Nautilus Paper

"Global Warming Threatening the Energy Security of Africa"

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1. Introduction:

Africa continues to suffer from severe poverty after the end of colonization in the 1960s. And now the continent is being eroded by another killer invader: global warming.

Africa consumes less than 4% of the oil, gas and electricity in the world. Equally important, Africa emits only 3.6% of the carbon dioxide. However, the damage it suffers is the most severe, because African countries do not have enough financial sources to tackle the issue. Are they at fault for the drying land or the melting ice? The world should know that African poverty and climate change are closely linked.

2. Executive Summary:

As most African countries do not have abundant money to invest in oil or gas exploration, they cannot secure future energy supplies. And as climate change damages the agricultural environment, many African countries will lose exports.

3. Energy Outlook of Africa:

<Exporter, but not consumer, of mineral resources>

While Africa produces 12.7 percent of the oil and 6.2 percent of the gas in the world, it consumes only 3.6 percent of the oil and 2.5 percent of the gas. Moreover, it consumes just 2.5 percent of the electricity in the world. Developed countries are drilling up and taking away African oil, gas, coal and uranium resources, but very few people benefit.

World Petroleum Consumption and Consumption

(2007, Thousand Barrels per Day)

Region	Production		Consumption	
Africa	10,711	12.7%	3,079	3.6%
Asia & Oceania	8,481	10.0%	25,036	29.1%
Central & South A	7,246	8.6%	5,980	7.0%
Eurasia	12,600	14.9%	4,200	4.9%
Europe	5,429	6.4%	16,077	18.7%
Middle East	24,589	29.1%	6,352	7.4%
North America	15,385	18.2%	25,174	29.3%
Total	84,441	100.0%	85,898	100.0%

(Source : US EIA)

World Dry Natural Gas Production and Consumption

(Quadrillion Btu, 2007)

Region	Production		Consumption	
Africa	6.4	6.2%	2.7	2.5%
Asia & Oceania	12.7	12.3%	16.2	15.2%
Central & South America	5.2	5.0%	4.5	4.3%
Eurasia	30.3	29.2%	25.4	23.9%
Europe	10.3	10.0%	19.6	18.5%
Middle East	10.1	9.7%	8.1	7.7%
North America	28.6	27.6%	29.6	27.9%
Total	103.6	100.0%	106.1	100.0%

World Electricity Generation

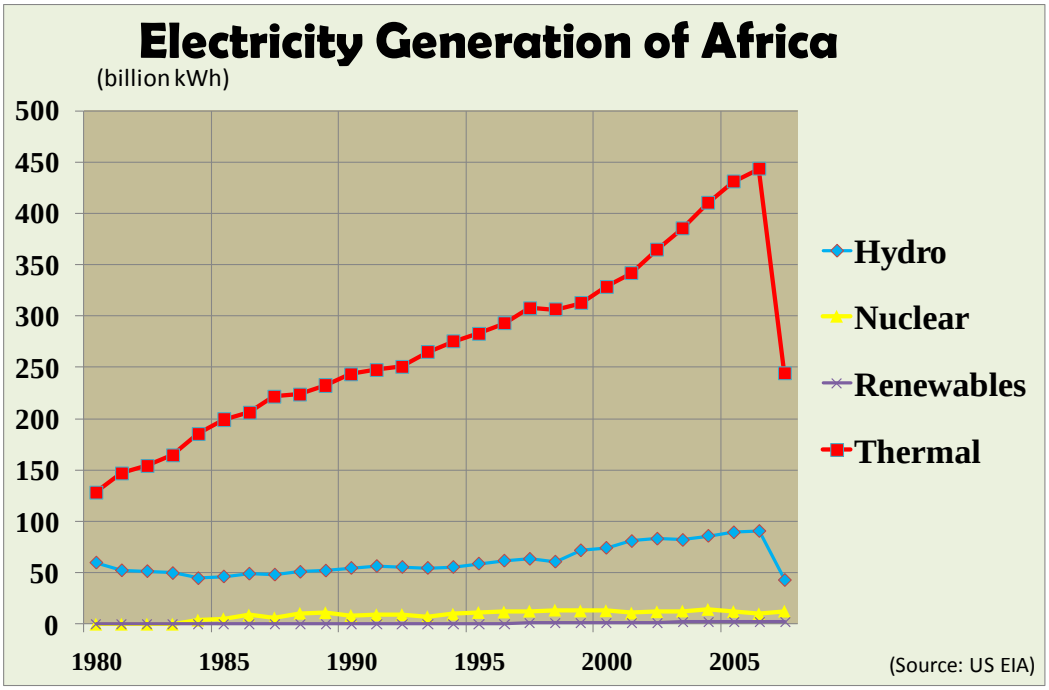
(2007, Billion Kilowatthours)

