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Africa hit hardest by Global Warming despite its low Greenhouse Gas Emissions

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Zusammenfassung

Es gilt als erwiesen, dass sich die Erde erwärmt, was für Länder mit geringer menschlicher, institutioneller und finanzieller Anpassungsfähigkeit besonders folgenschwer ist. Afrika leidet am höchsten unter der Erderwärmung, obwohl der Kontinent wenig mit der Verursachung zu tun hat. Im Rahmen ihrer begrenzten Human- und Kapitalressourcen haben afrikanische Länder versucht, mit dem Klimawandel umzugehen. Allerdings sollten entwickelte Ländern und internationalen Organisationen die afrikanischen Staaten mit umfassenden und nachhaltigen Maßnahmen bei diesem Vorhaben unterstützen. Obwohl der im Kyoto-Protokoll verankerte Clean Development Mechanism (CDM) das Ziel hat, nachhaltige Entwicklung zu fördern, indem er Entwicklungsländern erlaubt, in Klimaschutzprojekte zu investieren, erhält Afrika momentan nur einen geringen Anteil dieser Mittel, während sich Länder wie China, Indien und Brasilien dadurch Wettbewerbsvorteile verschaffen**.**

Abstract

There is now overwhelming scientific evidence that the earth is warming and its consequence is significant for countries with limited human, institutional and financial capacity to adapt to and cope with change. Africa hit hardest by global warming despite contributing very little to global climate change. Given the limited human and capital resources, many countries in Africa have been making efforts to cope with climate change; however, integrated and sustainable measures should be taken by developed nations and international organisations to help Africa mitigate the effects of global warming. Though the Kyoto Protocol's Clean Development Mechanism (CDM) is to help developing countries to achieve sustainable development by allowing developed countries invest in climate mitigation projects in developing countries, Africa is currently getting a meagre share as countries like China, India and Brazil gain strong competitive advantage.

Stichwörter: Afrika; Klimawandel; Globale Erwärmung; Kyoto-Protokoll

Keywords: Africa; Climate change; Global warming; Kyoto Protocol

JEL-Classification: Q51, Q54, Q56

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List of Abbreviations

CDM	Clean Development Mechanism
DFID	Department of International Development
EIA	Energy Information Administration
EIT	Economies in Transition
ET	Emission Trading
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
INC	Intergovernmental Negotiation Committee
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
KP	Kyoto Protocol
LULUCF	Land Use, Land Use Change and Forestry
MDG	Millennium Development Goal
ppm	Parts per million
SSA	Sub-Saharan Africa
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

1 Introduction

Global warming is a gradual increase in the earth's surface temperature. It is believed to result partly from a build-up of heat-trapping greenhouse gases (such as carbon dioxide, methane and nitrous oxide) emitted by human activities including fossil fuel burning and land clearing (IPCC, 2007a). Continued global warming has many damaging effects - it disrupts the ecosystems that provide us with water and food and exacerbates the existing environmental stresses like desertification, declining water quality and air pollution. The occurrence of some disease and other threats to human health are to some degree attributable to global warming.

Developed countries have by far the largest carbon dioxide emissions; however, regions most severely affected are those that emit the lease greenhouse gases. Africa emits low greenhouse gases but hit hardest by global warming. Thus, developed nations should not only bear responsibility for causing global warming but also fight against it.

To tackle global warming, the Kyoto Protocol (KP) set target levels for industrialized nations to reduce greenhouse gas emissions; however, the achievements made so far, especially with regard to a more equitable distribution of Clean Development Mechanism (CDM) projects, are not optimal.

The main objective of this paper is to examine the impact of global warming on Africa and assess the national and international efforts that have been made to reduce global warming. Following this introduction, the rest of the paper is structured into six sections. Section two describes the greenhouse effect and global warming. The impact of global warming on Africa is presented in section three. Regional and global efforts to tackle climate change are highlighted in sections four and five respectively.
Finally, the concluding section summarizes the main points of the paper.

2 The Greenhouse Effect and Global Warming

The greenhouse effect is the increase in temperature that the earth experiences as certain gases in the atmosphere trap energy from the sun. Generally, the part of sunlight that reaches the surface of the earth in the form of infrared radiation should escape into space by air currents to preserve a constant average temperature; however, it is delayed by greenhouse gases (IPCC, 2007a). Consequently, the temperature of the atmosphere near the earth increases, which in turn raises sea level, increases evaporation and precipitation to affect global cloud cover, and thereby changes the distribution of climate across the surface of the planet (Abrahamson, 1989).

