Journal of Health and Medical Sciences

Saunders-Hastings, Patrick R., Overhoff, Nadine, and Deonandan, Raywat. (2018), Likely Health Impacts of Climate Change in Guyana: A Systematic Review. In: *Journal of Health and Medical Sciences*, Vol.1, No.1, 42-49.

ISSN 2622-7258

DOI: 10.31014/aior.1994.01.01.6

The online version of this article can be found at:
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Published by:
The Asian Institute of Research

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The Asian Institute of Research
Journal of Health and Medical Sciences
Vol.1, No.1, 2018: 42-49
ISSN 2622-7258

DOI: 10.31014/aior.1994.01.01.6

Likely Health Impacts of Climate Change in Guyana: A Systematic Review

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Abstract
As anthropogenic inputs continue to drive climate change towards a "tipping point" of increasingly severe consequences, associated research has become more important than ever. Even if mitigation efforts are successful in slowing, or even halting, climate change progression, changes have already been triggered that will be felt for decades; the health impacts of these changes will be felt in most populations around the world and will threaten the well-being of billions. Further, it has been suggested that these impacts will be experienced differently, especially depending on geography. As such, it is crucial for location-specific analysis of the potential consequences of climate change to take place. This study constitutes a systematic review of the health consequences that can be expected in Guyana specifically, the results of which are of some relevance to Latin American more generally. Relevant documents selected for full review underwent quantitative and qualitative data analysis. From this analysis, six thematic categories emerged: i) dengue and malaria, ii) other infections, iii) flooding and waterborne diseases, iv) food and water shortages, v) respiratory issues, and vi) natural disasters. These represent the most likely and most severe health consequences that may be exacerbated by climate change impacts in Guyana. Despite these insights, a knowledge and research gap in this field is evident, and a call is made for further research and policy action to better understand and prepare for the upcoming challenges climate change will present.

Key Words: Guyana, Caribbean, South America, Health Impacts, Climate Change, Malaria, Dengue, Diarrhea, Flood

INTRODUCTION

Despite any political or public controversy that might still exist, the overwhelming scientific consensus is that anthropogenic factors (i.e., human inputs) have resulted in changes to our climate. By burning fossil fuels, we release greenhouse gas, primarily carbon dioxide (CO_2), which traps heat within the atmosphere (Cambell-Lendrum, Corvalan, & Neira, 2007). In the past century, the Earth's temperature has increased by approximately 0.8 degrees Celsius, with 75% of that change coming in the past three decades (Cambell-Lendrum, Corvalan, & Neira, 2007). There is great concern that we are on the verge of a "tipping point," which would occur if temperatures were to rise more than 2^{o}C above pre-industrial levels. This would create a situation where climate change became self-sustaining and uncontrollable, with the consequences becoming increasingly severe (Parry et al., 2001). By 2100, temperatures are expected to increase another 1.4 to 5.8 degrees, sending us over this

threshold (People's Health Movement, 2005).

Even if mitigation efforts are successful in slowing, or even halting, climate change progression, changes have already been triggered that will be felt for decades; the health impacts of these changes will be felt in most populations around the world and will threaten the well-being of billions (Costello et al., 2009). Categories of impact most commonly associated with climate change include extreme weather events, thermal stress, shifting patterns of infectious disease, and water and food insecurity (Costello et al., 2009; McMichael, Woodruff, & Hales, 2006). While predictions of these impacts are well-documented, the differential experience of various populations remains poorly understood. This is problematic, given that the greatest burden of health impact is likely to fall on the worst off, as it is the poorest populations that have the least capacity to adapt to these changes. In 2000, for example, the WHO has found that, while the developed countries of North America, Europe, and Australia experienced 8.9 disability-adjusted life years (DALYs) per million population due to climate change impacts on health, those in Latin America suffered 188.5 DALYs per million population (#8). This suggests there is a need for further study of how climate will impact particular geographic locations and ethnic groups; this study explores this gap in the understudied population of Guyana.

