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Global Climatic Change in Nigeria: A Reality or Mirage

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These were analysed using time series, correlation and percentages among other statistical tools. The result shows that while temperature at inverse relationship in Nigeria i.e. temperature is increasing, the rainfall is decreasing. While global temperature for the past 100 years is 0.72-0.74 OC that of Nigeria between the two climatic periods under study is 1.80 OC. Major spatial shifts were observed for example, southward shift in the divide between the double rainfall peak and single rainfall peak, and temporal shift in short-dry-season from August to July in Southern Nigeria.

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These were analysed using time series, correlation and percentages among other statistical tools. The result shows that while temperature at inverse relationship in Nigeria i.e. temperature is increasing, the rainfall is decreasing. While global temperature for the past 100 years is 0.72-0.74 ^{O}C that of Nigeria between the two climatic periods under study is 1.80 ^{O}C. Major spatial shifts were observed for example, southward shift in the divide between the double rainfall peak and single rainfall peak, and temporal shift in short-dry-season from August to July in Southern Nigeria.

The result also shows that although rainfall is generally decreasing in Nigeria, recently, the coastal region is experiencing slightly increasing rainfall. The current available pieces of evidence show that Nigeria, like most parts of the world, is experiencing not only regional warming but also the basic features of climate change. To reverse the trend, sustainable developmental policies and measures were recommended.

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I. Introduction

Intergovernmental Panel on Climate (IPCC, 2007) defines climate change as a change in the state of the climate that can be identified (eg., by using statistical tests) by changes in the mean and /or the variability of its properties, and that persists for an extended period typically decades or longer. Although the length of time it takes the changes to manifest matters, the level of deviation from the normal and its impacts on the ecology and environment are most paramount (Odjugo, 2010). Climate change via global warming is the end product of a changing climate.

Climate change is said to exist when the level of climatic deviation from the normal is very significant over a long period of time (preferably centuries) and such deviations have clear and permanent impacts on the ecosystem (Odjugo, 2009a; 2009b). It should be emphasized that global or regional climate has never been static but variability is an inherent characteristic of climate. Climate change is different from the generally known term as climatic variability which means variation in the mean state and other statistics of climate on all spatial and temporal scales beyond that of individual weather event. Such temporal scale variations could be monthly, seasonal, annual, decadal, periodic, quasi-periodic or non-periodic. Climate change is of two facets namely global warming and global cooling. Global warming is a gradual but systematic increase in average global temperatures experienced for a very long period of time while the reverse is true for global cooling. The ongoing global warming has taken about four decades without reversing. IPCC (2007) shows that the current warming of the earth's climate is unequivocal caused by anthropogenic forces as is now evident from observations of increases in global average air and ocean and atmospheric temperatures. If the current warming continues unabated for a prolonged period, it will attain a new climatic status – warm or hot climate – with its effects on man and the ecosystem.

Climate change is caused by two basic factors namely natural processes (bio-geographical) and human activities (anthropogenic). The extraterrestrial or extragenic factors include solar radiation quantity (sunspot), quality (ultra violet radiation change) and meteor (emphasized mine). A high solar quality and quantity and period of perihelion (when the earth is nearest to the sun), result in heating up of the earth surface which lead to global warming. The incident radiation on the earth during aphelion (when the earth is farthest away from the sun) is always low and if this combines with low solar quality and quantity, global cooling is experienced. Volcanic eruptions also lead to both global warming and cooling. Through volcanic eruptions, lot of gases, vapour and particulate matter are emitted into the atmosphere. Such emissions influence the atmospheric chemistry thereby creating short–term cooling and long-term heating of the atmosphere. Prominent examples of such eruptions of great magnitude were Krakatoa eruption in 1883, Mount Agung in 1963 and Mount Pinatubo in 1992 and many more recent events.

