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The economics of climate change and health: a review

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Abstract

Global climate change poses a threat to the well-being of humans and other living things through its impact on the ecosystem functioning, biodiversity, capital productivity, and human health. Climate change economics attends to this issue by offering theoretical insights and empirical findings relevant to the design of policies to reduce, avoid, or adapt to the climate change. The goal of this paper is to review the most relevant papers on economics of the climate change and health and what adaptation and mitigation policies are available. A systematic search of literature published from 1993-2011 was conducted. Grey literature (conference papers, technical reports), journal articles, abstracts, relevant books and internet articles were reviewed. The review showed that economic analysis has yielded estimates of mitigation benefits and improved understanding of costs of climate change action. These costs include costs of mitigation, adaptation, transition to new technologies and sources of energy. The costs of climate inaction, the difference between costs under the "business-as-usual" scenarios and an optimistic "rapid stabilization" scenario are the human, economic, and environmental damages that may be avoidable with timely actions to reduce green house gas emissions. Inaction on climate change would lead to damages worth 5% - 20% of gross domestic product (GDP). Most of these damages could be prevented by spending 1% of GDP on mitigation. In conclusion, when costs are incurred to reduce emissions today, the benefits of reduced climate change will occur decades or centuries later implying that it makes economic sense to take action now to secure those future benefits.

Key words: Climate change, Cost, Economics, Health, Mitigation, Adaptation

Introduction

Climate change has been called "the biggest global health threat of the 21st century" [1] It is the most reckless *market failure* the world has ever seen. Since the industrial revolution, activities of people have polluted the environment without paying for it probably because we did not value the environment, leading to tremendous concentration of green house gases (GHG) in the atmosphere. Every company, every farm, every household emits some GHGs as they are fundamental to our food production and our energy system. The warming now is caused by GHG, emitted decades ago by human activities mainly by the burning of fossil fuels releasing carbon dioxide (CO2). [2]

The emissions cumulate in the atmosphere and damage caused arises from the concentration of the gases and not from the current emissions themselves. Each GHG resides in the atmosphere before decaying naturally: CO2 persists for 2 to 200 years, methane for 12 years, nitrous oxide for 114 years, and in the case of perfluoromethane upwards of 50,000 years. [3] This warming has been linked to more extreme weather conditions such as intense floods and droughts, heavier and more frequent storms. It has been noted that the earth`s surface has warmed by more than 0.8 ^{O}C over the past century and by approximately 0.6^{O}C in the past three decades.[4] These CO2 emissions continue to rise and climate models project the average surface temperature will rise by 1.1^{O}C to 6.4^{O}C over the 21st century. [5]

Climate change therefore is a result of an "externality associated with GHG emissions". [6] In this case, the externality refers to the costs associated with transactions which are not accruable to the producer. In other words, **c**limate change is partly the result of an approach to development and economic growth that has proven to be unsustainable. The problem is more complex, and more uncertain than any other environmental problem. The health risks generated by warming include increased risks of extreme weather such as fatal heat waves, floods and storms**.** Less dramatic but potentially more serious effects are seen on: infectious disease dynamics, long term drought conditions in many regions, melting of glaciers that supply freshwater to large population centres and increase in sea level leading to salination of sources of agriculture and drinking water. [7] These risks are inequitable in that the GHGs that cause climate change originate mainly from developed countries but the health risks are concentrated in the poorest nations which have contributed least to the problem. [8] This is because, climate change is a development, economic, and investment challenge and it is believed that the poorest countries are more vulnerable to the effects of climate change since they possess the least capacity to respond to such health effects. Furthermore, poorer countries tend be hotter and therefore closer to biophysical temperature limits and short on spatial analogues should it get warmer still. [9]

Specifically, some of the health effects include

- More variable precipitation patterns are likely to compromise the supply of freshwater, increasing risks of water-borne disease.
- Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions, increasing risks of malnutrition.
- Rising sea levels increase the risk of coastal flooding, and may necessitate population displacement. More than half of the world's population now lives within 60 km of the sea.
- Changes in climate are likely to lengthen the transmission seasons of important vector-borne diseases, and to alter their geographic range, potentially bringing them to regions that lack population immunity and/or a strong public health infrastructure
- The spatial and temporal distribution of vector-borne diseases like malaria and dengue has been projected to increase due to favourable temperatures, with resulting alterations of communicable disease dynamics.[10]

Sub-Saharan Africa (SSA) is prone to climate change because it suffers from natural fragility (two-thirds of its surface area is desert or dry land), there is high exposure to droughts and floods, the economy of the region is prone to collapse because of dependence of SSA's economies on natural resources, reliance on biomass for the provision of 80% of the domestic primary energy supply, dependence on rainfall for agriculture which contributes some 30% of GDP and employs about 70% of the population.[6] With poor infrastructure, water storage and supply, efforts aimed at mitigation and adaptation to climate change effects will be hampered.

