

Summary of Climate Change Impacts on Africa – Income (aggregate)

Global Temperature Rise (relative to 1990)	Agriculture	Energy	Tourism & leisure	Infrastructure	GDP
Baseline	<p>Declining per capita food production since the 1980s.</p> <p>Decline in growing season rainfall (observed), disbenefit to agriculture (less developed world – Hare, 2003).</p> <p>Abrupt change in regional rainfall pattern causing food insecurity, water stress in the Sahel (observed – Dore, 2005)</p> <p>Africa is already experiencing major deficits in food production in many areas (observed).</p>	<p>Drought threatens energy security of a country by disrupting energy supplies from hydro-sources with negative effect on social and economic development.</p>		<p>Index of seasonal destructiveness of hurricanes has increased since 1975 at the global level (Emmanuel, 2005).</p>	
Current to 1°C	<p>Loss in length of growing period of greater than 20% in marginal areas of Sahel by 2020 and 2050 (ECHam4 and HADCM3 for A1F1, A2, BI, B2 scenarios – DFID, 2006).</p> <p>Some parts of East Africa and highlands gain growing days (HADCM3 for BI scenario).</p> <p>Projected decreasing grain yields and diminishing food security in small food importing countries with medium to high confidence (IPCCC WG III 2001).</p> <p>Fish production will be negatively affected by sea level rise and coral bleaching</p>	<p>Increased frequency and intensity of droughts – South Africa, Sahel (IPCC, 2001).</p> <p>The 1992-92 drought curtailed the hydro-power generation on Lake Kariba. The economic impacts of this estimated at US \$ 102 million in GDP. US \$ 36 million lost in export earnings and 3000 job losses. The 2000 drought in Kenya had similar effects.</p>	<p>Extinction of animal and plant species is projected to have an adverse impact on rural livelihoods, tourism, and genetic resources.</p> <p>The 1998 coral bleaching led to decreases in tourism value of coral reefs in Mombassa and Zanzibar, estimated at about US\$ 12-18 million (Payet and Obura, 2004).</p> <p>Africa’s last tropical glacier on Kilimanjaro could be lost by 2015 (Thompson et al., 2002).</p>	<p>Large scale damage to infrastructure and threat to human lives – small Islands (IPCC, 2001).</p> <p>Observed damage from 1999/2000 flood disaster in Mozambique worth over 427 million USD (Hirji, R. et al, 2002).</p> <p>Increase in global sea level of 1.8mm/ year (Thomas et al., 2004).</p>	<p>Economic burden of malaria is estimated at an average annual reduction in economic growth of 1.3% for those African countries with the highest burden with an estimated \$12 billion lost to the African continent’s GDP annually (Sachs, 2001).</p>

