Climate change mitigation and adaptation strategies for construction activities within planetary boundaries: Limitations of developing countries

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Climate change mitigation and adaptation strategies for construction activities within planetary boundaries: Limitations of developing countries

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Abstract. Continued unsustainable human activities have ushered in a new climate regime where storms have become more intense, droughts periods are now longer, floods are incessant and the occurrence of wild fires more frequent. Mitigating the effects of climate change is crucial for minimizing the occurrence of hazards associated with climate change. Adapting to this new climate era is important for the continued existence of life on planet earth. This paper presents a review of climate mitigation and adaptation strategies with specific focus on the construction industry. It discusses the following climate mitigation and adaptation strategies: use of green energy, use of sustainable building materials, construction of high rise buildings and living building elements, use of innovative designs and construction methods and recycling of urban waste. The paper also argues that developing countries are most vulnerable to climate change effects but certain factors limit them from mitigating and adapting to climate change.

Key words: climate change, construction industry, developing countries, planetary boundaries, sustainable development

1. Introduction

The planet has survived many centuries without much perturbation. However, developmental activities, particularly construction is altering the earth systems; thereby pushing the world to a point whereby it might not be able to sustain itself and other life forms. Construction particularly in developing countries, depend majorly on fossil fuel as an alternative source of energy. Emissions from the burning of fossil fuel contribute significantly to Green House Gases (GHGs) effects [1, 2, 3]. GHGs are trapped in the atmosphere and consequently warm up the planet; a phenomenon known as global warming. Moreover, construction wastes end up on landfills [4, 5]. These landfills emit several toxins which reduce urban air quality. Furthermore, improper disposal of domestic and industrial waste are emptied in the sea and other water bodies. This increases the acidity of the oceans and is referred to as ocean acidification. Ocean acidification destroys aquatic life and threatens the livelihood of fishermen. Construction also uses up large quantities of natural resources particularly, fresh water and timber. These two resources (fresh water and timber) play crucial roles in sustaining life on planet earth. Yet, they are consumed unsustainably at an alarming rate. For instance, in China, water consumption index per building area is about 0.46ton [6]. Although the earth comprises of 75% water,

only 25% of the world's water is fresh [7]. Construction competes with agriculture and manufacturing for limited fresh water supply. This also exerts pressure on domestic water use. [8, 9] noted that the conversion of forested systems for other purposes is occurring at an alarming rate. Unsustainable felling of timber makes humans vulnerable to GHGs effects. For instance, timber soaks in carbon, one of the major constituents of GHGs. As trees are cut down without replacement, the volume of atmospheric carbon will continue to rise. There are nine systems that support the existence of planet earth. Some researchers [8,10] described these systems as the planetary boundaries. The term 'boundaries' suggest that these systems have a limit beyond which irreversible changes will be triggered with devastating effects on life forms. The planetary boundaries are: climate change, ocean acidification, stratosphere ozone depletion, interference with global phosphorus and nitrogen cycles, rate of biodiversity loss, global fresh water use, land system change, aerosol loading and chemical pollution. Of all the nine planetary boundaries only stratospheric ozone depletion has been contained. This is as a result of the ban of ozone depletion chemicals after a large hole was discovered in the ozone layer over Antarctica [8,10].

Although construction activities bring about economic and social progress [11,12] construction activities ought to be carried out within the limits of planetary boundaries for the continued existence of planet earth. Paleogeography explains that climate change is caused by natural occurrences such as dynamics in solar radiation, continental drifting and volcanic eruptions [13, 14]. However, recent evidences show that current climate change is human induced [15, 16,17]. It is particularly crucial for developing countries to ensure that construction work is done within planetary boundaries, because developing countries are most vulnerable to the effects of planetary dynamics. Climate change affects both developed and developing countries, but the vulnerability of developing countries is in terms of weak institutions and poor funding to combat climate change. There is an argument that developing countries do not produce as much GHG emissions, hence proponents of such arguments believe that climate change should not be a topical issue in developing countries. However, there are local evidences to show that climate change effects can have global implications. In recent times, many developing countries have been experiencing intense storms, incessant flooding and prolonged drought periods. This is as a result of alterations in weather patterns due to climate change. Hence, developing countries have to become more interested in climate change discourse and take action to mitigate and adapt to climate change. This paper reviews literature on strategies for mitigating and adapting to climate change effects, specifically as it relates to the construction industry. It also discusses some of the challenges inhibiting developing countries from mitigating and adapting to climate change effects.

