

CLIMATE CHANGE INDUCED DISASTERS

Nwose, I.A. , Gbedu, A.M. & Ibrahim P.O.

Department of Surveying and Geoinformatics, FUTMinna, Niger State Nigeria

Climate change is one of the most critical challenges facing human beings. The impacts range from rise in sea level, increased incidences of drought and flooding, melting ice caps and glaciers, and so on. The change is already leading to more agricultural shortfalls, spread of vector borne diseases and endangered water security. The world has recognized that climate change is no longer solely an environmental problem. Rather, it has become an economic and security issue that will increasingly dominate global and national policies as its impacts become more apparent. Whilst mitigating climate change is highly imperative, its inevitable effects should be concretely looked into. The effects are felt mostly by the developing countries who are the least responsible. Since climate change is a global problem, it needs a global response that embraces the interests and needs of all nations. This paper examines the causes of climate change, projections for climate change, the impact of climate change on key sectors, the impact of Africa, Asia and Europe, climate change and induced disasters and methods and strategies of addressing the problem. Conclusion and recommendations were drawn from the observed reports.

piusibrahim.uk@gmail.com

Nwose, I.A¹ , Gbedu, A.M² , & Ibrahim P.O. (2016). CLIMATE CHANGE INDUCED DISASTERS Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

INTRODUCTION

For most people, the expression “climate change” means the alteration of the world’s climate that humans are causing, through fossil fuel burning, clearing forests and other practices that increase the concentration of greenhouse gases (CoHG) in the atmosphere. This is in line with the official definition by the United Nations Framework Convention on Climate Change (UNFCCC) that “climate change is the change that can be attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability, observed over comparable time periods” (UNFCCC, 2008). Scientists often use the term for any change in the climate, whether arising naturally or from human causes. The Intergovernmental Panel on Climate Change (IPCL) defined climate change as a change in the state of the climate that can be identified by changes in the mean and, or the variability of its properties, and which persists for an extended periods, typically decades longer” (IPCC Fourth Assessment Report, 2012). Each of these three definitions is very relevant and important in a study of this nature. ‘

The World’s climate has always varied naturally but compelling evidence from around the world indicates that a new kind of climate change is now under way, foreshadowing drastic impacts on people, economies and ecosystems (Whorf, 2009). For example, levels of carbondioxide and other greenhouse gases in the atmosphere have risen steeply during the industrial era owing to human activities like fossil fuel use, deforestation, spurred on by economic and population growth. Like a blanket round the planet, greenhouse gases trap heat energy in the earth’s lower atmosphere. If levels rise to high, the resulting overall rise in air temperatures – global warming – is liable to disrupt natural patterns of climate (Milano, 2013). The Intergovernmental Panel on Climate Change (IPCC) conclude in its fourth assessment report, that the evidence that climate change is already occurring is unequivocal and is due, in large part, to human activity. The IPCC says the world noted an average temperature rise of around 3⁰C this century if greenhouse gas emissions continue to rise at their current pace and are allowed to double from their preindustrial level. The impacts of this climate change, particularly temperature increases, are already being witnessed on natural and human systems around the world and they are very likely to increase.

There are strong indications that people in some areas may benefit from climate change, but many more will struggle to cope. Developing countries will suffer more than others, as their lack of resources makes them especially vulnerable to adversity or emergencies on a major scale.

Certainly the needs of developing countries in adapting to climate change is of critical importance. In several key ways, the problem of climate change is interlinked with development: economic growth is essential for developing countries to improve the health, economic livelihood and quality of life of their citizens. Economic growth is also essential to increase the capacity of developing countries to adapt to the negative impacts of climate change. But historically, increased economic development and the corresponding increase in energy use have also led to increased emissions of green house gases (Lawson, 2014). There is therefore, the need to break the link between economic development and green house gas emissions.

BACKGROUND

The First World Climate Conference held in 1979 marked the emergence of scientific evidence of human interference with the climate. In the 1980s, public awareness of environmental issues continued to increase and governments expressed greater concern about climate issues. The United Nations General Assembly adapted resolution 43/53, proposed by the government of Malta in 1988, which urged “the protection of global climate for present and future generations of mankind”. The governing bodies of the World Meteorological Organization and of the United Nations Environmental Programme created a new body, the Intergovernmental Panel on Climate Change in 1988, to marshal and assess scientific information on the subject.

