that a transition to a green global economy offers. African sustainable trade strategies have to integrate policies and incentives to overcome technical, technological, human, infrastructure, financial and institutional capacity constraints associated with the development of the environmental goods and services sectors. Regional integration and the implementation of regional industrial policies through the creation of development corridors can contribute to lowering these constraints by promoting a pooling of resources and expertise on the part of African countries and the development of large-scale infrastructure. South–South cooperation and FDI can as well contribute in addressing some of these constraints.

Africa's green industrial development will necessitate some forms of green infant industry protection in the form of tariff protection, export subsidies, procurement programmes and investment performance requirements. There is currently some room for green industrial policy space under current World Trade Organization (WTO) rules. Article XX of the General Agreement on Tariffs and Trade (GATT), under paragraphs (b) and (g), for instance allow member States to pursue policies that are inconsistent with GATT rules as long as these policies are necessary to protect human, animal or plant life and health, or are necessary to conserve exhaustible natural resources, all of which can be related to environmental protection. There also seems to be a "gentleman's agreement" among WTO member States not to act on non-actionable subsidies in relation to implementation of environmentally sound methods of production (ICTSD, 2007). Article 3 of the Trade-Related Investment Measures (TRIMS) agreement also allows exceptions akin to the exceptions permitted under GATT 1994. However, while African countries must start to make greater use of such green industrial policy space, they must also ensure that international trade negotiations do not in the future restrict their ability to use trade-based instruments to promote green industrialization.

C. THE PROMOTION OF A TRULY GREEN AGRICULTURAL REVOLUTION IN AFRICA

Africa needs a truly green agricultural revolution that combines land productivity increases with environmental sustainability. This section thus outlines two sets of policies: (a) policies for raising land productivity and (b) policies for promoting environmental sustainability in agriculture. Strong linkages exist between these two sets of policies. Higher land productivity that economizes on use of energy, land, water and fertilizers can contribute to reduced land degradation and deforestation, while a sustainable management of agricultural resources can in itself promote higher land productivity.

(i) Policies for raising land productivity

The raising of land productivity in Africa can only come about through the pursuit of simultaneous policies in an integrated manner, addressing the multiple factors constraining productivity growth in African agriculture. These policies will need to encompass elements of legislative, institutional and regulatory reform, incentive provision, capacity–building and financial mobilization.

An important component to raising land productivity in Africa lies in improving on the sustainable management of land resources through governance and institutional reforms that include reforming land tenure systems, land institutions and regulation of land and land-based resources (ECA, 2010). For instance, in many parts of rural Africa, women lie at the heart of agricultural production and yet are unable to own or inherit land. Their exclusion from decision-making on land-based resources management can yield sub-optimal outcomes that do not reflect their local knowledge about productive agricultural practices. In addition, small-scale farmers can be forced into occupying low-yield marginalized lands for a variety of reasons, with such displacement contributing to land degradation (UNCTAD, 2010c). Such reasons may include forced evictions and land grabs from powerful elites, improperly defined property rights, lack of land cadastres establishing clearly ownership rights, lack of due recognition to customary tenure systems that have been subordinated to individual tenure systems, farmers' poor access to justice and information about their rights and inadequate legislation dealing with land conflicts and land grabs. Raising agricultural land productivity may require (a) revisiting in certain African countries legislation and regulatory structures governing property rights, overlapping land rights and land-grabs; (b) strengthening rural facilities such as health facilities and access to finance so that ill-stricken farmers are not forced to sell land and inputs to face the costs of their illnesses; and (c) strengthening farmers' access to justice through the set-up of rural courts where they can resolve disputes. The set-up of dispute resolution mechanisms at community level can contribute towards mitigating land-related conflicts and land displacement and prevent small-scale farmers being pushed onto marginalized lands.

Technology has a central role to play in raising agricultural land productivity. The Comprehensive Africa Agricultural Development Programme of NEPAD identifies agricultural research, technology dissemination and adoption among its four pillars for increased investment. Technologies can be used to raise agricultural land productivity in various forms: (a) by raising directly crop yields through sustainable intensification agriculture technologies that can include technologies combating land degradation (e.g. soil erosion and soil salinization), integrated nutrient management, integrated pest management, improved watershed management, technologies improving on tillage and cropping systems such as Conservation Agriculture farming methods; and (b) by raising labour productivity through an increased mechanization of agricultural activities such as use of micro-irrigation pumps.

