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Climate Change: An Unprecedented Environmental Challenge

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Abstract
This study examines climate change with specific focus on its evolution, causal factors, global environmental effects, preventions and mitigations. The study argues that climate change is a cataclysmic consequence of uncoordinated anthropogenic activities on the global environment which should be mitigated to ensure sustainable environmental development. It observes that terrestrial, astronomical and extraterrestrial factors exacerbated by poor human activities in the mining, agricultural, forestry, transport, and urban environment planning sectors are responsible for its occurrence. From Africa to Asia, and from the Americas to Europe, and across Australia, the devastative impacts of climate change are clearly observed. These include thawing of permanent ice, increased ocean-sea waters, occurrence of torrential rainfall, flooding of towns and cities, destruction of infrastructures, prevalence of diseases, exacerbation of drought incidents in marginal locations, food insecurity, and unhealthy political struggles by countries for fertile lands, water and minerals. Based on its findings, the study suggests measures to prevent and mitigate the effects of climate change on the global environment. These include reduced emissions of greenhouse gases into the global environment, utilization of carbon sink, capture and storage techniques, implementation of the Kyoto Protocol, green belt resuscitation and conservation in cities, improved urban planning, sanitation, construction and monitoring, utilization of clean and renewable energy sources, and proper transport regulations in world's cities.
Keywords: Climate change, anthropogenic activities, challenges, effects, mitigations.

Introduction and Research Problem

Environmental change on a global scale first became a significant matter of public concern in the 1960s. Before this period, the perceived environmental problem was urban pollution, which affected human health and the quality of life of most urban residents. Although urban pollution became acute during the Industrial Revolution, it was certainly not a new occurrence. The smelting of toxic metals such as copper and lead was a health hazard in ancient Rome, as revealed by authentic scientific analysis of hair samples from the preserved corpses of Roman soldiers found in bogs, and from traces of metal in Greenland ice cores. Diseases such as bronchitis and tuberculosis were widespread following the Industrial Revolution, and nearly a quarter of deaths in Victorian Britain (1837-1901) were from lung cancer. In one horrific week in December 1952, 4,000 Londoners were killed by a particularly severe episode of smog. The ensuing public outcry in London resulted in the Clean Air Act of 1957 which restricted coal burning and resulted in the use of cleaner energy sources such as oil, gas and electricity (John, 2012).

An important milestone in the awakening of environmental concern was prompted by the widespread use of the persistent pesticides that were introduced after the Second World War and the publication of Rachel Carson's book *Silent Spring* in 1962. The *Silent Spring* clearly warned against the dangers of pesticides, especially to songbird populations, indicating how persistent chemicals might spread in food chains as well as in the atmosphere, and ultimately damage non-target species. At the same time, other scientists were demonstrating that the pesticide DDT could be found in rainwater in the Antarctic, and that pesticides were responsible for eggshell thinning in wild birds, threatening especially those species at the end of food chains such as raptors. Thus, the idea of environmental change on a global scale soon became a permanent part of the western culture, and part of the international research agenda (John, 2012).

The concept of climate change, which is widely discussed today by concerned environmental scientists and all the member-countries of the United Nations, was invented in 1870 by Alexander Von Humboldt, a renowned German environmental scientist who had extensive graduate studies in climatology, geomorphology and human geography from the University of Gottingen in Germany. After his university education, Alexander Von Humboldt carried out extensive physical surveys on a number of countries overseas particularly the North and South American Regions. The findings from his successful field surveys revealed, inter-alia, gradual changes in natural coral reefs in the marine locations owing to warm temperatures and increase in environmental degradations with particular regard to human-induced soil erosion precipitated by unplanned deforestation for infrastructural construction and poor agricultural practices. The field surveys also indicated increased precipitation in the South American Region owing to presence of rivers, continuous evapotranspiration from the thickly Amazon forests and regularly received insolation in the region's atmosphere. Alexander Humboldt summarized in his text, titled '*Kosmos,*' that these observed physical changes and cultural occurrences on this part of the continent were significantly influenced by natural and human-induced climate change. This

unprecedented *concept of climate change* became a significant point of reference in modern philosophy of Climatology. Currently, this concept has assumed a new dimension specifically in contemporary Climatology and generally in other allied environmental disciplines based on its vast impacts on the global environment (Okhakhu, 2014).

The term, *Climate change*, as considered in contemporary climate studies, means a realistic modification in the general circulation of the atmosphere on which climate ultimately depends (Ayoade, 2004). The concept refers to observable increase in the mean temperatures of the earth's atmosphere, lithosphere, hydrosphere, biosphere, cryosphere and other constituent elements which formed the planet Earth owing primarily to unregulated anthropogenic activities. In this regard, greenhouse gases which include methane, carbon-dioxide, nitrous oxide, chlorofluorocarbons, perfluorocarbons, sulphur hexafluoride including aerosols are released into the planet's atmosphere where they continually serve as physical barriers to out-going infrared radiation from the earth's surface to outer space. This occurrence results in increased warming of the atmosphere with related impacts on the vast underlying environments. This definition, by scientific inference, practically suggests that climate change is global warming. Authentically, climate change implies a physical alteration in the normal process, pattern and interactive system of climatic elements with other essential global environments in such a unique dimension that both benevolent and malevolent consequences are produced (Okhakhu, 2014). These observed changes in climatic characteristics range from months to decades, and from hundreds of years to several millions of years (Botkins and Keller, 1998; Gobo and Eze, 2014).