2. Climate change mitigation and adaptation strategies

Continued unsustainable human activities have ushered in a new climate regime where storms have become more intense, droughts periods are now longer, floods are incessant and the occurrence of wild fires is more frequent. Adapting to this new climate era is important for the continued existence of life on the planet. Moreover, mitigating the effects of climate change is crucial for sustainable development. In this section, climate change mitigation and adaption strategies are discussed. Figure 1 provides a conceptual framework of climate change mitigation and adaptation strategies and the limitations of developing countries.

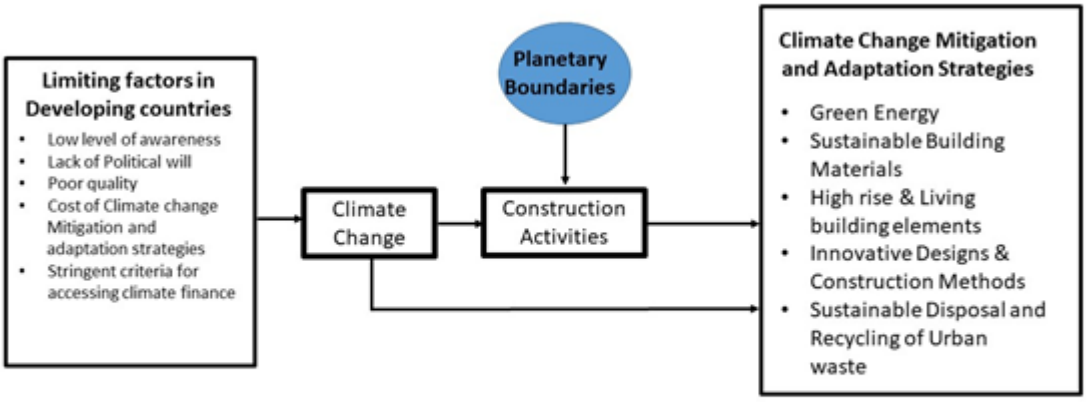

Fig 1: Conceptual framework for climate change mitigation and adaptation strategies and the limitations of developing countries.

2.1 Green Energy

Fossil fuel is the most common form of energy in developing countries. Emissions from fossil fuels contribute significantly to GHG effects. Green energy is energy that produces little or zero environmental effect. It includes all forms of clean and renewable energy sources. Namely: wind energy, solar energy, hydro energy, geothermal energy and bio fuels. Mainstreaming green energy will reduce Aerosol Optical Depth (AOD). AOD is a major trigger of climate change [18]. Green energy mitigates the occurrence of risks associated with climate change.

2.2 Sustainable Building Materials

Many conventional building materials carry embodied energy which is dissipated slowly over the life cycle of the building. Embodied energy is the energy required in the production of a component and it includes energy obtained during extraction, manufacturing, transportaion and assembly of the component [19, 20]. Emissions from embodied energy in buildings also contribute to GHG effects. When the volume of building stocks globally is considered, the magnitude of the problem can then be better imagined. Some construction activities for instance, asphalt work emit bituminous aerosols and Polycylic Aromatic Hydrocarbons (PAHs) aerosols [21,22]. This calls for the development of sustainable alternatives through intensive building materials research. Accumulation of aerosols in the atmosphere affects precipitation, which also results in drought and other extreme weather conditions. Sustainable building materials can be replaced with conventional building materials so that aerosol loading and GHG emissions (the greatest triggers of climate change) can be reduced.

2.3 High Rise and Living Building Elements

Biodiversity is one of the planetary systems that support the existence of the earth. Biodiversity is the differences that exist among plant and animal species in both terrestrial and aquatic habitat and their interactions with the ecosystem. Building construction and other infrastructure works affects terrestrial habitat in the form of soil sealing, soil compaction and fragmentation. Moreover, several hectares of

land are cleared yearly for residential estates, commercial use and tourism. This destroys terrestrial habitat and disrupts terrestrial biodiversity. High rise buildings can reduce the loss of biodiversity. Although not all lands have good load bearing capacity, some foundation types such as pile, raft and pad are purposely designed for poor load bearing soils. In high rise construction, less terrestrial land used is up thereby conserving more lands and preserving plant and animal species.
In addition, living building elements can facilitate the adaptation of plant and animal species in urban centers where urbanization is inevitable, thereby preserving terrestrial biodiversity. Specifically, roofs and walls can be designed to accommodate some life forms like flowers and little shrubs. By so doing, the living elements soak in carbon in the atmosphere and also provide a habitat for small terrestrial creatures so that they can easily adapt to ecological disruptions due to developmental activities.