The Intergovernmental Panel on Climate Change (IPCC) (2007a) reported that global atmospheric concentrations of carbon dioxide, methane and nitrous oxide increased markedly as a result of human activities since 1750 and now far exceeded pre-industrial value (see Table 1).1

Table 1: Global Atmospheric Concentration Value

	Pre-industrial	**2005**
Carbon dioxide	280 ppm	379 ppm
Methane	715 ppb	1774 ppb
Nitrous oxide	270 ppb	319 ppb

Notes: ppm is an abbreviation for parts per million and ppb for parts per billion

Source: IPCC (2007a)

The main sources of greenhouse gases caused by human activity are carbon dioxide, methane, fluorocarbons and nitrous oxide. The human activities that contribute to climate change, according to UNEP and WMO (1997), include the following facts. Carbon dioxide is created by fossil fuel burnings (such as coal, oil and natural gas) to generate electricity,

[1] Though greenhouse gasses occur naturally in the atmosphere, human activities have also contributed the levels of the naturally occurring gases.

heat homes, power factories and run cars. The increase of carbon dioxide in the atmosphere is also attributable to deforestation. Methane is added to the air by raising livestock, coal mining and drilling for oil and natural gas and rice cultivation. It is known that bacteria in the gut of cattle break down the food these animals eat, hence converting some of it to methane gas. Methane is also generated in the waterlogged soil of rice paddies. Fluorocarbons, which are manufactured by human beings for refrigeration and other uses, include chlorofluorocarbons which they trap heat in the atmosphere. Finally, nitrous oxide is added to the atmosphere through the use of nitrogen-based fertilizers, disposition of human and animal wastes and automobile exhausts.

In its first assessment report, the IPCC (1990) concluded that the amount of carbon dioxide in the atmosphere would double by the mid of 21 century. The report revealed that global mean surface air temperature increased by 0.3 to 0.6 degrees Celsius over the last 100 years. Another review by the IPCC (2001) concluded that the global warming over the past century increased by about 0.6 degrees Celsius (plus or minus 0.2 degrees Celsius) and the earth will warm by 1.4 to 5.8 degrees Celsius by 2100. Recently, the IPCC (2007a) reported that climate change would cause temperature to rise by as much as 6.4 degree Celsius by the end of the century. The report documented that: eleven of the last twelve years (1995-2006) are among the twelve warmest years of global surface temperature recorded; the average atmospheric water vapour content has increased since at least the 1980s over land, ocean and in the upper troposphere; widespread decrease in glaciers and ice caps have contributed to the sea level rise; long-term trends in precipitation amount over many regions; more intense and longer droughts, specifically in tropics and subtropics, over wider areas since 1970s; change in extreme temperature on the last 50 years; and intense tropical cyclone activity.

An interesting point is that most of the observed increase in average temperature in the world is very likely due to the observed increase in greenhouse gas concentration derived from human activities, and the future trends show the likelihood of extreme weather events (see Table 2)

Table 2: Assessment of Human Influences on the Trend and Projection for Extreme Weather Events

Phenomenon and direction of trend	Likelihood of human contribution to observed trend	Likelihood of future trends
Warmer and fewer cold days and nights over most land areas	Likely	Virtually certain
Warmer and more frequent hot days and nights over most land areas	Likely (nights)	Virtually certain
Warm spells/heat waves	More likely than not	Very likely
Heavy precipitation events	More likely than not	Very likely
Area affected by droughts increases	More likely than not	Likely
Intense tropical cyclone activity increases	More likely than not	Likely
Increased incidence of extreme high sea level	More likely than not	Likely

Source: IPCC (2007a)

The IPCC (2001) has documented that extreme weather events like the frequency of heat waves and heavy precipitation can cause prolonged droughts, forest fires, storms and floods. Infectious diseases like malaria, dengue fever and yellow fever may also increase due to an expansion of habitat for disease vectors like mosquito. The report highlights that glacier melting is seen in Alaska, northern Andes, European Alps, Himalayan, Arctic and tropical glaciers in Africa and the Pacific. Specially, the reduction of the west Antarctic and Greenland ice sheets is causing sea level to rise and thus coastal cities and island countries will easily be affected by swamps. Besides, rising sea levels will cause fertile coastal lands to lose. The faster evaporation of rain as a result of global warming is expected to hurt agriculture. The increase in temperature may cause a shift in growing seasons and affects countries that overwhelmingly depend on rain-fed agriculture.

3 Global Warming in Africa: Is it a Major Threat to the Continent?

The IPCC (2007a) has indicated that, throughout the African continent and in all seasons, warming is very likely to be larger than the global annual mean. Under global warming Africa is the continent that will suffer most, despite producing the least warming-causing greenhouse gases.

Selected key impacts of climate change on Africa are presented in Appendix 1.

Africa's share of carbon dioxide emissions in 2004 was only 3.3%, and, in general, there is a positive correlation between GDP per capita and emissions per capita, which this implies that wealthier nations have higher emissions per capita (EIA, 2007) (see Table 3).