In Nigeria human settlements will be affected by climate change in a variety of ways. Extreme climate change such as tropical storms, floods, landslides, wind, heat and cold brings with it droughts, floods, and sea-level rise. Urban and rural population concentration will be disrupted, especially along the coast due to the rise in sea levels. Some settlements are known to have already relocated farther inland from their original sites because of this. Rises in sea-levels will also threaten urban and rural facilities in low-lying coastal regions, as evident in Lagos.

The primary activity in Nigeria that adds to climate change is the release of harmful substances into the atmosphere from the oil and gas extraction sector, mainly from gas flaring throughout the Niger Delta and off shore. The secondary activity is the cutting of trees and the loss of forests from logging and the use of trees as firewood and for wood products. Reliance on firewood for home-heating is part of the equation. Nigeria destroys close to 600,000 hectares of her forests annually in feeding these industries. [11] Apart from the use of firewood, the reliance on freezers, fridges and washing machines contribute to climate change, as does exhaust from cars and trucks, especially the use of luxury cars, generators and similar items for the more upwardly mobile. All these activities lead to the release of GHGs to the atomsphere which are the major contributors to climate change.

In essence, the climate change story is not different in Nigeria. The impacts have started taking its toll. Using time series and variability analyses, Anuforom and Okpare[12] demonstrated some climatic variations which appeared as fluctuations of wet and dry years in an irregular pattern. The study suggested that most rainfalls between 1944-1970 and 1991-2001 were above normal for the four different climatic zones in Nigeria (mangrove forest along the coastline; Tropical Rainforest in the southern part; Guinea savanna in the middle belt and Sudan/Sahel savanna in the north), while the rainfalls between 1972-1975, and 1983-1989 were below normal. This has led to water stress/scarcity which exhibits obvious relationship with output of agricultural crops and livestock in the zones.

Evidence[13] also shows that the mangroves that provide protection from wind and rain storms causing fishes to produce well and which act as buffers to erosion are being destroyed rapidly leading to poor crop yields in recent times compared to before. Also, most fishermen return from fishing empty handed without a single fish in their net because of the *'Ukpo höre nkpö'* (meaning climate that has changed in Efik language).[10] Furthermore, desertification is spreading rapidly fire in the Nigerian Sahel communities of Toshua and Sansan, located in Geidam and Mobbar (Damasak) local government areas of Yobe and Borno states respectively and sand dunes are threatening people, their livestock and other means of livelihood. The movement of sand dunes caused by high winds and exacerbated by lack of tree cover has covered houses, farmlands, oases and trees in these areas.[10]

The economics of global warming

The economics of global warming refers to the economic costs and benefits of global warming and the economic impacts of actions aimed at the mitigation (reducing emissions or otherwise lowering atmospheric concentrations of GHG) and adaptation (minimizing social and economic disruption from climate change impacts) to global warming. The impact of climate change is global but developing countries are worse off. Global insured and uninsured property losses currently amount to

over $40 billion per annum compared to just $4 billion per annum some 50 years ago. At the Intergovernmental panel on Climate Change (IPCC) conference in April 2007, delegates from 120 nations discussed the specific economic and societal costs of mitigating global warming and eventually approved the IPCC Fourth Assessment Report.[14]

Thirty years after the Kyoto protocol which set limits on international carbon emissions the Fourth Assessment Report of IPCC observed that emissions of GHG are increasing at an alarming rate and that the impacts of climate change are very likely to impose net annual costs which will increase over time as global temperature increases.[15] The Report also noted that climate change over the next century is likely to adversely affect hundreds of millions of people through increased coastal flooding, reductions in water supplies, increased malnutrition and increased health impacts.[16]