Region	World Electricity Generation	
Africa	9,610.9	2.8%
Asia & Oceania	87,477.6	25.1%
Central & South America	16,823.5	4.8%
Eurasia	38,366.0	11.0%
Europe	79,758.5	22.9%
Middle East	8,595.7	2.5%
North America	108,079.1	31.0%
Total	348,711.3	100.0%

(Source : US EIA)

<96 percent of Electricity generated by five countries>

With respect to electric power, Africa heavily depends on thermal. From 68% in1980, now over 80% of electricity is generated by fossils, especially by coal.



Electricity Generation of Africa by Source

(billikonkWh, Source : US EIA)

Year	Hydro		Nuclear		Renewables		Thermal		Total	
1980	60	31.8%	0	0.0%	0	0.1%	129	68.1%	189	100.0%
1981	53	26.3%	0	0.0%	0	0.1%	147	73.6%	200	100.0%
1982	52	25.0%	0	0.0%	0	0.1%	155	74.8%	207	100.0%
1983	50	23.2%	0	0.0%	0	0.2%	165	76.6%	215	100.0%
1984	45	19.1%	4	1.7%	0	0.2%	186	79.0%	235	100.0%
1985	47	18.5%	5	2.1%	1	0.2%	200	79.2%	252	100.0%
1986	49	18.6%	9	3.3%	1	0.2%	206	77.9%	265	100.0%
1987	48	17.5%	6	2.2%	1	0.2%	222	80.1%	277	100.0%
1988	51	17.9%	10	3.7%	1	0.2%	224	78.3%	286	100.0%
1989	52	17.6%	11	3.7%	1	0.2%	233	78.4%	297	100.0%
1990	55	17.9%	8	2.7%	1	0.2%	244	79.2%	307	100.0%
1991	57	18.0%	9	2.9%	1	0.2%	248	78.9%	314	100.0%
1992	56	17.6%	9	2.9%	1	0.2%	251	79.3%	317	100.0%
1993	55	16.7%	7	2.2%	1	0.2%	265	80.9%	328	100.0%
1994	56	16.4%	10	2.8%	1	0.1%	275	80.6%	341	100.0%
1995	59	16.7%	11	3.2%	1	0.2%	283	79.9%	354	100.0%
1996	62	16.9%	12	3.2%	1	0.2%	293	79.7%	367	100.0%
1997	64	16.6%	13	3.3%	1	0.2%	308	80.0%	385	100.0%
1998	61	16.0%	14	3.6%	1	0.2%	306	80.2%	382	100.0%
1999	72	18.1%	13	3.2%	1	0.2%	313	78.5%	399	100.0%
2000	74	17.8%	13	3.1%	1	0.3%	329	78.8%	418	100.0%
2001	81	18.6%	11	2.5%	1	0.3%	342	78.6%	435	100.0%
2002	83	18.1%	12	2.6%	1	0.3%	365	79.0%	461	100.0%
2003	82	17.0%	13	2.6%	2	0.4%	386	79.9%	482	100.0%
2004	86	16.8%	14	2.8%	2	0.4%	410	80.0%	513	100.0%
2005	90	16.7%	12	2.3%	2	0.4%	431	80.5%	535	100.0%
2006	91	16.6%	10	1.8%	2	0.4%	443	81.1%	547	100.0%

South Africa generates 76.2 percent of electricity of the entire continent, and 95.5 percent is shared by just the top five countries (South Africa, Libya, Mozambique, Egypt, Ghana).