In essence, climate change is robustly observed and profoundly experienced on the global environment in terms of occurrences of torrential rainfall or lack of precipitation, increased mean temperatures or prevalence of extreme cold, massive or absence of cloud cover, high solar radiation owing to partly depleted ozone layer of the atmosphere, abundant humidity or lack of it, and accelerated violent winds or absence of breezes which results in poor natural ventilation in the environment. In a very unique dimension, the occurrences of these extreme climatic essentials might not be precisely predicted using weather instruments available in most conventional meteorological stations. However, contemporary weather satellites fixed in outer space by scientists in the developed countries of the world are providing authentic services in this regard with a purpose to mitigate the malevolent consequences of extreme weather events on the global environment (Okhakhu, 2014).

According to Ayoade (2004), the global state of climate naturally depends on three essential factors. First is the amount of insolation received by the climate system from the Sun. Second involves the distribution and absorption mechanism of solar energy over the earth's surface. Finally, we have the nature of interaction processes among the various components of the climate system which include the atmosphere, biosphere, cryosphere, hydrosphere, and the lithosphere. These factors do not contribute to significant climate change of malevolent proportion. Authentically, the continuous natural hydrological cycle has been able to maintain a balance in the process of interaction among these closely related global spheres. Also, it must be stated that the planet Earth has its own natural greenhouse effect where certain gases such as non-adulterated water vapour, aerosols and CO_2 present in the atmosphere allow solar radiation to enter for partial absorption and retention. This natural process helps to keep the mean surface temperature on Earth around 14^0C. Of course, without the natural greenhouse effect, the Earth's mean surface temperature would be around -19^0C. This suggests that man, with his numerous activities, cannot survive under this extremely low temperature in the planet Earth (US Global Change Research Program, 2009). Based on this background, the human-induced climate change becomes the focus of this current scientific assessment owing to its extensive impacts on the global environment, particularly from the malevolent dimension.

During the previous century, the Earth's temperature was observed to have gradually increased from 0.3^0C to 0.7^0C. In the current decade, researching climatologists have predicted that its mean temperature increased between 1.5^0C and 3^0C. Apart from this contemporary instrumental record from conventional meteorological stations, there are other authentic independent sources of information to demonstrate the phenomenon of climate warming: massive glaciers have been receding, snow cover has declined, polar ice has been thawing, the sea levels have risen above normal conditions in coastal locations, climate-induced wild forest fires have become routine occurrences, torrential precipitation has increased world-wide, marine habitats have declined in resources owing to increasing temperatures, insect-induced human and agricultural diseases have become rampant, heat-island human ailments have doubled in dimension, drought and desertification have vastly intensified in marginal locations, many inland lakes have fluctuated in their original water composition, tropical-temperate spring has been earlier than anticipated, and unprecedented numbers of humans have died owing to extreme tropical heat, temperate cold, and freezing temperatures in the polar regions of the world (Victoria and Aqqaluk, 2008; John, 2012).

Over the past five decades, countries in the developed and developing world have relentlessly nurtured the desire to produce adequate as well as surplus means of sustenance to promote human life in the planet Earth. To achieve this vital objective, these countries have carried out multi-dimensional activities on the global environment which have, in part, neglected proper environmental development principles geared towards the

attainment of sustainable global development. For examples, multinational crude oil refineries in the oil-rich Niger-Delta Region of Nigeria have spilled millions of barrels of crude oil into most fertile agricultural soils and the immediate marine environment. Also, these industries have persistently flared natural gas into the clean atmosphere thereby polluting it. Of course, the pollution of land, forest, water and the atmosphere is certainly worsening in this part of the country. Flooding of land and submergence of coastal settlements by surging sea waters are clear indications of the malevolent consequences of climate change in the region. A sharp decrease in marine resources owing to increased sea temperature and torrential rainfall in the Niger-Delta region has, in addition, been documented in recent studies by both political and environmental scientists (Umukoro, 2013; Okhakhu, 2014).

From the African north of Cairo to its southern limit of Cape Town in South Africa, realistic consequences of climate change are clearly observable. Prolonged absence of precipitation, increased daily temperatures and prevalence of dry dusty winds have exacerbated the effects of food insecurity in the vast Saharan Desert which serves as a huge physical landmass for the countries of Burkina Faso, Chad, Egypt, Libya, Mali, Niger, Senegal and Sudan. The nationalities' struggle for food, water, fertile grazing lands, mineral resources, forest products, and convenient habitats for human lives have accounted for the state of insecurity in this part of Africa recently. In the Democratic Republic of Congo, serious cases of deforestation owing to logging and poor agricultural practices have recklessly ejected smokes with aerosols into the rural atmosphere thus polluting it and decreasing the normal torrential precipitation in the country. In Kenya, Zimbabwe and Malawi, regular occurrence of heavy rainfall during the spring has spurred massive soil degradation and flooding of coastal infrastructures which have vastly displaced coastal residents. Outside of the African continent particularly in India, Pakistan, Bangladesh, Sri Lanka, Malaysia and Thailand, continuous torrential rainfall and occurrences of violent typhoons have triggered massive mudslides, landslides, rockfalls, flooding and the collapse of socio-economic infrastructures on the earth's surface. A number of residents have died as a result of these environmental degradations. In New Orleans and New York in the USA, violent hurricanes of immense ocean's energy have caused the destruction of numerous socio-economic infrastructures. In Europe, particularly in Italy and Portugal, including parts of Australia and some small island States in the Southern Hemisphere, the record of environmental damages precipitated by climate change is similar in experiences as in other parts of the world previously itemized (Ellen, 2007; African Economic Research Consortium, 2008; Okhakhu, 2014).