Table 3: GDP per capita and carbon dioxide emissions per capita in selected countries, 2004

	GDP per capita	Emissions per capita
USA	36.4	20.1
Canada	31.5	18.3
Japan	26.3	9.9
Australia/New Zealand	28.5	17.7
Africa	2.4	1.0

Note: GDP per capita is in thousand dollars

Source: EIA (2007)

The two main reasons why climate change hits Africa hardest are geographical location and high dependence on sectors (such as forestry, agriculture, fisheries and tourism) that are vulnerable to climate changes, besides, the Africa region is characterized by low development status and high aid dependence (IPCC, 2001).

The climate in African is predominately tropical, hot and dry and agriculture is the backbone of most African economy. In Sub-Saharan Africa (SSA), the agriculture sector employs between 60-90% of the total labour force and accounts as much as 40% of the total export earnings (UNEP, 2006). As a large part of those engaged in the agricultural sector are the poor, the threat of climate change to the sector implies poverty exacerbation.

With regard to development status, Africa contains the poorest and least developed nations of the world, though some countries in Africa have been making good socio-economic progress (IPCC, 2001). In 2004, 41.1% of the population in SSA lived on less than $1 a day, as compared to 29.5% in Southern Asia and 9.9% in Eastern Asia (UN, 2007). Africa is also a continent that highly depends on aid. As stated by the World Bank (2007) per capita net aid flows to SSA was $44 in 2004 – hence the largest of the six developing regions.[2]

A warming of approximately 0.7 degrees Celsius was recorded over most of the African continent during the 20th century (Elasha et al., 2006). In the past three decades, a 25% decrease in rainfall occurred over the Sahel and since mid 1970s a 2.4% per decade decrease in precipitation has happened in tropical rainforest regions in Africa (Elasha, et al. 2006).

Areas of concern for vulnerability to climate change include water resource (low rate of conversion of rainfall to runoff), food security (worsening of food security due to high temperature and aridity), natural resources and biodiversity, human health, coastal zones (vulnerability to sea level rise) and desertification (due to land clearing and overgrazing).

Lack of water resources affects water supply for household use, agriculture and industry. Many regions in Africa that were once fertile are now without rain, and the future is not bright (see Appendix 2). The Sahel, the Horn of Africa and Southern Africa have been affected by droughts since the end of 1960s.

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[2] The World Bank's six developing regions are East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, South Asia and Sub-Saharan Africa.

Evidence from trends in regional per capita water availability in Africa over the past half century indicates that availability of water has declined by 75% (IPCC, 2001). By 2050, area experiencing water shortages in SSA will increase by 29%, while river flow in the Nile region will decrease by 75% by 2100 (UNEP, 2006). In its report, the IPCC (2007b) has projected that by 2020 between 75 and 250 million people in Africa will be exposed to an increase of water stress due to climate change. In addition to the negative consequence of global warming, the continuous increase in population is likely to threat water security in many parts of Africa. With an average of 15% Africa is the continent with the lowest conversion factor of precipitation to runoff (IPCC, 2001). This implies that large part of the continent is either dry sub-humid or arid. Severe lack of available water in Africa has negatively influenced industrial activity, as many African countries have heavily invested in hydroelectric power schemes.

Climate change has a huge impact on agricultural productivity and hence shortages of food supplies and increase in food imports, which in turn lead to increase in food prices. Yields in many countries of Africa are reduced due to lack of rain, warmer temperature and increase in evaporation. The United Nations (UN) predicted that cereal crop yields would decline by up to 5% by the 2080s with subsistence crops like sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; millet in Sudan and groundnuts in the Gambia (Elasha et al., 2006). In some African countries yields from rain-fed agriculture could be reduced by up to 50% by 2020 (IPCC, 2007b). The consequences of food insecurity in Africa are evident in the incidence of hunger and undernourishment (see Table 4). In SSA - the region with the highest prevalence of undernourishment - one in three people deprived of access to sufficient food (FAO, 2006).

Table 4: Category of prevalence of undernourishment in Africa, 2001-2003

% of undernourished (in total population)	Countries
Less than 5%	Egypt, Libya, Tunisia
5 – 9%	Algeria, Morocco, Gabon, Mauritius, Nigeria
10 – 19%	Benin, Burkina Faso, Cote d'Ivoire, Ghana, Lesotho, Mauritania, Swaziland, Uganda
20 – 34%	Botswana, Cameroon, Chad, Congo, Gambia, Guinea, Kenya, Malawi, Mali, Namibia, Niger, Senegal, Sudan, Togo
35% or above	Angola, Burundi, Central African Republic, Democratic Republic of the Congo, Eritrea, Ethiopia, Liberia, Madagascar, Mozambique, Rwanda, Sierra Leone, Tanzania, Zambia, Zimbabwe

Source: FAO (2006)

Increase in temperature has the capacity to expand disease vector habitats. Increase in vector- and water-born diseases are major potential health impacts of global warming in Africa (Khasnis and Nettleman 2005). Human health in Africa is at risk because the effect of global warming depends heavily on adequacy of sanitary infrastructure, which Africa lacks, especially in rural areas.