In 1990, the IPCC issued its first assessment report, which confirmed that the threat of climate change was held in Geneva and it is called for the creation of a global treaty. Consequently, the General Assembly responded by passing resolution 45/212, formally launching negotiations on a convention on climate change, to be conducted by an Intergovernmental Negotiating Committee (INC). The IPCC in 1990 confirmed the threat posed by climate change, and therefore, proposed the threat posed by climate change, and therefore, proposed the creation of a global treaty.

In February, 1991, the INC met and its government representatives adopted the United Nations Framework Convention on Climate Change, after 15 months of negotiations on 9 May, 1992. The new convention was opened for signature at the Rio de Janeiro United Nations Conference on Environment and Development (or Earth Summit) of June, 1992. It however, came into force on 21 March, 1994. Thirteen years later, 191 States and the European community had joined the convention. The convention therefore, became the most universally supported of all international environment agreements. Since its formation, those countries that have ratified, accepted, approved, or acceded to the treaty have met annually at the conference of the parties, known informally as the COP. They are saddled with the responsibility of fostering and monitoring its implementation and continued negotiations on how best to tackle climate change. The decisions taken by the COP at its sessions now make up a detailed set of rules for practical and effective implementation of the convention (Pryor, 2010).

At the first conference of the parties (COP), held in Berlin, Germany in early 1995, a new round of talks was launched to discuss firmer, more detailed commitments for industrialized countries, a decision known as the Berlin Mandate. In December, 1997, a substantial extension to the convention that outlined legally-binding commitments to emissions cuts was adopted at COP3 in Kyoto, Japan. The Kyoto protocol sketched out basic rules, but did not specify in detail how they were to be applied. It also required a separate, formal process of signature and ratification by governments before it could enter into force. The negotiations launched in Buenos Aires, Argentina at COP4 in November, 1998 linked negotiations on the protocol's rules to implementation issues, such as technology transfer and finance under the umbrella of the convention. (Palmer and Ralsanen, 2012).

In July, 2001, governments struck a political deal, the Bonn Agreements, signing off the controversial aspects of the Buenos Aires plan of action. A third report from the IPCC improved the climate for negotiations by offering the most compelling scientific evidence so far presented, of a warming world (Milly, et al., 2012).

COP7 was held a few months later in Marrakesh, Morocco. There, negotiators built on the Bonn Agreements and brought a major monitoring cycle to a close by adopting a broad package of decisions. The Marrakech Accords spelt out more detailed rules for the protocol as well as advanced prescriptions for implementing the convention and its rules. The protocol entered into force after at least 55 parties to the convention had ratified it. The first parties ratified the protocol in 1998. With the ratification of the Russian Federation on 18th November, 2004, the prescribed 90-day count down was set in motion. The Kyoto protocol entered into force on 16th February, 2005.

A critical assessment of the devastating impact of climate change on the atmosphere or “global climate system” earth surface and oceans, would require a stronger commitment, by all parties to the conventions, to the implementation of the agreements. The gathering of the world leaders in France in December, 2015 to discuss the rampant green house gas emission should be commended. However to achieve a clear cut result, the decisions arrived at must be binding on all parties.

This paper examines the causes of climate change, projections for climate change, the impact of climate change on key sectors, the impact of Africa, Asia and Europe, climate change and induced disasters and methods and strategies of addressing the problem. Conclusion and recommendations were drawn from the observed reports.

Causative Factors in Climate Change

Climate change is predicted to have a range of serious consequence, some of which will have impact over a longer term, like spread of diseases and sea level rise, while some have immediately obvious impacts, such as intense rain and flooding. In fact, the earth’s climate has varied considerably in the past as reported by the geological evidence of ice ages and sea-level change, and by the records of human history over many hundreds of years (Meehl, 2007). The causes of past changes are not always clear but are generally known to be related to changes in ocean currents, solar activity, volcanic eruptions and other natural factors (Rousels, 2013).

