

# Impacts of Climate Change: Floods and Guyana Sugar Industry

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**Abstract-** Climate change is occurring all over the world and various forms of climate change impacts are being experienced by countries; Guyana is no exception. As a coastal country and an agrarian society, Guyana's environment, economy, and society are highly sensitive to climate change. This research explores the influences of climate change on the sugar industry in Guyana. Meteorological data for the period 2003 to 2016 showed that annual rainfall is decreasing; however, Guyana is experiencing a shorter wet season but with higher rainfall intensity. These variations in rainfall induced by climate change result in floods and have a wide range of impacts on the sugar industry and society as a whole. The negative consequences of the floods on the sugar industry including a chain reaction of impacts on communities and society were illustrated.

**Index Terms-** Climate Change, Floods, Guyana, Impacts, Sugar

## I. INTRODUCTION

Anthropogenic climate change has increased drastically during the last few decades and has become a major concern for the world as a whole. This is due to the variable effects it has in the different climatic zones, which includes the variability in temperature, rainfall, solar radiation, sea level and atmospheric CO<sub>2</sub> concentrations. (Mahato, (2014); Malla, (2008)) Climate change continues to occur all over the globe, carbon dioxide level has passed 406 ppm in 2017. Sea level continues to rise at an average of 3.1mm per year (U.S. Department of Commerce, 2016); while global world temperature has risen by 0.8 degree Celsius since 1880 with sixty-seven percent (67%) coming from 1975 onwards. (NASA) Continued global warming will result in detrimental impacts on freshwater resources, food security, health, ecosystems and the environment.

There have been significant impacts of climate change on Guyana (Guyana, 2002); mainly, an increase in average temperature by 1° C occurring between the period 1909-1998; before 1960, annual rainfall was usually around the national average however after 1960, the rainfall has been below average and; finally, the tidal data for Guyana in the period 1952 to 1979 shows on average that sea level has risen at 10.2mm per year, this is approximately five times the world average during the same time. Guyana is extremely sensitive to climate change because a majority of its population and economic activities occur in the low coastal plain region, which is one meter below sea level at high tide. (Office of Climate Change, Guyana, 2016)

Most developing countries, especially for Guyana, are agrarian societies and since the agriculture sector is extremely sensitive to climate change, this results in negative implications for the economy, human health, the environment and public infrastructure. In Guyana, there were significant changes in the weather pattern, namely: floods from rainfall combined with sea level elevation, shorter wet seasons combine with warmer temperatures. This had drastically impacted the agricultural sector which is the main economic activity of the country; thus, negatively disturbing the communities which are dependent on agricultural and also the environment. The aforementioned effects of anthropogenic climate change across the globe had resulted in environmentally destructive agricultural practices being adopted as a countermeasure.

## Agriculture in Guyana

Agriculture is one of the main economic activities in Guyana. The two major agricultural crops in Guyana are sugarcane and rice along with fisheries constitute a majority of the agriculture in the country. There are numerous intersectoral linkages provided by agriculture to other sectors, such as, health, education, social, etc, that help to keep macroeconomic stability in the country. However, climate change has and will greatly affect this since the agriculture sector is the most sensitive to climate change. The characteristics of the agriculture sector in Guyana are that it is seen as a sector that constitutes mainly of poor rural household battling for survival by making productive use of the land available to them. However, the sector is more than what it seems as it is a hub necessary for the economic and social stability of the country, as it provides for its population and exports the excess for foreign currency. There are numerous small-scale agriculture crops that help households to survive in many rural communities, especially Amerindian communities, which are dependent on cassava as their main food, which is usually converted to various dishes. Even on the coast

where commercial agriculture dominates, there are numerous households cultivating different crops for their nutritional value as well as for an income generation necessary for survival. Thus, increasing the implications climate change has on the country's economic well-being and its people livelihoods. The major impacts of climate change will be caused by variations in rainfall patterns, since the huge flood in December 2005 to January 2006 was estimated to cost losses in the agriculture sector by US\$ 16.6 million; whereas the overall impact of that flood was 60% of the country's GDP.

Climate Change is a global issue, with developing countries feeling the brunt of it compared to developed countries. (Stern, 2007) Guyana is a small and poor country with the lack of data collection and reporting, particularly, on climate change and its impacts on the various economic, environmental and social sectors. The agriculture sector is one of those sectors with limited information although it is an essential sector of the country as a whole. Thus, this research will look at the agriculture sector, with the focus on Guyanese sugar industry, its importance to Guyana under the economic, environment and social framework and the impacts that floods induced by climate change have on it.