The Stern Review predicted that climate change will have a serious impact on economic growth if there is no mitigation[6]. The report suggested that an investment of one percent of global GDP is required to mitigate the effects of climate change and failure to do so is risking a recession worth up to twenty percent of global GDP. In the Stern Review, net monetized cost estimates of climate change were negative for all global mean temperature increases. Even 2°C warming above preindustrial temperatures the minimum the world is likely to experience could result in permanent reductions in gross domestic product (GDP) of 4 to 5 percent for Africa and South Asia. The losses in high income countries will be minimal but there will be overall reduction in world consumption equivalent to about 1% of global GDP.[17]

Most developing countries lack sufficient financial and technical capacities to manage increasing climate risk. They also depend more directly on climate-sensitive natural resources for income and well-being. And most are in tropical and subtropical regions already subject to highly variable climate. The welfare impact of a doubling of the atmospheric concentration on the current economy is relatively small. Although the estimates differ, welfare losses are a few percent of GDP or less. It is therefore no surprise that cost-benefit analyses of climate change recommend only limited GHGs emission reduction for instance, it has been argued that the optimal rate of emission reduction is 10-15%.[18] This is one of the more contentious findings of the climate economics literature. It is rejected by most natural scientists and many economists, despite the impeccable pedigree of the estimate and its author.

Climate change and equity

Climate change and health inequities represent two of the greatest challenges to human development in the 21st century. Climate change affects equity through the following ways:

- Climate change negatively impacts on the social determinants of health the conditions in which people live, grow and work, as well as their access to money, power and resources as these are strongly influenced by political, economic, environmental, cultural and social factors. Where inequalities prevail in any of these determinants, there will be consequent inequalities in health.[19]
- The poorest one billion people in the world account for only 3% of the global carbon emissions but are faced with a higher burden of illnesses including those resulting from climate change[8,20]
- The poor, particularly in developing countries, are likely to face the worst effects of a changing climate. The poor are more likely to live in areas vulnerable to floods, storms and rising seas. And they are more likely to depend on agriculture and fishing for a living and therefore risk going hungry or losing their livelihoods when droughts strike, rains become unpredictable and hurricanes move with unprecedented force. And among the poor, women, children and the elderly are especially vulnerable.[21]
- Communities which are disadvantaged as is the case in most sub-Saharan African countries have the most vulnerability and least resources to respond to health threats

resulting from climate change such as increased natural disasters, food and water insecurity and changing disease distribution. Even when there are economic growth and development efforts ongoing in such countries, these improvements are usually inequitably distributed leaving poorest groups vulnerable to hazards resulting from climate change. Richer countries have more resources to cope with climate impacts, and better educated and healthier populations are inherently more resilient.[22]

- Policies that are aimed at mitigation or adaption to climate change can have greater impacts on poorer groups through increase in prices of goods and services due to carbon taxes, with decreased spending on essential needs such as food and health care. Moreover, the shift of agriculture from food production for household consumption to production of foodstuff for biofuel will also lead to food shortages and increased food cost with greater impact on the poorest.
- Resource constraints in poorer countries also means they will be unable to invest significantly in adaptation measures aimed at protecting individuals and households from the effects of climate change.
- Even when countries seek to invest in reducing health inequity, the processes of job creation, housing, economic development and industrialization would further worsen climate change. Such improvements in health status occurred in many east Asian countries in the last 4 decades. Many developing countries resist committing to emissions reductions which seem incompatible with the improvements in living conditions essential to improving health equity.
- However, some policies could improve equity and also help protect the climate. These include policies that promote safe, affordable and accessible use of active transport public transport, cycling and walking over the use of private motorized transport. Such policies can reduce the health burden from air pollution and motor vehicle injury and, by increasing physical activity, reduce cardiovascular disease, cancer and mental illness.[3]