Electric Power Generation of Selected African Countries

(2007, Billion kWh)

Country	Hydro	Nuclear	Renewables	Thermal	Total	
South Africa	2.4	12.6		215.3	230.3	76.2%
Libya				24.0	24.0	7.9%
Mozambique	15.2				15.2	5.0%
Egypt	12.7		0.7		13.4	4.4%
Ghana	5.6				5.6	1.9%
Cameroon	3.7				3.7	1.2%
Kenya			1.2	1.7	3.0	1.0%
Mauritius	0.1			2.2	2.3	0.8%
Namibia	1.6				1.6	0.5%
Madagascar	0.7			0.3	1.0	0.3%
Burkina Faso	0.1			0.5	0.6	0.2%
Congo (Brazzaville)	0.4				0.4	0.1%
Algeria	0.4				0.4	0.1%
Gambia, The				0.2	0.2	0.1%
Morocco			0.2		0.2	0.1%
Swaziland	0.2				0.2	0.1%
Mauritania	0.1				0.1	0.0%
Total	**43.1**	**12.6**	**2.1**	**244.3**	**302.2**	**100.0%**

95.5%

(Source : US EIA)

<Most people live without lights, cars or safe water >

Of about 770 million Africans, 63% live in rural areas, and about 40% survive on less than a dollar a day. Over three-quarters of Sub-Saharan Africans have no access to electricity, compared to less than 14 percent of people living in Latin America and East Asia. So, most Sub-Saharan Africans depend on biomass for cooking. And as the price of oil has doubled or tripled, people have to spend more and more money to buy kerosene or candles for lighting. What they need is a renewable energy system, but they just cannot afford such a big expense at once.

It is true that Africa is abundant not only for minerals but also for water, sunshine, wind and biofuel, but while researchers write papers about the capabilities, who invests? While the developed world selects renewable energy for “eco” reasons, renewable energy is the only option for many Africans.

While Africa constitutes over 20 percent of the land area of the world, most African people do not have cars. They only walk, walk and walk inside their small world. The main reasons why they do not buy cars are:

1. They cannot buy cars.
2. Although the income level compared with developed nations is very low, the gas price is almost same as Japan. (Except in some nations which have subsidies for gas prices, such as Libya, Egypt, Algeria, Angola, and Nigeria.)
3. As most of the roads are not paved, the cars in Africa should be as tough as off-road cars.
4. Without a strong garage, the cars would be easily stolen.

Every day, women and children have to walk for a long time to fetch water, which is not sanitary in many cases. Plastic water tanks are their lifeline.

5. *Interdependent Power Grid:*

In Africa, many power grids are interconnected. Therefore, if one country fails to produce electricity, the bad effect will instantaneously spread to the surrounding area. *(Please note that the samples indicated below have not been updated.)*