## II. THE SUGAR INDUSTRY IN GUYANA AND ITS INFLUENCES

Sugar cultivation (plantation agriculture) began in Guyana in the 1630s, which then expanded in the late half of that century to become the largest agricultural industrial operations in the country. It was historically the main commodity during colonial rule and its legacy still exists today in the twenty-first-century as it is a major economic activity for the country. It is the very foundations for which a majority of communities have been built on and around, its significance in Guyana's history cannot be overestimated. Today, although its influence on the Guyanese economy is on a decline mainly because of huge losses it has sustained in the past two decades; it still has strong social and cultural linkages throughout the country. The sugar industry is state owned by the Guyana Sugar Corporation (GuySuCo) which cultivates fifty thousand (50,000) hectares of land, containing six factories along the coastal area. It produces sugar for the local population and the majority for export. The increased intensity of the rainfall combined with the sea level rise (because drainage in Guyana is by gravity flow) has cause floods which impacted the industry's output negatively.

### **Economic Influences**

Agriculture in Guyana has contributed an average of 18.7% of GDP during the period of 2011 to 2014. While sugar alone has contributed an average 4 % of GDP during the same period, this, however, is a decline from previous years. Although it contributed such a small portion to the country's GDP during this period, it employs directly approximately 16,000 persons (with 95% being males; mainly because of the demand for manual labor), which is approximately one-seventh (1/7) of the country's employed population. It is the largest employer in any industry in Guyana and also the third largest earner of foreign exchange for the country. It depends on approximately 300 service providers for important inputs, while it also provides growth for rural communities since its employees are from rural communities. Out of its 50,000 hectares of cultivated land, approximately 8,000 hectares are operated by private individuals, thus it creates jobs for the private sector. Each factory has the ability to generate its energy needs during crop period by bagasse cogeneration. 60% of the drainage and irrigation the industry provides are for non-sugar areas; basically, it helps keep rural communities from flooding. (Thomas, 2015)

### **Environmental Influences**

Aerial applications of fertilizers, growth regulators, and herbicides to the crop at different growing stages have impacts on the environment, along with the increased use of agriculture inputs to counter the effects the of climate change. (Government of Guyana, 1996) Sugarcane is burnt before harvesting to get rid of any health hazards to manual harvesters; however, it has negatively impacted the environment because of the air pollution it causes.