The climate - economics linkages

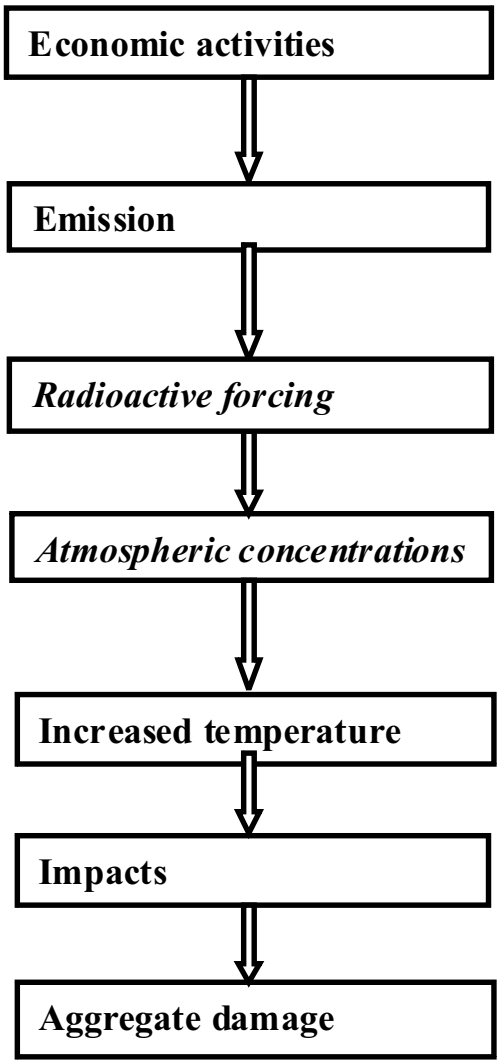
The role that emissions projections play in projections of warming and hence damage is, inescapably, complex. The sequence is as follows[3]:

The linkages are not straight forward as each of the linkages between the components of the diagram above involves complex factors. For instance, increased economic activity is related to changes in the population, including migration, as well as the rate of economic growth and development, and the change in the type of and amount of energy used. As far as the links from emissions to atmospheric concentrations of greenhouse gases and from concentrations to temperature change are concerned, what matters is the stock of greenhouse gases in the atmosphere. The impact on the economy also depends on the extent to which the economies adapt to changes in temperature, how vulnerable some economies are and how abruptly changes or impacts occur.

Costs of climate change

Climate change economics use economic analytic techniques to generate estimates of costs of climate change as well as costs and benefits of mitigation and adaptation, to such changes and impact on equity in order to inform policy discussions aimed at taking positive actions against the impacts of climate change. Although many people have argued that climate change is beyond cost-benefit analysis, cost estimates show that climate change initially improves economic welfare.[23-25] Some estimates point to initial benefits of climate change.[26] The initial benefits are partly because more carbon dioxide in the atmosphere reduces water stress in plants and may make them grow faster.[27] Another reason is that the global economy is concentrated in the temperate zone, where warming reduces heating costs and cold-related health problems. At the same time, the world population is concentrated in the tropics, where the impacts of initial climate change are probably negative. However, these benefits are

Figure 1: The climate - economics linkages



sunk and impacts would be predominantly negative later in the century.

Global average impacts would be comparable to the welfare loss of a few percent of income, but substantially higher in poor countries. The uncertainty about the social cost of carbon is large and right-skewed. For a standard discount rate, the expected value is $50/tC, which is much lower than the price of carbon in the European Union but much higher than the price of carbon elsewhere.[9] Current estimates of the damage costs of climate change are incomplete, with positive and negative biases. Most important among the missing impacts are the indirect effects of climate change on economic development, large scale biodiversity loss, low probability high impact scenarios, the impact of climate change on violent conflict, and the impacts of climate change beyond 2100. From a welfare perspective, the impact of climate change is problematic because population is endogenous, and because policy analyses should separate impatience, risk aversion, and inequity aversion between and within countries.[9]

The WHO's Intergovernmental Panel on Climate Change noted that the effects of temperature increases on some aspects of human health are already being observed; that the net global effect of projected climate change

on human health is expected to be negative, especially in developing countries, small island developing States and vulnerable local communities which have the least capacity to prepare for and adapt to such change.[28] In addition, exposure to projected climate change could affect the health status of millions of people, through increases in: malnutrition, death, disease and injury due to extreme weather events, the burden of diarrhoeal disease, the frequency of cardio-respiratory diseases, and through altered distribution of some infectious disease vectors. It has also been estimated that 200-250 million people could be displaced by climate-related disasters by 2050, climate change increases the risks of conflict and migration and the world's poor - who are the most vulnerable - need help to adapt. All these effects would reverse the hard earned development gains of the past decades and the progress toward achieving the Millennium Development Goals.[29] Setbacks will result from water scarcities, intense tropical storms and storm surges, floods, loss of glacial melt water for irrigated agriculture, food shortages and health crises.