Sea-level rise and coastal erosion and flooding are also major threats to Africa, as most of Africa's largest cities are along coasts (IPCC, 2001). Sea-level rise due to climate change will force people migrate and damage infrastructure, fauna and flora. In addition, fish production will be negatively affected as a consequence of sea level rise and coral bleaching. The number of people at risk in Africa from coastal flooding is expected to rise to 70 million by 2080 (from one million in 1990) (DFID, 2004). Countries at risk are Guinea, Senegal, the Gambia, Egypt, South Africa,

Mozambique, Tanzania and Nigeria. In some parts of Africa a massive flooding event resulted in crop destruction, electricity disruption, infrastructure demolition, and human displacement and death. During 1997-98 El Nino in East Africa extreme flooding caused malaria, fever and cholera epidemics in Djibouti, Somalia, Kenya, Tanzania and Mozambique (IPCC, 2001). In early 2000 flooding in Southern Africa left hundreds dead and destroyed crops.[3] Countries (and agricultural products) threatened by sea level rise due to climate change are Kenya (mangoes, cashew nuts and coconuts), Benin (coconuts and palm oil), Guinea (rice) and Nigeria, where coastal agricultural land accounts for about 75% of the total (UNEP, 2006).

Climate changes have also contributed to land degradation and desertification and this will aggravate the already overexploited land due to heavy dependence of rural people on agriculture.[4] As stated by the IPCC (2001) areas at risk include the Sahel and some nations (such as Botswana and Eritrea) that consist entirely of drylands.

Generally, poorer societies are likely to be more negatively affected by climatic change than richer ones because richer societies become relatively less dependent on nature and more able to adapt to climatic change (Pittock, 2005). Farmers in developed countries can easily get access to new varieties of crops that tolerate more heat and drought, whereas lack of resources and capacity to adopt make the poorest countries vulnerable to a changing climate. To adapt to and cope with climate changes a country should have wealth, technology, education, information, infrastructure and access to resources. Recent findings have revealed that Africa's low adaptive capacity is one of the main causes for its vulnerability to climate

[3] Countries affected by the 2000 flooding include Mozambique, South Africa, Zimbabwe, Botswana, Zambia and Madagascar.

[4] Though overall Africa's energy per capita consumption is low and thus its contribution to global warming is minimal, the evidence of localized impacts such as wood extraction for fuel is extreme and exceeds reforestation rates; besides, forest clearing to use for settlement and agriculture affects the climate system and jeopardizes water supply system (UNEP, 2006).

variability and change (IPCC, 2007b). It is known that lack of economic resources and technology is the main factor for low adaptive capacity of human systems in Africa (IPCC, 2001).

At a macro level, climate change has the potential to undermine economic development, exacerbating poverty and impeding the realisation of Millennium Development Goals (MDGs). Due to the adverse impact of climate change, many of the MDGs targets in Africa are less likely to be realized by 2015 (UNDP, 2003).

To a certain extent, however, Africa can manage climate extremes by designing appropriate coping and adaptation strategies and coherent policies, programs and deep structural changes.

4 How Africa can Respond

The following are a number of adaptation strategies highlighted by IPCC (2001) to limit climate change impacts on Africa. Adaptations concerning water resources include: water-use strategies; improvement of early warning systems; monitoring data reliability; rigorous research on energy usage, renewable energy technology, flood control management, coastal defence facilities and adaptive agricultural strategies. Increased afforestation, utilisation of underground water, public education and awareness are important adaptation options in water resource management. To lessen vulnerability to food insecurity, advance information on future season's climate, soil and water conservation practices, switching to crop varieties more adapted to lower soil moisture, increasing irrigation and pest and disease control are some of the techniques needed to be adapted. Adaptation strategies to limit climate change impacts on human health should embrace quick and adequate response strategy to the outbreak of diseases due to climate change, technology for safe drinking water supply and sustainable disease vector control strategies. Development of a sustainable fisheries livelihood program and integration of coastal zone management are effective adaptation measures to protect sea resources. Finally, diversification and intensification of resource use and more efficient management of resources are adaptation strategies for reducing desertification.

To cope with climate change a number of African countries have made efforts to stimulate technologies. The report by UNEP (2006) includes the following country examples. In Mozambique lessons on technological development are shared by farmers to shift to more drought resistant species. The construction of dams in Kenya is also an effort to increase access to water in traditional sand beds. The establishment of a regional climate outlook forum in Southern Africa countries is an effort to improve information and early warning systems. Coping strategies such as migration to other areas, reduction in number of meals, dependence on remittances and switching to non-farming activities are also seen in some parts of Africa as a traditional copying strategy in response to drought and floods caused by climate changes.

