

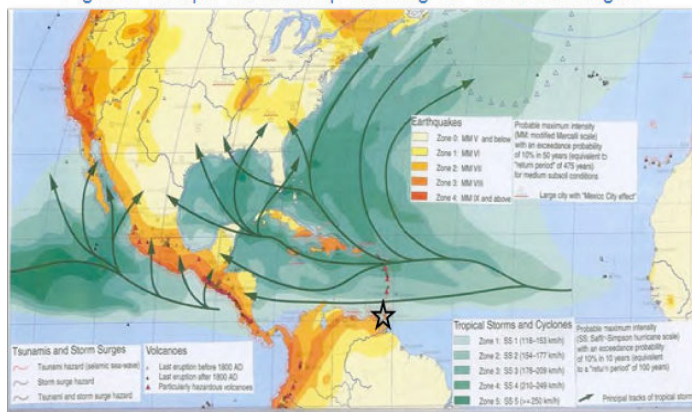
## Flood Management: an examination of mitigation measures for flooding in urban areas in Trinidad

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### Introduction

The Caribbean region is considered one of the most natural hazard-prone regions in the world. This designation is due in large part to a combination of multiple geophysical and geological processes which characterize the region. Floods account, in economic terms, for about a third of all natural hazards in the world. Flood events are the most common natural hazard affecting Caribbean Small Island Developing State (SIDS). In the region, flooding exerts a substantial and consistent influence on the societies of Caribbean SIDS and can create disastrous situations (Ahmad, 2007). The pattern of urban development underway in most Caribbean SIDS wields a significant influence on the occurrence of flood disasters in the region. Here, sprawling urban development typically overloads and overwhelms both natural and man-made systems within these small coastal entities and leaves them vulnerable to flooding.

Figure 1 Multiple Hazard Map Showing the Caribbean Region



Source: Ahmad, 2007

Figure 2 Map Showing Trinidad in Caribbean Context



Source: <http://www.mapsofworld.com/trinidad-and-tobago/trinidad-tobago-political-map.html>

The oil and natural gas rich island of Trinidad is the most southerly island within the Caribbean SIDS. The island lies just 11 kilometers off the Venezuelan mainland and has a landmass of approximately 4,828 square kilometers. The national population is approximately 1.26 million people and the estimated population density is 248 people per square kilometer. According to Stanfield and Springer (1993) private individuals own 47 per cent of the land while the State owns the remaining 53 per cent, much of which is held in forest reserves. Imprinted upon this backdrop of land ownership is a highly uneven distribution of population settlement and urban development. During the 1970s 'oil boom' period the country witnessed a spurt of growth. By the late 1970s the Trinidad and Tobago Town and Country Planning Division (TCPD) had ominously noted a skewed pattern of urban development which posed a dilemma to the sustainable development of the country. This pattern of development is still obvious today. Notably, the highest population densities in Trinidad are lumped within the capital city of Port of Spain and straddled along an urban corridor of communication known as the East West Corridor. This corridor is juxtaposed against the southern foothills of Trinidad's Northern Range.

The Northern Range is the most dominant relief feature on the island. According to the Environmental Management Authority of Trinidad and Tobago there is intense competition for land within this Corridor's urban belt (EMA, 2004). Since its establishment the East West Corridor has seized an urban prominence which it has never relinquished. The rapid expansion of the urban population continues to generate an increase in the demand for urban land for residential plots for all income groups, locations for industry and commerce, and land for public buildings and projects. To meet this growing demand for land, urban settlements have rapidly sprawled in many vulnerable locations which are subject to various types of natural hazards.