Global temperatures have risen rapidly over the last decades. There is evidence of increases in average global air and ocean temperature, widespread melting of snow and ice, and rising average global sea levels. The report of IPCC Fourth Assessment states that the global warming is unequivocal. Atmosphere and ocean temperatures are higher than they have been at any other time during at least the past five centuries, and probably for more than a millennium (IPCC Fourth Assessment Report, 2007).

Today, it is well known that the atmosphere’s green house gases act as a blanket which traps incoming solar energy and keeps the earth’s surface warmer than it otherwise would be, and that an increase in atmospheric green house gases would lead to additional warming (Saunders, 2008). The focus of the Kyoto protocol is on carbondioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydroflurocarbons (HFC_s), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). Carbondioxidde (CO₂), methane (CH₄) and nitrous oxide (N₂O) account for 50, 18 and 6 percent, respectively, of the overall global warming effect arising from human activities (Brown, 2013).

Albeit, these gases are naturally occurring, their emissions have increased dramatically over the past two centuries due to human activities. CO₂ is produced in large quantities from the

consumption of energy from burning fossil fuels, and deforestation. CH₄ and N₂O emissions are produced mainly from agricultural activities. The HFCs and PFCs are used as replacements for ozone-depleting substances such as chlorofluocarbons (CFCs) currently being phased out under the Montreal protocol. Sulphur hexafluoride (SF₆) is used in some industrial processes and in electric equipment (Trans, 2010).

The impact and relative level of one of the six green house gases is compared using their respective Global Warming Potentials (GWP). A GWP is a measure, defined by the IPCC, of the relative effect of a substance in warming the atmosphere over a given period (100 years in the case of the Kyoto protocols), compared with a value of one for carbon dioxide. The methane's GWP is 25, according to IPCC assessment report (Landson, 2010).

The current concentration of green house gases in the atmosphere is now the highest it has been for the past 600,000 years, having grown by 70% between 1970 and 2012 alone, having reached this level exceptionally quickly (IPCC Fourth Assessment Synthesis Report, 2011). While there has been some controversy in the past, it is now widely accepted that human activities, in particular fossil fuel use and changing land-uses, are the dominant factors in this growth and are responsible for most of the warming observed globally over the last 60 years (IPCC Fourth Assessment Report, Working Group I (2011)).

Projections for Future Climate Change

The future projections of climate patterns are largely hinged on computer-based models of the climate system which incorporate the factors and processes of the atmosphere, the oceans and the expected growth in greenhouse gases from socio-economic scenarios for the coming decades. The published results from different models have been examined by IPCC, and on the basis of the evidence, has estimated that by the year 2100:.

1. The sea level will rise between 18 and 59cm;
2. The oceans will become more acidic;
3. The global average surface warming (surface air temperature change) will increase by 1.1 to 6.4°C;
4. It is likely that tropical cyclones (typhoons and hurricanes) will become more intense with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures;
5. It is very likely that there will be more precipitation at high latitudes and it is likely that there will be less precipitation in most sub tropical land areas; and
6. It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent (Rooney, 2010).

Effect of Climate Change on Key Sectors

The likely effects of climate change on key sectors were postulated by Aberdeen (2010) and summarized as follows:

Health: The health status of millions of people is likely to be altered by projected changes in climate. The heat waves, floods, storms, fires and drought will result in increased deaths, disease and injuries.

There will also be an increase in malnutrition, diarrhea and malaria in some areas, and vulnerability to extreme public health and development goals will be threatened by damage to health systems from disasters.

Food: for people at lower latitudes, particularly in seasonally dry and tropical regions, the increase in temperature and the frequency of droughts and floods are likely going to affect crop production negatively and could result in hunger, displacement and migration. However, those at the mid-latitude and high latitude areas will initially benefit from higher agricultural production.

Industry, Settlement and Society: the industries, settlements and societies that are most vulnerable are those located in coastal areas and river flood plains, and those whose economies are linked with climate – sensitive resources. Such locations are those prone to extreme weather events or those areas undergoing rapid urbanization. The economic and social costs of those events will increase when the extreme weather events become intense or frequent.