Guyana is located on the north-eastern coast of South America. Numbering under 800,000 and shrinking, the Guyanese population is split into five major groups: Amerindians, Africans, Indians, Europeans, and Chinese. The Amerindian population makes up almost 10% of the overall population (Government of Guyana Bureau of Statistics, 2002). Each ethnicity or social group, Amerindians prime among them, may reflect particular vulnerabilities to environmental changes. To better understand the state of current thought on this matter, we conducted a review of the literature in order to identify and explore emerging climate-related concerns likely to impact the Guyanese population.

METHODS

Systematic Review

A systematic review is a summary and assessment of the state of knowledge in relation to a particular topic or research question. Long established in health sciences, systematic reviews have been increasingly used in climate change research, and differ from more traditional literature reviews in three key ways (Ford and Pearce, 2010). First, research questions are clearly structured and used to inform document review and facilitate the selection of relevant research. Second, key search terms and document inclusion and exclusion criteria are fully documented. Typical climate change literature reviews do not provide detail on their review procedures, making it difficult to replicate the study, validate its conclusions, or examine its comprehensiveness. Lastly, a systematic review of relevant publications allows for both quantitative and qualitative analysis of research trends.

Review Process

To assess the likely health impacts of climate change in Guyana, we identified and reviewed publications relating to climate change and health in both Caribbean and South American countries. Relevant publications were identified from four different international databases: Pubmed, CAREC/PAHO/WHO, Google Scholar, and Web of Science. For each database, the same search strategy was applied, involving Boolean combinations of keywords: climate, health, and geographic search terms, as outlined in Table 1.

Table 1. List of search terms employed in database search strategy.

Climate search terms	Health search terms	Geographic search terms
Climate change Global warming	Health Health impact Population health	Caribbean South America Guyana

Specific terms used for each database and the number of publications produced are included in Table 2.

Table 2. Search Strategy Specifics

Database	Terms	# Finds	# Useful finds
PubMed	Climate change + health + Caribbean	15	1
	Climate change + population health + South America	15	1
	Health impact + climate change + Caribbean	2	1
CAREC/PAHO/WHO	Climate change + health + Guyana	364 000	3
	Global warming + population health + South America	2 650 000	1
	Climate change + population health + South America	3 730 000	1
Google Scholar	Global warming + health + the Caribbean	19 600	2
	Impacts of climate change on the health of Guyana	25 300	1
	Climate change + health + Caribbean	79 400	1
Web of Science	Climate change + Guyana	23	1
Total		6868355	13

Data Analysis

Given the cell counts (n=13), inferential statistics were not feasible. Hence, qualitative data analysis was conducted using latent content analysis in order to identify key themes describing the relationship between climate change and health in Guyana within the selected publications. To do this, all publications selected for full review were read through, in order to detect key patterns, themes, and categories. This facilitated the establishment of six key thematic categories, within which coding categories were created. Two researchers then independently reread every publication in-depth and coded. Thereafter, the coded text was retrieved, evaluated, and compared with the quantitative analysis to identify key characteristics of climate change health impacts in Guyana.

RESULTS

Search Results

The initial search produced 6 868 355 documents. Of these, only 13 articles (numbered 1-13 in our inventory in Table 3), none of which were themselves systematic reviews, were identified as appropriate and of relevance to our research question, thus being retained for full review. Due to the number of documents obtained in the initial search, the inclusion of an inventory of publications excluded was not feasible.

Table 3 – List of reviewed articles

Numerical identifier (#)	Citation
1	Jury, M.R. (2008). Climate influence on dengue epidemics in Puerto Rico. International Journal of Environmental Health Research, 18(5), 323-34.