**Figure 3 Land Use/Cover Map for Trinidad showing East West Corridor**



Source: CLEAR, 2006

According to the UN- International Strategy for Disaster Reduction (ISDR, 2004) inadequate, ill-informed or non-existent land use planning has contributed to the vulnerability of communities exposed to natural hazards. Unwise land use is at the heart of the public policy problem involving natural hazards and disaster situations in Trinidad. Urban land tends to be the most vulnerable to catastrophes wrought by natural hazards, yet, there are inadequate measures to reduce the impacts of natural hazards on local populations. In Trinidad, unmanaged urban development has stamped its claim on vulnerable locations, which in turn suffer intolerable losses when disaster strikes. Furthermore, the uncertainty attached to climate change impacts and the resultant incidence of natural hazards is a growing concern for Trinidad. Already, flooding is the most prevalent and persistent natural hazard affecting Trinidad. The Water Resources Agency of Trinidad and Tobago (WRA, 2002) noted that the alleviation of flooding called for substantial capital investments, which may not be available within the short term. In Trinidad flooding has become a legacy of unmanaged land use that is exacting a predictable punishment. Urban development has occurred at a rate beyond the physical planning capacities to mitigate flood impacts. Rapid growth in the absence of adequate physical planning measures has contributed to flood disasters as water blasts off buildings and various surfaces and overwhelms the drainage systems. Yet, inappropriate land use activities such as deforestation, unplanned and improper housing development and inappropriate agricultural practices, persist unchecked, resulting in a failure to mitigate flooding. Given the range of impacts to the population, flooding is considered a major disaster for this small island and increasingly threatens the country's attempts to achieve sustainable development. Flood management requires a proactive approach to urban land use planning for disaster risk reduction.

This paper provides a background to the Trinidad setting within the wider Caribbean SIDS context, it then presents a review of literature related to natural hazards and climate changes issues for Caribbean SIDS and the urbanization dilemma facing these small islands. The paper thereafter illustrates the Trinidad case study highlighting its unmanaged urban development, flood setting and the inefficient land use planning environment for flood management. In its recommendation, this paper advances the view that a land use planning approach which is integrative and participatory is necessary to ensure the efficient application of mitigation measures for flood management. It advocates that integrated land use planning is crucial to resolving the myriad urban management issues which hinder appropriate flood management in Trinidad.

### **Natural Hazards and Climate Change as Priority Area for Caribbean SIDS**

In 1992, at the United Nations Conference on Environment and Development (UNCED), the world community adopted Agenda 21. Agenda 21 recognized SIDS as “a special case for both environment and development.” It went on to ominously described SIDS as ecologically fragile and vulnerable due to small size and limited natural resource endowments. Exposure to extreme natural phenomena coupled with the high level of economic and environmental vulnerability of SIDS is a perpetual challenge to sustainable development. It is against this backdrop that the 1994 Barbados Programme of Action (BPoA) tried to address the unique challenges and constraints facing SIDS. The BPoA presented a basis for action in fourteen (14) agreed priority areas challenging SIDS. Included amongst these priority areas were natural and environmental disasters, climate change and land resources.

Within the context of sustainable development planning in Caribbean SIDS the definition put forward by the Brundtland Commission in 1987 retains its currency and validity. The Commission defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Therefore sustainable development, in relation to land use planning, has the key objective of accommodating the present demands for land without compromising the ability of future generations to meet their land needs. This is particularly important for Caribbean SIDS as their limited landmasses leaves them challenged in providing physical development solutions for their youthful and growing populations. This situation is compounded by their inherent predisposition to a multitude of natural hazards. While no country in the world is entirely safe from natural hazards, a lack of capacity to limit the impact of hazards remains a major burden for developing countries. The World Meteorological Organization (WMO, 2009) notes that the degree of natural hazard vulnerability is highest in developing countries. Tompkins (2005), following Susman et al (1983) notes that, natural hazard vulnerability refers to “the degree to which different classes in society are differentially at risk, both in terms of the probability of occurrence of an extreme physical event and the degree to which the community absorbs the effects of extreme physical events and helps different classes to recover.” Hence vulnerability is generated through the combined effects of exposure to hazards and society’s capacity to withstand those hazards and recover from any impacts.

The settlement and land use history of the Caribbean territories has already placed population and livelihood in vulnerable areas and improper land use decisions have in turn exacerbated vulnerability (UNDP, 2001). Indeed, Caribbean small islands are no strangers to the devastation brought on by natural hazards. This devastation may be economic, social and environmental. According to the Inter- American Development Bank, Latin America and Caribbean region experiences an average of 40 major disasters a year and ranks second, to Asia, in terms of the frequency of disaster occurrence (IADB, 2000). Although recurrent natural disasters have

always plagued Caribbean countries, a closer analysis of what transforms a natural event into a human and economic disaster reveals fundamental challenges to development that the Caribbean region faces. These problems include:

- Rapid and uncontrolled urbanization;
- Widespread urban and rural poverty;
- Environmental degradation resulting from the mismanagement of natural resources;
- Inefficient public policies; and
- Lagging and misguided investments in infrastructure.