<p>1° C – 2° C</p>	<p>More areas experience loss in length of growing days of more than 20% (ECHam4 and HADCM3 for A1F1, A2, BI, B2 scenarios – DFID, 2006).</p> <p>Food price rise begins (Hare, 2003)</p> <p><u>Pessimistic</u> - \$ 23 billion agricultural loss <u>Optimistic</u>: +\$ 16 billion agricultural gain (FAO 2000) <u>Pessimistic</u>: -\$ 85 billion loss. <u>Optimistic</u> \$ 1 billion loss (UIUC II model (FAO 2000).</p> <p><u>Reduced model</u>: \$ 132 billion loss. <u>Ricardian model</u> \$ 11 billion. For a 2°C global temp rise by 2060 (Mendelsohn et al 1997).</p> <p><u>For Dryland</u> Total revenue loss of US\$ 22.6 billion by 2100;</p> <p><u>Irrigated Farms</u> Net income increases US \$ 1.4 billion in total net revenue.</p> <p>Reducing precipitation by 75 and 14% respectively reduces both dryland and irrigated revenue by about the same amounts per hectare.</p> <p>For small farms, warming at this temperature range could increase livestock net revenues by 25%, but reduces the net revenues of large farms by 22%</p>	<p><u>Reduced-form Model</u>: \$ 3 billion loss. <u>Ricardian model</u>: -\$ 2 billion loss for a 2°C global temp rise by 2060 (Mendelsohn et al 1997)..</p>		<p>Damage to infrastructure and vulnerability to coastal flooding</p> <p>Coastal damage: \$0bn for both Reduced and Ricardian models. (Mendelsohn et al 1997). But same source points out that countries with extensive coastlines most vulnerable</p> <p>The cost of a 0.5m sea level rise in Egypt without adaptation is estimated at about us\$2.5 billion (at 1992 prices), in addition to a loss of up to 14% of GDP, while the cost of protection is estimated at between 5 and 10% of GDP (Van Drunen, 2005).</p> <p>In Tanzania, a sea level rise of 0.5m would inundate over 2000km² of land, at a cost of approximately us \$ 51 million.</p>	<p><u>Reduced form</u>: -4.7 % GDP or a loss of \$22 billion by 2060 <u>Ricardian model</u>: -0.8 % GDP or a loss of \$133 billion by 2060 (Mendelsohn et al 1997).</p> <p>Damage from climate change to African agriculture is expected to range from 0.13% to 2% of GDP by 2100. (Mendelsohn et al 2000).</p>
<p>2.0°C – 3.0°C</p>	<p>Fisheries impacted in NW Africa and east African lakes (ECF, 2004).</p> <p>Fishery damage removes primary protein source for 50% of population in Malawi (ECF, 2004).</p> <p>Combined effects of precipitation changes, floods, droughts, reducing crop yields leading to significant risk of up to 50 % crop failure in Southern Africa (ECF, 2004). Kalahari dune activation threatens Sub-Saharan agriculture and ecosystem.</p> <p>10% loss in maize production equivalent to losses of \$2 billion/year by 2050 based on IS92 scenario (Jones and Thornton, 2003).</p>				

<p>3.0°C - 4°C</p> <p>4°C - 5°C</p>	<p>Pessimistic: -\$ 165billion Optimistic- \$ 30 billion (FAO 2000).</p> <p>Risk of crop failure rises from 50% to 75% in South Africa (ECF, 2004).</p> <p>14 African countries loose up to 16% of Agricultural GDP by 2080s based on HadCM3, CSIRO, CGCM2 and NCAR models (Fisher et al., 2001).</p> <p>By 2070, irrigation requirements increase in 12 of 17 world regions including Africa for HadCM3 and ECHAM4 models (Doll, 2002).</p> <p>Small decreases in cropland suitability between 2070 and 2100 in the tropics including Africa based on IS92a scenario at 710ppm CO₂ (Ramankutty et al., 2002)</p> <p>Net revenue loss of US \$95.7/ha. Drylands will suffer damages of about \$37.7 billion. Entire regions in South Africa could be out of production (Hare, 2003).</p>				
<p>> 5°C</p>	<p>By 2090, at global levels one could see 23% fall in cereal production without farm level adaptation, 2.4% with adaptation based on UKMO GCM (Darwin, 1995).</p>			<p>In Nigeria, a total of 5,955 km² of agricultural lands (75% of the total agricultural area), will be threatened with a 1.0 m sea level rise (Awosika <i>et al.</i>, 1993).</p> <p>In the Niger delta, about 259 producing oil fields are located in the threatened areas, representing a value at risk of 10,790 million us \$ for a 1.0 m sea level rise (French <i>et al.</i>, 1995).</p> <p>In the Gambia, it is estimated that a 1.0m sea level rise could submerge its capital city, Banjul, leading to a loss of about \$217 million dollars.</p>	

Summary of projected African impacts – Human Development (aggregate)