A review carried out in the United Kingdom estimates that climate change will result in a loss of 5-20% of world output per year through damages which are largely preventable by spending 1% of world output annually on mitigation.[30] Unconstrained, global GHG emissions will continue to grow over the next few decades, driven by the rising demand for cheap fossil fuel-based energy boosted by ongoing economic growth. The lion's share of this increase can be attributed to developing countries, for two reasons.[30] First, their economies will grow faster and second they start from a relatively higher carbon intensity of output.

Cost of actions

The costs of tackling climate change include costs of mitigation, adaptation, transition to new technologies and sources of energy. The geographical dimension of adaptation is very different from that of mitigation. Mitigation brings global benefits, whereas adaptation benefits are perceived at the scale of the impacted system which is mostly local.[9] As a consequence, the benefits of one abated carbon are global and the benefits of adaptation actions are at the community. The costs of tackling global warming is large in SSA as well as other developing continents because they are more exposed to climate damages. On an annuitized base computed, climate change adaptation would cost non-OECD countries about US$ 500 Billion (or 0.48% of their GDP) against the US$ 200 Billion (or 0.22% of GDP) of OECD and developing nations are unlikely to afford such a huge expenditure necessitating international cooperation.[31] Furthermore, the generation currently living in the world would largely bear the cost of new technologies and processes needed to halt and reverse the damage to the climate even though the benefits would be accruing to future generations.[32]

The cost of mitigation includes cost of all efforts aimed at preventing the levels of the hazards from reaching levels that they become dangerous. There are efforts being made at reducing the level of emission of GHGs. Renewable energies are being advocated including use of solar energy and biofuel. Spending less on mitigation will mean spending more on adaptation and accepting greater damages. There are also costs associated with changing to new low-carbon technologies and sources of energy, housing and transportation. These costs can be quite high and can also have differential impacts of different population groups, employment, income and migration.

A number of ways can be used to show the cost of action. For example the Integrated Assessment Models (IAMs), in which simplified climate models are combined with economic models of the world economy could be used to produce estimates of costs.[3] For example, using these models, it has been suggested that getting to the 550 ppm level may cost the equivalent of $2 trillion to $17 trillion in present value terms. This is equivalent of spending this sum of money once and for all today. And when this is expressed as an annual payment (annuitized form), it ranges between $80 billion to $1100 billion per annum, assuming these costs are borne in the first 20 to

50 years. When it is considered that the world's annual GNP is currently about $35 trillion, the annual expenditures would be 0.2 to 3.2% of annual current income. This is quite huge and developing countries cannot afford this except there is assistance from the developed countries. Another way of expressing the cost of action is in terms of cost per tonne of carbon removed or avoided and the figures range from $18 to $80/ tC. As one would expect, as the target for atmospheric CO_2 equivalent concentrations gets tougher and tougher, so not only the total costs of meeting those targets rise, but so do the incremental costs (the "marginal" cost).

Furthermore, the costs of action can be estimated by calculating the cost of emissions-reducing technologies. This model expresses the costs of carbon-reducing technologies relative to a "marker", i.e. the technology that would be displaced by the "new" technology. The fact that the costs of most of these technologies (wind, hydrogen from coal or gas, solar photovoltaic) remain above the current technologies means that the present free market will not bring about their natural substitution. That substitution must be managed, first by judging whether the extra costs of these technologies is smaller or greater than the money value of the environmental benefits they bring through cost benefit analysis, and second, by designing market-based environmental policies such as carbon taxes and tradable permit schemes, or of government directly sponsoring the required research and development (R&D).[3]

It has been noted that the cost of action is 1% of global GDP and the cost of inaction is 5% of global GDP meaning that it makes economic sense to act. The estimated investment in mitigation could range from $260 billion to $1.2 trillion by 2030 representing 0.2% of projected world GDP in 2030, or 3% of today's global investment spending. In other words, keeping warming around 2°C could entail a 3% increase in global investments.[3]

The Copenhagen accord provisions in terms of economic efficiency and environmental effectiveness

During the 15th conference of the parties (COP 15) of the United Nations in Copehagen Denmark, December 17-18 2009 an informal agreement called the Copenhagen Accord which represents a first step towards the successor to the Kyoto Protocol was delivered.[33] The Accord emphasizes an equal balance of the fast-start funds between adaptation and mitigation although funding mitigation is more urgently needed than adaptation depending on the size of climate change impacts and on their economic evaluation.[34]

