Climate Change

- Climate Change denotes a serious and consistent deviation from the regular patterns of weather conditions.
- It is not merely the deviation from the “standard” climactic conditions that has made the phenomenon dangerous to the environment but its overall multiplier impacts over time.
- Climate change has come to depict specific abnormalities outside the precincts of ordinary change in climate.

- Ordinarily, there are largely unnoticed cyclical changes in the weather from day to day; and in the climate, from year to year.
- These obviously normal variations mean that the climate is not static but constantly changing.
- Thus, the initial conceptual confusion surrounding climate change which originated from the normal variability of weather conditions was cleared by certain beacons set by the United Nations Framework Convention on Climate Change (UNFCCC).

- In Article 1 section 2, Climate Change is denoted as “a change of climate which is 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 1992).
- An important distinction in the definition of climate change is the recognition of the contributions of natural and man-made influences in engendering it.

- Far more than natural causes, in the form of volcanic eruptions and astronomical fallouts, human socio-economic activities drive climate change.
- The manifestations of climate change are varied and seem to cover the entire field of the environment.
- Thus, changes in: average climactic condition, climactic variability, the frequency and magnitude of extreme weather events, sea levels; and increases in maximum temperature are within the purview of climate change.

- This led the Intergovernmental Panel on Climate Change (IPCC) to define climate change as ***"statistically significant variations in either the mean state of the climate or in its variability persisting for an extended period (typically decades or longer)"*** (IPCC 2001, 788).
- The consequences of this variability are "shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature (Eboh, 2009, 11).

- The greatest contributors to climate change are the various human socio-economic activities whose watershed was the industrial revolution that began in the late 18th century.
- Despite the strides made since then, in terms of improved efficiency in the exploration and exploitation of renewable and non-renewable resources, as well as industrial activities, the march of civilisation is not without its stylised consequences.
- The trend of industrialisation and its dependence on fossil fuels such as coal, oil and gas to power our civilisation has significantly driven climate change.

- These fuels, which had been used consistently and in geometrically expanding quantities since the late 18th century, released greenhouse gases (GHGs) into the atmosphere that cumulatively eroded the eco-balance.
- **What do we mean by greenhouse gas? A gas that absorbs radiation; A** gas that contributes to the warming of the Earth's atmosphere by reflecting radiation from the Earth's surface, e.g. carbon dioxide, ozone, or water vapour.

- The Kyoto Protocol lists six major GHGs whose emissions have been implicated as constituting the large chunk of overall GHG emissions from human socio-economic activities.
- These include:
  - carbon dioxide (CO_2),
  - methane (CH_4),
  - nitrous oxide (N_2O),
  - sulphur hexafluoride (SF_6),
  - hydrofluorocarbons (HFCs), and
  - perfluorocarbons.

- By absorbing terrestrial radiation from the earth and re-radiating the heat back to earth, these GHGs lead to a general increase in temperature thus causing global warming.
- The earth is imbued with natural temperature control system.
- Certain atmospheric gases known as GHGs are critical to this system.
- Each day, the sun radiates rays of light onto the earth's surface.
- On the average, about a third of the solar radiation that hits the earth is reflected back to space.
- Of the remainder, the atmosphere absorbs some but the land and oceans absorb most.

- The earth's surface becomes warm and as a result emits infrared radiation.
- The GHGs trap the infrared radiation, thus warming the atmosphere.
- The problem we are facing today, which reflects in global warming is that human socio-economic activities increase the concentration and levels of GHGs in the atmosphere (IPCC 2001, 24; Ozor 2009, 27).
- Global greenhouse gas emissions from human activities have expectedly grown in magnitude since pre-industrial times with an increase of 70 percent between 1970 and 2004.
- Global atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have risen markedly since 1750 owing to increased productive activities.