UNCTAD's *Technology and Innovation Report 2010* details the range of technologies that can be deployed in Africa to raise agricultural productivity. These range from technologies for agricultural mechanization such as hand-tool, animal-draught and mechanical technologies, irrigation technologies and management systems, technologies for predicting when to irrigate, bio-technologies for increasing crop yields by using better crop varieties and disease-resistant crops, application of fertilizers, pesticides and tillage technologies, technologies for combating crop diseases, and post-harvest technologies for reducing post-harvest losses (see box 13 for an example) (UNCTAD, 2010c).

There are important intersectoral linkages to be recognized when addressing resource productivity and sustainability. For example, there are important linkages among land, energy and water management. Raising agricultural land productivity necessitates, besides land-use policies, improved watershed management and improved access to energy. Land-use patterns can affect farmers' access to quantity and quality of water while, without access to energy, farmers cannot apply mechanized technologies for reaping productivity gains and secure access to water efficiently through the use of electrical pumps. While framing policies for accelerating agricultural land productivity through the application of technologies, African governments need to also increase access of farmers both to water and energy. The deployment of RET and improved biomass technologies in rural areas can yet again be an option for facilitating farmers' access to energy and water, and consequently their ability to apply productivity-enhancing technologies in their fields.

The adoption and application of productivity-enhancing technologies by African farmers, though fraught with challenges, can be accelerated by a range of policies. Examples are (FARA *et al.*, 2006):

- Subsidizing access to such technologies;
- Designing distance-learning technological education programmes to increase farmers' access to technological information when they need it;
- Enhancing the use of ICTs by farmers such as mobile phone messaging services to increase their access to information;
- Involving farmers more in designing R&D and education programmes through cooperation agreements so as to better ascertain their needs and demands;
- Improving on the quality and scope of agricultural extension services by, for instance, doling out performance-related contracts to providers hired from many spheres – private and public sectors, local and international non-governmental organizations and national and international universities and research centres and by setting up local advisory facilities for farmers.

Policies must exist to encourage the acquisition of foreign technologies and their adaptation to local circumstances whenever appropriate, as well as increase national capabilities at producing indigenous innovative agricultural technologies. In this context, public support to agricultural research and R&D involving farmer input needs to be scaled up, accompanied by policies to enhance the quality of scientific, technological and agricultural education in schools and universities, and policies to secure better employment and working conditions for agricultural scientists and engineers as ways to motivate them into conducting research and innovation in the agricultural field. The forging of collaborative and innovative partnerships between national, regional and international agricultural research institutes can spur the churn out of innovative agricultural technologies.

In its *Technology and Innovation Report 2010,* UNCTAD advocates for the building of innovation capabilities in agriculture in Africa through the construction of national agriculture innovation systems (AIS), which "include the actors, institutions, organizations and policies that together support innovation in agriculture, along with the infrastructure and financing mechanisms that enable it" (UNCTAD, 2010c). Innovation, as opposed to science and technology, refers to the "ways in which incremental improvements in processes, products, inputs or equipments are needed to adapt existing technologies to the local environment in ways that enhance productivity and lower costs" (UNCTAD, 2010c). UNCTAD advocates for such AIS to be built through the provision of an enabling framework. Elements of this enabling policy framework should include significant investments in physical infrastructure and extensions services, increased financing for smallholder farmers,

Box 12. Sustainable intensification in African agriculture

Sustainable agricultural intensification is defined as producing more output from the same area of land while reducing negative environmental impacts and at the same time increasing contributions to natural capital and the flow of environmental services. Foresight commissioned reviews and analyses from 40 existing projects and programmes from 20 African countries, where sustainable intensification has been developed, promoted or practiced mostly in the 2000s. Results revealed that, across these 40 projects, by early 2010, 10.39 million farmers had reaped benefits and improvements over approximately 12.75 million ha with significant increases in food production. Based on lessons learnt across these 40 projects, Pretty *et al*. (2011), makes seven core recommendations for scaling up and spreading sustainable intensification in Africa. These are to:

(a) Harness scientific and farmer input into technologies and practices that combine crops-animals with appropriate ecological and agronomic management;

(b) Create novel social infrastructure that results both in flows of information and builds trust among individuals and agencies;

(c) Improve farmer knowledge and capacity through the use of farmer field schools, famer trainers, videos and modern ICTs;

(d) Engage with the private sector to supply goods and services and develop farmers' capacity to add value through their own business development;

(e) Focus particularly on women's educational, microfinance and agricultural technology needs and build their unique forms of social capital;

(f) Ensure that microfinance and rural banking are available to farmers' groups (for both consumption and production purposes);

(g) Ensure public sector support to lever up the necessary public goods for sustainable intensification of agriculture in the form of innovative and capable research systems, dense social infrastructure, appropriate economic incentives (subsidies, price signals), legal status for land ownership and improved access to markets, through transport infrastructure.