2	Githeko, A.K., Lindsay, S.W., Confalonieri, U.E., & Patz, J.A. (2000). Climate change and vector-borne diseases: A regional analysis. Bulletin of the World Health Organization, 78(9), 1136-47.
3	Ortíz, P.L., Pérez, A., Rivero, A., León, N., Díaz, M., & Pérez, A. (2008). Assessment of human health vulnerability to climate variability and change in Cuba. MEDICC Review, 10(2), 31-48.
4	Hales, S., Edwards, S.J., & Kovats, R.S. (2003). Impact of health on climate extremes. In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 79-102). Geneva: World Health Organization.
5	Patz, J.A., Githeko, A.K., McCarty, J.P., Hussein, U., Confalonieri, U, & De Wet, N. (2003). Climate change and infectious diseases. In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 103-32). Geneva: World Health Organization.
6	Sookdeo, A. (2008). Guyana report on climate change and health [PowerPoint slides]. Retrieved from http://www.carec.org/
7	Githeko, A.K., & Woodward, A. (2003). International consensus on the science of climate and health: The IPCC third assessment report. In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 43-60). Geneva: World Health Organization.
8	Campbell-Lendrum, D.H., Corvalán, C.F., & Prüss-Ustün, A. (2003). How much disease could climate change cause? In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 153-8). Geneva: World Health Organization.
9	Epstein, P.R. (2005). Climate change and human health. New England Journal of Medicine, 353, 1433-6.
10	Moreno, A. R. (2006). Climate change and human health in Latin America: Drivers, effects, and policies. Regional Environmental Change, 6(3), 157-164. doi: 10.1007/s10113-006-0015-z
11	Pelling, M. (1999). The political ecology of flood hazard in urban Guyana. Geoforum, 30(3), 249-61.
12	Costello, A., Abbas, M., Allen, A., Bell, S., Bellamy, R., Friel, S., et al. (2009). Managing the health effects of climate change. The Lancet, 373(9676), 1693-1733.
13	Narayan, K. (2006). Climate change impacts on water resources in Guyana. (2006). Climate Variability and Change-Hydrological Impacts, 308, 413-7. doi:10.1080/09603120701849836

The health risks and impacts associated with climate change, extracted from the included papers, are summarized below into six emergent thematic categories: (i) dengue and malaria, (ii) other infectious diseases, (iii) health issues relating to flooding, (iv) food and water shortages, (v) respiratory issues, and (vi) natural disasters:

(i) Dengue and malaria

Dengue and malaria concerns were the most common health issues reported as likely to become more severe under changing climatic conditions in Guyana. Ten publications included analyses of the association between climate change, dengue fever, and malaria; 7 dealt with climate change and malaria (#2-8), 3 with dengue (#9, 10, 12). There was considerable overlap in the published studies, with an overarching theme for consideration being the impact of climate change on mosquito populations. A WHO bulletin (#2) notes that the "most widespread and severe climate-sensitive and vector-borne disease in South America is malaria" and "new

breeding sites for vectors may arise due to increasing poverty in urban areas and deforestation and environmental degradation in rural areas." This was echoed by another WHO report (#6), that cited a "statistically significant relationship between El Nino and the malaria epidemic in Guyana."

Similar trends have been reported in numerous South American countries, including Columbia, Peru, and Venezuela (Gagnon, Smoyer-Tomic, & Bush, 2002). The suggestion is that changes in temperature and rainfall, with increases occurring in many locations, will lead to increases in vector density and transmission potential (#3, 5). Hurricanes and other climate-related weather events may lead directly to such increases, evidenced in 1998 by soaring incidence rates of dengue fever and malaria following six feet of precipitation in Central America over three days due to Hurricane Mitch (#8). Similarly, after rain and three cyclones inundated Mozambique for six weeks, incidence of malaria increase fivefold (#8). However, El Nino may also "act indirectly by causing changes in water storing practices brought about by disruption of regular supplies" (#5). It appears the changing weather patterns in Guyana, and South America more generally, will influence mosquito populations, potentially increasing risk of endemic vector-borne diseases like malaria and dengue.