- For instance, the concentration of CO_2 in the atmosphere prior to 1750 was about 280 parts per million (ppm) but rose to 368 ppm in 2000 and by 2005, it had reached 379 ppm and is still on the rise.
- Since the introduction of continuous atmospheric measurement in the 1950s, CO_2 emissions were larger from 1995-2005. (UNEP/GRID-Arendal 2009, 18-21).
- What is ***Greenhouse Effect***? It is the **warming of Earth's atmosphere;** warming of the Earth's surface as a result of atmospheric pollution by gases.
- It is now feared that the warming effects has undesirably increased, causing climate changes and melting polar icecaps.

- The obvious manifestation of the effects of global warming are reflected in such checklists as:
  - higher average surface and ocean temperatures,
  - more rapid evaporation and rainfall,
  - more variability and severity in floods and droughts,
  - rising sea levels, and
  - an increased frequency and intensity of extreme weather events.

- **Some Basic Concepts**
- **1) Climate Change Sensitivity:** *is* the degree to which a system can be affected, negatively or positively, by changes in climate.
- This includes change in mean climate and the frequency and magnitude of extremes.
- The effect may be direct (for example a change in crop yield due to a change in temperature) or indirect (such as damage caused by increased frequency of coastal flooding due to sea-level rise).

- Sensitivity includes exposure which considers the nature and magnitude of climate change and whether a system would be affected by such change.
- For example, the low-lying coastal areas of Bangladesh are exposed to sea-level rise, whereas the Rift Valley in Africa, because of its elevation, is not.
- Sensitivity also considers the extent to which an exposed system can be affected by climate change.

- Some crops such as maize are quite sensitive, while systems such as manufacturing are much less sensitive to climate change, although they can be affected by extreme events, reductions in water supplies, and power disruption.
- **2) Adaptive capacity:** is a system's ability to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities or to cope with consequences.

- It is a function of:
- the relative level of a society's economic resources,
- access to technology,
- access to information on climate variability and change, and skills to make use of the information,
- institutions (for example, the degree to which institutions can help to adapt), and
- equitable distribution of resources (societies with relatively more equitable resource distribution will be better able to adapt than societies with less equitable distribution).

- The level of adaptive capacity tends to be positively correlated with the level of development: more developed societies tend to have more adaptive capacity.
- However, possessing adaptive capacity is not a guarantee that it will be used effectively.

- **3). Vulnerability** is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.
- Vulnerability is a function of the character, magnitude and rate of climate change, and the degree to which a system is exposed, along with its sensitivity and adaptive capacity.
- Vulnerability increases as the magnitude of climate change or sensitivity increases, and decreases as adaptive capacity increases.

- **Vulnerability of countries to Climate Change**
- The vulnerability of countries and societies to the effects of climate change depends not only on the magnitude of climatic stress, but also on the sensitivity and capacity of affected societies to adapt to or cope with such stress
- Sensitivity to climatic stress is higher for activities entailing climate-dependent natural resources, such as agriculture and coastal resources – often critical for the livelihoods of the poor.

- The capacity to adapt and cope depends upon many factors, including wealth, technology, education, institutions, information, skills and access to resources, which are generally scarce in poor countries and communities.
- The concept of vulnerability to climate change recognises that socio-economic systems play a role in amplifying or moderating the impacts of climate change.

- Climate change is also likely to differentially affect certain sectors and regions.
- For example, certain coastal and marine ecosystems, such as mangroves, salt marshes and coral reefs will be subject to multiple stresses.
- Climate change will affect many key resources that are critical for development.

- These impacts will generally become more significant and more widespread with increasing climate change.
- For example, water resources in some dry regions at mid-latitudes, including arid and semi-arid regions, and in the dry tropics will be affected by changes in rainfall and evapotranspiration (the return of moisture to the air through both evaporation from the soil and transpiration by plants).

- Low-lying coastal systems will be affected by sea-level rise and more frequent extreme weather events.
- Also, it is likely that certain regions will be strongly affected by climate change.
- Africa is considered one of the regions most vulnerable to climate change because of its low adaptive capacity.
- Asian and African mega deltas will also be at high risk due to their large populations and high exposure to sea-level rise, storm surges and river flooding.