Source: Pretty J, Toulmin C and Williams S (2011).

increased private sector involvement in African agriculture, increasing linkages between farmers and other actors in the AIS such as through the creation of new organizations for collaborative learning, linking R&D from firms to farmers through licensing, joint ventures and PPP and increasing partnerships between small-and large-scale farmers (UNCTAD, 2010c). Given the prevalence of small-scale farming, headed by women in Africa, it is important, as the *Technology and Innovation Report 2010* recommends, to place small-scale farmers and women at the heart of any policies for building innovative agricultural capabilities in Africa. This implies designing policies that cater to the specific constraints faced by small-scale farmers and women in applying and adapting technologies such as barriers to finance, education and information.

In order to stimulate private investment in agricultural R&D by large firms and farmers alike, the State will have to implement measures to secure them a stable rate of return on their investments. Examples of State support may include (a) the set-up of price support schemes whereby prices of inputs are subsidized while taxes on product prices are reduced; and (b) access to low-cost credit. Policies are also needed in building farmers' capacities in trading, marketing and exporting their agricultural products. To the extent that the increased adoption and adaptation of technologies by farmers on the supply side leads to productivity gains and a

Box 13. Example of technology solutions: Applying infra-red spectroscopy

Soil fertility depletion in smallholder agricultural systems in sub-Saharan Africa is a challenge both for food production and environmental sustainability. A critical constraint to managing soils in sub-Saharan Africa is poor targeting of soil management interventions. This is partly due to lack of diagnostic tools for screening soil condition (Awiti *et al.*, 2007). Scientists at the World Agro-forestry Centre have developed cheap, accurate and easy to use infrared, x-ray and laser spectroscopic instruments to analyse soils. When used by research and development programmes, the surveillance approach eliminates the guesswork involved in matching improved agricultural technologies to specific soil types. They can also be used to plan and monitor environmental programmes. For example, in East Africa infrared spectroscopy has been used to identify the source of pollution that threatens Lake Victoria. The African Soil Information Service, funded by the Gates Foundation and the Alliance for a Green Revolution in Africa, is a four-year project that will use these techniques to develop high-resolution maps that will provide a picture of soil health across the whole of sub-Saharan Africa. By improving access to information on soil health, the project will also allow a better utilization of integrated soil fertility management, a new technique that has been developed by scientists working in Africa to improve soil health through a combined use of organic and inorganic fertilizers.

Sources: Excerpt from the website of World Agroforestry Centre, and Awiti *et al*, 2007.

larger volume of agricultural goods being produced, this must be matched on the demand side by national trade policies that will support the commercialization of those increased agricultural products. In this context, policies are needed to facilitate farmers' access to national, regional and international markets through improvements in trade-facilitation infrastructure (e.g. roads, storage facilities, ports) and export promotion activities. The acceleration of regional integration and promotion of intra-African trade can contribute to the creation of large-scale markets for absorbing larger volumes of agricultural products while meeting the food insecurity challenges of the continent.

(ii) Policies for promoting environmental sustainability in agriculture

Policies in Africa should also involve developing and using technologies that can enhance sustainable agricultural practices, meaning ecologically sound agricultural practices that have no adverse effect on the natural ecosystem (Khassie and Zikhali, 2009). In addition to raising agricultural land productivity per se, an important goal lies in fostering agricultural practices that will not be detrimental to the environment. The two set of policies are strongly interlinked. Sustainable agricultural practices can raise land productivity and vice versa.

For example, in Tigray, Ethiopia, the adoption of environmentally sound technologies, such as composting, biological and physical water and soil conservation and crop diversification led to a near doubling of grain production in the region from 2003 to 2006, accompanied by a notable decrease in chemical fertilizer use, improved hydrology and rehabilitated lands (TWN, 2007). The scaling up of sustainable intensification agriculture methods can contribute to achieving both productivity increases and sustainability in Africa (see box 12). In Madagascar, the pioneering development of System Rice Intensification (SRI) in the 1980s, a crop management system involving less water use, fewer seeds but more organic fertilizer, led to higher rice yields as compared to traditional methods or methods using fertilizer. SRI methods have since spread out of Madagascar and been adopted in around 50 countries in Africa, Asia and South America (Berkhout and Glover, 2011).

The diffusion of sustainable agricultural practices again rests critically on the adoption of foreign EST and their adaptation to local conditions, and the indigenous innovation of technologies. As discussed earlier, policies for building national innovation capabilities in agriculture are key here.