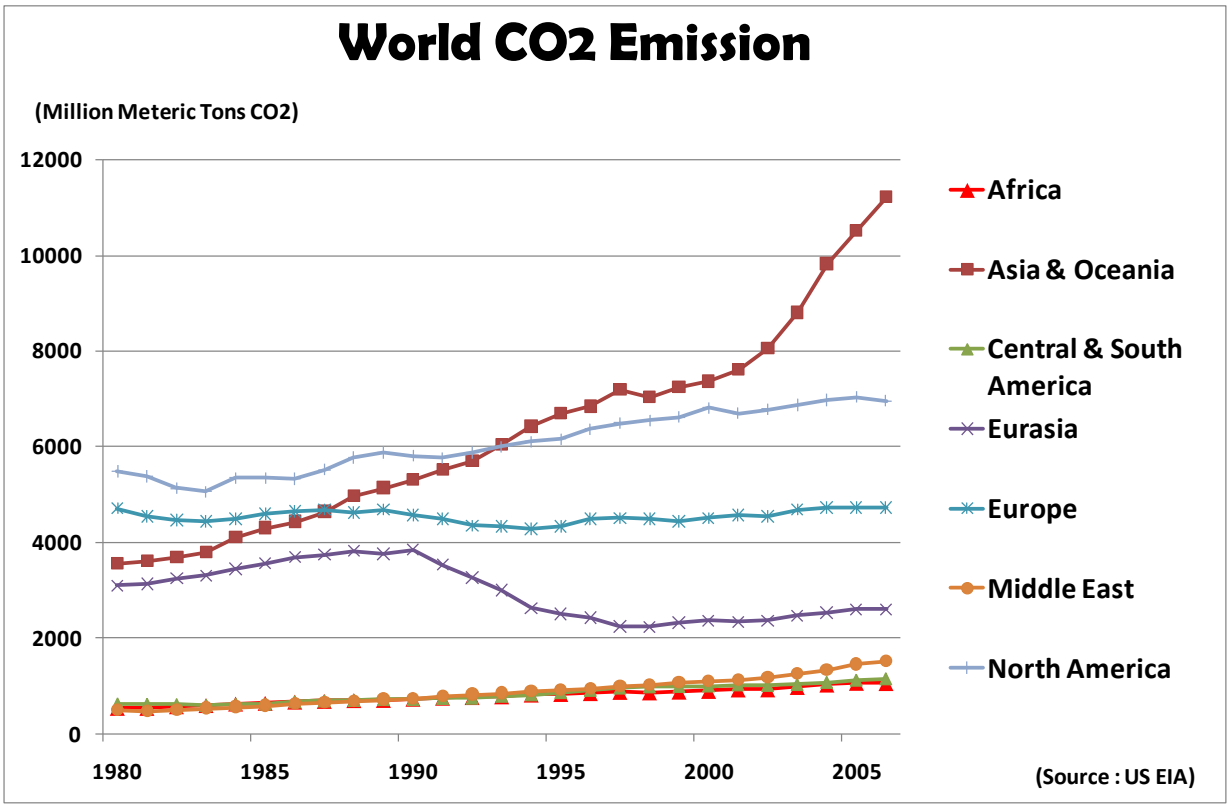
- Benin, one of the most democratic countries in Africa, imports electricity from Togo and Ghana. And as Ghana is suffering from severe power crisis, Benin will also face difficulty.
- Botswana, an exporter of diamonds, spends most of its electricity on the diamond industry. And as Botswana imports electric power from South Africa, Zimbabwe and Zambia, their economy must plunge if electricity from those countries stops. In fact, South Africa has been in a power crisis since 2007.
- Burkina Faso, which has to stop hydro power stations in winter, imports the power it lacks from Côte d'Ivoire.
- Côte d'Ivoire, which has oil, gas and hydro resources, is exporting electricity to Benin, Mali, Togo, Ghana and Burkina Faso.
- Malawi, 99.9 percent of whose electricity is generated from hydro, exports power to Mozambique, Zambia and Zimbabwe.

- Mauritania, two-thirds of which is a desert, constructed hydropower plants in Senegal and Mali and imports 15 percent of its electricity. The remaining 85 percent is thermal.
- Mozambique exports a huge part of generated electricity to South Africa and Zimbabwe.
- Niger imports 80 percent of its electricity from Nigeria.
- Although the Republic of Congo has abundant resources of oil, gas and hydro, it has to import one-third of its electricity from the Democratic Republic of the Congo (formerly Zaire) because of the lack of a transmission system.
- Togo imports huge amounts of electricity from Ghana and Côte d'Ivoire.
- Uganda exports electricity to Kenya, Tanzania and Rwanda when they have energy to spare.
- Zimbabwe imports 40 percent of its electricity from South Africa, the Democratic Republic of the Congo (formerly Zaire) and Mozambique.