- **Implications of Climate Change on Key Sectors Important for Development**
- **Water Resources**
- Climate change will provide an additional stress on water resources through:
- increased evaporation losses and water demands as a result of rising temperatures;
- reduced coastal freshwater supplies because of sea-level rise and salinisation;
- increased precipitation extremes in certain regions (such as high latitudes) which has implications for flooding risks;

- initial increase and eventual reduction in glacial meltwater as glaciers recede and possibly disappear in certain regions;
- reduced rainfall in other regions (such as southern Africa and the Mediterranean rim) leading to enhanced drought risk;
- displaced rainy seasons; and
- decreased water quality in many regions as a result of higher temperatures, increased loadings of pollutants from more intense precipitation, and lower flow conditions during some seasons.

- **Food Production**
- Food production is closely linked to water availability and will face increased stress in regions where water stress is exacerbated.
- Although higher concentrations of carbon dioxide are projected to increase yields for many crops, changes in temperature and precipitation may modify and even limit the direct effects of “carbon dioxide fertilisation”.
- Overall, climate change is expected to lead to declining cereal production in developing countries, with risks of decreasing yields particularly high in Africa, South and South-East Asia, and Latin America (except for mid-latitude areas such as the pampas- treeless grassy plains in temperate South America, especially Argentina).

- **Health**
- Climate change is also projected to have wide-ranging consequences for human health directly through increased temperatures, heat waves, floods, droughts and storms, as well as indirectly through its effects on water- and food-borne diseases, and on the geographical and seasonal ranges of vector-borne diseases.

- **Coastal Zones**
- Coastal zones, especially mega deltas in Asia and Africa, low-lying coastal urban areas and atolls (**coral islands surrounding lagoon**s) are also particularly vulnerable to the impacts of sea-level rise, storm surges, and increases in the intensity of cyclones in certain regions.
- These increases in exposure to the risks of climate change are juxtaposed on the already high (and growing) vulnerability of coastal areas, which are home to 23% of the world's population and have population densities three times the global average.

- **Ecosystems and Natural Resources**
- In addition to the above, ecosystems and natural resources, which contribute a significant share of income in developing countries, are also vulnerable to rising temperatures, changes in rainfall and rainfall extremes, and sea-level rise.
- A critical reason for the vulnerability of ecosystems and natural resources around the world is that the combination of rapid climate change and stresses from human settlement, such as habitat fragmentation, population depletion (*e.g. of many fisheries),* blocked migration routes and pollution, is likely to result in the threat of widespread ecosystem dislocation and extinctions of many species.

- Mountain regions, meanwhile, are at the front lines of many of the impacts of climate change through near-term effects of rising temperatures on glacier retreat and resulting implications on water availability, glacial lake expansion, flooding from melting of glaciers and bursting of glacial lakes and permafrost melt increases in the risk of related natural hazards.

- **Impacts of climate change on the developing world**
- Climate change will lead to differential impacts on countries and communities throughout the world.
- Developing countries are believed to be the most vulnerable to the negative impacts of climate change because they rely heavily on climate-sensitive sectors, such as agriculture and fisheries, and have a low GDP, high levels of poverty, low levels of education and limited human, institutional, economic, technical and financial capacity.

- Climate Change may also have implications for migration
- The number of environmental migrants could substantially rise in future because of the impacts of climate change. Migration, usually temporary and often from rural to urban areas, is a common response to natural disasters such as floods and famines, and large numbers of displaced people are a likely consequence of extreme events.
- The increase in intensity and/or frequency of certain weather extremes due to climate change, in combination with population growth, unstable institutions and poverty, may increase migration pressures (WBGU, 2007).
- Development strategies should therefore take greater account of climate change impacts at the local level, including the implications of such impacts on migration both within and between countries.

- **Africa**
- Africa is one of the most vulnerable continents to climate change and variability.
- It has more climate-sensitive economies than any other continent with 50% of its population living in dryland areas that are drought-prone.
- In addition, its agricultural sector contributes an average 21% of GDP in many countries, ranging from 10% to 70%.
- Climate models project a warming trend for the whole of Africa during this century, with the median temperature increase situated between 3°C and 4°C.
- Trends in annual rainfall vary across regions, with increases likely in East Africa and decreases likely in much of Mediterranean Africa, northern Sahara and on the western margins of southern Africa.
- A general increase in the intensity of high rainfall events is also expected in Africa.