2.4 Innovative Designs and Construction Methods

Use of innovative designs and construction methods can minimize the effects of conventional construction on the environment and also minimize the use of natural resources. Dry construction can reduce the use of fresh water in buildings. Dry construction is construction that uses little or no water. It includes the use of glass, aluminum and steel. Modular construction and the use of precast building elements can also minimize the use of water in construction. There are other innovative systems that can be used to control water use in buildings. Such systems include: High Efficiency Toilets (HETs) and High Efficiency Urinals (HEUs).

2.5 Sustainable Disposal and Recycling of Urban Waste

Improper disposal of urban waste is a threat to oceans and water bodies. Unsustainable disposal of municipal waste from agriculture, industries and domestic sources is a major threat to oceans and water bodies. This situation can lead to ocean acidification and eutrophication. Ocean acidification is the rise in acidic content of the sea. This occurs mainly when the sea soaks in atmospheric carbon. Ocean acidification is also as a result of Nitrogen and Phosphorus compounds in urban waste that end up in the sea. Eutrophication on the other hand occurs when the nutrient level of the sea becomes very high as a result of the presence of Nitrogen and Phosphorus based compounds from urban waste. Eutrophication triggers the growth of algae and other organisms. It however, reduces the oxygen level of oceans which affects aquatic life. Proper disposal of urban waste will minimize the incidence of ocean acidification and eutrophication.
Recycling of waste water can have positive implications for water conservation. Fresh water conservation is necessary because population growth and drought are exerting great pressure on limited fresh water. Water recycling is one of the identified techniques of preserving water [23]. Recycled water is waste water that has been treated to an acceptable and approved quality [24]. In some regions of the world such as Namibia, United States of America, Belgium, United Kingdom and South Africa, water recycling is used to argument limited water supply [25]. [26] noted that residents are willing to use recycled water provided it is limited to non-potable uses such as toilet flushing, car washing, clothes washing, gardening of non-edibles like flowers because of the perceived health risks associated with the consumption of recycled water [27,28,29]

3. Limitations of Developing Countries

The climate mitigation and adaptation strategies discussed in this paper are not new. In some countries these strategies are already operational. However, the narrative is different for many developing countries. Some challenges hinder the development and implementation of the climate mitigation and adaptation strategies discussed. These challenges include;

i. Low level of awareness

ii. Lack of political will

iii. Poor quality research

iv. Cost of climate change mitigation and adaptation strategies

v. Stringent Criteria for accessing climate finance

3.1 Low Level of Awareness

In many developing countries particularly in Africa, there is a low level of awareness about the effects of developmental activities on the continued sustainable existence of the planet. Problems of poverty, insurgency and leadership clog the minds of politicians and the people. They are so engrossed in these problems that they become less concerned and uninterested in environmental issues [30, 31]. This is particularly so because the negative impacts of environmental challenges are not noticeable immediately; it takes a while before environmental challenges begin to take its toll. There is a possibility that people might become more interested in environmental issues such as climate change if they understand that climate change can threaten their existence.

3.2 Lack of Political Will

Government plays a key role in the development and implementation of policies that can reduce the effect of developmental activities on the environment. Sustainability policies can facilitate the attainment of green growth [32] for businesses thereby reducing the impact of human activities on the environment. However, leaders in many developing countries lack the political will to develop and implement climate mitigation and adaptation policies for the sustainable development of their people and regions.

3.3 Poor Quality Research

Many research institutes in developing countries are poorly funded. Many of these research institutes do not have sophisticated equipment that can yield robust and significant research output. In cases where significant research outputs are obtained, commercialization of such products remains a challenge.

3.4 Cost of Climate Change Mitigation and Adaptation Strategies

Most of the strategies and technologies available for mitigating and adapting to client change are still expensive. Hence, governments of many developing countries see climate change mitigation and adaptation strategies as an additional cost which they are not ready to bear with the cost of governance, education, health care, housing, etc.

3.5 Stringent Criteria for accessing climate finance

Donor agencies and international organizations must be commended for their contribution towards climate finance for solving climate change problems. However, some of the criteria for assessing climate finance are too stringent. Given the obvious challenges in developing countries which include weak institutions and poor funding, donor agencies and international agencies should make their criteria less stringent so that more countries and research institutes in developing regions can have access to finance for tackling climate change related challenges.

Conclusion

This paper reviewed climate change mitigation and adaptation strategies for the construction industry. These strategies include: green energy, use of sustainable building materials, construction of high rise buildings and living building elements, use of innovation designs and construction methods and recycling of urban waste. Developing countries are most vulnerable to climate change effects. However, certain factors limit these regions from mitigating and adapting to climate change. These factors include: low level of awareness, lack of political will, poor quality research, cost of climate change mitigation and adaptation strategies and stringent criteria for accessing climate finance.

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