A looming natural hazard threat to sustainable development in the Caribbean SIDS is the wave of challenges that climate change portends. Globally, emissions of greenhouse gases (GHGs) have damagingly increased as a result of various human-related, economic and physical, development activities. Increased GHG concentrations have enhanced the Earth's 'natural greenhouse effect' and led to climatic variability and long term climate change. The United Nations Framework Convention on Climate Change (UNFCCC), states that climate change is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC, 1992). Climate change is expected to result in increased seasonal and inter- annual variability, as well as generating slow changes in mean conditions such as sea level, air temperature and precipitation rates; an increase in the frequency of extreme events; and possibly abrupt systems changes (Tompkins, 2005). Vulnerability to climate change is considered to be high in SIDS due to their social, economic, and environmental conditions that amplify susceptibility to the negative impacts and contribute to low capacity to cope with and adapt to climate change phenomena. According to Lewsey et al. (2004) few areas in the world are more vulnerable to climatic change impacts than the low lying island states of the Caribbean. Climate change impacts in Caribbean SIDS can be exacerbated by poor land use decisions. The Caribbean region is by definition a coastal region and improper land use changes along the regions' coasts contribute to environmental degradation. Environmental degradation has increased the risks that climate change is predicted to have on Caribbean SIDS economies as many of them are involved in heavy exploitation of their limited natural resources (Lewsey et al. 2004). As such, the (IPCC, 2001) suggests that most of the Caribbean SIDS face severe economic disruption from climate change effects.

For Caribbean SIDS, climate change does not only threaten the coastlines, but portends a wave of impacts for the entire extent of these small islands. The Caribbean's geographic panorama is freckled with SIDS situated in or near the Atlantic hurricane belt. Schleupner (2008) asserts that climate change scenarios project an increasing frequency and intensity of hurricanes and tropical storms, for the Caribbean region. Already, in 2008, the Caribbean Meteorological Organization reported that the region experienced an above normal hurricane season with 16 named storms, one tropical storm and one tropical depression (CMO, 2008). Knutson and Tuleya (2004) report that climate change could bring more intense hurricanes, which will have devastating impacts for those islands most exposed to hurricane activity. The tourism and transport industry is affected every time there is a major hurricane, either through damage sustained to property and infrastructure or as a result of consequential downturn in arrivals, cruise visits and cargo trips. This is a worrying situation for Caribbean SIDS. The Caribbean is the most tourism dependent region in the world (Tewarie, 1997) as well as the most tourism penetrated region (McElroy, 2002). Most of the Caribbean region has become largely dependent on the tourism industry as an important source of income and foreign exchange. The region is characterized by coastal tourism and more than ninety five percent of all tourism infrastructure is located within 10 kilometres of the coastline (Smith, 2007). The sensitive and

fragile ecosystems of Caribbean SIDS form the backbone of the tourism products but suffer lengthy recuperation periods when disturbed. As such, natural hazard phenomena and climate change scenarios highlight a key challenge to Caribbean SIDS. The region is compelled to find proactive and innovative ways to balance the need for physical development to facilitate immediate economic needs while minimizing the environmental stresses that improper land use creates. In order to reduce its vulnerability to natural hazards and climate change, sound land use planning must take centre stage in these priority matters.

### **The Urbanization Dilemma**

Just over two decades ago Brown et al (1987) asserted that “aside from the growth of world population itself, urbanization is the dominant demographic trend of the late 20th century.” Urbanization is the process through which cities and towns develop and grow. It includes the movement of people from rural areas to urban areas, as well as movements among towns and cities (UN- HABITAT, 2002). Although, since the 1800s urbanization had gathered its momentum from within the developed world, since the 1950s this momentum has shifted dramatically to the developing countries. In support of this, Drakakis- Smith (2000) noted that since 1980 the greater portion of the world’s urban population has been contributed by developing countries. UNHABITAT (2002) indicates that urbanization is a response to economic, social and political forces, but the specific ways in which urban settlements develop and grow in different countries, change under the influence of new factors. In the developing world urbanization has been closely linked to colonial influences which changed tropical countries and brought them under an industrial capitalist system. Today, most of the large cities of the developing world are based on administrative roles initiated by earlier colonial powers and on economic activities that tie them into the world trading and economic system. Urban areas act as the centres of trade, commerce and industry that underpin national and regional economic development. The concentration of people in towns and cities can bring great benefits and opportunities (Hague et al, 2006).