### **Social Influences**

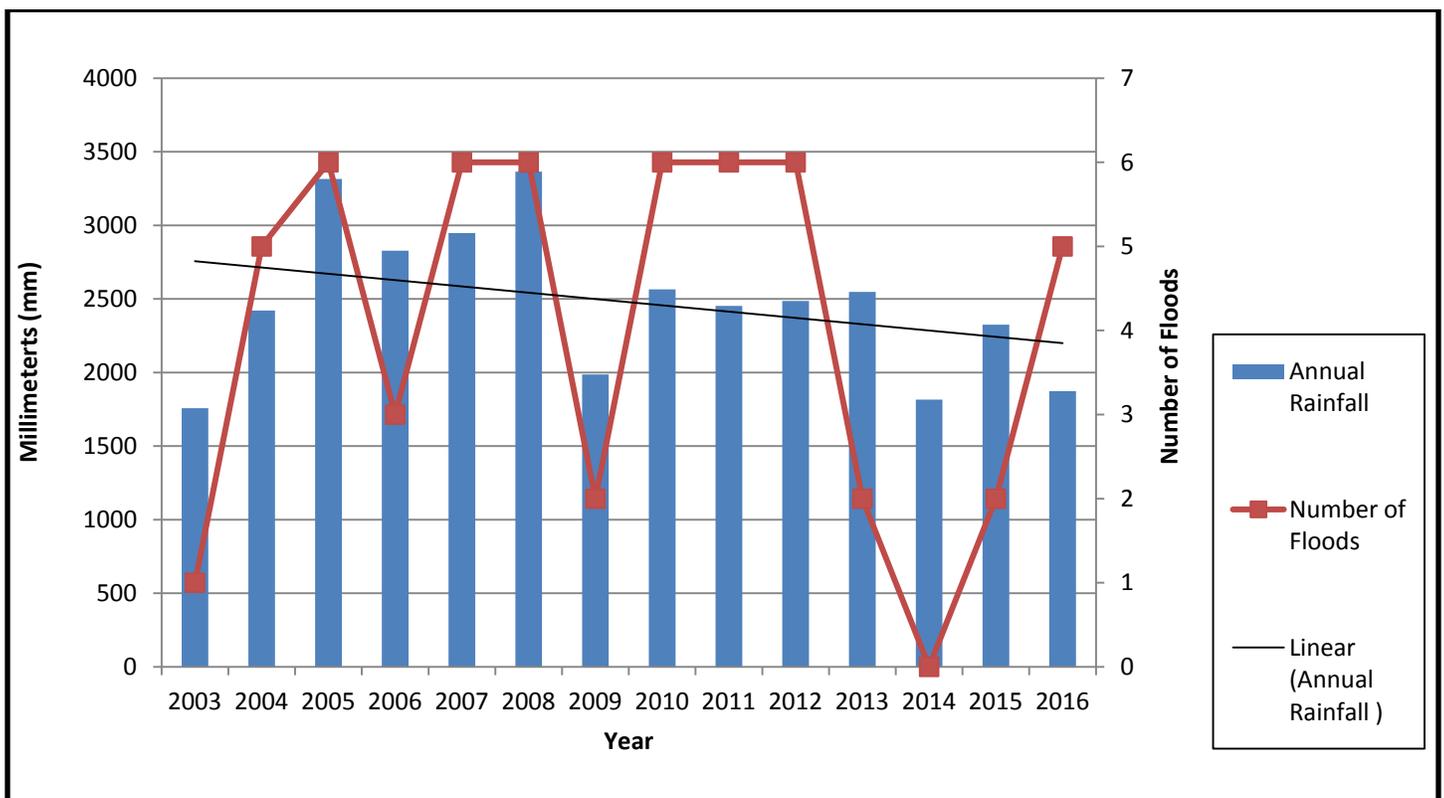
Sugar is much more than an economic activity for Guyana. For the rural communities, it is an institution of strong social and cultural ties due to the history of sugar in the country. GuySuCo creates a connection among employees since most of the work must be performed in teams. This builds a strong relationship among the workers, which in turn build the sense of a community because most of the villagers are working in the sugar industry. It provides an opportunity for personal relationships building. It is also the basis for which some communities are formed and if climate change causes the industry to downsize, it will result in the separation of people in the community because they will each have to go their separate ways in order to earn an income. In addition, GuySuCo has been over the years providing a number of services for communities, including, medical centers, provision, and maintenance of community grounds, training to private sugarcane farmers, transportation infrastructures, and drainage services. Thus, the impacts of climate change on it will affect the quality of services it offers, which in turn will affect the quality of life in the communities which depends

on these services, negatively affecting human development. In the end, basically, people are the ones who will have to suffer the consequences of climate change.

### III. DATA COLLECTION, VALIDITY AND RELIABILITY

Meteorological data was collected from hydrometeorological office in Guyana. A documentary method was used to obtain other secondary data from sources, such as GuySuCo’s budgets, damage reports, climate change statistics, census data, agricultural statistics in the area, and other reports from GuySuCo, the agriculture ministry and the office of climate change in Guyana. The data collected was valid and reliable because it was obtained directly from GuySuCo (Albion/Port Mourant (A/PM) Estate), the hydrometeorological office, and other authorities which are official documents of the respective authorities.

### IV. RESULTS AND DISCUSSION



**Figure 1:** Dual-axis bar and line graph showing the annual rainfall (hydrometeorological office) and the number of floods (GuySuCo – Albion/Port Mourant (AN/PM) estate) for the period 2003 to 2016; along with a linear trendline of the bar graph.

The bar graph above shows the decrease of average annual rainfall during the period 2003 to 2016, as identified by the linear trendline. There was also a positive correlation of 0.64 between the numbers of floods, which is shown by the line graph, that GuySuCo (AN/PM Estate) recorded and the annual rainfall. The average annual rainfall during this study period is 2,478mm, whereas, the optimal annual rainfall for sugarcane growth is 1,500mm. (Sugarcane expert)

The bar graph in figure 2 below shows the inconsistency and unpredictable of the rainfall during the period 2003 to 2016. There is not a single month where the monthly rainfall is the same as the year before. This makes it extremely difficult for the sugar industry to cope with the situation which usually results in floods.