The Copenhagen accord succeeded in considering some of the climate policy principles, namely credibility, equity and fairness. First the change in political leadership indicates a more collaborative mood. Regarding equity and fairness, developing countries obtained an explicit commitment by developed countries for technology assistance centered on financial transfers through the Global Environmental Facility (GEF) programme, the Clean Development Mechanism (CDM) and Joint Implementation (JI). The major limitation of the accord was the way it addressed the trade-off between political viability, implicit fairness, and economic and environmental effectiveness. Therefore, future negotiations should deal with fairness, and the eventuality of a global temperature increase above the 2 degrees, even in the presence of successful global mitigation.[31]

Financing and the role of Carbon market

A variety of new financial markets have emerged, offering businesses key incentives apart from taxes and other measures to slow down overall emissions growth and global warming. A key feature of these markets is emission trading or cap-and-trade schemes, which allows companies to buy or sell "credits" that collectively bind all participating countries to an overall emission limits and the biggest emission market is for carbon. For nations that have signed the Kyoto protocol, which holds each country to its own CO2 limit, GHG emissions trading is mandatory. Under a basic cap-and-trade scheme, if a company's carbon emissions fall below a set allowance, the company can sell the difference in the form of credits- to other companies that exceed their limits. In 2007, the trade market for CO2 hit $60

billion worldwide.[35] It has been predicted that Nigeria can make over N34 billion on sale of carbon credit if the nation is able to implement the CDM and reducing emission from deforestation and degradation (REDD) projects.[3]

This issue of financing was at the top of the agenda during the 2009 Copenhagen conference and financial transfers to protect the global environment change takes place under the GEF programme which collects public resources from the governments of countries, the CDM and JI which allows countries to acquire emission credits in foreign countries. The GEF finances programmes and projects in six focal areas: climate change (mitigation and adaptation), biodiversity, international waters, persistent organic pollutants, ozone depletion, and land degradation (desertification and deforestation) and for the period of 2006 to 2010, GEF trust fund received US$ 3.13 billion.[36] A positive feature of the GEF's funding policy is that it covers the incremental costs for projects that would not otherwise receive private sector finance.

The Copenhagen accord also envisages a fast-track fund of US$ 10 billion per year from 2010 to 2012 for a total of US$ 30 billion.[30] This support requires developing countries to put in place mitigation measures in order to guarantee the allocation of money to carbon-free measures and mitigation policies with developed countries committing to transfer US$ 100 billion dollars a year by 2020 if the appropriate mitigation measures are in place. There is an explicit commitment by developed countries to provide adequate funding to developing countries and a significant part of these funds will come from the Copenhagen Green Climate Fund and other sources including public, private, multilateral and bilateral organizations. Compensating mitigation costs in developing countries would require US$ 400 billion already in 2020, which is four times the upper bound proposed in Copenhagen and about US$ 50 billion will go to preventive adaptation strategies.[33]

Climate change policy

Economic growth alone is unlikely to be fast or equitable enough to counter threats from climate change, particularly if it remains carbon intensive and accelerates global warming. So climate policy cannot be framed as a choice between growth and climate change. In fact, climate-smart policies are those that enhance development, reduce vulnerability, and finance the transition to low-carbon growth paths**.** Economic theory implies that the risk premium should be *negative* for policies that reduce major risks to future economic welfare[3]. From this it follows that the discount rate employed in evaluating the net benefits of climate change policies should be no higher than the risk-free rate of return.

Because the damage done by the emission arises from gases that accumulated decades ago, any action now to reduce emissions will have no immediate short-run effects. Any beneficial results will not accrue for decades to come.[33] By implication, climate policy is about reducing impacts in the decades and centuries to come; therefore, if impacts in 2100 are to be mitigated, action has to be taken sooner rather than later.

However, policy discussions of climate change have been primarily concerned about mitigating GHG. When adaptation to climate change is a global public good, an efficient allocation cannot be achieved by the imposition of a carbon tax alone to abate GHG. An alternative policy framework in which a carbon tax is levied globally while adaptation is supported through the recycling of carbon tax revenue has been proposed.[37]

The current policies on climate change:

The current global policies on climate change include[38]:

UK policy: This is embedded in the Climate Change Act 2008 which is legally binding targets for GHG emissions. These are policies specific to dealing with climate change. The policy stipulates Climate Change Risk Assessment to be undertaken every five years and the first assessment will be completed by 2011 using Cost-Benefit Analysis. This policy also mandates all public agencies to have an adaptation strategy

EU Energy and Climate Change objectives for 2020: This was agreed on at the European Council 9 March 2007. This policy stipulates 20% to 30% GHG reduction compared to 1990 20% renewables share of final energy consumption and 10% biofuels.