- **Asia**
- Asia is the world's largest and most populous region.
- Although a number of Asian nations have had rapid economic growth and reductions in poverty, nearly one in three Asians today lives on less than one US dollar per day.
- The region's governments are struggling to cope with the effects of rapid deforestation, soil erosion, recurrent floods and other major disasters, environmental pollution and the social consequences of depleted natural resources (Estes, 2007).
- Climate change will reinforce some of these problems and lead to new problems and stresses, which Asian governments will have to respond to.

- The climate models project a warming of at least 2.5°C over Asia by the end of the century. Winter rainfall (December-March) is projected to increase in northern Asia, the Tibetan plateau, eastern Asia and the southern parts of South-East Asia.
- Summer rainfall is likely to increase in northern, East and South Asia and most of South-East Asia, but is likely to decrease in central Asia.
- In addition, extreme rainfall and winds associated with tropical cyclones are likely to increase in East, South-East and South Asia.
- It is also projected that heat waves will be of longer duration, more intense and more frequent in East Asia.

- **Latin America** is a region heavily dependent on natural resources with, for example, 30% to 40% of its working population employed in the agricultural sector.
- The impacts of climate change on agriculture will, therefore, affect the region's economy, development, and poverty reduction efforts.
- Despite the region's progress in reducing poverty in recent years, 38.5% of people still live in poverty (Inter-American Development Bank, 2006) and inequities in the distribution of wealth among the population of this region are among the highest in the world.
- These factors contribute to make this region one of the most vulnerable to climate change.
- The mean warming projected for this century in Latin America ranges from 1°C to 6°C. Annual rainfall is estimated to decrease in most of Central America, resulting in a drier spring season, and in the southern Andes, where rainfall changes are projected to be largest in summer.

- Winter rainfall in Tierra del Fuego and summer rainfall in south-eastern South America is likely to increase.
- It is uncertain how annual and seasonal average rainfall will change over northern South America, including the Amazon forest.
- However, there is consistency in the projections for some areas: rainfall increasing in Ecuador and northern Peru, and decreasing at the northern tip of the continent and in southern north-east Brazil.
- Over Central America, tropical cyclones may become an additional source of uncertainty for regional scenarios of climate change, since the summer rainfall over this region may be affected by systematic changes in hurricane tracks and intensity.

- **Small Island States** are a heterogeneous group of countries, which vary by geography, location, stage of economic development, and physical, social, political, cultural and climatic character.
- However, they share common characteristics that underscore their overall vulnerability to climate change:
  - limited physical size;
  - limited natural resources;
  - high susceptibility to natural hazards, such as tropical cyclones, storm surges, and droughts;
  - thin water lenses that are highly sensitive to sea-level changes;

  - generally high population densities and in some cases high population growth rates;
  - frequently poorly developed infrastructure; and,
  - limited funds and human resource skills (IPCC, 2001).
- All Caribbean, Indian Ocean and North and South Pacific islands will warm during this century, albeit at a slightly lower rate than the global annual mean warming.
- Summer rainfall in the Caribbean is likely to decrease in the vicinity of the Greater Antilles (island group in the northern Caribbean, comprising Cuba, Jamaica, Hispaniola, and Puerto Rico) but changes elsewhere and in winter are uncertain.

- Annual rainfall is likely to increase in the northern Indian Ocean with increases likely in the vicinity of the Seychelles in December, January and February (DJF), and in the vicinity of the Maldives in June, July and August (JJA), while decreases are likely in the vicinity of Mauritius in JJA.
- Annual rainfall is likely to increase in the equatorial Pacific, while decreases are projected for just east of French Polynesia in DJF. Sea levels are likely to rise during the century around the small islands of the Caribbean Sea, and the Indian and Pacific Oceans.

- **Adapting to the Impacts of Climate Change**
- There are two broad categories of responses to climate change:
  - **Mitigation** and,
  - **Adaptation**
- Both mitigation and adaptation help to reduce the risks of climate change.