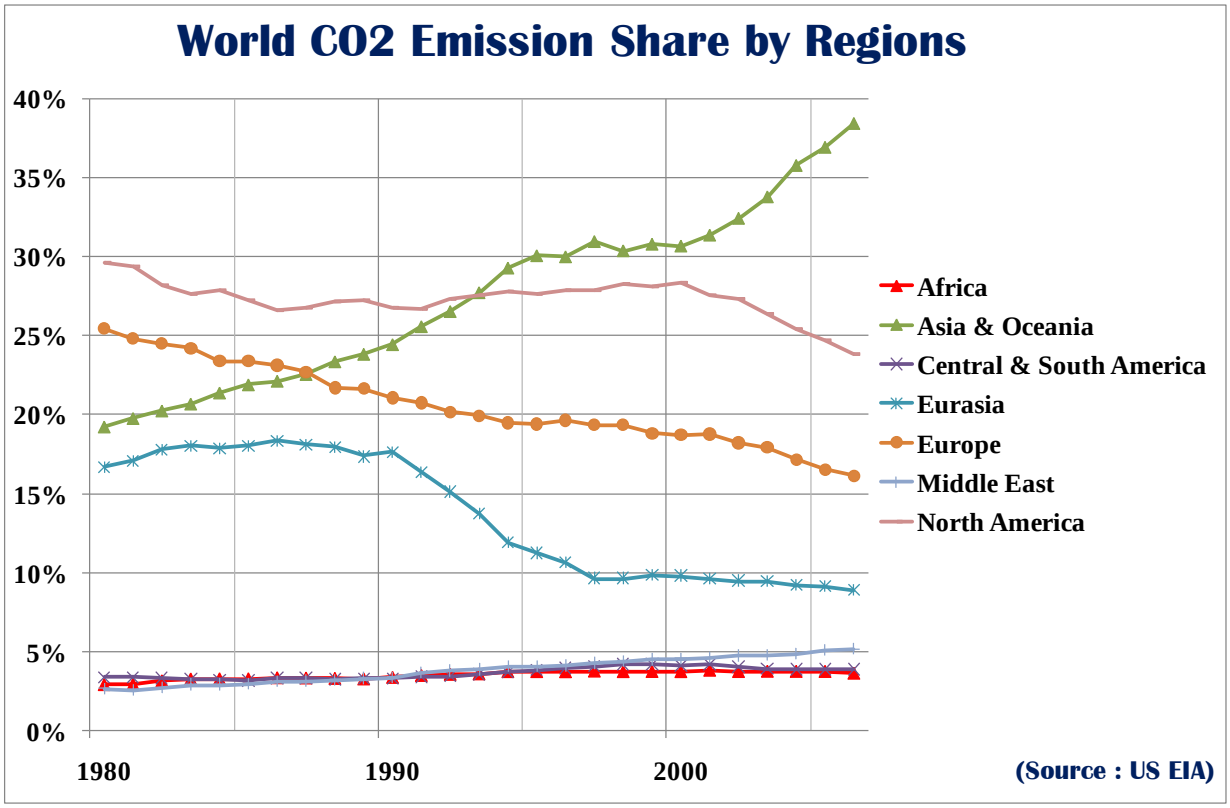
6. CO2 Emission from Africa:

In 2006, Africa emitted only 3.6 percent of the CO2 in the world, which is the least of any region. And while other regions, especially Asia, are increasing their CO2 emissions, the pace of increase in Africa is very slow. In 2006, the whole African continent emitted only 18 percent of China's emissions alone.