Climate and Health Council policy: This stipulates what health professionals should be doing collectively and individually. The council's strategy is to recruit as many health professional as possible; identify the most effective low carbon policies that when implemented will reduce GHG emissions; establish a coalition of health professionals to act as policy advocates nationally and internationally and encourage individual lifestyle change among health professionals around the world.

Health systems policy: Stipulates healthy hospitals, healthy planet and healthy people. It addressing climate change in health care settings.

Questions for designing adaptation policies and measures

In designing adaptation policies and measures, the following questions need to be answered:

- Adaptation to what?
- What is currently being done to reduce the burden of disease?
- How effective are these policies and measures?
- Are additional interventions needed?
- What are the projections for the outcome?
- Who is vulnerable?
- Who adapts? How does adaptation occur?
- When should interventions be implemented?
- How good or likely is the adaptation?
- Apply win/win or no-regrets strategies

And for the Health systems, there is need to:

- Develop and maintain skills / knowledge base (clinical expertise) on emerging health/cc issues and disasters
- Facilitate information exchange
- Include environment and public health in clinical training
- Improve communication between emergency response and spatial planners
- Integrate environmental issues in clinical practice and case management
- Research needs
- Building design for heat / cold / storms
- Disaster resilience (cross boundary, mutual aid

Unfortunately, Outside the OECD, there is no climate policy although these countries are most vulnerable to climate change, and their share of the social cost of carbon is positive even at high discount rate. Many of these countries subsidise fossil fuel use, rather than taxing it. Climate mitigation policy should be imposed over a long period, and spur development of new technologies in order to make stabilization of GHG concentrations economically feasible. The government may announce current and future policy packages that stimulate current research & development in climate-friendly technologies. However, once climate-friendly technologies have been developed, the government may have no incentive to implement the pre-announced future policies, that is, there may be a time inconsistency problem.[39]

Africa continent's stance on climate change

In a pre COP 15 meeting, the Africa's new climate leader Ethiopian Prime Minister Meles Zenawi stressed that Africa has "no intention to free-ride" a post-Kyoto agreement and that she should not be seen as a charity case in global negotiations on climate change.[40] The interest is not to claim compensation for climate change and its damages but to prevent that from happening. He stated that *"Our interest is not to claim compensation for climate change and its damages. Our interest is to prevent that from happening. It makes no sense to us for someone to make large parts of our continent unliveable and then pay some compensation for doing so."* Although the continent needs financial help from developed countries to adapt to the effects of climate change and limit its own

contributions to the phenomenon, it does not come to the negotiating table empty-handed for the following reasons:

- *Africa's potential as a market for clean development technologies and the creation of a potential carbon sink.*
- *By partnering with Africa on green development, the developed world could create a more robust market and overall environment for the mitigation efforts that it alone must shoulder*

The African contingent to the COP15 meeting estimated that the amount required for adaptation programmes globally is more than US$400 billion and requested that at least half of this should go to projects in Africa. The African ministers agreed that the African Union should demand US$67 billion per year from the global community in compensation for the effects of climate change. Also at the pre COP 15 conference, the World Bank and the Africa Development Bank agreed to support efforts at climate change adaptation by Nigeria and South Africa with the sum of $200m.[41] The fund will constitute 20% - 30% of investment requirement to help the countries in the drive for the promotion of clean development projects in order to promote a low carbon economy in the countries.

However, the misunderstanding among Africans when it comes to making crucial decisions came to light during the COP15 conference in Copenhagen. After two weeks of intensive negotiations, the African group made a formal submission to the UN Framework Convention on Climate Change on Africa's position on dealing with climate change. Unfortunately, Ethiopian Prime Minister Meles Zenawi who is the spokesman of Africa on climate change uncharacteristically teamed up with France and heavily modified the African document, a move that shocked the African negotiators. For instance, the document presented by Zenawi shows that the African countries had pushed for the adoption of a "fast-start" fund of $10bn per year covering the next three years from 2010 through 2012 but the original document puts the figure at $600bn. In addition, the modified document indicated that 40 per cent of the fund should be dedicated to adaptation in Africa while the original agreement was 50 per cent of the fund.[42] And EU is already backing this deal.