Based on a large-scale survey of agriculturalists in 11 different African countries, Maddison (2007) found that for most countries under investigation planting different varieties of the same crop and changing dates of planting were the important adaptation techniques used in response to climate change.

Adaptation is a necessary strategy; however, it is expensive for poor countries, and that is why African countries are more vulnerable to the adverse effects of climate change.[5] Governments in Africa, in collaboration with international organisations, should fight the challenges of climate change by designing adaptation strategies that include: the use of drought resistance plants; crop diversification; improved farming technology; water conserving technologies; and the use of efficient and pollution-free source of energy. It is crucial to work with civil societies and community-based organisations to promote adaptation to climate change.

When it comes to policy, there are a wide range of options that help Africa to mitigate climate change, though their applicability solely depends on country circumstances. The IPCC (2007c) has highlighted sectoral

[5] Article 4.4 of the UNFCCC states that developed country parties shall assist the developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects (For more information on UNFCCC visit http://unfccc.int/2860.php).

policies, measures and instruments that are useful to lessen the negative impact of climate change. Financial incentives are crucial for improving land management, efficient use of fertilizers and irrigation, increasing forest area, reducing deforestation, maintaining and managing forests and improving waste and water management. In addition, land use regulation and enforcement, renewable energy incentives and waste management regulations are equally important to mitigate climate change in sectors such as agriculture, forestry and water management. In transport and energy supply, change in fiscal polices (that impose taxes on fossil fuels and vehicle purchase and encourage investment in renewable energy and public transport facilities) are necessary.

5 Global Efforts to Tackle Climate Change[6]

In 1990, the UN General Assembly set up the Intergovernmental Negotiation Committee (INC) to draft a framework convention, as well as any related legal instruments it considered necessary, and on May 1992, the INC adopted the United Nations Framework Convention on Climate Change (UNFCCC). The Convention was opened for signature at the United Nations Conference on Environment and Development (UNCED), the so-called Earth Summit, held in June 1992 and came into force on 21 March 1994 (Oberthuer and Ott, 1999; Long, 2004). The principal aim of the UNFCCC is to attain stabilisation of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system.

In June 1992, 154 nations signed the UNFCCC, which upon ratification committed signatories' governments to a voluntary non-binding aim to lessen atmospheric concentrations of greenhouse gases. These actions were primarily focused on industrialized countries, with the objective of stabilizing their emissions of greenhouse gases at 1990 levels by the year 2000. In 1997, the third conference parties to the UNFCCC was held in Kyoto and industrialized countries undertaking the commitment agreed to

[6] In this section, information on the UNFCCC is extracted from the web site http://unfccc.int/2860.php

reduce greenhouse gas emissions of an average of 5% below 1990 levels between the year 2008-2012.[7] In addition, the parties at the conference agreed that: (i) the developed countries are the main originators of the historical and current global emissions of greenhouse gases; (ii) in developing countries, per capita emissions are relatively low; and (iii) the share of global emissions originating in developing countries will grow to meet their social and development needs. The KP also reaffirms that developed countries have to support and supply technologies to countries for projects focusing on climate. As of November 2007, 174 countries and other governmental entities have signed and ratified the KP.[8] While United States is the only country that signed but not intending to ratify the Protocol, Kazakhstan is a country that signed but not yet ratified. African countries that have neither signed nor ratified are Central African Republic, Chad, Comoros, Somalia and Zimbabwe. The reason given by USA for not ratifying the Protocol is that the KP does not commit developing nations (especially China and India) to targets, as exemption established under the convention (Spence, 2005). It is also concerned about negative economic impacts due to costs of emissions reductions (Hardy, 2003).[9]

In the KP, all industrialized countries are grouped in Annex I, developed countries which pay for costs of developing countries are called Annex II countries (these are an Annex I subset) and all countries that are not included in either Annex are known as non-Annex I countries. Countries with economies in transition (EITs) are mostly countries of Eastern and Central Europe and the former Soviet Union. These countries are Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russian Federation, Slovakia, Slovenia and Ukraine.

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[7] A full range of information on the Kyoto Protocol is provided by Oberthuer and Ott (1999).

[8] The count on the UNFCCC list includes Niue and Cook Islands (self governing Islands but are not independent from New Zealand) and the European Union which is counted as an individual entity.

[9]At the UN Climate Change Conference in Bali (Indonesia) between December 3 and 15, 2007 the United States, which is the world's top emitter of greenhouse gases, says it will accept a compromise to set the stage for intense negotiations in the coming two years aimed at curbing carbon dioxide emissions.