The greenhouse gases (GHGs) which include carbon dioxide (CO_2), methane (CH_4), nitrous oxide

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(N_2O), hydro fluoro carbons (HFCs), per fluoro carbons (PFCs), chlorofluorocarbons (CFCs) and sulphur hexa fluoride (SF6). Global GHGs emissions due to human activities have grown since pre-industrial times, with the increase of 82 % between 1970 and 2011 (Fig 1). As at 1970 and 2011, the contributions of each of the GHGs by gas to the atmosphere are shown in Figure 2 and 3 respectively. It is obvious that CO_2 is the most important contributor to the GHG with anthropogenic activities contributing to 53.6% and 55.2% for 1970 and 2011 respectively. The contribution of different anthropogenic sectors to GHGs as at 2011 is presented in Table 1 while for Nigeria Land Use and Change and Forestry (LUCF) topped the list and that of the World, energy supply topped the list, waste and wastewater emitted the least GHGs into the atmosphere. Like CO_2 the contribution of CH_4 grew sharply after the pre-industrial period of the 18th century (Fig 4). The pre-industrial value of CH_4 was 700ppbv (part per billion by volume). This increased to 1774 ppbv by 2005 and it is expected to rise to 3700ppbv by 2100 (Fig 4). There is high level of agreement and much evidence to show that with the current climate change mitigation policies and related sustainable development practices, global GHGs emissions will continue to grow over the next few decades. The IPCC Special Report on Emissions Scenarios (SRES, 2000) projects an increase of global GHGs emissions by 25% to 90% between the year 2000 and 2030, with fossil fuels maintaining their dominant position of the global energy mix to 2030 and beyond (IPCC, 2007). Gas flaring which is also term as fugitive gas is another source of GHGs emission in Nigeria. Nigeria is the largest gas flaring nation in the world. She flares more than 70% of her natural gas (Odjugo, 2005b; 2007a). A drastic change in the climate systems either due to natural forces or unsustainable human activities results in climate change. The latter is regarded as the basic cause of on-going climate change and the advanced countries are most responsible (DeWeerdt, 2007). As vividly study by IPCC (2007) which shows that observed climatic data from developed countries reveal significant change in many physical and biological systems in response to global warming but there is remarkable lack of geographic balance in data and literature on observed changes with marked scarcity in developing countries. It is thus to assess the causes, rate and effects of climate change and global warming with emphasis on Nigeria.

II. Review

The increasing evidence for climate change, and the lack of adequate action, has brought keen interest on adaptation policies. The IPCC Fourth Assessment of mitigation efforts which shows that with the current commitment including Kyoto Protocol agreement would may not lead to stabilization of the atmospheric greenhouse concentration as agreed by the Cophengan Convention of 2008 and that it is due to lag times in the climate system. 'No mitigation efforts, no matter hoe rigorous and relentless, will prevent climate change from happening in the few decades'

As a matter of identity no country is left out in the acceleration of global warming and consequent climate change. Nigeria be it small in the global context cannot detached herself from the little ways it is contributing to climate change. Nigeria is emitting 183.92 $MTCO_2$-eq as at 2011 of total CO_2 in the world even though that account for less than 1 % of the world total as shown in table 2. Given the data as at 2011, Nigerian total emission of GHGs exluding Land-Use Change (LUCF) and Forestry and GHGs including Land-Use Change and Forestry (LUCF) are 324.51 $MTCO_2$-eq and 496.13 $MTCO_2$-eq respectively. Although CO_2 is the is the most contributing gas when we talk of global warming, in Nigeria CH_4 (205.52 $MTCO_2$-eq) accounts for the highest and then follow by CO_2 (83.93 $MTCO_2$-eq), while when we considered emission of GHGs by sub-sector, it shown that the emitter of gas follows this pattern of magnitude, fugitive gas > other gases > transportation. Fugitive gas had been on the rise in Nigeria and by 2011 it has accumulated to 57.33 $MTCO_2$-eq and this will continue as Nigeria is still the number 2 country in the world with great history of gas flaring and in the process release CO_2 to air causing global warming. Also as shown in table 2, the GHGs contribution of gas by sector account for 171.63 $MTCO_2$-eq , 158.50 $MTCO_2$-eq and 100.68 $MTCO_2$-eq for Land-Use Change and Forestry, Energy and Agriculture in the order of magnitude respectively. Depicting that most of our emission is from forestry and agriculture in that combine effect because our society is an agrian one and also for the factor that we are developing though unsustainably might has cause great increase in emission from the energy sector as shown in table 2.