A causal association between greenhouse gases and rising temperatures is inevitable in this global situation being assessed. Physical variation in Sun's energy output is also proposed as a possible cause of global warming currently. The rise in CO_2 and CH_4 concentrations in the atmosphere has been attributed to increases in anthropogenic activities, and these include vast energy production from fossil minerals and unabated emissions from rice fields, landfills, waste treatment, ruminant livestock management, mining operations and biomass burning. It is also significant to mention that periodic changes in the aerosol content of the atmosphere spurred by major volcanoes and heavy industrial ejections or biomass burning have the capacity to increase the mean temperature of the planet Earth (Ayoade, 2004; John, 2012). In all, these global occurrences have produced hazardous gases and chemicals such as carbon-dioxide, methane, nitrous oxides, aerosols, chlorofluorocarbons and sulphur hexafluoride which have the physical capacity to trap and retain certain percentage of infrared radiation within the planet's atmosphere. Particular mention must be made of sulphur hexafluoride which could spend more than a hundred years in the earth's atmosphere before withdrawing its destructive presence owing to subsequent natural purification process. It is against these problem-induced occurrences of vast dimension on the global environment in the 21st Century that *climate change* is assessed from its causes, consequences, preventions and mitigations in the current study from the climatologist's perspectives.

Causes of Climate Change

In its simple assessment, closely related natural factors which are terrestrial, astronomical and extraterrestrial are accountable for the occurrence of climate change. The terrestrial factor links changes in climate to variations in environmental conditions and occurrences. Marked changes in the distribution of land and oceans tend to exert a change in energy distribution and hence the general circulation and climate because of the well-known differences in the thermal characteristics of land and water surfaces. The theories of polar wandering and continental drift are used to clarify these occurrences. Shifts in the locations of continents and oceans would mean that some given areas would be located nearer or farther away from the poles or equator with concomitant changes in climate. Important also is the influence of orogenesis on climate. Mountain building processes could result in marked changes on the environment. A change in topography would exert some profound influence on the immediate climate particularly on its air flow, insolation, and other elements like precipitation, temperature and humidity. Volcanic eruptions and earthquakes could also release aerosols and other pollutants which are capable of affecting the transparency of the atmosphere, and consequently the amount of energy reaching or leaving the earth's surface. The extent of ice and snow cover on the earth's surface directly affects the albedo of the earth. This influences the general radiation balance of the planet and its climate (Ayoade, 2004).

Astronomical factors of climate change are distinctly premised on changes in the earth's geometry. These changes are observed in the eccentricity of the earth's orbit, in the procession of the equinoxes, and in the obliquity of the plane of ecliptic. Fluctuations of the eccentricity of the earth's orbit cause variations in the receipt of solar energy by the earth. The distance of the sun from the centre of elliptical orbit controls the distance of the earth from the sun at different times of the year as well as the duration of the four seasons. The last relates to extraterrestrial inducement of climate change which considers changes in the amount of solar energy reaching the earth owing to changes in the solar output or changes in the amount of solar radiation absorbed outside the earth's atmosphere. It is, therefore, important to sum up that, these natural factors examined in the preceding phases are incapable of exerting profound impacts on the world's climate such that cataclysmic occurrences would be experienced on the global environment.

Continuous applications of pesticides to eliminate adverse effects of pests in major agricultural establishments particularly as observed in the developed world have spurred the release of methylbromide into some water surfaces, fertile soils and the atmosphere. The chemical reaction of methylbromide with nitrous oxide and chlorofluorocarbon tends to deplete the ozone layer of the atmosphere. This negative occurrence permits rapid smooth sail of solar radiation through the atmosphere into the earth's surface for temporal retention and its eventual emission to outer space. Erupting volcanoes and earthquakes could spew sulphur dioxide, volcanic ashes, cinders and thick dusts into the earth's atmosphere thus polluting it. Wild forest fires induced by increased temperatures and thunder lightings have the capacity of releasing carbon-dioxide and aerosols into the natural environment. Added to these factors is the industrial production and maintenance of refrigerators with air-conditioners where chlorofluorocarbons are irresistibly released into the atmosphere. The continuous refinement of crude oil into petrol, aviation fuel, diesel, oil, and kerosene including natural gas production in heavy refineries in crude oil-rich countries of the world has caused the release of vast quantities of greenhouse gases particularly carbon-dioxide, methane and nitrous oxides into the planet's naturally clean atmosphere. This singular activity is the primary cause of climate change in the world today (John, 2012).

The recent explosion of human populations from 6 billion to approximately 9 billion worldwide with a reciprocal proliferation in anthropogenic activities has strongly exacerbated the release of greenhouse gases into the planet's atmosphere. Massive exhausts from the use of numerous cars, motorcycles, trains, domestic power-generators, airplanes, industrial and public office energy plants, including miscellaneous waste burning in open fields by people have added a new dimension to the current challenges being experienced on the global environment. Currently in New Delhi, India, and Beijing in China, radical efforts are on-going on the part of government authorities to stamp out massive vehicular release of carbon-dioxide and aerosols into the urban atmosphere with a view to restoring quality air for normal human respiration and other relevant uses.

Recent scientific studies have established the facts that atmospheric carbon-dioxide concentrations have increased by almost 40% since the pre-industrial times from approximately 280 parts per million by volume (ppmv) in the 18th century to 390 ppmv in 2010. The current CO_2 level is higher than it has been in at least 800,000 years. Human activities currently release over 30 billion tons of CO_2 into the Earth's atmosphere every year. This build-up in the atmosphere is like a tub filling with water where more water flows from the faucet than the drain can channel off (US NRC, 2002).

The preceding discourse has clearly recognized two major types of climate change. The first is 'natural climate change' which concerns a physical change in the normal climatic processes, occurrences, and patterns which cannot exert profound and cataclysmic consequences on the global environment. Cataclysmic consequences in this regard relate to massive occurrences of environmental degradations particularly coastal sea surges, mudslides, landslides, rockfalls, flooding, soil, wave, ice and wind erosions, and ice thawing which are caused by extreme climatic forces such as torrential precipitation, atmospheric lightning, thunderstorms, hurricanes and high daily mean temperatures. The second is 'human-induced climate change' spurred by inadvertent and deliberately released greenhouse gases and other related dangerous chemicals into the earth's atmosphere which are capable of causing serious and destructive occurrences on the global environment as a result of extensive increase in mean temperatures. Flooding of settlements, destruction of established socio-economic structures by hurricanes, spread of heat waves with related human ailments, and occurrence of landslides are realistic cases in scientific records.