In addition to technology use and diffusion, the promotion of sustainable agriculture can also require reforms behind the governance of common natural resources such as forestry, fisheries, pasture and wildlife, in order to ensure their sustainable management and recognize the linkages among these resources. For example, farmers' ability to use non-polluting affordable organic fertilizers may critically depend on their ease of access to biomass available from forests. The destruction of nearby forests can eliminate habitats for animals that are natural enemies to certain types of pests, thereby impeding biological pest control. Pollution of rivers and lakes by large-scale agro-farmers can impact on productivity of small-scale farmers that draw water from these same waterbeds. Due to these important linkages, a holistic approach is needed in the management of natural resources in rural communities. This may call for a strengthening of governance arrangements at a rural community level, necessitating the creation of community institutions, allocation of rights to communities rather than individuals and set-up of dispute resolution mechanisms whereby the agricultural community can address externalities at a community level. Certain types of environmental subsidies may also have to be reviewed to ensure policy coherence, such as subsidies on fisheries that promote overfishing and unsustainable production.

Recently, there has been a spate of large-scale land deals in Africa involving foreign investors acquiring or leasing land. In Ethiopia, Ghana, Madagascar, Mali and Sudan, there have been 2,492,684 ha of approved land allocations from 2004 to 2009, excluding allocations below 1,000 ha (FAO *et al.*, 2009). These large-scale investments by foreigners, if carefully and properly negotiated, can generate benefits in the form of rural infrastructure development, and additional private investment in agriculture. However, African governments must also ensure that such large-scale deals do not result in lowering agricultural land productivity by small-scale farmers and harm to the environment. This can happen if small-scale farmers are displaced to lower-yield lands, far from markets and irrigation facilities, and find it difficult to access inputs due to higher prices and growing scarcity. Research has also revealed that industrial agriculture, which large-scale farming facilitates, can increase environmental risks, while small-scale farming and diversified farming can actually enjoy significant advantages over large-scale monoculture systems in terms of productivity, food production and environmental protection (DESA, 2011). These large-scale land deals can be made to benefit small-scale farmers if contracts are negotiated in such a way as to stimulate linkages between the large-scale foreign investing companies and the small-scale farmers. African policymakers should aim to (a) secure commitments from foreign investors to invest in infrastructure and agricultural R&D, (b) promote business models that favour local benefits and linkages with local communities, (c) set up mechanisms that local people can use to vindicate their rights and (d) develop environmental standards that foreign investors need to adhere to in order to minimize impact of their activities on the environment. Such investments should be accompanied by social and environmental impact assessments to ensure that sustainable development objectives are not compromised and by proper compensation in case damages to the environment occur (FAO *et al.*, 2009).

Trade policies and instruments can act as levers in the promotion of sustainable agriculture. Trade-based policy instruments such as reduced tariffs, export subsidies, increased use of environmental standards and environmental labelling can be used to encourage agricultural farmers to switch to organic, less environmentally-harmful agricultural practices. Support in the form of export promotion activities can also be provided to help them tap into export niches for certified organic farm and farm-based products in high-end markets abroad. According to estimates, the global organic agricultural market has been averaging growth rates of 10 to 20 per cent a year for the past few years, representing growth of $5 billion a year (Sahota, 2009). Uganda is an example of an African country that has been actively supporting the growth of organic agriculture in its sustainable development strategy. Both the Uganda Export Promotion Board and the Uganda National Bureau of Standards play a pro-active role at promoting organic exports and developing organic standards (UNEP/UNCTAD, 2010).

Many African countries are parties to multilateral environmental agreements, whose implementation can contribute towards promoting both sustainable agriculture and higher agricultural land productivity. For example, the Rotterdam and Stockholm Conventions contain provisions that allow countries to restrict and regulate imports of hazardous chemicals and pesticides, and imports of Persistent Organic Pollutants, whose use can harm the environment and lead to unsustainable agricultural practices. Under the United Nations Convention to Combat Desertification, many African countries have prepared National Action Programmes under participatory approaches. Efforts should be enhanced to accelerate implementation of these National Action Programmes and multilateral environmental agreements.

There is actually a need, as pointed out by the 2011 World Economic and Social Survey, for countries to build sustainable agricultural innovation systems (SAIS) that promote investment and innovations in technologies that marry agricultural productivity with environmental sustainability (DESA, 2011). The building of SAIS will require the State to take a lead role in building research capacities and multiply partnerships among the actors of the SAIS (farmers, private foundations, research institutes, universities, etc.). As the World Economic and Social Survey points out, capacities will have to be built in order to increase adaptation of the innovation system to changes in the global environmental and marketing conditions. This will require viewing innovation as a learning and experimentation process where failures are condoned as long as lessons are learnt from the experiment. The building of SAIS will be fraught with challenges for African countries. Garnering long-term international support in the form of finance, technical assistance and technology transfer will be critical in this context (DESA, 2011).