Climate change Policy: Economic implications for Nigeria

Policies adopted globally to mitigate climate change will have negative implications for specific sectors in Nigeria, such as the coal, oil and gas industries. Nigeria's economy today remains mono cultural and heavily dependent on the oil sector, which accounts for around 80% of government revenues, 90-95% of export revenues, and over 90% of foreign exchange earnings. The extent of this heavy dependence in monetary terms is signified by the fact that the country earned in excess of US$200 billion from oil exports between 1970 and 1990.[43] Currently, the Nigerian government is in the process of lessening this unhealthy dependence on crude oil through its development of the natural gas industry. Nigeria is believed to have an estimated 124 trillion cubic feet (Tcf) of proven natural gas reserves- 9th largest in the world.[44] Due to a lack of gas utilization infrastructure, Nigeria currently flares 75%of the gas it produces and re-injects 12% to enhance oil recovery. But the development of the natural gas sector is intended to stem this wastage as well as further expand the government's revenue base. The agreement between the government and the oil companies puts the end of all gas flaring in Nigeria at 2004. Despite this diversification attempt, Nigeria's economy stands to remain dependent on fossil fuels. This is particularly worrying because fossil fuels are the chief culprit implicated in global warming.[2]

Currently action to stem the emission of GHG as encapsulated in the Kyoto protocol is restricted to the developed countries or Annex 1 countries. This requires the so-called Annex 1 countries to cut their GHG emissions by 5% compared to 1990 levels by the period between 2008-2012. Nigeria which belongs to the non-Annex 1 countries is thus not required to take any abatement action now. So, when the global community begins to substitute renewable energy alternatives for fossil fuels, Nigeria

stands to suffer income losses. Given the exclusive reliance on fossil fuels for foreign exchange and the predominant focus on further expansion of this sector of the economy by the Nigerian government, the impact of the global shift away from fossil fuels is bound to cripple the Nigerian economy. As it stands, the Kyoto Protocol, if fully implemented, would lead to a dramatic loss of revenue for oil-exporting countries, as a result of a heavy reduction in demand for petroleum. Independent studies estimate the loss at tens of billions of US dollars per year for OPEC's members of which Nigeria is one, and up to 25% reduction in the OPECs revenues by 2010.[11]

Despite this huge implication of climate change response measures for Nigeria's economy, there is no visible demonstration of the preparedness of the government to tackle this issue. The greatest cause for concern is that the blueprint for Nigeria's development Vision 2010 fails to give a mere acknowledgement of the importance of climate change to Nigeria's economy, let alone stipulate the development strategies with which to tackle it.

Conclusions

Effective climate policy involves making investments today to yield future returns in the form of a beneficial climate with due regard for the scientific and economic uncertainty involved. Those investments could take several forms, such as restrictions on emissions levels and research to improve understanding of the physical processes of climate change and to develop alternatives to fossil fuels. We need growth based on a low carbon or zero-carbon economy which invariably needs financing by other means like green taxation and a strong carbon price. Moreover, it will be more difficult to cope with the estimated 50 percent growth of the world population from 6 to 9 billion people by mid-century if we simultaneously lose more than 1/5th of the world's wealth.

The costs of climate inaction**,** the difference between costs under the "business-as-usual" scenarios and an optimistic "rapid stabilization" scenario are the human, economic, and environmental damages that may be avoidable with vigorous, timely actions to reduce GHG emissions. Inaction on climate change would lead to damages worth 5% - 20% output per year (GDP). Most of these damages could be prevented by spending 1% of world output annually on mitigation. It therefore makes economic sense to act**.** When costs are incurred to reduce emissions today, the benefits of reduced climate change will occur decades or centuries later implying that it is "worth it" to take action now to secure those future benefits.

Acting now is essential or else, options disappear and costs increase as the world commits itself to high-carbon pathways and largely irreversible warming trajectories. Acting together is key to keeping the costs down and effectively tackling both adaptation and mitigation. Acting differently is required to enable a sustainable future in a changing world. In the next few decades, the world's energy systems must be transformed so that global emissions drop 50 to 80 percent. Doing nothing is much more expensive than de-carbonizing our economy level. "There are three choices: mitigation, adaptation and suffering. We will do some of each. But we can still choose the mix."[45]

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