Effects of Climate Change

In the coastal areas of the world where sea levels are altered as a result of thawed ice and snow caused by increased surface temperatures, extensive flooding of built infrastructures and submergence of fertile agricultural lands and crops would be experienced. The people who live in flooded settlements are always vulnerable to water-induced diseases such as cholera, typhoid, malaria and dysentery. The treatment of residents affected by these diseases would consume substantial part of their daily savings and these might not be easy to afford as such plans were not previously conceived to tackle these unforeseen human health challenges. In similar locations where hurricanes, typhoons and other violent winds are experienced, massive damages of private and public

properties will also be observed on the environment. In situation as this, normal terrestrial and marine resources for human sustenance would be scarce to afford, and with serious human health challenges on the rise also, sustainable human development would definitely be unattainable in these coastal environments. This suggests that inadequate infrastructures, scarcity of food for human's healthy life, rampant poverty and insecurity of lives would be broadly observed in these coastal environments.

Proliferation in earth's surface temperatures and occurrence of torrential precipitation would result in broad accelerations in sea-ocean temperatures and inland waters. A number of marine habitats would be largely dislodged and destroyed, and consequently sea-ocean resources would decrease in supply in such locations. A colony of known reptiles and animals like crocodiles, alligators, pythons, snakes, sharks, hippopotamuses and fish would migrate to more receptive cooler parts of the oceans to live. Increased tropical ocean temperatures would further spur occurrences of violent hurricanes and typhoons which arrival on coastal settlements would cause profound destruction of many socio-economic and political structures worth billions of dollars to reconstruct in the future. Low-lying environments like New Orleans and Florida in the USA, Lagos and Bonny in Nigeria, some states in Italy, including prominent cities of the world and some entire small island states like Madagascar, may be broadly inundated as a result of thermal expansion of the oceans and melting of ice. Rates of rise in sea level, according to John (2012), are likely to be in the range of 0.20-0.86m from 1990 to 2100.

Food supplies to markets, particularly in the drought-prone developing humid tropics of the world, would experience a sharp decrease in tonnage. Increased temperatures in these locations would cause a decrease in soil moisture which is available to cultivated crops owing to rapid surface evaporation. On the other hand, the prevalence of torrential precipitation in routine cycle would stimulate the occurrence of soil erosion in some agricultural locations. Furthermore, some cultivated crops would be eroded while the presence of excessive soil moisture devoid of commensurate sunlight would lead to poor crop yields and consequently unfavourable harvests. Unfavourable harvests simply imply inadequate food production for human consumption which inevitably results in starvation and poor human health. In the polar regions of the world such as Siberia in Russia and Sweden in Europe, rapid thawing of ice and snow would pave suitable avenues for new agricultural lands to be developed based on efficient technology, skilled labour, adequate funds, favourable climate and participatory market. The impacts of this new development would be largely experienced in abundant food and cash crops production as well as supply to the world market. The governments of these regions should anticipate these laudable developments in the agricultural sector of their complex economies.

In some marginal locations of the world, particularly in the Sahel savanna, drought and desertification would likely prevail and might even intensify in dimension. Water and food scarcity would be experienced in these locations. Also, the inadequacy of these essential resources in some arid areas might trigger some civil upheavals among the interacting communities. As Ayoade (2004) observed, drought and desert locations of the world are regularly vulnerable to extreme heat stresses, absence of food and water, poor visibility, poor biodiversity, snake bites and occurrence of many diseases. The West African Sub-Region and parts of Ethiopia, Kenya, and Namibia in Africa are vulnerable to these occurrences.

The prevalence of extreme climatic forces such as high temperatures, sea waves, violent winds and dangerous thunderstorms could promote profound weathering and alteration of colours of some built socio-economic and political structures available in some locations on the global environment. The observed case of the humid tropics is cited in this aspect of the discussion. Also, some of the built houses sited on unstable surfaces could collapse owing to tremendous pressures persistently exerted by extreme winds and torrential rainfall. The original colours of machinery installed in industries and automobiles found in locations which atmosphere has been altered by the presence of chlorofluorocarbons, carbon-dioxide and methane would be changed in physical appearance. In one part, acid rains could fall on the underlying environments, thereby polluting everything found on its course of flow. On the other hand, the humans living in these locations such as Beijing in Asia and the Netherlands in Europe would experience some unique difficulties in respiring alongside skin cancers, cataracts of the eyes, and related lung cancers. Increased terrestrial temperatures are capable of inducing intense water evaporation from lakes, rivulets, streams and dams. This occurrence might result in serious water scarcity for adequate hydropower production. Increased surface temperatures could cause excessive human perspiration which leads to dehydration with its associated ailments particularly body debility and poor resistance to diseases. The observed case of the Lake Chad in West Africa which surface water has retreated significantly from its original banks to its current position over the decades is a genuine justification of our explanation in this regard.

It has been authentically prognosticated that many of the world's main food producing regions might become too hot and dry for crops to grow abundantly as it was in past centuries. This would include the major 'bread or food basket' regions of Central and Southern Europe and North America. The overall consequences of this occurrence would be profound reduction in the world's agricultural productivity and hike in food prices. In this regard, the rich people would be able to purchase their normal nutritional requirements at exorbitant prices while the poor humans would experience marked food scarcity with its associated starvation consequences. We

might postulate in the current study that the world's agricultural deficiency could be closely balanced by the anticipated agricultural revolution and productivity in Russia owing to recent thawing of ice as analyzed at the outset of the study. It is also suggested that diseases are likely to spread from the tropics to the temperate and northern regions as the climate continues to warm. Conspicuous outbreaks of pests might become more extreme as the natural biological control processes might not be present continually. Of particular concern is the northern spread of insect pests which damage crops or transmit diseases. One such authentic illustration is the Lyme disease, which is a life-threatening disease borne by ticks and observed to be more rampant in the United Kingdom during warm seasons (John, 2012).