A case was explored from the experiment conducted by environmental experts in Nigeria to know the extent to which global climate change had been realistic in the country and as it was with many countries, Nigeria expert also have divergent view on the reality of climate change.

This was conducted by Olofintoye and Sule (2010) with the major aims of looking into the impact of global warming on the rainfall for some selected cities in the Niger Delta of Nigeria, and deducing if urban water supply is sustainable under the prevailing climate condition. The time series of meteorological data (rainfall and temperature) were analysed with the aim of detecting trends in the variables and vulnerability.

The non-parametric Man-Kendall test was used to detect monotonic trends, and the Sen's slope estimator was used to develop models for the variables.

The study revealed that there is evidence of global warming in Owerri, and rainfall has significantly increased in Calabar over the years. Though the trends in rainfall at Owerri and Port-Harcourt were not significant, the slope estimates revealed a positive trend in the rainfall of the stations. Thus, it is concluded that water supply is sustainable under the current climate condition.

From the results of the analyses, the temperature at Owerri demonstrates a significantly increasing trend. Thus, it may be concluded that there is sufficient evidence of global warming in Owerri. The rainfall at Calabar also demonstrates a significantly increasing trend. Although the temperature trends at Calabar and Port-Harcourt are not significant, the positive values of slope estimates are indicative of a positive trend. The Sen Slope estimates of the rainfall trends in the three stations are positive and the plots of rainfall against year reveals an upward rise over the years (1983 – 2012).

Thus, it was concluded that since global warming is not having a significant negative effect on the rainfall of the selected cities, urban water supply is still sustainable under the present climate condition of the Niger Delta (Olufintoye and Sule, 2010).

III. Materials and Methods

Mean monthly and annual temperatures and rainfall from 30 synoptic stations between 1901-1938 and 1971-2012 in Nigeria were collected from the Nigerian Meteorological Agency, Lagos and Meteorological Department in some Airports. Although there are more than 30 meteorological stations in Nigeria, the study was limited to 30 stations because of consistency in available climatic data since the establishment of the stations.

Moreover the selected stations are true representative of the various climatic zones of Nigeria. The Two most important climatic elements (temperature and rainfall) were used in this study. These climatic elements were measured regularly in the stations used and these climatic elements best determine the prospects as well as the ecological and socio-economic problems of Nigeria. Data from different secondary sources were also used.

Eighty years period were covered in this research work. This is important because we were able to capture the period when climate change signals were not an issue (1901-1938) and when they are stronger (1971-2012). With 80 years, two climatic periods of 38 and 42 years can be studied and this will provide a better platform to investigate the changes within the climatic periods. The mean annual temperature data were used to construct the isothermal maps of Nigeria, while the rainfall data were used to construct the isohyets maps of Nigeria for the two climatic periods. With these maps, the analysis of the spatial pattern of rainfall and temperature with implication to climate change in Nigeria was carried out. The temporal climatic changes over the years were examined by employing the time series.

Also data from World Resources Institute via Climatic Analysis Indicator Tools (WRI-CAIT) were also employed to analysed recent and current Green House Gases with respect to Nigeria and the World at large.

IV. Results and Discussion

Climate change has started impacting and will continue to affect global temperatures, water resources, ecosystems, agriculture and health among others. Continued GHGs emission at or above the current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century. There had being variation in world temperature since 1860 when direct temperature measurement started as shown in Figure 5. The global temperatures were below average until the late 1930s when alternating cooling and warming started. This trend continued up to the 1980s when a renewed and pronounced warming continued till date. 1998 is recorded as the warmest individual year followed by 2002. Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global temperatures since 1860. Between 1906 and 2005, the average global temperature increased by 0.74^{O}C (0.56 to 0.92) (IPCC, 2007).