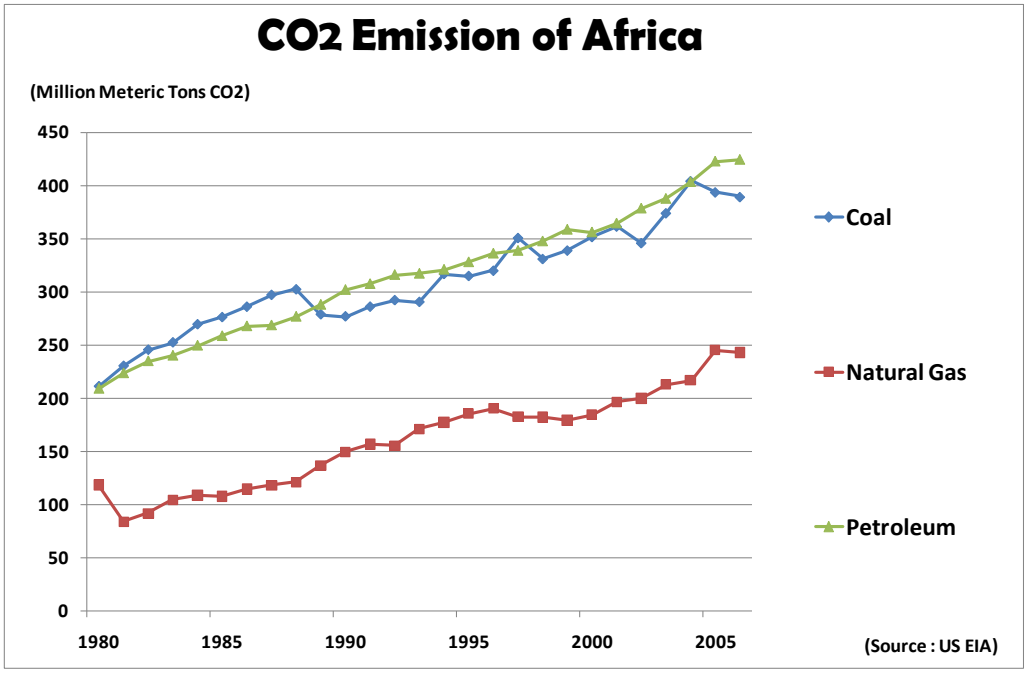
The reason why CO2 emissions from Africa is small is very simple. It is because the night of Africa is dark, and because they are far behind the developed world.



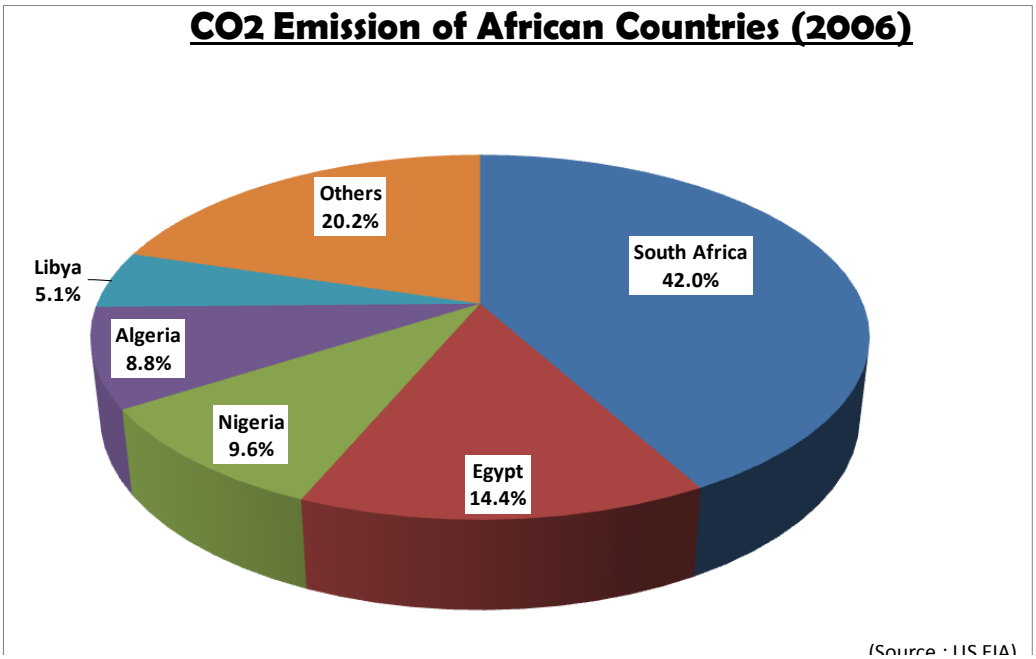
The share of CO2 emissions of Africa was around 3 percent in the 1980s, from 3.5 percent to 3.7 percent in the 1990s, and from 3.6 to 3.8 percent in the 2000s. Who can tell Africa to reduce CO2, when it is the least-emitting region?



In 2006, 40 percent of CO2 emissions in Africa were from petroleum, 37 percent from coal, and 23 percent from natural gas.