The closely related 'four F gases' are chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. These gases are widely utilized for making coolants, foaming agents, fire extinguishers, solvents, pesticides and aerosol propellants in the industries. The developed world leads in the production of these essential manufactures. Recent studies have authentically established that these gases, having escaped into the planet's atmosphere, do have a long lifetime there, stretching from decades to hundred years beyond. It has been established also that these gases possess the potentials of depleting the atmospheric ozone layer which clearly serves as the natural shield for all living species on the underlying environments against the Sun's ultraviolet radiation (US NRC, 2002).

In our immediate environment, the adverse effects of climate change are noticeable. The inside weather of some built houses has become increasingly hot for the desired comfort of some humans particularly during the daytime owing to received and absorbed solar radiation. A resort to the use of electrical appliances like ceiling and standing fans, air-conditioners and refrigerators has become the timely measure to such an unbearable hot weather. The regular use of these appliances demands functional sources of power which, as observed in the developing humid tropics, are practically inadequate because of poor technology, dearth of funds and inefficient management. Routine utilization of electrical generators to power means of ventilation provision in most built houses also contributes largely to unpleasant noise pollution in the immediate environment and the release of greenhouse gases into the earth's atmosphere. Of course, noise pollution induced by electrical generators always disrupts most academic activities on the environment, it produces dark smokes which physically impair atmospheric visibility of people, and it prevents the benefits which accrue from the prevalence of silence on the environment. High temperatures induce continuous evaporation of moisture from water bodies, vegetal covers and bare lands into the atmosphere. During the days and nights, massive clouds are produced in the atmosphere. When these clouds are mixed with aerosols, carbon-dioxide and methane, they form dangerous clouds of poor visibility known as smog. Smog could present very serious obstacles to the smooth navigation of airplanes in the atmosphere, ships at seas, trains on their tracks, and automobiles on the roads. Different road and rail accidents, ship wrecks and air disasters are consequences of poor atmospheric visibility regardless of issues of direct mechanical failure and poor human control.

On the positive dimension, increased transpiration in a warm world leads to formation of more clouds in the atmosphere. Also, deforestation in the world directly accelerates soil erosion and promotes the release of more aerosols into the earth's atmosphere. On the earth's surface, solar radiation would decline owing to its poor reflectance. In addition, increased precipitation and thawing of ice would give rise to accelerated run-off into some sensitive parts of the oceans. This phenomenon would alter the original equilibrium between fresh and saline waters thereby reducing ocean circulation and allowing the northern high latitudes to cool. These major environmental occurrences would, no doubt, produce extensive cooling throughout the planet Earth (John, 2012). As Okhakhu (2014) argued, increased ocean temperatures could stimulate the rise of hurricanes in the coastal environments. Characteristically, hurricanes have the potentials to airlift fertile sands from the ocean and deposit same in nearby coastal locations as rich alluvial soils. These fertile soils can be used for both domestic and commercial agriculture as well as green zone development in cyclone-prone locations. The immense contributions of agriculture to human existence, income generation, food provision, and the stability of the global economy cannot be over-discussed.

As it is, it appears that more salient effects of climate change will be observed in some years ahead on the global environment. However, as authentic scientific studies have shown, we can conveniently argue that climate change has impacted both the physical and human aspects of the global environment: the climate-system and all anthropogenic activities which range from agriculture, infrastructures, water resources, human health, scientific researches, recent innovations, businesses, national security, international politics, and governance to world's security.

Research Findings

Based on in-depth assessment of climate change with regard to research problem, causes, and vast effects on the global environment in the previous sections, the following findings are made.

The study observes that the global state of climate, in part, depends naturally on the amount of insolation received from the Sun, distribution and absorption mechanism of solar energy over the Earth's surface

and the nature of interaction processes among the various components of the climate-system. This state of climate is balanced essentially by the hydrological cycle and the natural greenhouse effect.

It notes that during the past 20th Century, the Earth's mean temperatures increased from 0.3^0C to 0.7^0C owing significantly to moderate human activities in the primary, secondary and tertiary sectors of the global economy. As a result of extensive anthropogenic activities which violated established environmental principles of sustainable development in the current 21st Century, the Earth's mean temperatures were observed to have increased between 1.5^0C and 3^0C by researching environmental scientists.

The study observes the existence of natural and human-induced climate change. The former concerns a physical change in the normal climatic processes, occurrences and patterns which are cataclysmic impacts free while the latter spurs serious disruptive occurrences on the climate-system. It also notes that increasingly uncoordinated anthropogenic activities currently release over 30 billion tons of carbon-dioxide into the Earth's atmosphere per annum.

The study clearly observes, on the one hand that, climate change is spurred by terrestrial, astronomical and extraterrestrial factors where variations in environmental conditions and occurrences such as orogenesis, volcanic eruptions, earthquakes, the distribution of lands and oceans, and changes in Earth's geometry and amount of solar energy reaching the Earth stand as the most significant. On the other hand, the study reveals that increased anthropogenic activities which include vast energy production from fossil minerals in heavy refineries and continuous emissions of different gases from rice fields, landfills, waste treatment, ruminant livestock management, mining operations and biomass burning are the primary causes of climate change. These human activities release greenhouse gases such as CO_2, methane, nitrous oxide, chlorofluorocarbons and aerosols into the earth's atmosphere where they accumulate by obstructing the normal emission of infrared radiation into outer space. The persistent presence of these heat-trapping gases in the atmosphere results in large-scale environmental warming.