Water: By mid century, water availability will likely decrease in mid latitudes in the dry tropics and in other regions supplied by melt water from mountain ranges. In fact, more than one sixth of the world's population is currently dependent on melt water from mountain ranges. Heavier precipitation events are very likely to increase in frequency leading to higher flood risks.

Effect of Climate Change on Africa, Asia and Europe

The devastating effects of climate change are more pronounced among the poorest people in underdeveloped and developed countries. This is because they live mostly in high risk areas such as unstable slopes and flood planes and cannot afford well built houses. Majority of them depend on climate sensitive sectors such as agriculture, and they have no means of coping with climate change, owing to low savings, zero property insurance, and poor access to public services. Many developing countries are likely to witness increase in death rates of their citizens and several illnesses due to climate change. The latter is also expected to lead to low incomes. Abudahab (2014) stated that Africa, small Island States, and the Asian and African mega-deltas are likely to be particuallry affected by climate change.

Africa: Due to multiple stresses and low adaptive capacities arising from endemic poverty, weak institutions, and complex disasters and associated conflicts, Africa is particularly vulnerable to the effects of climate change. Adegbiya (2013) reported that “drought will

continue to be a primary concern for many African populations, and that the frequency of weather and climate related disasters has increased since the 1970s, and the Sahel and Southern Africa have become drier during the twentieth century. Water supplies and agricultural production will become more severely diminished". It is also reported that by the year 2020, agricultural yields in some African countries could be reduced by 50%. And in 2080, the area of arid and semi-arid land in Africa will likely increase by 5 to 8% (Jawal, 2013).

Asia: the continued melting of glaciers in the Himalayan region has been projected to increase flooding and rock avalanches and to adversely affect water resources in the next two to three decades. The sustainable development in the continent will also be challenged as climate change compounds the pressures that rapid urbanization, industrialization, and economic development have placed on natural resources (Lisbon, 2011). The availability of adequate fresh water, by the 2050s will be a concern for possibly more than one billion people. The heavily populated coastal areas, the delta regions, will become more prone to increased flooding due to the rising sea levels and flooding of river.

Europe: the concern areas of focus of the continent are the retreating glaciers, reduced precipitation in southern Europe, and the possibility of more droughts in some areas, as well as increased risk of flash floods. Health risks and frequency and severity of wildfires will be increased as a result of higher temperatures and heat waves. There are also the likelihood of reduced forest area and agricultural productivity and greater vulnerability of low-lying coastal areas, and rising sea levels. Less water will reduce hydro power potentials, tourism and crop production in Southern Europe (Babalola, 2014).

Climate Change Induced Disasters

The combination of an exposed, vulnerable and ill-prepared population or community with a hazard event, result in a disaster. Therefore, natural hazards by themselves do not cause disasters. Climate change will affect disaster risks in two ways: through the likely increase in weather and climate hazards; and through increases in the vulnerability of communities to natural hazards, essentially through ecosystem degradation, reductions in water and food availability, and changes to livelihoods. Climate change engenders environmental degradation and rapid unplanned urban growth, further reducing communities abilities to cope with even the existing levels of weather hazards (Lisbon, 2011).

From 1991 to 2010, more than 9,460 million people were affected by disasters, 3,780,000 people died and economic losses were US \$12,163 billion (Centre for Research on the Epidemiology of Disasters (CRED, 2012). It has been observed also that poor countries are disproportionately affected, due to intrinsic vulnerabilities to hazards and comparatively low capacities for risk reduction measures (Mills, 2008). Many small countries are also vulnerable – Grenada lost 919 millions dollars due to hurricane Ivan in 2004 and were equal to 2.5times its GDP. In the last three decades, 76% of all disaster events were hydrological, meteorological or climatological in nature. These accounted for 45% of the deaths and 79% of the economic losses caused by natural hazards. Today, there is already evidence of increase in extreme conditions for some weather elements in some regions (Meehl, 2007).

It has also been revealed that several long term precipitation trends have been observed, including significant increases in eastern parts of North and South America, Northern Europe and Northern and Central Asia, and more dry conditions in the Sahel and Southern Africa, throughout the Mediterranean region, and in parts of Southern Asia (Deque, 2003). The observed frequency of heavy precipitation events has increased over most land areas, which is consistent with global warming and the observed increase of atmospheric water vapour (Patz, 2009).