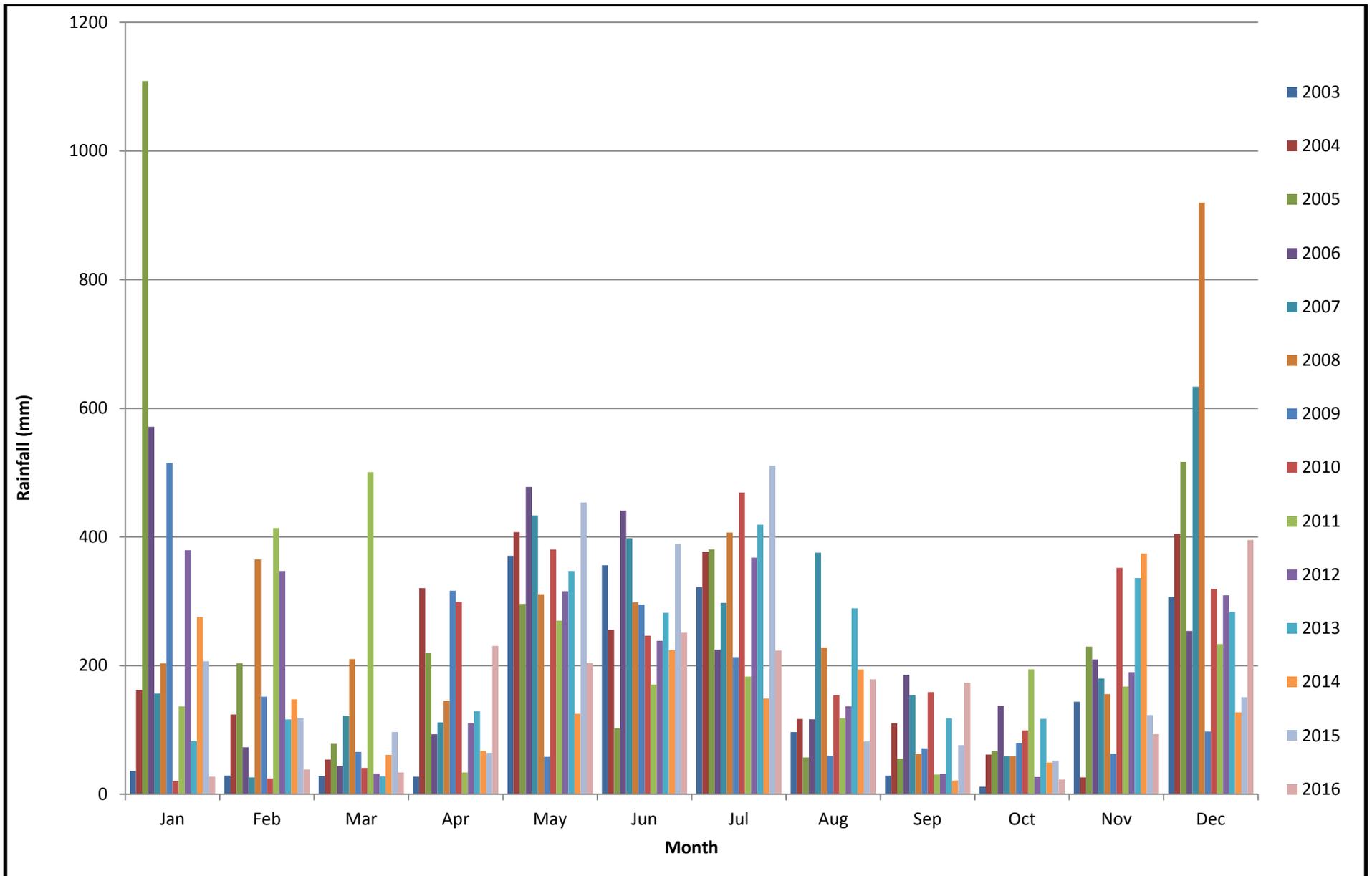


Figure 2: Bar chart showing the inconsistency and unpredictable among the monthly rainfall for the same month during the period 2003 to 2016

### **Impacts of the climate change induced floods on the Sugar Industry**

These floods are a result of climate change and have had a number of impacts on the sugar industry. The impacts identified are as follows:

1. Reduced sugar production, the tons of cane per hectare (TCH) ratio is affected by floods because when sugarcane is planted and floods occur, it rots the newly planted shoots in the fields or it severely affects its root development which is usually reconciled by extensive use of fertilizers which are expensive. Results in losses in the yield per hectare, which is a reduction of production/profit, since money was spent planting the sugarcane and now on fertilizers and workers to apply it. Finally, it results in the reduction of workdays for harvesting, transport and factory employees because of less sugarcane to harvest, transport, and process.
2. Increase pest usually occurs during the height of the rainfall period (usually December to January and May to June) because the sugarcane fields are surrounded by rice fields (which is on lower ground) and during these periods the rice fields are flooded first and pests (mostly sugarcane rats "Holocheilus brasiliensis") migrate to the sugarcane fields. This results in lower quality of cane sugar and also workers have to be paid to "catch rats"; which is, a cost and a reduction in profit.
3. Reduce workdays are imminent during floods for the harvesting and transporting area employees simply because they cannot work or even reach the work location if all the roads/dams are flooded. This results in the loss of workdays for the factory area employees because there will be no sugarcane to process. Also, the floods may be unexpected, sugarcane is usually "burn" and are waiting to be cut/harvest or worst the sugarcane is already cut and are left on the ground to be loaded onto punts to be transported to the factory but because of the floods, these sugarcane cannot be loaded or transported, as time passes, it reduces the sucrose content and quality. All of which results in a cost that must be borne by the corporation and usually results in millions of dollars.
4. Increase transporting time occurs when there are low levels of the flood, that is, sugarcane fields are not totally covered with water, only the roads/dams for traveling are and traveling is done by a makeshift boat (called "labor punt"). This results in more time being taken to get to the work location by the harvesting employees and thus less amount of work/harvesting being done, which also reduces the amount of sugarcane the factory has for processing. Since the roads/dams are flooded, punts cannot be pulled by tractors which are the usual transporting method but now punts will be pulled by a tug (a punt with a tractor engine installed), which is slower; resulting in a higher cost since workers are paid for their time spend, thus reducing profit.
5. Reduction in production, that is in the tons of cane per ton of sugar (TCTS) ratio, which occurs at the factory because of the above impacts, that is, pests' damage sugarcane and sucrose content are reduced because of the delays in harvesting and transporting time during floods.
6. Slower processing time during floods because whenever sugarcane is harvested in floods (small), there is mud being loaded onto the punts with the sugarcane either manually or even worse by machines (sugarcane bell loaders). This increases the amount of processing time of the sugarcane to sugar, which leads to reducing sugar production per day and crop; thus, the corporation not being able to meet its production targets and loss of foreign exchange because the sugar is exported to other countries. In some situations, it threatens to lose a market and when this occurs, the corporation has to buy sugar from other countries and sell it to its buyers just to keep a contract valid. This results in huge amount of financial losses for the corporation.
7. The loss of workdays result in less income for the employees and their family to survive on and since communities were formed around the sugar corporation, almost all of the adults work for the corporation. This reduction of income now has an impact on communities/society, such as the workers stop sending their children to school because of the reduced income, workers become discouraged in work and will engage in crimes, such as robberies. So the floods have a chain reaction of impacts and if the corporation is to downsize or closure occurs because of financial losses, it will cause entire communities to collapse. Since the corporation profits are negatively affected by floods, it caused a reduction in services or quality of services the corporation provides to the communities, these include but not limited to health centers, training institutions for various academic and technical skills and community grounds for any kind of activities/events.