In Nigeria, temperature has been on the increase. The increase between 1901 and 1938 was not much. The increase became so rapid since the early 1970s. The mean temperature between 1901 and 1938 was 26.04 ^{O}C while the mean between 1971 and 2012 was 27.84. This indicates a mean increase of 1.80 ^{O}C for the two climatic periods. This is significantly higher than the global increase of 0.74 ^{O}C since instrumental global temperature measurement started in 1860. Should this trend continue unabated, Nigeria may experience between the middle (2.5 ^{O}C) and high (4.5 ^{O}C) risk temperature increase by the year 2100.

The result is a clear indication that Nigeria is experiencing global warming at the rate higher than the global mean temperatures. The observed temporal increase is also evident in the spatial increase. Between 1901 and 1938, the southernmost part of the country was marked by 25.5 ^{O}C isotherms while the northernmost was 28.5 ^{O}C. With the global warming becoming more pronounced, the southernmost part was marked by approximately 27 ^{O}C isotherms and the north 30 ^{O}C. The study also noticed that the increase in temperature is more in the northern part of the country than in the southern part. The temporal rainfall pattern in Nigeria shows a declining trend. Between 1901 and

1938, rainfall decrease was negligible but by 1971-2008 the decline became so pronounced. The mean rainfall value for the 1901-1938 was 1571 mm while a decreased was recorded at 1478 mm in 1971-2008. This shows a decrease of 93 mm between the two climatic periods.

The decreasing rainfall and increasing temperatures are basic features of global warming and climate change. Spatially, a declining trend is also noticed. In the 1901-1938 climatic periods, the 600 mm isohyets engulfed Nguru, but is was replaced by 496 mm during the 1971-2012 climatic period. Moreover, prior to 1938, the 1200 mm isohyets that was found close to Kaduna, has dropped to Minna axis. Odjugo (2005a; 2007b) also observe that the number of rain-days dropped by 53% in the north-eastern Nigeria and 15.5% in the Niger Delta coastal areas while rainfall intensity is increasing across the country.

Although there is a general decrease in rainfall amount in Nigeria, the coastal areas like Warri, Brass, Port-Harcourt, Calabar and Uyo among others have experienced slightly increasing rainfall in recent years. It is expected that the 2800 mm isohyets of the southernmost part of Nigeria in 1901-1938 be replaced by say 2700 or 2600 mm in 1971-1938, but a critical look at the scenario in Port Harcourt and Ikom that were within 2600 mm is now replaced by that of 2800 mm. Another major disruption in climatic patterns of Nigeria which shows evidence of climate change and global warming might be short-dry-season shift (popularly known as August Break). In the 1901-1938 climatic period, short-dry season was experienced more during the month of August but since the 1970s, it is being experienced more in the month of July. Another prominent change in rainfall pattern in Nigeria is that the areas experiencing double rainfall maximal is undergoing gradual shift in the short-dry-season (locally referred to as August Break) from the month of July-August.

The short-dry- season is a brief period of low rainfall (dry spell) that separates the two rainfall peaks. In 1901 – 1938, the short dry season occurred 31 years in the month of August and 7 years in July. By 1971 – 2012, the short dry season occurred 12 years in the month of August, 23 years in the month of July and 4 years for both months. This implies that the dry spell which used to occur in the month of August followed by heavy rains in the month of September (1901-1938) now shifted to July followed by wet period in the months of August and September (1971-2012).

V. Conclusion

The paper shows that climate change is caused by both anthropogenic and natural factors. What we are experiencing now is global warming caused by anthropogenic factor (human activities) and when the on-going warming continue unabated for decades or centuries with significant ecological impacts then, the earth will attain a changed climate (warm or hot climate). The human activities that cause global warming are transportation, industrialization, urbanization, agriculture, deforestation, water pollution and burning of fossil fuel among others. These either emit greenhouse gases into the atmosphere or reduce the rate of carbon sinks.