Since 1970s, more intense and longer droughts have been observed over wider areas, particularly in the tropics and sub tropics. Pielke (2009) stated that higher temperatures and decreased precipitation have increased the prevalence of drier conditions as well as contributing to changes in the distribution of droughts.

Wind patterns, decreased snow pack, snow cover, and changes in sea surface temperatures, have been linked with changing drought occurrence (Saunders, 2008). Widespread changes in extreme temperatures have been observed in many regions of the globe over the past 50 years – notably the higher frequency of high-temperature days and nights, and heat.

There is however, strong evidence for an increase of more damaging intense tropical cyclone activity in the North Atlantic since 1970s, which is correlated with increases in tropical sea surface temperatures (Keatinge, et al., 2008). Today, there is no clear trend evident in the global annual number of tropical cyclones (Trenberth, 2010). Generally however, it is impossible to be absolutely certain about all the disaster – related effects of climate change, due to the intrinsic uncertainty in the climate projection, the diverse and rapidly changing nature of community vulnerability and the random nature of individual extreme events (Mills, 2008). There is however, plenty of information on the serious impacts of events that have occurred in the past decades, and on this basis, there is much to be concerned about.

Excessive heat waves will increase the number of deaths, particularly among the very young, to the elderly and those who are chronically sick and therefore, socially isolated. (Palmer and Ralsanen, 2012). Increased drought in some regions will likely lead to land degradation, damage to crops or reduced yields, more livestock deaths, and an increased risk of wildfire. Such conditions will increase the risks for populations dependent on subsistence agriculture, through food and water shortage and higher incidence of malnutrition, water-borne and food borne diseases, and may lead to displacements of populations. Emmanuel (2010) also observed that increased frequency of high precipitation in some regions will trigger floods and landslides, with potentially large losses of life and assets. These events will disrupt agriculture, settlements, commerce and transport and may further increase pressures on urban and rural infrastructure. Although, it is quite obvious that increases in the number and intensity of very strong cyclones (typhoons and hurricanes) will affect coastal regions, with potentially large additional losses of lives and assets.

Brown (2013) stated that sea-level rise, coupled with coastal storms, will increase the impacts of storm surge and river flooding and damage livelihood systems and protective ecosystems. He also posted that low lying settlements may become unviable, which may result in increased potential for movement of population. Higher temperatures and melting glaciers may also cause glacier lake outbursts that could flood downstream settlements (McCarthy, 2008).

Methods and Strategies of Addressing the Problem of Climate Change

Till date, countries are actively engaged in discussing ways of dealing with the problem of climate change. This is particularly within the United Nations Framework Convention on Climate Change (UNFCCC) which clearly spelt out steps to follow in tackling the problem. One of such steps is to address the root cause by reducing green house gas emission from human activity. This step will require, as it were, radical changes in the industrial operations, urban development, fossil fuel use and land use. The reduction of green house gas emissions is known as “mitigation”

Mitigation is conceptualized by the Intergovernmental Panel on Climate Change (IPCC) as “an anthropogenic intervention to reduce the anthropogenic forces of the climate system. It includes strategies to reduce green house gas sources and emissions and enhancing greenhouse gas sinks”. Mitigation actions include actions such as developing new low-energy technologies for industry and transport, switching to renewable forms of energy, such as solar and wind power, reducing consumption of energy intensive products, and efficient furnace systems. Technologies are being developed today to capture carbon-dioxide at industrial sources and to inject it into permanent storage deep underground. Also, carbon (natural) sinks, such as soils, forests and vegetation, can be managed to absorb carbondioxide. (Christensen and Christensen, 2010).

Another relevant step in responding to climate change is the management of its impact. Christensen (2010) observed that due to the amount of green house gases already in the atmosphere from past decades of industrial and other human activity, and including the amounts from continued emissions over the next few decades until such a time that mitigation policies would become effective, future impacts on the environment and the society are really inevitable.