Over the period 1990-2004, total aggregate greenhouse gas emissions without emissions/removals from land use, land-use change and forestry (LULUCF) for Annex I countries decreased by 3.3% and by 4.9% for emissions with LULUCF, largely due to a fall (around 40%) in emission in countries with economies in transition (EITs) (UN, 2006). Greenhouse gas emissions for the Annex I non-EITs countries increased by around 11.5% between the year 1990 and 2004.

Most Annex I countries are committed to combating climate change, though they don't want to reduce international competitiveness. They have designed policies that deal with energy, transport, industrial process, agriculture and land-use change and forestry. However, many Annex I countries, especially those non-EIT countries, are not on track to meet their commitment (UN, 2006). Critics say many industrialized countries that signed the treaty will not be able to meet the goals by the 2012 deadline. It is argued that the targets and timetables for reducing greenhouse gas emissions are economically flawed and politically unrealistic (Victor, 2001; McKibbin and Wilcoxen, 2002). One positive thing about the KP is that countries have improved understanding of the challenges and uncertainties that climate change presents. Many countries have improved their experience on how to reduce emissions without damaging competitiveness or creation of jobs. The increase in public awareness of global warming and the advancement in science and technology to tackle climate change should be seen as a positive step. Finally, it is now clear that the greenhouse gas emission reduction is a problem that can be soluble and that the instruments for achieving the overall objectives are within reach.

As an instrument to allow governments in Annex I countries to reduce parts of their emission, the KP introduces "flexible mechanisms", which include Emission Trading (ET), Joint Implementation (JI) and Clean Development Mechanism (CDM).[10] A CDM mechanism allows Annex I countries to gain emissions credits for projects that aim at reducing emissions in non-Annex I countries. It is an arrangement that allows Annex I

[10] Through ET Annex I countries can buy and sell emission cards, and through JI they are allowed to gain credit from financing projects that aim at reducing emissions in other Annex I countries.

countries to invest in emission reducing projects in non-Annex I countries as an alternative to the more costly emission reductions in their own countries. Projects that are eligible under CDM comprise renewable energy, energy efficiency, recovery and utilisation of methane, switching from fuels with greater to less greenhouse gas intensity and planting trees and other biomass to sequester carbon. The CDM is believed to be one of the most attractive instruments for countries in Africa because it gives these countries the opportunity to gain technology transfer and attract foreign investment needed for sustainable economic development.[11] But in practice, CDM projects in Africa are very few in number. As of the end of October 2006 19 projects from Sub-Saharan Africa were in the CDM project pipeline, out of a total of 1274 projects for all developing countries (World Bank, 2006).[12] One reason for few CDM projects in Africa is that developing countries like China, India and Brazil have greater capacity to attract foreign direct investment than most African countries (Bess, 2005). In addition, there are few options for implementing CDM projects in Africa because Africa's carbon emissions are low and there is also limitation in availability of statistical data and local private sector participation. The reasons for grim trends in African CDM participation, as stated by Desanker (2005), include lack of private investors, uncertain markets for emission reductions, lack of national technical and institutional capacity to implement all the requirements of CDM projects and lack of international institutional capacity for the various steps in a CDM project. To attract Annex I countries a project should be feasible to reduce high level of emissions at relatively low transaction costs. However, in much of Africa, access to electricity is still a major challenge and thus mitigation opportunities are also limited (World Bank, 2007).

Currently, Africa gets more benefit from capacity building on CDM rather than from the actual CDM projects (UNEP, 2006). Thus, it is im-

[11] CDM gives developed countries a possibility to take on efforts on an international scale along with action taken domestically, in the interests of minimizing the overall costs of cutting greenhouse gas emission.

[12] These countries are Equatorial Guinea, South Africa, Nigeria and Ivory Coast.

portant to make efforts to create a more equitable distribution of CDM projects. Some governments and institutions have designed programs and make funds available to enable investment in emission reduction projects in Africa.[13]

Developed nations should help Africa in: integrating adaptation goals into sustainable development strategies; increasing the use of renewable energy; and improving the capacity for environmental and climatic research. Given Africa's vulnerability to climate change, the European Union (under the EU-Africa Strategic Partnership) intends to develop the financial and human resources needed to establish a sustainable energy policy in Africa with the aim to provide favourable conditions for investment in infrastructure in the field of energy.[14]

However, the key question about the effort to reduce greenhouse gas emissions is what happens when the KP first commitment period comes to an end after 2012. The international climate change community has begun to seriously explore how it will effectively deal with the long-term threat of climate change after 2012. Most Kyoto nations favour deeper cuts for themselves but want more nations involved.