The implication is that global warming is being experienced with global temperatures rising by 0.74 ^{O}C since 1860 while that of Nigeria increased by 1.80 ^{O}C and rainfall decreased by 93 mm within the two climatic periods. The impacts of climate change are global but it will hit harder on developing countries because of their poor status and low mitigating and adaptive capacity. To reverse the impacts, appropriate measures are needed to reduce the rate of greenhouse gases emissions while adequate adaptation and mitigation strategies should be applied especially with respect to sustainable development policies and measures as applied in many developing countries like China (Motorization), Indian (Electrification), Brazil (Biofuel Production) and South Africa (Carbon Capture and Storage). To do this, efficient and effective energy supply based on solar, wind, geothermal, hydro and bio-energy should be encouraged. Fuel efficient vehicles especially with the European standard and aircrafts alongside mass transportation, light and sub-rail and non-motorised means of transport are needed. While deforestation should be reduced, afforestation and reforestation as well forest management should be encouraged.

Advanced countries like the U.S.A, Canada, United Kingdom and Japan etc., have been putting strategies like developing clean mechanism in place both to reduce the emission of GHGs and mitigate the effects of climate change but there is no evidence that Nigeria has started anything with respect to emission reduction and preparedness for mitigation measures (though adaptive strategies are in place which are not really implemented). We hope that the bill on climate change and the recommendation to establish climate change commission will have appropriate political backing to start GHGs emission cut and mitigation measures against climate change in Nigeria.

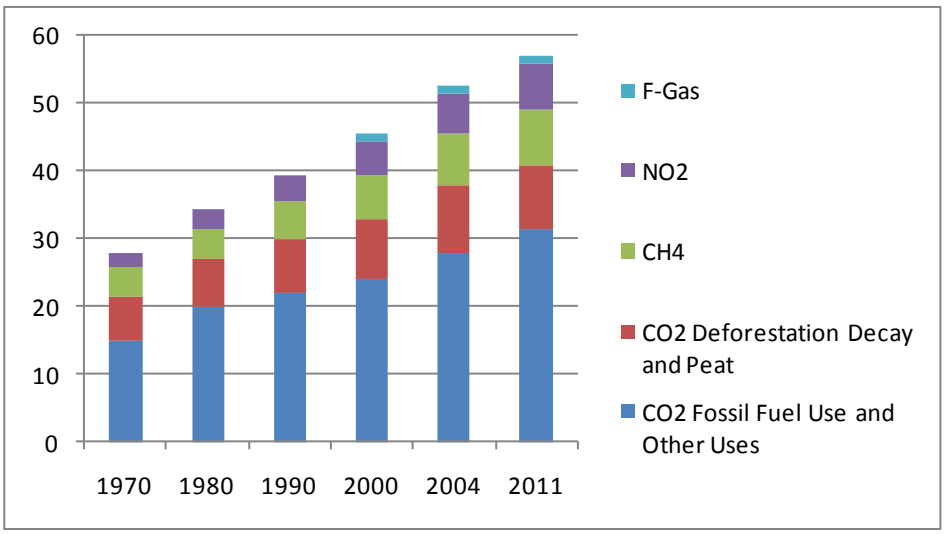
Table 1 : Share of different sectors in total anthropogenic GHGs emissions in 2011 in terms of MTCO_2-eq

	Nigeria	World	Percentage of Nigeria
Energy	158.50	33,338.44	0.48
Industrial Process	n/a	2,588.54	n/a
Agriculture	100.68	6,031.15	1.67
Waste	65.04	1,480.97	4.39
LUCF	171.63	2,074.70	8.27
Bunker	2.87	1,044.22	0.27