Adaptation, on the other hand, means the steps to cope with the changed climate conditions. It is particularly conceptualized by Intergovernmental Panel on Climate Change (IPCC) as “the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities”. Adaptation therefore, include managing water resources, building settlements in safe zones, preparing risk assessments, protecting ecosystems, developing early warning systems, improving insurance coverage, developing social safety nets, and instituting better building designs and improving agricultural methods. The measures reduce the risk to lives and livelihoods and improve resilience of community to hazards. They are therefore, intrinsically linked to sustainable development. While mitigation measures can be planned to reduce, and not inadvertently exacerbate, disaster risks, adaption measures can contribute to the reduction of green house gas emissions (Environment Agency UK, 2005) (Pielke, 2009).

Disaster risk reduction is aimed at counteracting the added risks arising from climate change. It is defined as “action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events.

The Hyogo Framework for Action (2005-2015) sets out five priorities for action, each elaborated into a number of specific areas of attention which offer a strong basis for developing concrete risk reducing adaptation measures. These are, ensuring that disaster risk

reduction is a national and local priority with a strong institutional basis for implementation; identification, assessing and monitoring disasters risks and enhancing early warning, using knowledge, innovation and education to build a culture of safety and resilience at all levels; reducing the underlying risk factors; and strengthening disaster preparedness for effective response at all levels (Trenberth, 2010).

Adaptation and disaster risk reduction measures can be viewed from three sectoral perspectives – water sector, health sector and agricultural sector.

Water Sector: the adaptation measures under this sector include actions such as developing flood ponds, water harvesting, desalination, improved irrigation, protecting water supply infrastructure, and traditionally water supply sources, non-water based sanitation, improved watershed and trans-boundary water resource management.

Health Sector: the measures under this sector include the enforcement of relevant regulations; supply for education, research and development on climate related health risks, early warning systems and air conditioning to address extreme weather events; vector control and safe water and food handling regulations; and systematic action on water and vector borne diseases to raise public awareness of watershed protection.

Agricultural sector: the measures here include changing planting times and cropping patterns, altering crop strains to enhance their drought and pest resistance, and altering land topography to improve water uptake and reduce wind erosion.

In the area of early warning systems, measures include instituting specific means to disseminate warnings to affected people in a timely, useful and understandable way, improving existing systems to cover the changed hazard circumstances, and providing advice on appropriate actions to take upon receiving warnings.

Also, in the area of environmental management, measures include protecting ecosystems, such as coral reefs or mangrove forests that shield communities from coastal hazards; supporting transitions of livelihoods away from those that degrade environments and aggravate risk; enforcing regulations concerning these practices; and strengthening of environmental management in areas of greater risk from weather hazards (Patz, 2009).

CONCLUSION

There is convincing evidence that changes in the earth's climate are taking place all over the world. This can be explained by taking into account human influence through the emission of greenhouse gases (GHGs). The theoretical understanding of the physical processes behind the influence of climate change on various extreme weather events indicate that more extreme events would in general be an expected outcome. Empirical evidence in some cases have revealed that climate change has already had an impact on some disasters in several parts of the world. However, given the increasing severity of extreme events, further and improved adaptation measures are needed.

RECOMMENDATIONS

1. There is an urgent need for the nations to raise and intensify the level of discussion on extreme events linked to climate change. In fact, there should be persistent discussion on policy action required to prevent or mitigate the impacts of extreme events, such as droughts, heat waves, flooding, desertification, and green house gas emission. There should be a follow up to the meeting of world leaders in Paris in December, 2015 where the issue of green house gas emission was discussed.
2. It is absolutely necessary for policy makers and environmental experts to always support better data gathering and scientific inquiry into extremes and dissemination of several conclusions drawn.
3. A thorough evaluation of plans is very important, particularly when funds are spent in the most effective ways. There is therefore, the need to review nations funding needs and persistent readiness for a future in which extreme events such as drought, heat waves and flash floods, are likely to occur.

