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**A STUDY ON CLIMATE CHANGE IN THE CARIBBEAN:
IMPACTS OF CLIMATE CHANGE IN SMALL COMMUNITIES**

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Abstract

Climate change is arguably the biggest environmental global issue of our time that brings about tremendous challenges for the world. It has captured international public imagination in a way that few environmentalists thought possible. The impacts on small communities may be even more significant than on larger communities. This is because residents of these communities, particularly those of coastal areas, are already vulnerable and disadvantaged as they experience significant health problems, insecure and inadequate housing and comparatively lower levels of education training as well as lower economic standards of living. The impacts of climate change would exacerbate these conditions and render these people more vulnerable. These communities may well suffer the impacts of climate change in areas of agriculture, health and housing, all of which would inevitably have downstream effects on education, life expectancy and the general quality of life. It is, therefore, important that measures be put in place to adapt to, and mitigate against, the impacts. Such measures include the development of salt-tolerant crops, engineering of drought-resistant crop varieties, building/reinforcing sea defences, developing measures to protect drinking water sources and embarking on public education and awareness strategies so as to empower communities to cooperate with, and to take action in adapting to, climate change. It would also be recommended that strategies to reduce community anxiety about climate change and loss of well-being be pursued.

I. INTRODUCTION

Current literature has identified climate change as, increasingly, the biggest environmental issue of our time. The 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), 2006, has indicated that global atmospheric concentration of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) has increased since 1750 as a result of human activity. Increases in concentrations of CO₂ have been due to fossil fuels use and land use changes, while increases in CH₄ and N₂O have been attributed primarily to agriculture. The IPCC report also indicated that there has been an increase in CO₂ concentration from 280 parts per million (ppm) in 1850 to 364 ppm in 1998, and to 379 ppm in 2005.

The report further stated that warming of the climate was unequivocal as evidenced by the noticeable increases in global average air and ocean temperatures. These rises in temperature are supported by widespread melting of snow and ice and an increase in global average sea level of 1.8 mm yr⁻¹ between 1961 and 2003. The report also noted that the rate of sea level rise was faster between 1993 and 2003.

The Stern Review supports these findings and further indicates that, without concerted action, the concentration of greenhouse gases (GHG) could reach double their pre-industrial level as early as 2035, with a short-term rise of 2^oC and that, in the longer term, it is likely that this could reach 5^oC. This would lead to major changes in human geography. All countries would be affected, but the poorest and most vulnerable would suffer earliest and more intensively even though they had contributed least to climate change.

The Economic Commission for Latin America and the Caribbean has also reported that Caribbean countries are concerned about impacts of climate change on the agriculture, health and tourism sectors as these are regarded as having the potential for greatest impact on Gross Domestic Product, human well-being and employment.

It is likely that all of these changes would affect small islands more significantly than the large land masses even though these islands may be contributing minimally to the causes. Local communities would be impacted even more as they often lack the economic and technical resources available to respond to social and environmental challenges, such as those posed by changes in climate. The disadvantaged residents of these communities experience increased health problems, insecure and inadequate housing and comparatively lower standards of education and training; and these lower economic standards of living render them more vulnerable to the impacts of climate change.

More particularly, living conditions of residents of small communities coupled with projected temperature increases are likely to lead to higher levels of health issues. Small communities are particularly at risk for water-borne and vector-borne diseases, which can be spread through intake of infected water and food. Climate change is likely to exacerbate poor housing and sanitation, which can increase the spread of those diseases. The dietary health situation of small communities is predicted to worsen, as the plants and animals that comprise their traditional diet could be at risk of decline and/or extinction, through climate change. In a 2004 study, Nature magazine reported that climate change could result in the extinction of between 15%-37% of species (Thomas *et al.* 2004). Therefore, traditional food sources might be replaced with processed foods. Such a switch in diet would expose communities to increased obesity, diabetes and hypertension, which are related to consumption of such processed foods.