(ii) Other infectious diseases (schistosomiasis, chagas, leishmaniasis, diarrheal diseases)

Concerns also exist regarding a range of infections other than malaria and dengue, which may similarly increase due to the shifting environmental conditions caused by climate change. A total of 8 articles (#2-8, 10) were found that addressed these concerns, a strikingly low number given the broad variety of maladies included under this umbrella category, ranging from neglected tropical diseases such as schistosomiasis and leishmaniasis to water contamination illnesses such as cholera and diarrheal disease. It should also be noted that all but one of these articles (#10) overlaps with those discussed in the previous section, covering malaria and dengue fever. This points to a lack of specific analysis targeting a single health issue; the current state of the literature deals more commonly with over-arching reviews of the variety of health risks associated with climate change, preempting as much depth of analysis as might otherwise be possible. Also, of the 8 articles relevant to these issues, five (#2, 4, 5, 7, 8) were WHO global risk assessments that broke down the estimated burden across geographic regions. Of the other 3, one dealt with Cuba (#3), and one with Latin America (#10); only one focused specifically on Guyana (#6) and was a set of Powerpoint slides from 2008. This further indicates the knowledge gap present in Guyana climate change and health research.

With respect to diarrheal diseases, it has been found that incidence rates increase significantly with increased temperature, with mixed findings regarding the relationship between incidence and humidity or precipitation (#8). These associations have been elucidated over daily, seasonal, and annual time periods, suggesting long-term climatic change will lead to significant changes in diarrheal rates, especially amongst the worst off. Checkley and colleagues (2000), for example, found that, while controlling for seasonal variation, daily hospital admission rates for a paediatric diarrheal disease clinic in Lima, Peru increased 8% per 1^{o}C temperature increase, indicating that severe cases of child diarrheal disease increase with temperature. Meanwhile, another study focused on Pacific islands found a significant increase in overall diarrhea rates associated with temperature increase, with rates increasing 3% per 1^{o}C temperature increase, and with rainfall conditions either higher or lower than average (Singh et al., 2001). In fact, after floods, diarrheal diseases were expected to be the most severe health risk exacerbated by climate change in Latin America (#8).

(iii) Health issues relating to flooding

While diarrheal diseases were the most commonly referenced disease other than malaria and dengue fever, it was also noted that heavy rainfall events had the potential to carry contaminants into water supplies, indirectly increasing incidence, not only of diarrheal diseases but other waterborne illnesses such as cholera (#4). Such findings have also been reported in the wake of extreme precipitation in the United States (Curriero, Patz, Rose, Lele, 2001). The WHO predicts that "climate-related ecological changes may enhance primary and secondary transmission of cholera in developing countries, particularly among populations settled in low-lying coastal areas in the tropics"; this suggests that Guyana will be at elevated risk of such a burden (#10). Meanwhile, at the other extreme, the reduced availability of fresh water during droughts could lead to decreases in hygiene-related practices, increasing chances of infections such as trachoma (#4).

(iv) Food and water shortages

There are a number of avenues through which climate change can disrupt both food and water systems, creating or exacerbating shortages that will be felt most strongly amongst vulnerable populations. Water supplies for domestic, agricultural, and industrial uses, for example, rely upon a combination of surface and ground freshwater sources; both will be severely compromised by continuing sea level rise (#13). Sea level rise will lead to flooding of coastal lands, resulting in salination and contamination of both freshwater resources and agricultural lands, as well as the potential loss of nursery areas for fishing (#12). Additionally, rising temperatures will further constrain farmer's crop yields, with estimates suggesting half of the world's population could face severe food shortages by the end of the century (#12). These shortages will be most catastrophic in areas like Guyana that rely heavily on agriculture for sustenance and have the least capacity to adapt to changing conditions.

(v) Respiratory issues

One health risk that receives less attention than those previously mentioned, but has been an area of concern for some higher income countries, is the effect climate change will have on respiratory issues like asthma, with the concern being that it could increase incidence while exacerbating and worsening outcomes associated with asthma. While no articles were found that explored this association in Guyana specifically, research has shown that, in Caribbean islanders, respiratory irritants are present in the form of dust clouds from Africa's expanding deserts that are swept across the Atlantic (#9). This phenomenon is accelerating due to widening pressure gradients over warming oceans (#9). As a result, not only will higher temperatures risk worsening outcomes from respiratory distress, but the increased amounts of respiratory irritants in the Caribbean and Latin America, Guyana included, risks increasing rates of illnesses such as asthma.