Global temp rise	People at risk - water stress, migration, conflicts	People at risk of hunger	People at risk - diseases and mortality impacts	People displaced by coastal flooding
Baseline	Since 1970s, number of people affected by drought increased from 0 to 35 million with resultant migrations and environmental conflicts (ECF, 2004).	An estimated 200 million people on the continent are undernourished, and their numbers have increased by almost 20 percent since the early 1990s.	Vector- and water-borne diseases are spreading as a result of shifting temperature zones especially in areas with inadequate health infrastructure.	Increase in magnitude/frequency of precipitation events, with an increase in floods, landslides, avalanches, and soil erosion
Current to 1 ⁰ C	<p>The future impacts of climate change likely to lead to widespread loss of human life and livestock, and substantial changes to the social system. (IPCC WG III, 2001)</p> <p>Increased frequency and intensity of droughts (IPCC, 2001; ECF, 2004).</p> <p>Globally, 240 million at risk (including Africa) from water stress by 2020 based on HadCM2 GCM and IS92a and with stabilization at 750 ppm (Arnell, 2002).</p> <p>By 2025 under the Ai/B and B2 scenarios countries in east and west Africa become stressed (Arnell, 2004).</p>		<p>In West Africa, risk of death due to flooding could increase by 1.44 with stabilization at 550ppm by 2050 (McMichael et al., 2004).</p> <p>Climate change has been modelled to have caused the loss of 150,000 lives since the 1970s, particularly in Africa (McMichael et al., 2004).</p>	<p>El-Nino induced floods in Kenya (1997/98) cost the country about \$60 million in treatment costs (World Bank, 2004)</p> <p>By 2015 cities like Lagos, Kinshasa and Cairo with populations of about 8 million people will be exposed to sea level rise. The threat of cyclones will rise with sea surface temperature rise</p>