II. IMPACTS OF CLIMATE CHANGE ON SMALL COMMUNITIES

Climate change may well result in tremendous changes in small communities with its negative impacts on agriculture, health, tourism and human security, as addressed in this paper.

A. AGRICULTURE

Jones and Thornton (2003) predict an overall reduction of 10% in maize production in 2055 in Africa and Latin America, equivalent to losses of \$2 billion per year, affecting principally 40 million farmers in mixed systems of Latin America and 130 million in sub-Saharan Africa. These yield losses will intensify as temperatures increase and as rainfall differences become less conducive to maize production. It is obvious that climate-related, environmental stresses are likely to affect individual households differently. Some researchers predict that as climate change reduces crop yields, the effects on the welfare of subsistence farming families may be quite severe, especially if the subsistence component of productivity is reduced. Changes in quality and quantity of production may affect the labour productivity of the farmer and negatively influence family health and welfare (Rosenzweig and Hillel 1998).

Some specific effects of climate change include:

- **Salt intrusion into agricultural lands**

This is a common occurrence especially on rice lands thereby tainting the colour and quality of the product and reducing its marketability. Salt may also infiltrate rivers that are used as sources of water and seep into supplies of ground water. This may be apparent on the southern coastal areas of Trinidad and Tobago, in some parts of Barbados and, possibly, in Guyana owing to breaching of the coastal sea defence systems. This is already occurring in Bangladesh, where paddy husks are taking on a red colouration before drying and wilting away (Black 2008).

- **Species may change their distribution ranges**

As temperatures become warmer, species would migrate north and south in search of desired temperatures. This is expected to impact, for example, on fisheries as species of tuna and dolphinfish may change their distribution ranges. The medium-term impact would be on livelihoods and food security.

- **Water temperature may affect fish production by disrupting the food chain**

The primary producers upon which the larger organisms rely as sources of food may well be unable to withstand the increased temperatures, thereby migrating or perishing and placing at risk the consumers that depend on them for food.

- **Increased pest infestations**

Conditions are usually more favourable for the proliferation of insect pests in warmer climates. Longer growing seasons may facilitate the reproductive capacity of many species of insect pests. Most studies have concluded that insect pests will generally become more abundant as temperatures increase, “through a number of inter-related processes, including range extensions and phenological changes, as well as increased rates of population development, growth, migration and over-wintering” (Altieri and Nicholls 2004). Given the greater dispersal capacity of migrant pests than itinerant species, they are, therefore, expected to respond more quickly to climate change than plants, and may be able to more quickly colonize newly available crops/habitats. A gradual, continuing rise in atmospheric CO₂ will

affect pest species directly (i.e. the CO₂ fertilization effect) and indirectly (via interactions with other environmental variables). Some recent experiments under elevated CO₂ concentrations have suggested that aphids may become more serious pests, although other studies have discerned no significant effects on sap-feeding homopterans (Altieri and Nicholls 2004). However, few, if any, of these experiments have fully considered the effects on pest population dynamics.

- **Increased incidence of plant diseases**

The limited literature suggests that the most likely impact of climate change will be felt in three areas, namely, in losses of productivity capacity from plant diseases; in the efficient management of diseases; and in the altered geographical distribution of plant diseases. Climate change could alter stages and rates of development of certain pathogens, modify host resistance, and result in changes in the physiology of parasite-prey interactions. The most likely consequences of this are shifts in the geographical distribution of parasites and prey and increased crop losses, caused in part by changes in the efficient functioning of control strategies and disruptions in the food web. Bacteria and fungi that are the agents of wind-borne plant diseases may be differently dispersed by altered wind patterns. Climate change could have positive, negative or no impact on individual plant diseases, but, in general, with increased temperatures and humidity, many pathogens are predicted to increase in severity. The possible increases in pest and disease infestations may bring about greater use of chemical pesticides to control them, a situation that may enhance production costs and also increase environmental problems associated with agrochemical use (Altieri and Nicholls 2004).

- **Increased wildfires**

The result of warmer conditions and conditions of drought that may occur could well lead to damage to agricultural lands, loss of forests and residential buildings through the increased incidence of wildfires.