UN- HABITAT (2002) recognized that in the decade since the adoption of the BPoA, SIDS have become increasingly urban. Of the 52 million people living in SIDS, 30 million already live in urban areas. The Caribbean’s urban development patterns are highly skewed as a result of the Plantopolis model of historical settlement. Caribbean cities were initiated as gateway cities to support their monoculture agricultural economy. Although, built on a monoculture economy the region is highly urbanized and in 1960 was the most urbanized of any region in the world (Potter, 1985). The pull of population to the urban areas has been inextricably linked to inequalities, heightened and intensified by a colonial system which focused wealth in the cities and exploited the rural hinterlands of much of their resources. Historically, the disparity between the urban cores and more peripheral areas has been intensified by policies of national governments which favour urban development. The Caribbean SIDS have witnessed a rapid process of urbanization. However, despite some formal planning of the colonial cities by the then colonial governments, the post- emancipation rapid urbanization and resultant physical developments have been largely unplanned (Potter, 1985).

Hague et al (2006) illustrate that while the concentration of people in towns and cities brings great benefits and opportunities the way that urban growth is currently happening cannot ensure an acceptable quality of life, let alone an improvement in it, for the vast majority of urban dwellers. One of the consequences of unmanaged urbanization is a large and increasing number of urban residents who, seemingly oblivious of the cost to the environment, simply seek to survive as best as they can (Drakakis- Smith, 2000). This represents a troublesome trend in the Caribbean where runaway urban sprawl, the occupation of high-risk land and the use of substandard materials leaves a large percent of the population vulnerable to natural hazards.

This trend is exacerbated by a general inability of land use planning and development regulation systems to keep pace with the demand for land for urban use.

### **The Trinidad Case:**

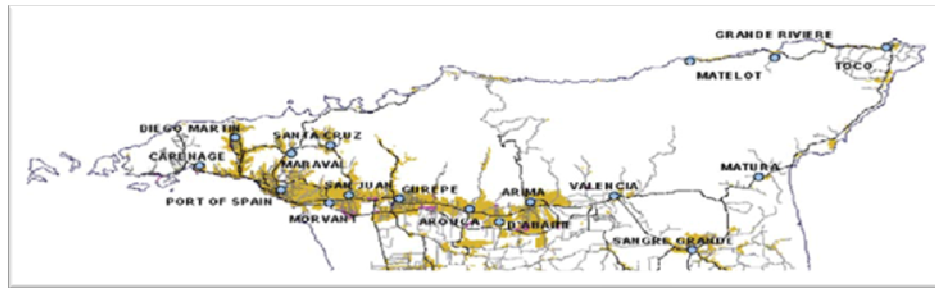
#### ***Urbanization in Trinidad***

Potter (1985) noted that Trinidad has a predominantly uneven distribution of population and development. This inherited pattern of skewed development, initially focused on the north- west and west coasts, then stretched north east as a product of the poorly managed phenomenon of rapid urbanization. An examination of the process of urbanization in Trinidad reveals that it is not a recent phenomenon occurring in the country. Instead, the urbanization process underway in Trinidad had its genesis in the socio- historical past of the island. He noted demographic heterogeneity- migration and natural increase, uneven economic growth and the colonial and post-colonial experience of Trinidad and Tobago, as contributory factors which have given rise to its uneven pattern of urban development (Potter, 1985).

Trinidad has been described as having the most diversified and industrialized economy in the Anglophone Caribbean. The petrochemical sector is the driver of its economy. Since the early 1960's its economy has been characterized by a heavy dependence on the production and export of petroleum and natural gas. During the 1970s Trinidad enjoyed a burst of growth fueled by the sharp increase of world oil prices which emerged from the energy crisis created by the 1973 decision by the Organization of Petroleum Exporting Countries (OPEC) to limit the supply of oil to the international market. Oil windfalls between 1973 and 1982 brought increases in income, expansion of jobs in the public sector, investments in physical infrastructure, and improvements in living conditions (Mycoo, 2006). However, following the global economic recession which started around the mid- 1980s consecutive governments have experienced problems with keeping pace with its population growth and the resultant demands.