The study reveals that the negative effects of climate change are extensively global in dimension. In Africa, particularly in the West African sub-region, serious drought and desertification, inadequate water for human consumption, food insecurity, absence of grazing lands, and inundation of built infrastructures are observed. The nationalities' excessive struggle to acquire these scarce means of human existence has given rise to civil, military and terrorist upheavals in the region. Also, increased temperatures spurred by intensive deforestation for natural logs and firewood including rudimentary agricultural practices in the Democratic Republic of Congo, Ethiopia, Kenya, Zimbabwe and Malawi have resulted in devastative environmental inundation and continuous ejection of CO_2 into the region's atmosphere thus exacerbating the deplorable state of global climate.

It shows that climate change is apparently accountable for the dislodgement of a number of marine habitats in the humid tropics which results in physical migration of known reptiles, animals and different fish species to cooler regions of the world endowed with more receptive mean ocean temperatures. The study observes that low-lying environments, including prominent coastal cities and some entire small island states of the world would be inundated by surging ocean waters inlands owing to thermal expansion and vast melting of ice if efficacious measures are not adopted by countries of the world.

Decrease in fertile soil moisture through evaporation and evapotranspiration spurred by high solar radiation and occurrence of torrential precipitation induced surface degradation of farm products would result in decreased agricultural productivity in the developing humid tropics. This would cause hike in market food prices and consequent food scarcity in these parts of the world. The study observes that extreme climatic forces are accountable for the routine weathering and collapse of some built social, economic, political, and religious structures on the global environment. Increased terrestrial temperatures in the developing humid tropics have also resulted in rapid evaporation of stored waters in small dams thereby decreasing the hydropower generated for various human consumptions.

Preventions and Mitigations

The devastative effects of climate change are most pronounced in coastal settlements and metropolitan cities of the world where high human populations are concentrated. Excessive inundation of houses owing to thermal expansion of the oceans and down slope river deposition of water and sediments are causal factors as indicated in the study. On this note, it is recommended that prompt relocation of coastal settlers to higher grounds for permanent safety should be carried out. These new environments must have adequate and comfortable houses installed with contemporary heat-reducing facilities for human utilization. In addition, functional socio-economic and political services physically observable as hospitals, financial institutions, markets, post offices, different workplaces, transport means, police stations, and recreation centers should be provided through the combined efforts of governments, corporate organizations and private bodies in the settlements. Proper environmental sanitation which requires continuous disposal of wastes in a manner where exacerbated environmental pollution is not created is suggested for implementation in both the new settlements and old cities of the world. This

approach needs to be complemented by relocating heavy heat producing machinery and industries from the city centers to the pristine country side. These suggestions should be consolidated with national laws and guidelines which are genuinely implementable on the environment, with the understanding that climate change is the direct result of poor anthropogenic activities carried out by each country which accumulated to a disproportionate damaging level today.

Functional optimum populated settlements which are immune from heat-island effects should be established in certain locations on the earth's surface. This recommendation requires planned settlement establishment which starts from the local, through the regional, and completes at the national level within countries. It is a practicable polycentric approach to mitigating the emission of anthropogenic greenhouse gases into the clean environment. Specifically, certain percentage figures of humans should be allowed to settle and live in some town and cities. This would help regulate the generation and circulation of anthropogenic and technological heat across the entire region. This measure calls for a complementary practice of green belt rehabilitation in urban environments. Established green belts in cities have the natural potentials to produce refreshing breezes required for continual human well-being. They can also serve as physical shields against occurring violent rain and wind onslaughts on the city infrastructures and populations. In addition, established green belts assist immensely in the dispersion of aerosols towards the country side. This is a natural atmospheric purification process which is cheap to sustain physically and financially, and it is essentially beneficial to urban residents in the aspect of quality air provision for hygienic respiration and body stability.

The study reveals that bush and wild forest fires, including massive deforestation, contribute significantly to occurrence of climate change. Prevention of bush and wild forest fires through awareness creation using public campaigns, radio, television, and internet networks is suggested for continuous enforcement. Effective monitoring of the dynamics in forest landscapes particularly during the summer in temperate locations and dry season in the humid and dry tropics using high resolution satellite cameras and incorporation of direct human inputs is necessary to halt the incidents of fire outbreaks in vastly rich and deeply weathered forests on a global scale. This would partly eliminate the release of carbon-dioxide into the atmosphere thus mitigating the adverse impacts of climate change discussed in previous sections of the current study.

All mining, quarrying, crude oil and gas refining activities on the earth's surface should be properly regulated, monitored, supervised, and diligently managed throughout the world to prevent environmental pollution. This measure can be achieved by directly incorporating the invaluable services of experts in the mining and refining activities. These required experts, to be specific, include petroleum, mechanical, production, civil, and structural engineers, chemists, physicists, geologists, climatologists, architects, biologists, conservationists, economists, and remote sensing analysts. This suggestion represents the first significant phase among other vital attempts to prevent the emissions of greenhouse gases into the global atmosphere.

There should be a global ban on the utilization of chlorofluorocarbons to produce coolants, fire-extinguishers, solvents, foaming agents, aerosol propellants, and pesticides. This prohibition should be announced and enforced by the United Nations, and it must be faithfully respected and implemented by all countries. Chlorofluorocarbons are known for depleting the ozone layer of the earth's atmosphere thereby stimulating easy penetration of high solar energy through the troposphere towards the underlying environments. In this regard, we suggest that perfluorocarbons and hydrofluorocarbons which are notably hazard-immune and environmental-friendly, specifically with regard to the planet's atmosphere, should be used in the production of these electrical and mechanical essentials for continuous human existence and sustenance. However, these manufactures should be carefully used in our houses, office buildings, hotels and recreation parks so as to prevent excessive heat emission into the global environment without exacerbating the negative impacts of climate change.