6 Conclusion

The continuous increase in average global temperatures is mainly caused by increase in greenhouse gases emitted through human activities. Global warming threatens dangerous consequences such as drought, diseases, floods and lost ecosystem. Though it is known that the richest nations are causing the greatest global warming, poor countries suffer the most. Africa is particularly vulnerable to the effects of global warming as it overwhelmingly depends on rain-fed agriculture.

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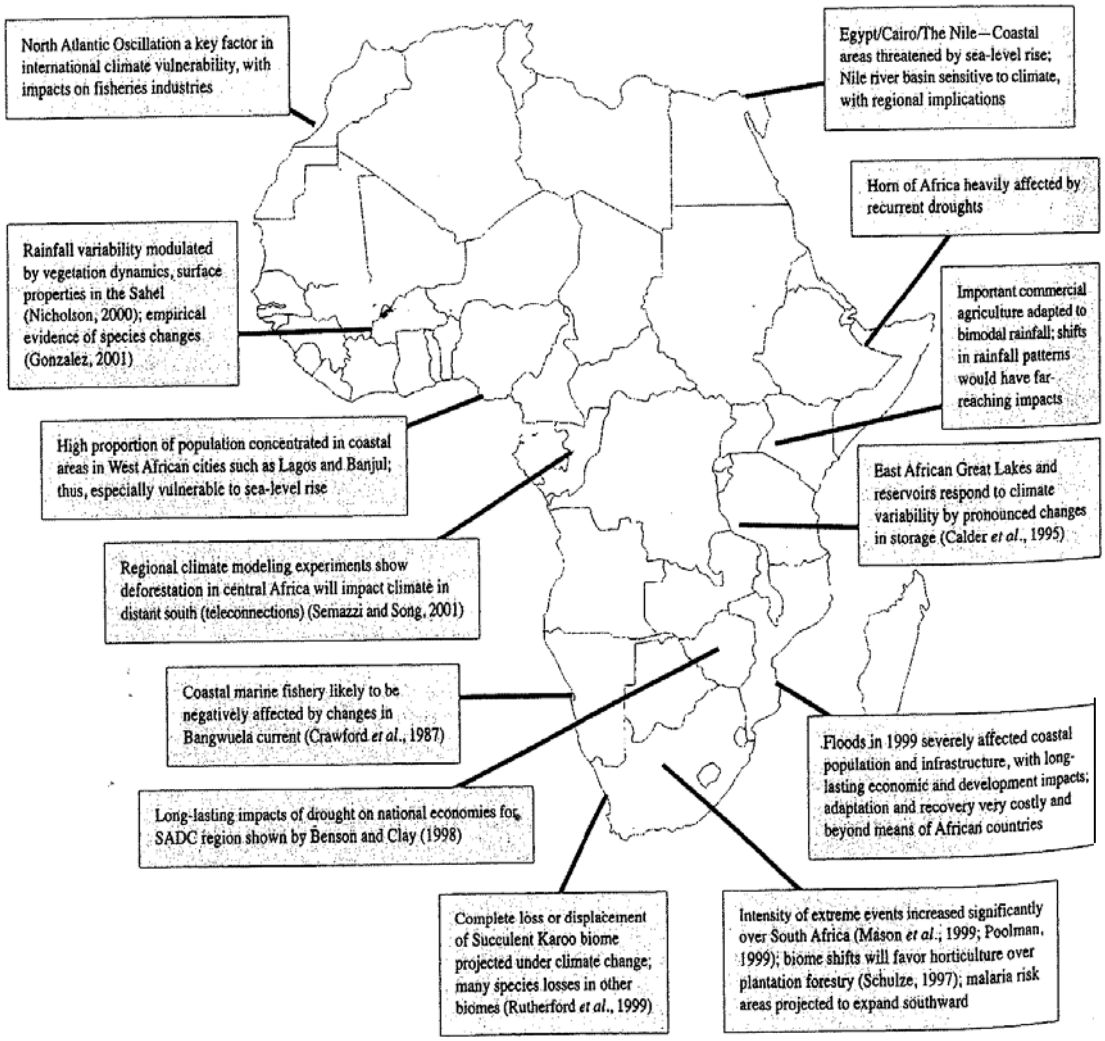
[13] Funds accessible to Africa for emission reeducation projects include World Bank carbon fund, World Bank community development carbon fund, World Bank biocarbon fund, and other bilateral projects supported by Netherlands, Australia, Sweden, Belgium, Finland, etc.

[14] For further information refer to http://www.www.eudevdays.eu

Many African countries have been making efforts to adapt to climate change; however, national efforts should be complemented by international cooperation to achieve the desired results. To tackle the challenge posed by climate change the Convention on Climate Change set an overall framework for intergovernmental efforts. In 1997, many parties by signing the KP agreed to specific targets for reducing their emissions of greenhouse gases. As part of the effort to address climate change issues flexible mechanisms, that include CDM, were introduced; however, the CDM strategy, which was partly designed to provide non-Annex I countries new financing for sustainable development, has not helped Africa.