REFERENCES

- Aberdeen, E.A. (2010). Public Health Responses to Extreme Weather and Climate Change. American Meteorological Society, Vol. 99, 2709-2718.
- Adegbija, A.M. (2013). Climate Variability and Change in Coastal Parts of Africa. Ibadan: International Publishers.
- Babalola, F.T. (2014). A Data of Drought Severity in West African Sub-Region: Soil Moisture and Effects of Surface warming. Valdosta GA: Valdosta State University.
- Brown, S. (2013). Temperature Extremes, the Past and the Future. Poster presentation, stabilization. www.stabilization.2013.com.
- Christensen, J.H., and O.B. Christensen (2010). Sever Summer Time flooding in Europe, Nature, 421, 805 – 806.
- Deque, M. (2013); Uncertainties in the Temperature and Precipitation Response of Prudence Runs over Europe. Abstract from the European Science foundation and prudence. 3rd Annual Conference on “Regional Climate Change in Europe” Wengen, Switzerland, September 29 – October 3, 2003.
- Emmanuel, K. (2010). Increasing Destructiveness of Tropical Cyclones over the past 30 years. Nature, 436, 4 August 2010, 686-688.
- Environment Agency (U.K) (2005). The Thames Estuary; http://www.environment-agency.gov.uk/regions/thames/323150/335688/335743/?version=lang=_e.
- IPCC Fourth Assessment Report, Working Group I, Glossary of Terms: [Http://ipcc.wgi.ucar.edu/wgi/report/AR4WGI.print annexes.pdf](http://ipcc.wgi.ucar.edu/wgi/report/AR4WGI.print annexes.pdf)
- IPCC Fourth Assessment Synthesis Report: <http://195.70.10.65/pdf/assessment-report/ar4/syr/ar4-syr.pdf>.
- Jawal, T.C. (2013). United Kingdom, Trends in Daily Intensity. International Journal of Climatology 931-942.
- Keatinge, W.R., G.C. Donaldson, E. Cordiolo, M. Martinelli, A.E. Kunst, J.P. Mackenbach, S. Wayha, L. Vuori (2008). Heat related mortality in cold and warm regions of Europe: Observational study, BMJ: 321, 670-673.

- Landson, A.A. (2010). Status of Global Climate in 2010. WMO Press Bulletin, 299.
- Lawson, K.L. (2014). Adaptation to climate change in Europe EUR 20184 EN.
- Lisbon, C.A 92011). Preliminary Description of the Terrestrial Natural Communities of California. California Department of Ecological Studies, Sacramento, CA.
- McCarthy, J.J. (2008). Reply to Pielke, et al. American Meteorological Society, vol 86 No 10, October, 2008, 1483-1484.
- Mechl, G.A. (2007). An introduction to trends in extreme weather and climate events. Observations, socio-economic impacts, terrestrial ecological impacts, and model projections. Bull American Meteorological Society 81, 413-416.
- Milano, B. (2013). Flash food prevention and mitigation strategies. Global Perspectives: London Kogan Page.
- Mills, E. (2008). Insurance in a climate of change. Science 310, 9 December, 2008, 1616.
- Palmer, T.N. and J. Ralsanen (2012). Quantifying the Risk of Extreme Seasonal Precipitation Events in a Changing Climate. Nature 415, 512-513.
- Pielke, R.A Jr (2009). Attribution of Disaster Losses, Science, 310, 9 December, 1615-1616.
- Rodney, M. (2010). Ecology and Restoration of Northern California Dunes: Humboldt County Planning Department, Eureka, CA.
- Rousels, D. (2013). Factors Responsible for Escalation of European Heat Wave in 2003. Newyork: Alfred .A. Knopf.
- Saunders, M. (2008). Head of Climate Protection, Department of Space and climate Physics, University College, London, quoted in Jha, 2008.
- Trans, Z. (2010). Trends in Climate Change over Past Decades. J. Climate, 14, 4922-4947.
- Trenberth, K. (2010). Uncertainty in Hurricanes and Global Warning: Science, 308, 17 June, 1753-1754.
- Tsar, J.O. (2012). Climate Variability: Observation and Reconstruction. Cambridge: Harvard University Press.
- UNFCC Article I, Definitions: <http://unfccc.int/essential...background/convention/background/items/1349.php>
- Whorf, T.A. (2009). Occurrence of Extreme Floods in Central Europe. New York: Macmillan.