- **Loss of soil**

A climate change effect potentially significant to small farm production is loss of soil organic matter due to soil warming. Higher air temperatures are likely to speed the natural decomposition of organic matter and to increase the rates of other soil processes that affect fertility. Under drier soil conditions, root growth and decomposition of organic matter are significantly suppressed, and as soil cover diminishes, vulnerability to wind erosion increases, especially if winds intensify. In some areas, an expected increase in temperature may result in heavier rainfall, which can cause severe soil erosion. All of these would collectively impact on post-harvest practices as higher temperatures and increased humidity could threaten storage facilities, thereby resulting in loss of harvests.

B. HEALTH

- **Heat wave-related health problems**

Heat waves are projected to become more frequent, resulting in increased heat and pollution-related illness and deaths as a result of longer, hotter and drier periods. The very old and young, chronically ill and poor are most susceptible.

- **Cold-related illness and deaths**

Cold-related illness, falls, crashes and deaths are likely to decline due to warmer, wetter winters.

- **River, coastal flooding and flash floods**

The risk of major flooding disasters caused by storms, hurricanes, heavy rainfall and coastal erosion will potentially increase contamination of drinking water, increase water borne infections and exposure to toxic pollutants, accompanied with psychological consequences, disruption, injuries and deaths. Later effects of flooding include stress and mental health problems. River floods or storm surges, which can be forecasted several days in advance, have fewer casualties compared to flash floods where there is no prior warning. Small communities that are already vulnerable to the vagaries of climate change would be even more negatively impacted by these occurrences.

- **Infectious diseases**

Cases of food- and water-borne disease linked to warm weather are likely to increase and may be even more deleterious to small communities that would already be living under less than optimum health conditions.

- **Sunburn and skin cancer**

These are likely to increase because of greater exposure to warmer weather.

- **Possible ancillary health benefits**

Extended warm weather may encourage increased physical activity but outcomes could be worse due to extreme heat. Possibly, healthier eating may occur if sustainable farming methods are adopted.

- **Extreme weather-related event (droughts, hurricanes)**

These may well lead to social disruption, injuries, deaths, disability, migration, homelessness and food shortages. Storms and droughts are likely to increase in frequency and intensity leading to increased flooding, contamination of drinking water and potentially unsafe releases of wastewater into the environment.

C. TOURISM

Climate change is likely to have a substantial impact on the tourism industry which is a growing source of income for many small communities. This is because such communities are more likely to have limited scope to adapt to the changes in climate which would impact more heavily on their small-scale industries that are a source of valuable income. In addition, frequent periods of flooding and drought could necessitate migration, which could lead to a loss of place-specific cultural heritage practices and fragmentation. Also, the uncertainty over, or lack of planning controls on development may well exacerbate the situation for small communities.

Climate change could result in loss or degradation of beaches and the near shore environment which are a source of income for many small-scale fishing activities. This problem would be exacerbated by loss of road access to fish landing sites due to coastal inundation and/or flooding. Flooding could also result in significant losses in biodiversity, especially coastal and freshwater biodiversity upon which coastal communities may depend for livelihoods through the promotion of ecotourism activities.

With respect to living conditions of people living in small communities, losses in housing settlements may result when the infrastructure, especially in low lying areas that they occupy informally, is inundated as a result of flooding. This may be further compounded by flash flooding as drainage systems become overcapacitated. Loss of access to sports grounds and other recreational areas may also occur as a result of flooding.

D. HUMAN SECURITY

The impacts of climate change may cause conflicts resulting in threats to human security and welfare and have the potential to affect small communities more gravely than larger, well-established towns. One of the main avenues of impact is in the reduction in arable land for farming, leading to a drop in agricultural productivity thereby lowering farmers' income and increasing food insecurity. Diminishing crop production and decreased availability of fish stocks, as a result of overfishing, would exacerbate this situation.