- **Climate Change Mitigation**
- ***Mitigation*** aims to avoid or at least limit climate change itself, by reducing the emissions of GHGs, for instance: by
  - promoting energy efficiency,
  - the use of renewable energy such as solar and wind power, and,
  - avoiding deforestation.
- Refers to efforts to reduce or prevent emission of greenhouse gases.
- Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior.

- It can be as complex as a plan for a new city, or as a simple as improvements to a cook stove design.
- Efforts underway around the world range from high-tech subway systems to bicycling paths and walkways.
- Protecting natural carbon sinks like forests and oceans, or creating new sinks through silviculture or green agriculture are also elements of mitigation.
- (***Silviculture is the study, cultivation, and management of forest trees***)**.**

- UNEP takes a multifaceted approach towards climate change mitigation in its efforts to help countries move towards a low-carbon society.
- ***Mitigation*** consists of activities that aim to reduce GHG emissions, directly or indirectly, by avoiding or capturing GHGs before they are emitted to the atmosphere or sequestering those already in the atmosphere by enhancing "sinks" such as forests.
- Such activities may entail, for example, changes to behaviour patterns or technology development and diffusion.

- **Adaptation** consists of deliberate actions undertaken to reduce the adverse consequences, as well as to harness any beneficial opportunities.
- ***Adaptation*** is defined as adjustments in human and natural systems, in response to actual or expected climate stimuli or their effects, that moderate harm or exploit beneficial opportunities (IPCC (2001).
- **Adaptation Within International Negotiations on Climate Change**
- Adaptation is a relatively recent concern within the context of international negotiations on climate change.
- Adaptation is mentioned in both the United Nations Framework Convention on Climate Change (UNFCCC) negotiated in 1992, and the Kyoto Protocol, negotiated in 1997.

- The implementation of adaptation has come into a much sharper focus since the Seventh Conference of the Parties (CoP-7) in Marrakech in 2001 which established three funds dealing with adaptation:
  - *The Least Developed Countries Fund* is intended to address the particularly low adaptive capacity of the least developed countries (LDCs). The Marrakech Accords established the fund to help such countries prepare their National Adaptation Programmes of Action (NAPAs), which establish and prioritise adaptation needs. The fund also supports institutional capacity building and other activities.

– *The Special Climate Change* Fund finances a multitude of activities in both mitigation and adaptation in all developing countries. The activities can be specific to sectors – energy, transport, industry, agriculture, forestry and waste management – or aimed directly at adaptation, technology transfer and economic diversification.

– *The Adaptation Fund* – the only Marrakech fund linked to the Protocol rather than the Convention –provides funding only to parties to the Protocol. Like the other two funds, its resources come from voluntary contributions, but it also benefits from a 2% share of the proceeds of certified emissions reductions from projects under the Protocol's Clean Development Mechanism (CDM).

- These funds are part of a more complex architecture of international funding sources for adaptation that also includes the Strategic Priority on Adaptation of the Global Environmental Facility and the World Bank Group Climate Investment Funds as well as bilateral initiatives.
- Successive rounds of negotiations have sought to develop a more comprehensive approach to addressing adaptation.

- This includes:
- A five-year (2005-10) programme – the Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change – that is fostering a wide range of initiatives to help governments improve their understanding of the impacts, vulnerability and adaptation to climate change, and take informed decisions on practical adaptation actions.

- The programme aims to achieve the following outcomes:
  - improve capacity at international, regional, national, sectoral and local levels to further identify and understand impacts, vulnerability, and adaptation responses, in order to effectively select and implement practical, efficient and high-priority adaptation actions;
  - enhance and improve the level and amount of information and advice to the UNFCCC Conference of the Parties and its subsidiary bodies on the scientific, technical and socio-economic aspects of impacts, vulnerability and adaptation;

  - enhance the degree of dissemination and utilisation of knowledge from practical adaptation activities;
  - enhance co-operation among parties, relevant organisations, business, civil society and decision makers, in order to advance their ability to manage climate change risks; and,
  - enhance the integration of adaptation into sustainable development plans.
- The Nairobi Work Programme serves as a platform for the dissemination of scientific and technical knowledge, and, in so doing, aims to support and catalyse the implementation of adaptation.
- Enhanced action on adaptation is also highlighted as a priority within the “Bali Roadmap” to finalise a post-2012 climate regime by the end of 2009.