(vi) Natural disasters

Natural disasters are influenced by short- and long-term averages and variability in weather conditions and are expected to become more frequent and more severe as climate change increases weather variability (#8 ref 51, 52). The most likely increases will be coastal flooding, due to sea level rise, and inland flooding and mudslides do to more common episodes of extreme precipitation (#8). Natural disasters are already responsible for a significant burden of disease worldwide, and the problem continues to increase (#8). Though estimates vary widely due to uncertainty, the relative risk of flood deaths in Latin America attributable to climate change by the year 2030 is expected to be as high as 4.43 for inland areas, and 4.20 for coastal areas (#8). Guyana may be in a particularly precarious position, given that approximately 90% of its population is "at risk from the contemporary flood hazard and the potential impacts of climate change and sea level rise" (11). This is due in part to the fact that 90% of the population, and 75% of its GNP-producing activities, are located along the North Atlantic coastal plain, a strip of land 200 km long that is seldom wider than 15 km, resulting in both the population and the national economy being extremely vulnerable to coastal flooding (#11).

DISCUSSION

The results of this review suggest that Guyana, and South American countries more generally, are at a high risk of adverse health consequences resulting from climate-related impacts. Such consequences may manifest in the form of communicable and non-communicable diseases, as well as direct injury, malnutrition, and economic instability resulting from resource shortages and disaster events. In all, the most striking finding arising from this review has been the overall lack of current knowledge and study of upcoming climate challenges in South America, of particular concern given the broad range of potential consequences that have been catalogued. These impacts can be expected to result in substantial morbidity and mortality, creating a strain on health resources and the public health system as a whole.

There are a few limitations to this study that are worth noting. First, it is possible that a broader research sample size could have been obtained via snowball sampling, where references from articles identified as appropriate would be retrieved for review, as well. In addition, certain articles may have been overlooked as a result of the

search strategy neglecting to included specific health issues, such as "malaria," and "flood." While this may have produced a wider search net, it was concluded that such an approach was unlikely to yield new information not included in the original article, particularly due to the dearth of information in this field. Second, information was sought exclusively from countries of Latin American origin. This decision was made in recognition that it would result in the exclusion of potentially relevant health trends and predictions from other countries, including some countries in Africa and the southern United States, which have ecological factors comparable to those of Guyana.

One avenue for future study is improved surveillance relating to the identified health consequences in Guyana specifically, as it is clear that those consequences have received insufficient emphasis to date. It would be valuable, for instance, to examine the differential burden of climate change impacts experienced by the various Guyanan ethnic groups, as identification of high-risk populations would allow targeted resource management to reduce vulnerability. The establishment of a quality surveillance and primary health information system is also crucial to meeting future challenges, as are region-specific predictions relating to climate change and disease exposure. Further, as is becoming the case in countries with well-documented climatic impacts, research must be tied to adaptive action designed to reduce the adverse consequences of climate change related to health and other sectors. Communities and countries must share knowledge and adaptation strategies, while national governments must coordinate to develop early warning systems and preparedness plans.

While lower-income countries like Guyana have not been responsible for emissions, they are likely to suffer a disproportionately high health burden resulting from the resulting climatic changes. Adaptive action taken now, such as disease vector control and fortification of the coastal economy to reduce flood vulnerability, could help to reduce and prevent a variety of losses in the future. Management of the health impacts of climate change will require intersectoral action and collaboration, for which substantial knowledge and understanding is required.

CONCLUSION

While a range of serious health consequences has been documented, little is known regarding specifics of what can be expected and what can be done to mitigate or adapt to these changes. It is an unfortunate truism that countries likely to experience a high burden of climate-related impacts are also those wherein the least climate research is being conducted. Having highlighted six key, evidence-based mechanisms of climate-related harm, this review has identified key avenues in need of further research and action.

REFERENCES

Campbell-Lendrum, D.H., Corvalán, C.F., & Neira, M. (2007). Global climate change: implications for international public health policy. Bulletin of the World Health Organization, 85(3), 35-7.

Campbell-Lendrum, D.H., Corvalán, C.F., & Prüss-Ustün, A. (2003). How much disease could climate change cause? In McMichael, A.J., Campbell-Lendrum., D.H., Corválan, C.F., Ebi, K.L, Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 153-158). Geneva: World Health Organization.