D. CONCLUSION

This chapter has analysed policies in the energy, industry and agricultural sectors at two levels: in terms of increasing productivity/efficiency by economizing on use of resources (e.g. energy, water, land) and in terms of mitigating environmental impacts. The discussion mentions five types of policy instruments (as illustrated in box figure 1, chapter 3): (a) the provision of market-based incentives through fiscal-based and trade policy-based instruments (e.g. grants, taxes, subsidies, public procurement, tariffs, technical standards); (b) legislative and regulatory instruments such as laws, plans, regulations, norms and standards; (c) information-based instruments; (d) cooperation arrangements; and (e) education and research, including R&D and capacity-building through public investments. These policy instruments should be used in combination with one another. The optimal choice of policy instruments for relative decoupling will vary across countries depending on the costs and benefits associated with the implementation of such instruments. There is no “one-size-fits-all” approach to relative decoupling for promoting SST. The feasibility and applicability of these policy instruments will also depend on each country’s circumstances, political economy conditions, and inherent capabilities. However, many of these policy instruments are already being used in the pursuit of Africa’s sustainable development, as the case studies illustrate. The challenge therefore is to scale up current actions within the context of national development strategies geared to SST and to garner further international support to accelerate SST in Africa.

CHAPTER 5

STRUCTURAL TRANSFORMATION AND SUSTAINABLE DEVELOPMENT IN AFRICA: MAIN FINDINGS AND RECOMMENDATIONS

A. INTRODUCTION

Over the past decade, African countries have had a relatively good economic growth performance, with real output growing at an annual average rate of about 5.8 per cent over the period 2002–2008 (AfDB et al., 2011). There are, however, indications that the current pattern of growth in the region may not be sustainable, because it is based on the use of non-renewable or exhaustible natural resources and has not been associated with significant improvements in employment. UNCTAD has consistently argued that structural transformation is necessary to address these current as well as emerging development challenges facing Africa. However, structural transformation is a double-edged sword. While it lays the foundation for high and sustained economic growth, it will also lead to deterioration in environmental quality, unless deliberate action is taken to ensure environmental sustainability during the transformation process.

Against this background, the *Report* examines how African countries could promote structural transformation without jeopardizing the objective of environmental sustainability, paying particular attention to how the relative decoupling of resource use and environmental impact from economic growth could contribute to the structural transformation process. Furthermore, the *Report* shows how resource use and environmental impact change during the development process. It also presents stylized facts on resource use and efficiency in Africa, which are crucial for understanding the nature and scale of the sustainable development challenges facing the region. Finally, the *Report* provides a strategic framework for sustainable structural transformation and identifies policies that could be adopted to promote it in Africa. The main findings and messages of the report are highlighted below.

B. MAIN FINDINGS

1. *The level of domestic material extraction per capita in Africa is very low compared to the global average.* In 2008, domestic material extraction per capita in Africa was 5.4 tons, which is quite low compared to the global average of 10.2 tons. There are, nevertheless, major differences between African countries. For example, Algeria and South Africa had per capita extraction levels of 10.4 and 14.4 tons respectively, while Côte d'Ivoire and Malawi had per capita extraction levels of 2.7 and 2.0 tons respectively.

2. *There has been a significant increase in domestic material extraction in Africa over the past three decades, but a decline in per capita terms.* Although Africa has a very low level of domestic material extraction per capita, total domestic material extraction in the region increased from 2.8 billion tons in 1980 to 5.3 billion tons in 2008, representing an approximately 87 per cent increase in extraction over the past three decades. However, in per capita terms, domestic material extraction declined by about 8 per cent over the same period.

3. *Biomass accounts for over half of the material extraction in Africa, but the share of non-renewable resources in total material extraction has increased from 1980 to 2008.* In terms of material categories, biomass accounts for the bulk of domestic material extraction in Africa, although its share of extraction decreased from 62 per cent in 1980 to 53 per cent in 2008. Consequently, the share of non-renewable resources in total extraction increased from 38 per cent to 47 per cent over the same period.

4. *Fossil fuels are the dominant material export and import of Africa. Furthermore, Africa is a net exporter of non-renewable resources and a net importer of renewable resources.* In 2008, the share of fossil fuels in total exports was 75 per cent, which is well above the global average of 50 per cent. Other material categories, such as metals, non-metallic minerals and biomass, accounted for 11, 7 and 2 per cent of total exports respectively in 2008. On the import side, fossil fuels accounted for about 37 per cent of total imports, biomass 32 per cent, non-metallic minerals 18 per cent, and metals 13 per cent. When materials are classified into renewables and non-renewables, it turns out that Africa is a net importer of renewable resources (biomass) and a net exporter of non-renewable resources. However, within the non-renewable resources material category, it is a net exporter of fossil fuels and metals, and has almost a balanced-trade position for non-metallic minerals.