Increased flooding and prolonged droughts may well realize loss of access to agricultural produce and in the reduction in the availability of fresh water by as much a 20% – 30% in certain regions and, moreso, in small communities. This situation has the potential to cause civil unrest and to lead to significant economic losses.

Small communities that already suffer from poor health conditions, unemployment or social exclusion may be rendered more vulnerable and this could trigger migration to other areas. This is the concept of "environmental migration". This situation may increase conflicts among small communities where borders are crossed.

Reduction in the availability of, and access to, energy supplies is another impact of climate change. Many of the energy-producing regions of the world are in areas vulnerable to the effects of climate change and, should they be affected, this may result in civil unrest thereby disrupting supplies of energy to small communities.

III. RESPONSE TO THE IMPACTS OF CLIMATE CHANGE

In responding to the effects of climate change on small communities, it would be worthwhile to consider the long-term tenure and slow evolutionary processes related to climate change and the need to tailor responses appropriately. As such, small communities in the Caribbean may respond at the individual and commercial levels through adaptation and mitigation.

A. ADAPTATION

Treatment of identified risks is an essential step in the risk management process. In climate change parlance, the treatment of risks is generally referred to as 'adaptation'. Climate change adaptation can be defined as '*actions in response to actual or projected climate change impacts that lead to a reduction in risks or realisation of benefits*'. Adaptation represents a planned, active response to climate change. Adaptation may comprise the following objectives:

- (a) Identification and assessment of priority risks

- (b) Development of an approach to climate change adaptation that has the potential to be applied more generally.

1. Community-based adaptation strategies

The importance of stakeholder engagement and feedback in designing adaptation strategies and testing options cannot be underscored, since synthesizing indigenous practices and knowledge with scientific knowledge into suitable adaptation options is critical to the successful development and implementation of any strategy. Equally important is community mobilization and raising awareness and sensitization through local culture and practices, such as highlighting drama and musical performances about climate change. Nationally, and at the local governmental level, it is necessary to integrate agriculture with other strategies related to income diversification and policy formulation.

Some examples of adaptation strategies that small communities might employ include:

- (a) Harvesting of rain water through the employment of metal sheets to prevent rainwater leakage
- (b) Alternative storage tanks or irrigation canals for rainwater collection
- (c) Temporary migration of coastal communities to higher levels
- (d) Cultivating crops with shorter growing seasons thereby maintaining employment levels
- (e) Prayers and offerings at local places of worship with which the communities identify
- (f) Support in gathering data to assess climate change intensity in the small communities
- (g) Developing a needs-based service mechanism to support vulnerable households
- (h) Establishment of village knowledge centres that would serve to sensitize communities and build awareness of the impacts of climate change, thereby encouraging support for adaptive strategies and removing barriers

B. MITIGATION

Essentially, mitigation is addressing the root causes of climate change and taking the necessary actions to reduce greenhouse gas emissions. On the one hand, it may be argued that small communities do not have the ability to develop and employ the use of alternative energy technologies. However, it may be posited that, indeed, small communities are well positioned to participate in small-scale pilot initiatives that would provide alternative energy on a subsistence scale. This has actually been done through the United Nations Development Programme Small Grants Programme and is currently occurring in small host homes in Tobago, where solar energy for water heating is being effectively and efficiently utilized.

1. Community-based mitigation strategies

(a) Taking a lead in addressing carbon emissions

This may be achieved by small communities lobbying policymakers in ensuring that climate change is incorporated into Joint Strategic Needs Assessments that would inform the formulation of new policies or amendments to existing policies.

(b) Taking a lead in lobbying for research on climate change impacts

Small communities are in a position to influence the research agenda through lobbying regional and national institutions to place climate change on their agendas. This would be particularly important in the area of biotechnology through which varieties of crops and livestock that are more adaptive to changing climatic conditions may be developed.

(c) Lobbying for the conduct of a carbon audit

This would facilitate the establishment of a baseline or reference from which measureable changes in carbon dioxide levels could be determined with a view to informing required action.