The twentieth-century development pattern for Trinidad was one of increased urban primacy. In 1946 the two major cities of Port of Spain and San Fernando accounted for approximately 22 per cent of the national population. Rapid suburbanization, in the form of urban sprawl, occurred from 1960 onwards as a result of the prohibitively expensive costs of land within the Port of Spain urban area. Low density housing initially developed in a linear pattern along the major transportation routes along the East West Corridor. These communities developed as loose, non-compact and non-contiguous settlements. They depicted a laissez-faire concentration realized through unplanned growth in which public sector and social costs were factored in as criteria in the allocation of development (GORTT, 1984). As residential lands along the Eastern Main Road were more affordable than those in Port of Spain, new 'dormitory' developments took place along the East West Corridor. Facilitated by the growth in automobile ownership residents were able to work and socialize in Port of Spain while living in communities east and west of the city. Port of Spain has never relinquished its urban primacy. In 1997, 24per cent of the total number of jobs available in Trinidad were located in Port of Spain. However, 79 per cent of the persons working in Port of Spain resided outside of its boundaries (Halcrow Group, 2000). Additionally, while in 2002, the population density of Trinidad stood at 254 people per square kilometer, the population density of Port of Spain was 5,118 people per square kilometer (Agard & Gowrie, 2002).

**Figure 4 East West Corridor Residential, Commercial, and Municipal (brown); and Industrial (pink) Cover**



Source: EMA (2004)

The more recent land use trends in Trinidad have been dominated by a steady increase in inadequately managed urban growth. This has been predominantly characterized by uncontrolled housing development; agricultural activities, such as slash and burn, and deforestation. The conversion of natural areas for residential purposes has been related to an annual population growth rate of approximately 1.1%. As a result, urban development has sprawled and progressively penetrated, from the East West Corridor, northwards and upslope of a number of valleys on the southern flanks of the Northern Range. These slopes are considered critical for soil and water conservation. EMA (2004) has indicated that the aforementioned upslope development typically occurs in non conformity with land capability and proper land use management. Baban et al (2008) indicate that the Government has since 1976 specified that development should not be permitted above the 300 ft contour level and on slopes greater than 1:6. However, they noted that “this policy proved to be ineffective, restrictive and inappropriate.” The Northern Range Hillside Development Policy of 1988 was created to address these deficiencies but has faced a lack of compliance and enforcement (Baban et al, 2008). In the meantime, there has been a continuation of rapid urban expansions into the Northern Range, with the effect of altering the natural slopes and hydrological properties of the watersheds. Already, the loss of forest cover has caused considerable gully and sheet erosion induced by rainfall. The National Action Programme to Combat Land Degradation in Trinidad and Tobago (NAP, 2006) indicated that illegal hillside squatting has increased tremendously over the years, resulting in large tracts of State and private lands being utilized in an unsustainable manner. Squatting is by no means a new phenomenon in Trinidad. Instead, Lemel (1993) stated that in Trinidad “squatting is effused with popular legitimacy.” Residential squatting communities are generally associated with poverty, overcrowding, limited basic infrastructure and amenities, and poor sanitary conditions. At the same time, the slopes of the Northern Range have grown highly attractive for high income homes. EMA (2004) notes that facilitated by the current wealth of the country and by modern architecture, engineering and means of mobility the Northern Range has been affected by authorized high income housing as much as by unauthorized low income settlements.