This applicable measure leads us to the climatic concept of improved energy efficiency in our homes and office buildings which, as discussed by Okhakhu (2013), can reduce significantly greenhouse gas emissions into the environment with additional benefits of mitigating the risks of human-heat related ailments. The buildings that are older and poorly insulated, or made of some materials that retain heat, require more energy to regulate temperature. Improving the insulation of buildings and utilizing innovative building techniques such as putting gardens or vegetation on the roofs of buildings can reduce their physical capacity to retain heat. This in turn decreases energy use, leading to decreased greenhouse gas emissions. In the event of a heat wave, these 'cool' buildings would also provide a place for people to cool off, thereby reducing their risks of heat-related illnesses. Additionally, 'cool' buildings could decrease the heat-island effect, and this would mitigate the people's susceptibility to heat-related illness (Cutter and Finch, 2008).

Efficient energy use simply known as energy efficiency, is the goal of efforts to reduce the amount of energy required to provide products and services. For example, a careful insulation of a building allows it to use less heating and cooling energy to achieve and maintain a comfortable temperature. Also, the installation of fluorescent lights or natural skylights helps to reduce the amount of energy required to attain the same level of

illumination compared to using traditional incandescent light bulbs. In realistic situation, most compact fluorescent lights use two-thirds less energy and may last 6 to 10 times longer than incandescent lights. In fact, energy efficiency has become a significant cost-effective strategy for most building economies without necessarily increasing their energy consumption. As observed, the State of California in the USA started the implementation of energy-efficiency measures in the mid-1970s, including building code and appliance standards with strict efficiency requirements. During the following years, the State of California's energy consumption remained approximately flat on a per capita basis while the national US consumption doubled. As part of its strategy, California implemented a 'loading order' for new energy resources that puts energy efficiency first, renewable electricity supplies second, and new fossil-fired power plants last (Diesendorf, 2007).

New buildings can be constructed using passive solar building design, low-energy building, or zero-energy building techniques by using renewable heat sources. Existing buildings can be made more efficient through the use of insulation, high-efficiency appliances particularly hot water heaters and furnaces, double or triple-glazed gas-filled windows, external window shades, and building orientation based on selective location. Dependence on the use of renewable heat sources such as shallow geothermal and passive solar energy can reduce the amount of greenhouse gases emitted into the environment. In addition to designing buildings which are more energy efficient to heat, it is also possible to design buildings that are more energy efficient to cool by using lighter-coloured and more reflective materials in the development of urban areas. This approach saves energy because it cools buildings and reduces the urban heat-island effect thus reducing the use of air conditioning (Committee on Science, Engineering and Public Policy, 1992; Rosenfeld, Romm, Akbari and Lloyd, 1997).

It is relevant to integrate transportation and land use policies in some parts of the global environment. As Younger, Morrow-Almeida, Vingigni and Dannenberg (2008) argued, better integration of transportation and land use policies can reduce the production of greenhouse gases and improve the health of urban residents across the world. In places with greater distances between homes, workplaces, and everyday destinations, commuters drive more and produce more automobile emissions. By developing communities where our everyday destinations such as schools, workplaces, daycare centres, and post offices, among others, are closer together and linked by easy accessible transit services, the number of cars on the road can be reduced. Less driving means reduced car exhausts, reduced greenhouse gas emissions, and improved air quality. In addition, the development of neighbourhoods with accessible destinations close by can lead to increased physical activity within the community, with more people choosing to walk to work or to run an errand. This will reduce immensely motor vehicle collisions, improve air quality, and strengthen human physical fitness.

As observed in the study, persistent emission of dangerous greenhouse gases into the global environment is the primary cause of climate change, although other natural and anthropogenic factors also apply. Based on this observation, this study suggests that enforceable national and international guidelines should be put in place by member-countries of the United Nations to regulate and control the ejection of these dangerous gases into the global environment. Guidelines in this consideration are assessed in four major phases which are environmental, economic, social, and political. The environmental phase suggests that absolute reliance on the use of fossil minerals for energy generation and provision in contemporary cities of the world should be replaced with clean and renewable energy sources such as geothermal, solar, wind, water, ethanol, and tidal powers. These energy sources are totally hazard-immune and vastly environmental friendly. There should be 82% global reduction in the release of greenhouse gases into the environment (John, 2012). This should be complemented with a general education of the global populations that the planet Earth must be maintained and sustained for future generations to live comfortably and survive. The economic phase requests adequate funding of all renewable power sources by government authorities, business organizations and private bodies. The continuous costs of monitoring, maintenance, security provision, and management of these renewable power sources by experts to ensure improved performance are included in the economic phase. The social aspect relates to research sustenance on the part of energy scientists with a purpose to eliminate obstacles on the energy sector and to educate the global populations on the need to adhere strictly to the twin-concepts of energy conservation and energy efficiency. The politics of energy provision relates to enactment of national codes and foreign ethics which must be satisfied by all the business interests so as to prevent the pollution of the global environment which can lead to unprecedented challenges so immense for government authorities to control urgently.

As revealed in the current study, CO_2 is one of the most frequently emitted greenhouse gases into the global environment. Its production, emission into, and concentration in the Earth's atmosphere should be regulated and urgently stabilized using the most recent technologies and techniques devised by scientists. The use of carbon sinks, carbon capture and storage is suggested as a first measure. A carbon sink is defined as a natural or artificial reservoir which accumulates and stores some carbons containing chemical compounds for an indefinite period. Some suitable storage locations in this regard include subterranean geologic formations, the oceans, some specifically designated water bodies and forests. However, the storage of carbons in the oceans and forests could cause acidification of these natural surfaces, and the realistic results would be observed in poor

larva development, delayed formation of shells in some living species like crocodiles, snails, ducks and other marine birds, and reduced natural respiration in marine animals. The carbon capture and storage is a method devised to mitigate climate change by capturing CO_2 from large point sources and storing it away safely in secured enclosures instead of releasing it into the environment. Above all, high carbon emission intensity power sources should be replaced with very low carbon power sources. Authentically, electricity provision by renewable energy sources would deliver the largest proportional carbon reductions under an economically efficacious climate policy in this consideration.