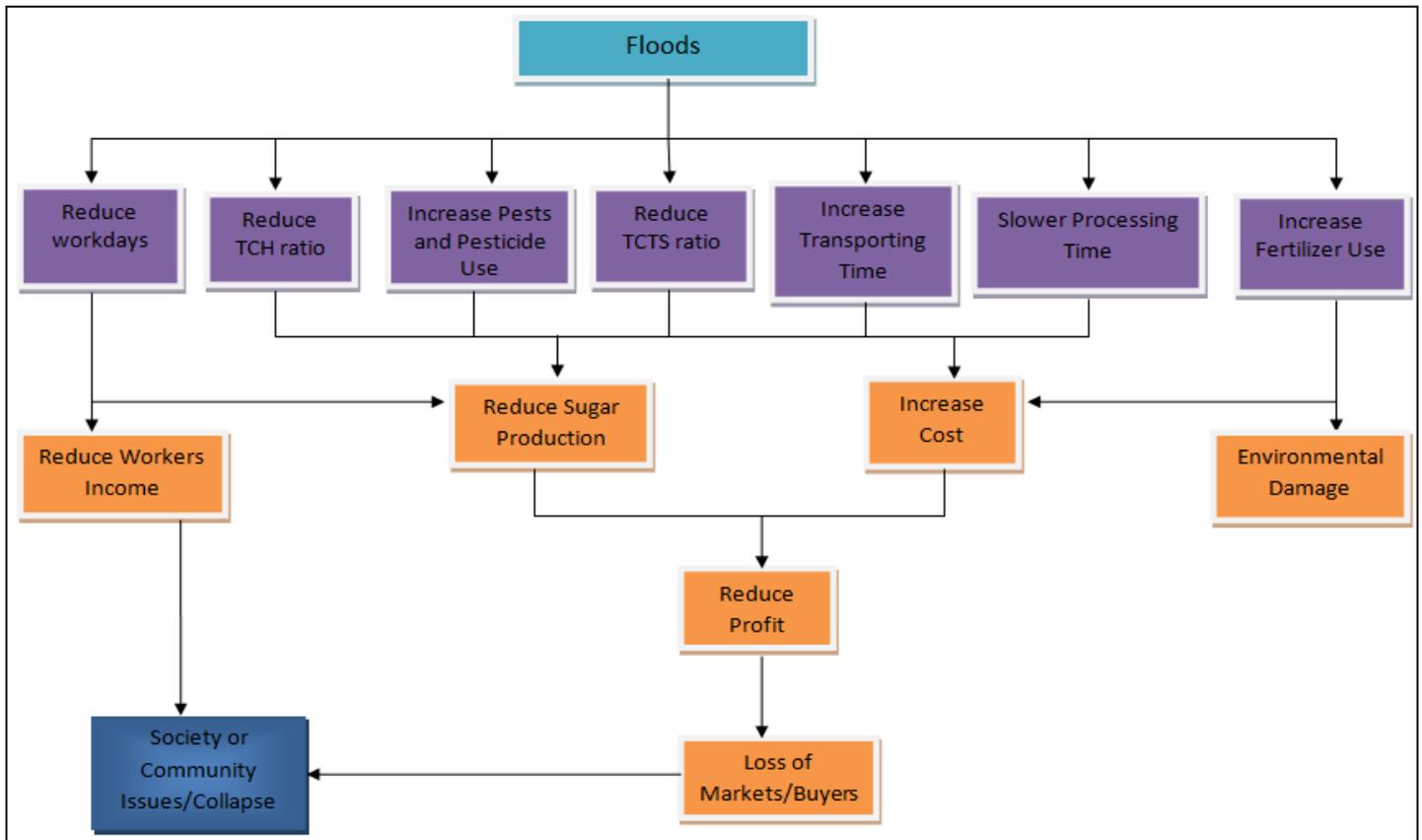


Figure 3: illustration of the impacts of floods on the Guyanese sugar industry and the chain reactions

## V. CONCLUSION

The effects of climate change are felt throughout the world including Guyana. Guyana is an agriculture-dependent nation, thus climate change has impacts on it. The sugar industry is the largest agriculture industry in Guyana and has been faced with floods that have been caused by the variations in rainfall induced by climate change. This research was undertaken to understand the importance of the sugar industry in Guyana and to identify the impacts of floods to it so that information can be provided to the respective stakeholders.

Guyana had an average annual rainfall of more than 2,400mm during the period 2003 to 2016, whereas the sugarcane optimal growth rainfall per year is around 1,500mm, the excess rainfall (which is random, that is, the amount of rainfall is not predictable for any month because of the variations from one year to another and of higher intensity) usually results in floods and negatively affect the sugar industry. The number of floods experienced annually by GuySuCo (AN/PM estate) and annual rainfall had a positive correlation. These floods resulted in a number of impacts; namely, increased: cost, pests, fertilizer use, transporting, and processing time along with reduced profits, workdays and income, all of which had secondary impacts and a chain reaction on the economy, environment, and society.

In the final analysis, the sugar industry has economic, environmental and social influences in Guyana and under the condition of floods induced by climate change, it is being negatively impacted economically, environmentally and socially. This study adds significantly to addressing climate change in small countries like Guyana with minimal climate change studies. This study can serve as a guide for the stakeholders in climate change studies in Guyana. Suggestions for further research would include impacts of climate change on the entire agriculture sector or any other sector or even an entire country against the forms of climate change.

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