5. *The level of domestic material consumption per capita in Africa is about half the global average and has decreased slightly from 1980 to 2008.* In 2008, per capita domestic material consumption in the region was 5.3 tons, compared to the global average of 10.4 tons per capita. Furthermore, there has been no significant change in domestic material consumption per capita in the region, due largely to high population growth. While average per capita domestic material consumption in Asian and Latin American countries

increased during the period under consideration, it decreased slightly in Africa from 5.6 tons in 1980 to 5.3 tons in 2008. Although Africa has a low level of domestic material consumption per capita, total domestic material consumption in the region increased from 2.5 billion tons in 1980 to 4.9 billion tons in 2008, representing an approximately 90 per cent increase in material consumption over the period under consideration. Furthermore, in 2008 Africa accounted for about 7.2 per cent of global material consumption, compared to 6.8 per cent in 1980.

6. *Non-renewable resources account for a large share of domestic material consumption in African countries that are at a relatively higher level of industrial development.* Among the 16 African countries for which we have good-quality data by material category, the countries that have higher domestic material consumption per capita than the African average of 5.3 tons also have a relatively higher level of industrial development. For example, Algeria, Egypt, Morocco, Seychelles and South Africa have high per capita domestic material consumption, and, in addition, have manufacturing value added per capita, above the regional average of $125.

7. *Material productivity in Africa is the lowest for any region in the world, but has improved over the past three decades.* Over the past three decades, the level of material productivity in Africa has been very low compared to the global average. For example, in 2008, the average level of material productivity in Africa was about $520 per ton of material, which is quite low relative to the global average of $950 per ton of material. It should be noted, however, that although the level of material productivity in Africa is low, it has increased significantly over the last three decades, from $338 per ton of material in 1980 to $520 per ton of material in 2008.

8. *Energy use in Africa is low, and has been increasing much less rapidly than material use.* In 2009, per capita electricity consumption in Africa was only 561 kilowatt-hours (KWh), compared to 741 KWh for Asia, 1,884 KWh for Latin America, and 2,730 KWh for the world. Nevertheless, the level of energy use in Africa increased by about 16.3 per cent over the period 1980–2008. This increase in energy use is far below the 92 per cent increase in material use over the same period.

9. *Africa has contributed the least to global greenhouse gas emissions but is the region most affected by climate change.* In 2009, emissions of carbon

dioxide (CO_2) from Africa totalled 928 million tons, compared to 10,030 million tons from Asia and 12,045 million tons from the countries of the Organization for Economic Cooperation and Development (OECD). Africa accounted for only 3.2 per cent of global CO_2 emissions in 2009, reflecting the fact that it is at a much lower level of industrial development and so has lower levels of income and energy consumption. With regard to the impact of climate change, it is estimated that agricultural yields will decline by as much as 50 per cent by 2020. It is furthermore expected that between 75 and 250 million people in Africa will be at risk of increased water stress as a result of climate change.

10. *Land use processes are inefficient over large parts of Africa.* Land use efficiency is very low in sub-Saharan Africa, due primarily to large-scale land cover changes (deforestation) and land degradation. In several African countries, the productivity losses associated with human land use are much higher than the harvested biomass. Furthermore, in contrast to many European and Asian countries, many African countries have not been able to improve land use efficiency (e.g. increase crop yields per land area) over time. For example, in the Democratic Republic of the Congo, Senegal and Uganda, land use efficiency has declined over the past decades. Egypt and South Africa, both with relatively advanced agricultural production systems, are among the few countries in the region that do not follow this trend.

C. MESSAGES AND RECOMMENDATIONS

The *Report* argues that although structural transformation is necessary to address Africa's key development needs and challenges, it should be carried out in a manner that is consistent with environmental sustainability. In this regard, it recommends that African countries should not follow the development path adopted by currently industrialized economies, which involved promoting economic growth at the expense of the environment. The main message of the *Report* is that *achieving sustainable development in Africa requires deliberate, concerted and proactive measures to promote structural transformation and the relative decoupling of natural resource use and environmental impact from the growth process.*

The *Report* emphasizes the need for sustainable structural transformation, defined as structural transformation accompanied by the relative decoupling of resource use and environmental impact from the economic growth process. There are several reasons why African countries should promote SST now. The current pattern of economic growth is unsustainable in the medium and long term, and current trends of resource depletion and ecosystem degradation are likely to accelerate in a future with increasing populations, rising living standards and structural transformation. Infrastructure and technology choices have a lock-in effect, in which countries get stuck on a particular development path. Consequently, delaying the implementation of SST may become extremely costly in the future, particularly if worsening environmental conditions force the early replacement of past investments. And yet, at the same time, there are potential economic benefits from decoupling, which are in particular associated with increased resource productivity.