Based on its devastative consequences on the environment when immensely affected by earthquakes and volcanic eruptions, the uranium fuelled nuclear power should be replaced with thorium based nuclear power because the latter is better cost-effective to establish and maintain, safer and cleaner in nature, more reliable in energy provision, hazard-immune to the environment, and proliferation resistant. In fact, reducing energy consumption would help the world community to prevent and reduce the emission of greenhouse gases into the global environment. Similarly, all established renewable energy sources throughout the world should be carefully managed by experts to prevent the incident of over-heating which, in turn, results in inadvertent emission of high heat energy into the global environment.

It is very essential to effect a change from the passengers' over-dependence on the safety of air and truck means of transport to contemporary electric rail transport which is free from the release of greenhouse gases into the global environment. Also, the use of reliable communications technologies such as video-conferencing and internet discussions to conduct vital academic and business activities would further mitigate the hazards involved in long distance air flights which affect both the travelers and the underlying environments.

Effective population control measures should be carried out world-wide to reduce its vast negative impacts on the global climate-system. These measures are necessary because the more the populations the more accelerated human activities would be on the environment and these would contribute greatly to the emission of greenhouse gases into the global system. Therefore, improved access to family planning and reproductive health care premised on adequate information on the part of world community is necessary. In addition, improved access of women to formal education and rewarding economic opportunities including reduction in natalistic politics is recommended for urgent implementation by different government authorities across the world. The overall essence of these recommendations is to regulate anthropogenic explosion and the release of greenhouse gases into the atmosphere.

Proper and objective land-use planning is necessary throughout the world in order to mitigate anthropogenic heat production and emission of greenhouse gases into the global atmosphere. First, compact community development and standard practices designed to rehabilitate and conserve urban green space should be carried out based on experts' specifications. Second, mixed land-uses should be encouraged while multiple transportation choices should be available for people's easy selection. In this regard, practical focus must be on the use of surface and overhead bicycle and electric rail transportation. The surfaces on which the structures are established and services provided should be designed to reflect much solar energy into space thereby creating relatively cool conditions for comfortable human habitation.

In addition, the world's economy should be partitioned into a number of sectors such as agriculture, forestry, water resources, mining and quarrying, energy provisions, industrial aspects, social establishments, and the tertiary components. Standard restraints must be exercised by the world's countries in carrying out vital activities in these sectors identified. Furthermore, functional high-resolution satellites would have to be installed by experts in space to monitor these on-going activities on the global environment. The philosophy of complete dependence on the crude oil and gas sectors for the supply of required powers for use in different aspects of the global economy should be replaced with rational focus on the utilization of clean and environmentally friendly renewable energy sources such as geothermal, wind, tide, water and solar. This specific measure would help mitigate the widespread emissions of greenhouse gases into the natural global environment.

The current international agreement on combating climate change is the Kyoto Protocol which came into force on 16th February, 2005. The Kyoto Protocol is the formal amendment to the United Nations Framework Convention on Climate Change (UNFCCC). The member-countries that have ratified this protocol have made irrevocable commitments to reduce the emissions of carbon-dioxide with five other notable greenhouse gases into the global environment, or engage in emissions trading if they maintain or increase the emissions of these gases. This international agreement on mitigating the adverse effects of climate change on the global environment took place in Kyoto, Japan, in 1997. Other important global conferences held with vital promises to proffer realistic measures to reduce and prevent climate change were the 1992 Earth Summit in Rio de Janeiro, Brazil, the 2007 European Union Green Summit, and the recent Lima Summit in Peru, South America. These summits, no doubt, represent some significant global mitigation efforts directed at the negative impacts of climate change on the environment. In 2010, member-countries to the UNFCCC agreed that future global warming should be limited to below 2.0^0C relative to the pre-industrial revolution level. Based on the observed magnitude of destruction induced by climate change across the world in recent months, this current

study suggests a target of limiting global warming to below 1.5^0C relative to the pre-industrial revolution level. In other words, the mean global temperature should be stabilized below 1.5^0C using all the relevant measures suggested in the current study.

Conclusion

Climate change, as established in the study, is the most cataclysmic human-induced environmental occurrence observed since the planet Earth evolved in 4004 BC. Terrestrial, astronomical, and extraterrestrial natured factors are its elementary causes. These natural factors have been largely exacerbated by uncoordinated anthropogenic activities in the mining, agricultural, transportation, forestry, and urban environment planning sectors leading to emissions of greenhouse gases into the global environment. These unique activities have resulted in increased global mean temperatures from 1^0C to 2^0C relative to pre-industrial revolution level. Massive ice thawing in the polar region, increased ocean-sea waters, sea surges inlands, flooding of towns and cities, destruction of human properties, prevalence of diseases, urban heat-island crises, food insecurity, water scarcity in marginal locations, and unhealthy political struggles over fertile lands, water, minerals and other related resources were observed as effects of climate change on the global environment. Reduced emissions of dangerous greenhouse gases into the environment, adherence to standard environmental planning principles, urban green belt conservation, the use of carbon sink, capture and storage techniques, population control, resort to utilization of renewable energy sources, adoption of standard sanitation measures, and adherence to proper transport regulations in urban areas, inter-alia, were suggested for global implementation to prevent and mitigate the adverse effects of climate change on the complex environment. The final implementation of measures must be polycentric in nature and holistically integrative: embracing all the local, regional, national and the international authorities. International business interests, corporate organizations, philanthropic societies and the United Nations must make their contributions significantly felt in this consideration.

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