**Figure 5 Housing Developments in the East West Corridor**



Source: Author, 2010

Deosaran (2000) indicated that present day Trinidad demonstrates all the signs of conspicuous wealth: highly visible commercial centres, impressive business and state edifices in the capital city, luxury town homes and the latest models of private vehicles. However, 36% of the population lived below the poverty line of US\$200 per month in 2000. Deosaran (2000) lamented that it was a perplexing situation that a small, oil and natural gas rich, country still had so many poor people. As more people concentrate in the urban areas so too has the geography of poverty changed. The existence of gross disparities in the living conditions of the urban population in Trinidad leaves a growing amount of the population unable to access basic services and amenities and forced into vulnerable circumstances. Indeed, the increase in unmanaged urban development is causing environmental, social and economic problems in Trinidad. Baban et al (2007) stated that in Trinidad *“the population has a tendency to make demands on the environment to support activities that are essential for society’s well being and development... but these demands, particularly when driven by unplanned rapid development, tend to have a negative impact on and degrade the environment.”*

### **Flooding in Trinidad**

Trinidad is divided into twelve major catchment/hydrometric areas: North Coast; North-West Peninsula; Caroni North; Caroni South; North Oropouche; Nariva; San Fernando; Ortoire; South Oropouche; Guayaguare; South-west Peninsula and North South-west Peninsula. Major flooding in Trinidad generally occurs in the Caroni, Caparo and Santa Cruz basins (Gray, 2005). In October 1993, flooding in Trinidad resulted in five deaths and economic damages totaling US\$70,000. Fortunately, flooding has not usually enumerated a large number of fatalities in Trinidad. However, its impacts on infrastructure and the agriculture sector have been more extensive. The perennial flooding problem over the past 20 years in Trinidad have devastated agriculture produce worth over US\$20 million and caused damages to over 1,000 homes and businesses (Ramlal, 2008). Flooding in Trinidad has been caused by a combination of natural and anthropogenic factors. Most of the flooding occurs within the rainy season (June to December). More recently, flooding has been linked to the increased intensity of rainfall events. Trinidad is located in a tropical climatic zone where it is prone to what is described as high intensity- rainfall or very heavy rains occurring within a short time period. High intensity rainfall periods in the wet season often lead to flash floods (Ramlal, 2008). Human activity has also influenced flood events. The EMA (2004) identified a number of human causes to flooding such as unplanned development; shifting hillside agriculture practices; and forest fires. These



situations are compounded by poor practices such as improper disposal of solid waste by dumping in rivers and drain ways.



Source: Author, 2010

The repository of information regarding floods in Trinidad is very fragmented. Historically, flood information has not been well documented by any single agency. The WRA (2002) recognized that there exists a highly inadequate database on flood occurrences and their parameters such as frequency levels and extent of damages, financial or otherwise. Additionally, in the limited instances where flood studies have been conducted, these have been done in an ad hoc catchment by catchment basis instead of being incorporated within an integrated framework. In relation to losses from floods the data remains obscure.

### ***Flood Management in Trinidad***

Flood management for urban areas highlight the need to integrate structural and non- structural measures to cope with floods. In Trinidad, the legislation makes arrangements for the implementation of structural measures to mitigate flooding under the Water Works and Water Conservation Act. The Drainage Division of the Ministry of Works and Transport has this major statutory responsibility under the Act. Gray (2005) wrote that the charge of the Drainage Division is to develop and maintain main watercourses and irrigation systems; design and construct hydraulic and coastal structures; provide advisory services to ensure efficient and effective flood erosion and sedimentation control, drainage, irrigation, coastal protection and reclamation, in a cost effective manner, in order to improve the quality of life of the citizens of Trinidad and Tobago. Current thinking highlights that structural measures alone are inadequate for disaster management. Britton (2006) asserts that policies, legal and institutional arrangements form the foundation of any society's approach to disaster management. In this regard, the policies will be derived from information drawn on to establish appropriate action; the legislation will identify the explicit decisions about how a particular policy will be conducted and gives legitimacy to those actions; and institutional arrangements identify specific agencies and their relationships for carrying out the missions and duties associated with the policy.

At present there is no policy which explicitly addresses disaster management nor clearly states or identifies any agency as having the sole responsibility for disaster management in Trinidad. Instead the legislative and institutional arrangements are broken up amongst different State ministries and agencies. As a result, flooding is addressed in a piecemeal approach. Existing policies and legislation governing disaster management in Trinidad include:

- Trinidad and Tobago Small Building Code (draft 2000): This draft legislation was strongly influenced by the Caribbean Uniform Building Code (CUBiC). It provides minimum requirements to safeguard life, limb, health and public welfare.
- Environmental Management Act No. 34 (1995): This Act is the legislative framework for comprehensive control and protection of the country's natural resources. It has a very important role in regulating land-use and land development, and the prevention and control of water pollution. The Act provides for the requesting of a Certificate of Environmental Clearance by developers before proceeding with certain types of activities.
- Waterworks and Water Conservation Act (Revised 1980): This Act provides for matters relating to the control and use of water in the country. It also provides for the making of regulations for the control of the supply and use of water in "Water Improvement Areas" and the prevention of waste or misuse of water in those areas.
- State Lands Act (1980): Provision is made for the management of all state lands: the prevention of squatting and encroachment, the prevention of injury to forests, and the settlement and allotment of State lands.
- Forest Act (Revised 1980): Provides for the preservation of trees.
- Agricultural Fires Act (Revised 1980): Provides for the prevention and control of agricultural fires.
- Town and Country Planning Act (1969): This is the principal legal instrument for regulating land-use in the country. It provides for the orderly and progressive development of land and gives power of control over land-use and its acquisition. Policy instruments are also available for development control.
- Water and Sewerage Authority Act (1965): This Act is intended, inter alia, to ensure the development and control of the water supply as well as to promote the conservation and proper use of water resources.

With several pieces of legislation governing the flood management process there are conflicting and overlapping responsibilities which contribute to confusion, neglect of duties, lack of coordination and unclear responsibilities. This has been described by Mycoo (2002) as being symptomatic of a deep public sector malaise. The current environment for flood management in Trinidad is painted by a general absence of national strategic planning and a lack of integrated planning. This translates to a sectoral approach to planning and the segregation of planning and development actions along sectoral lines. The absence of an integrated approach to planning results in 'turf wars' and singular responses to development planning. This promotes the sub optimal use of already limited financial, human and technical resources. The situation is worsened by outdated legislation and inadequate plans. In Trinidad and Tobago the NPDP is to be revised every five years according to the TCP Act. However, the 1984 NPDP is yet to be revised. Planning policy statements which are utilized in absence of an up to date NPDP have no legal gumption as the development plans. Bernstein (1994) notes that the causes of many of the problems related to rapid urbanization emerge from inappropriate regulation, lack of secure tenure, inadequate infrastructure, and weak and poorly coordinated actors in the land market. To address these issues there is a need to adopt principles of integrated land use planning and management in order to produce sound flood management.

### **Conclusion and Recommendations**

Solutions for flood management in urban areas of Caribbean SIDS are often complicated by the fact that urbanization has proceeded through historical processes motivated by tendencies and driving forces which did not result from the optimal use of space nor integrated planning. As the urban development in Trinidad proceeds irreversibly, the challenge is to marshal the limited

available resources to correct adverse conditions, upgrade and repair run down and non-operational infrastructure, and create and promote zoning concepts and the rational use of urban space (Petry, 2002). These challenges can only be met through an approach to integrated land use planning which is based on sound legislative and institutional arrangements. In support of this Birkland (2003) indicated that the most promising way to yield ecological benefits while mitigating damage to people and the environment is to discourage inappropriate land-use. In Trinidad, although the legal basis for land use planning is to provide spatial order as the basis for infrastructure provision to protect public health and safety, promote economic development prospects and mitigate negative environmental impacts that may arise from land development the present situation does not reflect such. The planning system is fragmented and mired with challenges. These challenges include political interferences, insufficient resources and state circumvention of processes to engage civil society in environmental and planning discourse

Land use planning that integrates the social, economic, and environmental spheres is critical to the attainment of urban management to mitigate the disastrous impacts of flooding in Trinidad. The planning exercise must be undertaken with the participation of all of the relevant agencies in order to come up with a framework for the holistic flood management within the country. The input of civil society, non-governmental organisations (NGOs) and private sector stakeholders is also essential to the identification of issues which require attention, and to the formulation of strategies that would receive widespread support. An important element of the flood management process should be the establishment of flood hazard maps to assist the planners in determination of development zones and the type and quantum of development that the zones can accommodate. Priority should be given to the development of coordinating mechanisms to ensure that physical planning and flood management plans are implemented at the central, local and private sector level. Added to this is the need to build institutional capacity to secure the enforcement of existing policies and laws. Land use planning prescribes the use and restrictions on the use of land resources and is critical for sound flood management. Adequate land use planning is paramount to mitigating flood impacts and should be supported by legal regulations, management plans and institutional arrangements.

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