The Report stresses that African countries are heterogeneous, and so the optimal choice of policy instruments for decoupling will vary across countries. Furthermore, it suggests that decoupling lies at the heart of sustainable structural transformation, but argues that given Africa's special development needs and its low level of resource use, the focus of African policymakers should be on relative rather than absolute decoupling. Relative decoupling implies that resources may be increasingly used but at a rate lower than the rate of increase in output, while absolute decoupling requires a decrease in the absolute quantity of resources used irrespective of the output level. African countries should continue to use their natural resources to propel growth, but they should do so in a more efficient and sustainable manner. In this regard, the Report recommends that African countries should give priority to three sectors critical to promoting resource productivity and mitigating the environmental impact of resource use, namely (a) energy; (b) industry; and (c) agriculture.

(a) *Energy.* Fostering sustainable structural transformation in Africa requires better access to modern energy sources, improving energy efficiency, and facilitating a switch from non-renewable to renewable energy sources. Policy options for increasing access to modern energy sources include rural electrification programmes and using economic incentives to lower the relative cost of modern energy to households and firms. Regional cooperation in energy production and distribution is also crucial in enhancing access to modern energy in the region. In terms of improving energy efficiency and the use of renewable energy, the *Report* suggests that better access to technology is a crucial factor. This can be achieved through technology transfer from developed and emerging partners to Africa and through building national capabilities to access, use and adapt existing technologies, and also, when possible, to create needed technologies.

(b) *Industry.* Making structural transformation compatible with environmental protection requires improving resource productivity and reducing the environmental impact of industrialization. The *Report* recommends that African countries should incentivize domestic firms to improve resource productivity through, for example, subsidizing the adoption of clean or environmentally sound technologies and promoting low-carbon foreign direct investment (FDI). It also suggests that African countries should pay more attention to mitigating the environmental impact of resource use in the industrial sector through, perhaps, using economic incentives and regulatory measures to induce firms to adopt recycling technologies. In addition, it suggests that the removal of fossil fuel subsidies could also play an important role in inducing substitution away from fossil fuels to renewable energy sources. The *Report* also suggests that African governments should use fiscal, trade and regulatory instruments to create and build competitiveness in producing and exporting environmental goods and services (such as solar water heaters, recycling products, fluorescent lamps etc.).

(c) *Agriculture.* The effective promotion of sustainable structural transformation in Africa requires both increasing agricultural productivity and promoting environmentally sustainable agricultural practices. In this regard, the *Report* suggests that African governments should subsidize access to productivity-enhancing technologies and also improve the sustainable management of land and natural resources through reform of land tenure systems, better definition and enforcement of property rights, and restriction or regulation of imports of hazardous chemicals, pesticides and other pollutants.

The *Report* emphasizes the importance of technology and innovation in promoting sustainable structural transformation. In this regard, it suggests that strategies geared towards relative resource and impact decoupling should encompass science, technology and innovation policies. These policies should emphasize the acquisition, application and adaptation of clean and efficient technologies and also develop the capacities of African countries to leapfrog into such types of technology. The emergence of sustainability-oriented innovation systems can support this objective. But technological leapfrogging will require more technology transfer from developed and emerging partners to African countries, greater domestic absorptive capacities, and a stronger domestic science and technology base.

Other messages and recommendations emanating from the *Report* include:

(a) *The State has to play a crucial role in promoting sustainable structural transformation.* Given the externalities associated with promoting sustainable structural transformation and the long-term nature of the required investments, it is unlikely that firms (or the private sector) will on their own commit to making these investments. Consequently, there is a need for deliberate action by the State to initiate the transformation process. More specifically, the State should exercise the following functions: (i) play a lead role; (ii) liaise with other local stakeholders to identify priority areas or activities; and (iii) support these priority areas using available instruments. While the State is expected to play a lead role in promoting sustainable structural transformation, it is important to stress that it should make a genuine effort to involve other local stakeholders in the process in order to enhance the likelihood of success.

(b) *Environmental problems in Africa should be treated as a development issue.* The *Report* contends that African countries should not deal with environmental problems in isolation. These should be addressed as part of overall efforts to promote development. Far too often, there is very little coordination between government departments dealing with environmental issues and key departments such as finance, trade, agriculture and energy. This has led to incoherence in policy design and implementation. There is a need for African governments to strengthen inter-ministerial collaboration on environmental issues to ensure that these are addressed in a holistic manner. This calls for mainstreaming of the environment into national development strategies.