In Africa, 42 percent of CO2 is emitted by South Africa, and 89.2 percent of CO2 is emitted by the largest ten countries, which are South Africa, Egypt, Nigeria, Algeria, Libya, Morocco, Angola, Tunisia, Sudan, and Kenya.



7. Harbingers looming around the Continent:

Most Africans have not heard of global warming, the Kyoto Protocol, and carbon emissions. However, the continent is the most vulnerable to global warming.

- Cairo, Egypt -- Warmest August on record, 1998. Temperatures reached 41C on August 6, 1998.
- Southern Africa -- Warmest and driest decade on record, 1985-1995. Average temperature increased almost 0.56C over the past century.
- Senegal -- Sea-level rise; Sea-level rise is causing the loss of coastal land at Rufisque, on the South Coast of Senegal.
- Kenya -- Mt. Kenya's largest glacier disappearing. 92 percent of the Lewis Glacier has melted in the past 100 years.
- World Ocean - Warming water. The world ocean has experienced a net warming of 0.06C from the sea surface to a depth of 10,000 feet (3000 m) over the past 35-45 years. More than half of the increase in heat content has occurred in the upper 1000 feet (300 m), which has warmed by 0.31C. Warming is occurring in all ocean basins and at much deeper depths than previously thought. These findings lend support to the hypothesis that the oceans are taking up excess heat as the atmosphere warms, and would account for the apparent discrepancy in the magnitude of the observed atmospheric warming as compared to climate model predictions.
- Mount Kilimanjaro, Tanzania - Ice projected to disappear by 2020. 82% of Kilimanjaro's ice has disappeared since 1912, with about one-third melting in just the last dozen years. At this rate, all of the ice will be gone in about 15 years. Scientists hypothesize that less snow on the mountain during the rainy season decreases the surface reflectivity, leading to higher rates of absorption of heat and increased ice melt.

- Rwenzori Mountains, Uganda - Disappearing glaciers. Since the 1990s, the glacier area has decreased by about 75%. The continent of Africa warmed by 0.5C during the past century, and the five warmest years in Africa have all occurred since 1988.
- Kenya -- Deadly malaria outbreak, summer, 1997. Hundreds of people died from malaria in the Kenyan highlands where the population had previously been unexposed.
- Tanzania -- Malaria expands in mountains. Higher annual temperatures in the Usamabara Mountains have been linked to expanding malaria transmission.
- Indian Ocean -- Coral Reef Bleaching (includes Seychelles; Kenya; Reunion; Mauritius; Somalia; Madagascar; Maldives; Indonesia; Sri Lanka; Gulf of Thailand [Siam]; Andaman Islands; Malaysia; Oman; India; and Cambodia).
- Persian Gulf -- Coral reef bleaching.
- Seychelles Islands -- Coral reef bleaching.
- Kenya - Worst drought in 60 years, 2001. Over four million people were affected by a severely reduced harvest, weakened livestock, and poor sanitary conditions.
- Lake Chad - Disappearing Lake. The surface area of the lake has decreased from 9,650 square miles (25,000 km2) in 1963 to 521 (1,350 km2) today. Modeling studies indicate the severe reduction results from a combination of reduced rainfall and increased demand for water for agricultural irrigation and other human needs.
- South Africa - Burning shores, January 2000. One of the driest Decembers on record and temperatures over 40C fueled extensive fires along the coast in the Western Cape Province. The intensity of the fires was exacerbated by the presence of invasive vegetation species, some of which give off 300% more heat when burned compared to natural vegetation.

(Quoted from "The impact of global warming in Africa" http://www.climatehotmap.org/africa.html),

- Rainfall is predicted to decline in the Horn of Africa and some parts of the south by as much as 10 percent by 2050, while the land may warm by as much as 1.6C, all of which is likely to affect the crop harvests for hundreds of millions of people.
- If, for example, temperatures rise by as much as 2C, the report says, large areas of Kenya currently suited to growing tea would become unsuitable and the impact on Kenya's economy would be enormous. (Tea provides nearly a quarter of the country's export earnings.)