<p>1° - 2°C</p>	<p>By 2050, between 224 and 310 million people in north Africa at risk of water stress based on HadCM3 GCM and A2 scenario (Arnel, 2004).</p> <p>Increase in water stress in Africa (Vorosmarty et al., 2000).</p> <p><u>Water</u> <u>Reduced form:</u> -\$ 2 billion <u>Ricardian model:</u> -\$ 3 billion by 2060 (Mendelsohn et al 1997)</p> <p>By 2050 the monsoon winds that bring seasonal winds to Sub-Saharan Africa could be 10 to 20% drier than the 1950– 2000 averages in southern Africa. (Kigotho, 2005).</p> <p>Large scale displacement of people by 2050 (climate refugees from low food security, poverty and water stress in North Africa and the Sahel based on a synthetic scenario of 40% simulated decrease in rainfall (ECF, 2004).</p> <p>Regional conflict over water supplies or food supplies in the Nile (ECF, 2004).</p>	<p>By the 2050s, 12 million people at risk from hunger as a result of falling crop yields (Parry et al., 2004)</p>	<p>By 2080 based on hadCM2 and IS92a scenario with stabilization at 450ppm, about 165 million at risk of malaria globally, majority of whom will be in Africa (Parry et al., 2001).</p> <p>Risk of death due to flooding increased by 1.64 with stabilization at 550ppm by 2030 (McMichael et al., 2004).</p> <p>By 2055 based on A2 scenario, 0.1 diarrhoeal incidence per capita per year at global scale (Hijioka et al., 2002).</p>	<p>Increase in magnitude of cyclones likely, increasing risks to human life, infectious disease epidemics, coastal erosion and damaging coastal infrastructure in tropical and sub-tropical regions (IPCC, 2001).</p> <p>Loss of sovereignty of small island states and countries with large low-lying deltaic regions (several in Africa) (ECF, 2004).</p> <p>In Guinea, by 2050 between 132.6 and 234 km² of rice fields (respectively 17% and 30% of the existing ones) will be lost due to permanent flooding (République de Guinée, 2002).</p>
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<p>2.0°C - 3.0°C</p>	<p>By 2055, about 300 millions at risk of water stress in northern Africa under A2 scenario and about 220 million under B2 scenario. In south Africa population at risk is about 120 million (B2 scenario), and 90 million (A2 scenario) (Arnell, 2004).</p>	<p>About 55 million additional people at risk of under-nourishment by 2080 under HadCM3 and the socioeconomic scenarios of A2 (Fisher et al., 2001).</p>	<p>By 2050 based on HadCM2 and IS92a scenario with stabilization at 450ppm, between 180 - 230 million at risk of malaria globally, majority of whom will be in Africa (Parry et al., 2001).</p> <p>By 2080 based on HadCM2 and IS92a scenario with stabilization at 450ppm, between 230 - 270 million at risk of malaria globally, majority of whom will be in Africa (Parry et al., 2001).</p> <p>By 2080 based on hadCm3 and the B1 scenario, 38 more millions at risk of 1 month exposure to malaria and 21 more millions at risk of 3 months exposure to malaria in sun-Saharan Africa (Van Lieshout et al., 2004).</p> <p>By 2080 based on HadCM3 and the B2 scenario, 67 more millions at risk of 1 month exposure to malaria and 51 more millions at risk of 3 months exposure to malaria in sun-Saharan Africa (Van Lieshout et al., 2004).</p> <p>15.5 million additional person months exposure to malaria under HadCM3 and assuming a constant population into the future (Tanser et al., 2003).</p> <p>By 2085 based on HadCM3, ECHAM4, CCSR/NIES, and CGCMA ½ models under IS92a scenario, proportion of world population exposed to dengue fever increases from 30% in 1990 to 50% (Hales et al., 2002).</p>	<p>20 million more people at risk from coastal flooding by 2050 based on HadCM2 model under the IS92a scenario (Parry et al (2001)</p> <p>By 2080 based on HadCM3 GCM and B2 scenario, 16-27 million at risk from coastal flooding globally with some of these in Africa (Nicholls, 2004).</p> <p>0.5 m rise in Sea level by 2050 in Egypt could force nearly 1.5 million people to migrate, population at risk will be almost 4 million, with almost 2,000 square km of cropland that could be lost (Sawahel, 2005).</p>
<p>3.0°C - 4.0°C</p>		<p>55 to 70 million at risk by the 2080s with the HadCM3 model and A1F1 scenario (Parry et al., 2004)</p>	<p>By 2080 using the HadCM3 and the A2 scenario, 38 more millions at risk of 1 month exposure to malaria and 21 more millions at risk of 3 months exposure to malaria in sun-Saharan Africa (Van Lieshout et al., 2004).</p> <p>23.2 million additional person months exposure to malaria in Africa, assuming a constant population.</p>	<p>By 2080 based on HadCM3 GCM and IS92a scenario, 80 million at risk from coastal flooding globally (with some of these in Africa) and only 14 million at risk in the absence of climate change. (Nicholls, 2004).</p>

4.0°C– 5.0°C			<p>By 2080 using the HadCM3 and the A1F1 scenario, 44 more millions at risk of 1 month exposure to malaria and 49 more millions at risk of 3 months exposure to malaria in sun-Saharan Africa (Van Lieshout et al., 2004).</p> <p>28.2 million additional person months exposure to malaria in Africa, assuming a constant population.</p> <p>Based on the HadCM2/3, projected 25% increase in potential malarious zones; 40% increase in seasonal zones and most of these in Africa (Martin and Lefevre, 1995).</p> <p>Area suitable for malaria transmission in South Africa could double by 2100 (Republic of South Africa).</p> <p>Tanser et al. (2003) using parasite survey data in conjunction with HAD CM3 GCM estimated a 5-7% potential increase (mainly altitudinal) in malaria distribution with little increase in the latitudinal extent of the disease by 2100.</p>	<p>By 2080 based on HadCM3 GCM and A1F1 scenario, 7-10 million at risk from coastal flooding globally (with some of these in Africa) (Nicholls, 2004).</p>
> 5.0°C			<p>Based on the HadCM2/3, projected 30% increase in potential malarious zones; 55% increase in seasonal zones and most of these in Africa (Martin and Lefevre, 1995).</p>	<p>UNEP (2002): people at risk from coastal flooding will increase from 1 million in 1990 to 70 million in 2080.</p> <p>With a sea level rise of 1.0m in Egypt, the population at risk is about 6 million with more than 4,000 square km of cropland that could be lost.</p> <p>In Kenya losses for three crops (mangoes, cashew nuts and coconuts) could reach 472.8 million US \$ for a 1.0 m sea level rise (Republic of Kenya, 2002).</p>