- **What does adaptation involve?**
- The need to adapt to changing environmental and climatic conditions is not a new one.
- Societies throughout history have had to adapt to variations or changes in their climate through a variety of strategies and by using knowledge accumulated through experience of past climatic events.
- In addition, societies have also had to cope with and respond to extreme weather events, such as droughts and floods.
- For example, the Sahel region has historically frequently faced extreme climatic variability and events such as droughts.
- Societies in the Sahel have, therefore, had to regularly adapt to unreliable rainfall and drought conditions for example by diversifying their livelihoods and adopting new crop varieties.
- Adaptation reduces the impacts of climate stresses on human and natural systems.
- It consists of a multitude of behavioural, structural and technological adjustments.

- Adaptation measures can vary in their:
  - **timing** (anticipatory vs. reactive),
  - **scope** (short-term vs. long-term; localised vs. regional),
  - **purposefulness** (autonomous vs. planned; passive vs. active); and,
  - **adapting agent** (private vs. Public; societies vs. natural systems).
- Examples of adaptation measures include:
- changing crop varieties and altering farming practices;
- developing heat- and drought- resistant crops;
- diversifying livelihoods;
- building flood defences and land-use planning;
- building new water reservoirs;
- enhancing water use efficiency;
- changing building codes; and,
- constructing sea walls.

- **Classification of the Generic Adaptation Measures**
- ***1) Bear losses.***
- All adaptation measures may be compared with the baseline response of “doing nothing” except bearing or accepting the losses.
- In theory, bearing loss occurs when those affected have no capacity to respond in any other ways (for example in extremely poor communities) or where the costs of adaptation measures are considered to be high in relation to the risk or the expected damages.
- ***2) Share losses.***
- This type of adaptation response involves sharing the losses among a wider community. Such actions take place in traditional societies and in the most complex, high-tech societies.
- In traditional societies, many mechanisms exist to share losses among a wider community, such as extended families and village-level or similar small-scale communities.
- At the other end of the spectrum, large-scale societies share losses through public relief, rehabilitation, and reconstruction paid for from public funds.
- Sharing losses can also be achieved through insurance.

- ***3) Modify the threat.***
- For some risks, it is possible to exercise a degree of control over the environmental threat itself.
- When this is a “natural” event such as a flood or a drought, possible measures include flood control works (dams, dikes, levees).
- For climate change, the major modification possibility is to slow the rate of climate change by reducing GHGs and eventually by stabilising GHG concentrations in the atmosphere (*i.e. mitigation).*
- ***4) Prevent effects.***
- A frequently used set of adaptation measures involves steps to prevent the effects of climate change and variability.
- For example, in agriculture such measures include: changes in crop management practices, such as increased irrigation water, additional fertiliser use, and pest and disease control.

- ***5) Change use.***
- Where the threat of climate change makes the continuation of an economic activity impossible or extremely risky, consideration can be given to changing the use.
- For example, a farmer may choose to substitute a more drought tolerant crop or switch to varieties with lower moisture.
- Similarly, crop land may be returned to pasture or forest or other uses may be found such as recreation, wildlife refuges, or national parks.
- ***6) Change location.***
- A more extreme response is to change the location of economic activities.
- There is considerable speculation, for example about relocating major crops and farming regions away from areas of increased aridity and heat to areas that are currently cooler and which may become more attractive for some crops in the future.

- ***7) Research.***
- The process of adaptation can also be advanced by research into new technologies and new methods of adaptation.
- ***8) Encourage behavioural change through education, information and regulation.***
- Another type of adaptation is the dissemination of knowledge through education and public information campaigns, leading to behavioural change.
- Such activities have been little recognised and have received low priority in the past, but are likely to assume increased importance as the need to involve more communities, sectors and regions in adaptation becomes apparent.