People's Health Movement. (2005). Climate Change. In Global Health Watch 2005-2006: An alternative world health report. (193-206). London: Zed Books Ltd.

Checkley, W., Epstein, L.D., Gilman, R.H., Figueroa, D., Cama, R.I., Patz, J.A., & Black, R.E. (2000). Effects of El Niño and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children. Lancet, 355(9202), 442–450.

Costello, A., Abbas, M., Allen, A., Bell, S., Bellamy, R., Friel, S., et al. (2009). Managing the health effects of climate change. The Lancet, 373(9676), 1693-1733.

Curriero, F.C., Patz, J.A., Rose, J.B., & Lele, S. (2001). The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948–1994. American Journal of Public Health 91(8), 1194–9.

Epstein, P.R. (2005). Climate change and human health. New England Journal of Medicine, 353, 1433-1436.

Ford, J.D., & Pearce, T. (2010). What we know, do not know, and need to know about climate change vulnerability in the western Canadian Arctic. Environmental Research Letters 5. doi: 10.1088/1748-9326/5/1/014008

Gagnon, A.S., Smoyer-Tomic, K.E., & Bush, A.B. (2002). The El Niño southern oscillation and malaria epidemics in South America. International Journal of Biometeorology, 46(2), 81-9.

Githeko, A.K., Lindsay, S.W., Confalonieri, U.E., & Patz, J.A. (2000). Climate change and vector-borne diseases: A regional analysis. Bulletin of the World Health Organization, 78(9), 1136-47.

Githeko, A.K., & Woodward, A. (2003). International consensus on the science of climate and health: The IPCC third assessment report. In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 43-60). Geneva: World Health Organization.

Government of Guyana Bureau of Statistics. (2002). Population and Housing Census: Population distribution. [online] Available at <*www.statisticsguyana.gov.gy/download.php?file=22*> [Accessed March 9, 2014].

Hales, S., Edwards, S.J., & Kovats, R.S. (2003). Impact of health on climate extremes. In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 79-102). Geneva: World Health Organization.

Jury, M.R. (2008). Climate influence on dengue epidemics in Puerto Rico. International Journal of Environmental Health Research, 18(5), 323-334.

McMichael, A.J., Woddruff, R.E., & Hales, S. (2006). Climate change and human health: present and future risks. Lancet, 367, 859-69.

Moreno, A. R. (2006). Climate change and human health in Latin America: Drivers, effects, and policies. Regional Environmental Change, 6(3), 157-64.

Narayan, K. (2006). Climate change impacts on water resources in Guyana. Climate Variability and Change-Hydrological Impacts, 308, 413-7.

Ortíz, P.L., Pérez, A., Rivero, A., León, N., Díaz, M., & Pérez, A. (2008). Assessment of human health vulnerability to climate variability and change in Cuba. MEDICC Review, 10(2), 31-48.

Parry M, Arnell, N., McMichael, T., Nicholls, R., Martens, P., Kovats, S., Livermore, M., et al. Millions at risk: defining critical climate change theats and targets. Global Environmental Change, 11(3), 181-3.

Patz, J.A., Githeko, A.K., McCarty, J.P., Hussein, U., Confalonieri, U, & De Wet, N. (2003). Climate change and infectious diseases. In McMichael, A.J., Campbell-Lendrum, D.H., Corvalán, C.F., Ebi, K.L., Githeko, A.K., Scheraga, J.D., & Woodward, A (Eds.), Climate change and human health: Risks and responses (pp. 103-132). Geneva: World Health Organization.

Pelling, M. (1999). The political ecology of flood hazard in urban Guyana. Geoforum, 30(3), 249- 261.

Singh, R.B., Hales, S., de Wet, N., Raj, R., Hearnden, M., Weinstein, P. (2001). The influence of climate variation and change on diarrheal disease in the Pacific Islands. Environmental Health Perspectives, 109(2): 155–9.

Sookdeo, A. (2008). Guyana report on climate change and health [PowerPoint slides]. Retrieved from http://www.carec.org/