(Quoted from "Global Warming in Africa: The Hottest Issue of All", the lndependent/UK http://www.commondreams.org/headlines05/0620-02.htm)

- Africa has always been predicted to be the continent that will be worst hit by global warming and climate change. Could those predictions be coming true? Extreme rains and floods have made for a very wet summer in Africa, and there is no end in sight to the downpours that are swallowing towns and forcing over a million to flee their homes in at least 20 countries. Since June, Uganda, Sudan, Ethiopia and Kenya have had hundreds of thousands of people uprooted from their homes. Scores have died since. West Africa has seen its worst floods in years, with 300,000 fleeing the earth-colored

waters of northern Ghana. Meanwhile, forecasts by African meteorologists say the rains have yet to peak. October may be the worst month to come in this very wet year.

- Nigeria has a variety of ecosystems, from mangroves and rainforests on the Atlantic coast in the south to the savannah in the north bordering the Sahara. Whether dry or wet, those ecosystems are being battered by global warming. While excessive flooding during the past decade has hurt farming in coastal communities, desertification is ravaging the Sahel. Traditionally, desertification in the Sahel has been blamed on overgrazing practices of the local population. But it has been discovered that the real problem is climate change.

(Quoted from "Is Global Warming Drowning Africa?" TIME http://www.time.com/time/world/article/0,8599,1664429,00.html)

- Rainfall in the Sahel, Nigeria, has been declining steadily since the 1960s. The result has been the loss of farmland and conflicts between farmers and herdsmen over ever decreasing land. Many different communities, including fishermen, farmers and herdsmen, are now confronted with difficulties arising from climatic changes. Peoples' livelihoods are being harmed, and people who are already poor are becoming even more impoverished. Climate refugees are being created, as the changes make some land unlivable and affect water supplies.

(Quoted from "Global Warming Batters Nigerian Ecosystems", News VA.com http://www.voanews.com/english/archive/2008-04/2008-04-23-voa64.cfm?CFID=120307138&CFTOKEN=99830585&jsessionid=de303cccf1e2a96bd3a2702d766435747d5e)

8. Energy Security under Climate Change:

As only a few countries possess minerals reserves, many African nations have to import oil, gas, coal and electricity. However, as many African countries rely on agricultural exports to acquire dollars, global warming will surely affect future energy security.

For example, Kenya, the world's biggest exporter of tea, is now suffering from hailstorms and demands on water resources. And as the lowlands dry up, farmers will be forced to move into higher areas that are now covered with forests. On the other hand, mineral exporting countries such as Libya, Nigeria, Angola, Algeria, South Africa, Egypt, and so on, will not face such a severe decrease in exports. Of course, if the sea level rises, the countries should pay to reinforce the ports, but the damage would be slight compared with agriculture-dependent nations. And more importantly, many African nations rely not only on agriculture, but foreign aid.

Then, the energy security strategy against climate change for African nations completely depends on whether the country exports natural resources or not. Oil or gas exporting countries may still be rich, unless the foreign investment for exploration comes in. Therefore, they will find themselves in a better position to attack global warming issues than poor countries.

And what can the poor countries do? Many believe that the only way is to increase foreign aid against climate change. (Please refer to "Global Warming in Africa: The Hottest Issue of All" the Independent/UK http://www.commondreams.org/headlines05/0620-02.htm)

And as shown before, African nations are NOT INDEPENDENT for electricity. Therefore, even though one country takes action for climate change, electric power can't be perfectly guaranteed in many cases.

9. Simple Conclusion:

In essence, African nations are too interdependent for the security of oil, gas and electric power. Therefore, what can the governments do?

<Oil, gas and uranium>

The African nations may not become the winner in the severe competition between the within the developed world. When China, India and many other countries are heavily investing in oil, gas and uranium, poor nations have nothing to do and nothing to earn.

<Biofuel>

Biofuel is not an easy answer, because it is an agricultural crop, which is vulnerable to global warming. Moreover, African nations neither have the market system, nor enough finance for refinery plants.

<Electricity>

African nations should seek a way to be independent in electricity. One way is that the governments should give a subsidy for solar systems, because solar is the most affordable renewable energy. However the earth heats up, the solar panels do not mind.