Source: World Resource Institute - CAITs 2014

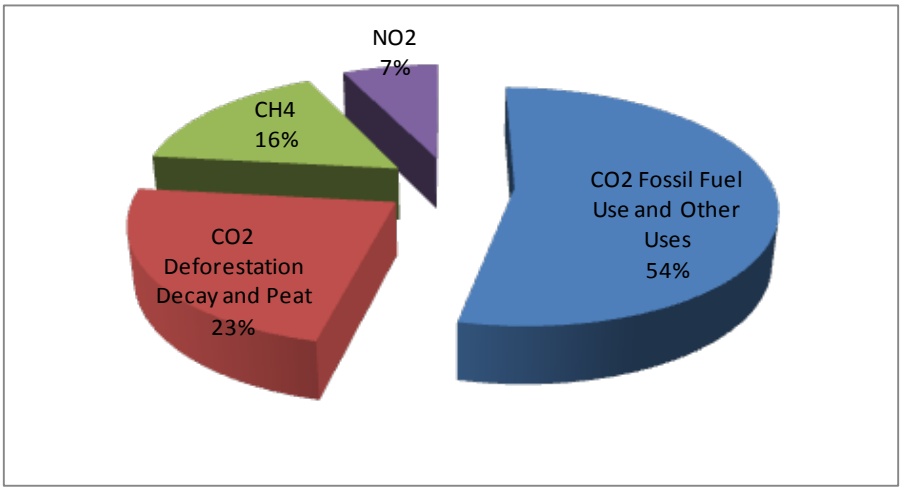
Table 2 : Nigeria's Emission in relative to World global emission as at 2011

PARAMETRE	SECTOR/SUB SECTOR	NIGERIA MT CO_2-eq	WORLD MT CO_2-eq
Total CO_2	Total CO_2	183.92	32,127.54
Total GHGs	Excluding LUCF	324.51	43,645.77
	Including LUCF	496.13	45,720.46
GHGs by Gas	CO_2	83.93	32,127.84
	CH_4	205.52	7,245.63
	N_2O	34.52	3,550.22
	F-Gas	0.28	722.38
GHGs Emission by Sector	Energy	158.50	33,338.44
	Industrial Process	n/a	2,588.54
	Agriculture	100.68	6,031.15
	Waste	65.04	1,480.97
	LUCF	171.63	2,074.70
	Bunker	2.87	1,044.22
GHGs Emission by Sub-Sector	Heat/Electricity	18.11	14.542.27
	Manufacturing/Construction	4.32	6,489.75
	Transportation	23.58	5,850.32
	Other Fuel	53.16	3,958.37
	Fugitive Emission	57.33	2,523.00
CO_2 Emission by Sub-Sector	Heat/Electricity	18.11	14,542.27
	Manufacturing/Construction	4.32	6,489.75
	Transportation	23.58	5,850.32
	Other Fuel	53.16	3,212.58
	Fugitive Emission	31.07	224.86



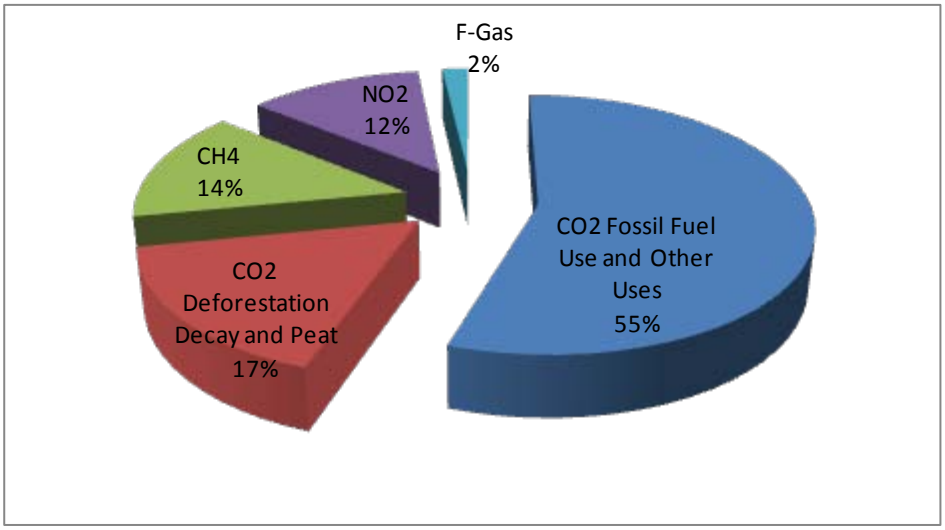
Source: IPCC, 2007 and World Resource Institute - CAITs 2014