Summary of projected African Impacts – Environment (aggregate)

Global Temp Rise	Ecosystem services	Species Loss	Change in size of habitat
Baseline	Climate change has already affected the marine animals of Africa. Coral reefs in the Indian Ocean experienced massive bleaching in 1998, with over 50 percent mortality in some regions (Spalding 2001).		
Current to 1.0°C	Loss of grassland and acacia, loss of flora/fauna, shifting sands in the Sahel already observed (ECF, 2004).	Increased drought in the Sahel would cause many local flora and fauna to disappear (ECF, 2004). Based on HadCM2 and doubling of CO2, loss in extent of Karoo, the richest floral area in the world (Rutherford et al., 1999).	Range losses begin for animal species in South Africa based on the HadCM3 model (Rutherford et al., 1999).
1.0° – 2.0°C	97% of all global coral reefs bleached including those in the Indian Ocean coasts of East Africa (Hoegh-Guldberg, 1999). By 2050, shorelines behind bleached coral reefs will become vulnerable to storm damage and tourism loss, particularly in small islands. Kalahari dune activation commences (Thomas et al., 2005). Forests <u>Reduced model:</u> \$ 4 billion <u>Ricardian:</u> \$ -6 billion by 2060 Mendelsohn et al 1997	Based on HadCM2 and doubling of CO2, severe loss in extent of Karoo, the richest floral area in the world by 2050 (Rutherford et al., 1999). 18% of all global species lost (including those in Africa) by 2050 based on SRES B1 scenario (Thomas et al., 2004). Assessment of endangered species in 141 National parks in Sub-Saharan Africa using HadCM3 model under A2 scenario shows that assuming no migration of species, 10-15% of the species were projected to fall within the IUCN Critically Endangered or Extinct categories by 2050 (Midgley and Thuiller, 2005).	
2.0°C - 3.0°C	Fish populations decline strongly with drought, while wetland ecosystems dry and disappear in Malawi and the African Great Lakes (ECF, 2004). Kalahari dune activation threatens Sub-Saharan ecosystems (Thomas et al., 2005)	15-37% of all species extinct, including those in Africa under the AIFI scenario (Thomas et al., 2004). Assessment of endangered species in 141 National parks in Sub-Saharan Africa using HadCM3 model under A2 scenario shows that assuming no migration of species, 25-40% of the species were projected to fall within the IUCN Critically Endangered or Extinct categories by 2080, but with migration the proportions drop to 10-20% (Midgley and Thuiller, 2005). 66% of animals lost from Kruger National Park in South Africa and 4 endangered species become totally extinct based on HadCM2 (Erasmus et al., 2002). By 2050, the HadCM2 predicts extinction of 10% in Fynbos hotspot for plant biodiversity in South Africa (Midgley et al., 2002).	Based on HadCM2 and doubling of CO2, succulent Karoo fragmented and reduced to 20% of area, threatening 2800 plants with extinction; and 5 South African parks could lose more than 40 % of their animals (Rutherford et al., 1999). Endangered species in South Africa lose more than 50% of range under HadCM2 (Erasmus et al., 2002). By 2050, we could see a 51-65% loss of Fynbos area based on HadCM2 model (Midgley et al., 2002).

3.0°C - 4.0°C	Few ecosystems can adapt to temperature increases of 3.0°C and above (Lemans and Eickout, 2003).	Based on HadCM2 model, 22% of global coastal wetlands lost, including those in Africa (Nicholls et al., 1999).	
4.0°C - 5.0°C			