(d) Place energy at the heart of the communities

This could be achieved through the promotion and practice of measures to increase energy efficiency, including:

- Upgrading light fittings and using energy efficient bulbs
- Switching off and unplugging appliances and lights when not in use
- Cooperating in the use of sources of renewable energy
- Encouraging the use of public transportation

(e) Reduce water consumption and flooding

This may be achieved by:

- Using tap designs and flushes that minimize water consumption
- Ensuring that tap water is safe to drink, and creating an awareness of this and encouraging its use rather than using expensive bottled water
- Increasing the ratio of green area to concrete so as to increase absorption of flood water thereby preventing excessive run-off
- Increase water harvesting. Farmers can harvest water from rooftops and divert water from natural springs into tanks. This ensures that they have a substantial amount of water in storage. In case of a drought, the stored water will be able to sustain them depending on the volume of the tank. The water may also be used for supplementary irrigation
- Widespread dissemination and attention to meteorological data and forecasts

(f) Ensure sustainable catering and food procurement policies

- Promote, to the extent possible, local food procurement and cut down on food transport miles

- Provide healthier, fresh, seasonal menus; increase vegetable to meat protein ratio and reduce use of processed foods
- Recommend the use of green gyms, allotments and city farms

(g) Influence sustainable housing and the built environment

- Design sustainable healthcare buildings with green spaces which provide healing views, assist in cooling and in flood run off
- Promote summer cooling by increasing internal and external shading, plant trees and green the surrounding environment.

(h) Promote sustainable forms of transport

Promote and encourage no carbon mechanisms, such as walking, and low carbon forms of transport, such as the use of bicycles that would also have positive health impacts

(i) Develop a carbon neutral waste management policy

- Build environmental awareness, recycling and sustainable printing (on both sides of paper and, in other cases, printing in draft form) into the workplace environment
- Implement environmentally friendly waste contracts and procedures

(j) Promote local employment and skills

- Boost local recruitment through skills qualifications and “Grow your own” workforce
- Adopt flexible work systems that reduce commuting.

III. CONCLUSIONS AND RECOMMENDATIONS

It is clear that climate change would impact the Caribbean subregion and, moreso, its small communities, in particular where they operate at a subsistence level. However, the picture is not totally gloomy since in promoting adaptation to and mitigation against climate change, new and emerging opportunities would arise. The opportunity for promoting south–south cooperation, such as with Brazil and Cuba, does exist; also there is scope for technical cooperation among both developed and developing countries. Making use of these opportunities has already been observed to have positive impacts on small communities in other parts of the world, such as:

(a) In Bangladesh, lands affected by intrusion of salt water are now being used for shrimp farming

(b) In Madagascar, Conservation International and its partners are hiring villagers to plant trees on eroded land which creates corridors to connect fragmented habitats. This activity may earn carbon revenues and provide much needed employment (Time 2009)

- (c) Increased employment of investors in alternative energy technologies would accrue and, associated with this, is diversification in employment opportunities in small communities
- (d) There would be increased opportunity for capacity-building in the utilization of alternative energy technologies. Associated with this may be the opportunity for improved remuneration packages
- (e) Savings in travel by people in temperate climates as the planet warms, but tourism in tropical climates may need to diversify differently
- (f) Costs associated with clothing may decline, but so would investment in the clothing industry
- (g) A greater demand for air conditioning and refrigeration may occur, again creating the opportunity for offsetting losses in employment
- (h) Increased investment in the insurance industry would help to offset the impacts of climate change
- (i) Investment in the infrastructure industry would also increase thereby offsetting any loss in employment from the negative impacts of climate change
- (j) A reduction in investment by consumers in the transport sector
- (k) Promoting the initiative for Reducing Emission from Deforestation and Degradation (REDD) initiative, as in Guyana and Belize
- (l) Small communities could benefit from other carbon trading initiatives through reforestation projects
- (m) Small communities could also be the guardians of environmental resources performing the role of monitoring and evaluating the use of these resources and utilizing their indigenous knowledge to make recommendations for development.

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