Figure 1 : Global annual emission of anthropogenic GHGs (1970-2011)



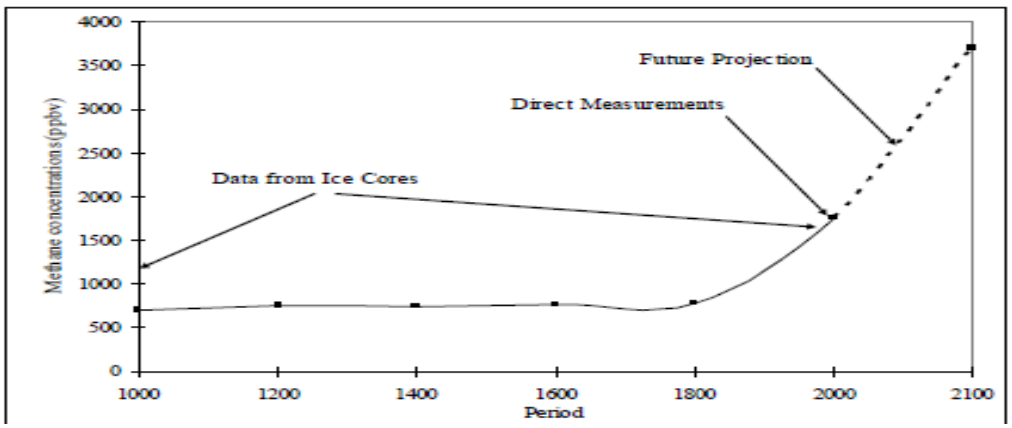
Source: IPCC, 2007

Figure 2 : Share of different anthropogenic GHGs in total emissions in 1970 in term of carbon dioxide equilvalent (CO_2-eq)



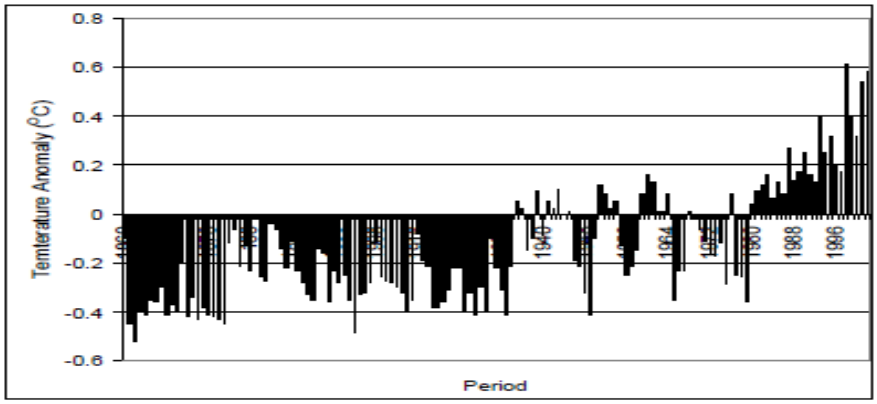
Source: World Resource Institute - CAITs 2014

Figure 3 : Share of different anthropogenic GHGs in total emissions in 2011 in term of carbon dioxide equilvalent (CO_2-eq)



Source: Hengeveld et. al (2005)

Figure 4 : Trends in methane concentration over the past millennium and future projections



Sources: (IPCC, 1996; Danjuma 2006)

Figure 5 : Observed world temperature changes between 1860 and 2005

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