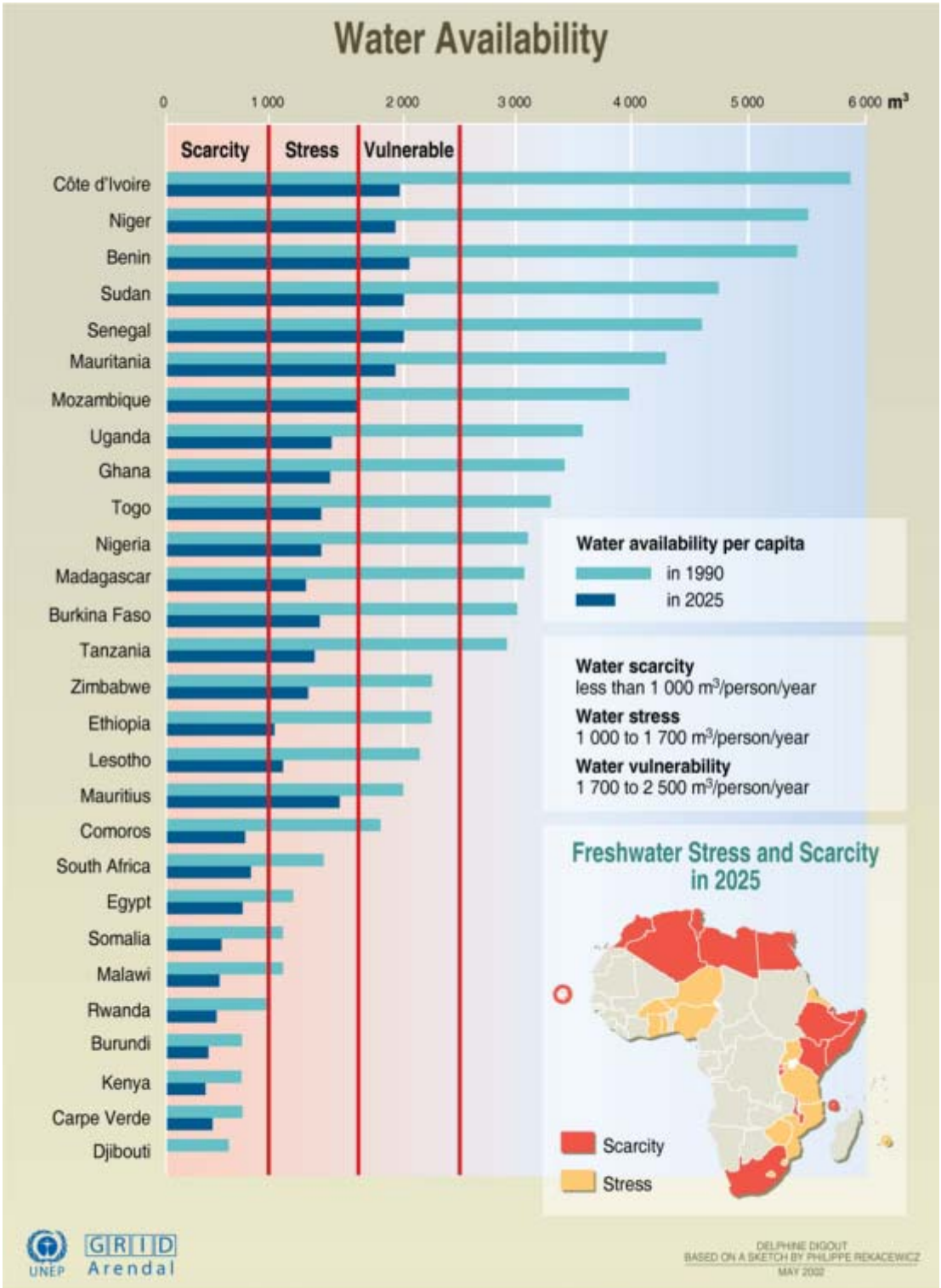
It is unfair to expect the non-Annex I countries to make emissions reduction as global warming is caused by industrialized nations, besides, developing countries need to increase their own emissions to meet the needs of development. Developed nations should not only make efforts to reduce their greenhouse gas emissions but also help developing countries by mobilizing financial resources, technical assistance and capacity building programs. It is especially difficult for Africa to achieve climate friendly sustainable development on its own and thus developed nations and international non-government organisations should help Africa cope with impacts of global warming.

Appendix 1 Selected Key Impacts for Africa



Source: IPCC (2001)

Appendix 2 Water Availability per Capita in Africa



Source: United Nations Economic Commission for Africa (UNECA), Addis Abeba ; Global Environment Outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

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