(c) *Better management of natural resource rent.* The mobilization of financial resources is critical to success in promoting sustainable structural transformation. It allows local ownership of the transformation and development process, and provides access to much-needed long-term finance. In this regard, the *Report* suggests that African countries should make better use of their natural resource rent, by, for example, putting a certain percentage of such rent in a Special Fund meant to finance public investments in infrastructure, human capital formation, technology development and acquisition, energy development, and protection of natural capital. Transparency and accountability are important in ensuring that the Special Fund is not misappropriated but used for the purpose for which it is intended.

(d) *Monitoring and evaluation of policies is important.* There is a need for African countries to put in place an effective system for monitoring and evaluating progress in the implementation of sustainability programmes and policies. This will require strengthening domestic capacity in collecting environmental statistics, which are necessary for designing sustainability indicators and also for evaluating the impact of environmental policy measures.

(e) *International support is needed.* While African governments must play the leadership role in formulating and implementing strategies of sustainable structural transformation, it is essential that an appropriate enabling environment, including support measures, be established at the international level. The international enabling environment should seek to apply the principle of common and differentiated responsibilities which was articulated at the 1992 United Nations Conference on Environment and Development. In broad terms, this implies that African countries should not be constrained in their pursuit of accelerated economic growth and structural transformation, and should seek to enhance environmental sustainability through relative decoupling rather than absolute decoupling, as absolute decoupling is much more relevant for countries that have already achieved high living standards. It also implies that developed countries should provide financial support, particularly aid for developing the energy sector, facilitate technology transfer to support sustainable structural transformation, and design the international trade regime and intellectual property rights regime in a way that facilitates the sustainable development process.

(f) *Policy space is needed at the international level.* The international trading, monetary and financial systems affect Africa's capacity to promote sustainable structural transformation, because they determine the set of feasible policy instruments that countries could use to support the transformation process. Consequently, the *Report* stresses the need for the international community to provide African countries with enough policy space to promote sustainable structural transformation. For instance, reforms under the Doha Round of trade negotiations should not restrict Africa's ability to use trade instruments to promote sustainable structural transformation. There is also a need for international trade rules to be made more coherent with the objectives of environmental protection and poverty reduction. Furthermore, the intellectual property rights regime should be geared more towards facilitating technology transfer to poor developing countries.

(g) *Policy coherence is also needed at the regional and international levels.* Africa's efforts to promote sustainable structural transformation will have maximum impact if policies at the regional and international level are consistent with those at the national level. For example, it is often the case that African countries compete among themselves to attract FDI in the extractive industries by offering generous incentives to foreign investors without due consideration of the environmental consequences of these investments both at the national and the regional level. There is a need for African countries to avoid a "race to the bottom" and also to put into place regional environmental standards that foreign investors have to comply with. There is also a need for the international community to have more coherent trade, finance, investment and environmental policies towards Africa to ensure that these complement national efforts to promote sustainable structural transformation.

NOTES AND REFERENCES

NOTES

1 Note that the current ratio of urban to total population in Africa (40 per cent) is similar to the urbanization rate in currently developed countries after the first Industrial Revolution (Bairoch, 1988).

2 Herman Daly (1992) uses this term to imply that the world has become "full" in the sense that the scale of the global production and consumption is reaching, and even surpassing, the planet's carrying capacity.

3 Biomass is defined as the total mass of living or dead organisms in a given habitat, population or sample. More specifically, it refers to plant material and animal waste used as a fuel or energy source.

4 The focus here is on used material extraction, which differs from unused material extraction, that is material that is extracted but not further processed in the production system (for example, mining waste).

5 Upstream flows, often also called hidden flows, ecological rucksacks or materials embodied in trade, are defined as the materials used directly or indirectly during the extraction and production process without being physically incorporated in the good or commodity, for example overburden and excavation, fossil fuels used for production, pesticides and herbicides, industrial waste. Please note that the methods and concepts to assess upstream flows are still in development and discussion (OECD, 2008).

6 Locally, HANPP can be much higher, in particular in areas of high population and infrastructure density. At the grid level, i.e. units of 10 per 10 km, HANPP in Africa ranges from 0 (deserts, untouched ecosystems) to 10 tC/ha/yr (e.g. Burundi, Nigeria, Rwanda).

7 See the *Economic Development in Africa Report 2011* for arguments as to why industrial development lies at the heart of structural transformation.

8 Environmentally Sound Technologies (ESTs) are technologies that protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their waste and by-products, and handle residual wastes in a more acceptable manner than the technologies for which they are substitutes. (WIPO, 2011).

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2011 Fostering Industrial Development in Africa in the New Global Environment - UNCTAD/ALDC/AFRICA/2011
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