# Investigating the impact of climate change on the tourism sector of SIDS

*Sheereen Fauzel*, Boopen Seetanah^ , Robin Sannassee# & Robin Nunkoo***

**University of Mauritius, Mauritius, s.fauzel@uom.ac.mu ,*
*^University of Mauritius, Mauritius, b.seetanah@uom.ac.mu*

*#University of Mauritius, Mauritius, rvsan@uom.ac.mu*

***University of Mauritius, Mauritius, r.nunkoo@uom.ac.mu*

## ABSTRACT

The tourism sector is vital for the development of small island developing states. However, climate change can negatively impact on tourism demand and affect these economies both on the economic and social level. The purpose of this study is to investigate the relationship between climate change and tourism demand in 20 small island developing states (SIDS) from 1995 to 2015. Using panel autoregressive distributed lag model based on two alternative estimators such as mean group estimator (MG) and pooled mean group (PMG), it was found that there is a significant relationship between climate change and tourism demand in the long-run for the selected SIDS. Further analysis of the results shows a bi directional causality between tourism demand and real GDP.

**Keywords: Climate change, tourism demand, Panel ARDL, SIDS**

## 1.0 INTRODUCTION

The tourism sector is vital for the development of small island developing states. This sector provides a flow of foreign exchange and creates employment both directly and indirectly in the SIDS. Moreover, the tourism sector offers the opportunity for economic diversification. As identified by Ashley et al, 2007, the tourism sector has many linkages with other economic sectors which ultimately can contribute to the growth of all tourism related activities in all of the major economic sectors - agriculture, including fishing, industry and services, including transportation. In some SIDS like Mauritius, the tourism sector has become a major contributor to economic growth.

Thus the significant effect of the tourism sector on economic growth has motivated many researchers to study the main factors that determine the development of the tourism sector. The most important factors that determine the demand for tourism are mainly revenue, price, quality, political relations between countries, economic relations between countries, socio-cultural relations between countries, government regulations, foreign exchange restriction and transportation technology. Apart from these factors climate change is also one factor that affect the tourism demand. Island tourism is a climate-sensitive industry, and being largely concentrated in coastal locations is vulnerable to sea level rise. This would result in inundation of coastal and some inland areas, menacing sanitation systems and freshwater supplies as seawater infiltrates subterranean water tables, with possibly catastrophic consequences for island tourism[1]. Reliable sunshine is one of the major tourism assets for these islands. Potential threats of climate change, which are beginning to appear in greater health risks from direct exposure to sunlight, may undermine this asset[2].

This paper aims to examine the impact of climate change on the tourism demand in selected SIDS. Since less study have been done in this area, this study is believed to supplement the literature and explores the impact of climate change in the tourism sector for the case of 20[i] small island developing states for the period 1995-2015. This study uses a typical tourism model and expands the model to include two climatic variables namely temperature and precipitation (rainfall). The paper also methodologically departs from most of the previous empirical studies as it uses rigorous dynamic analysis, namely a panel auto regressive dynamic lag model (Panel ARDL), to carry out the analysis. Thus, this paper sought to investigate the short-run and long-run relationship between climate change and tourism demand. Thus, the MG (Mean Group) and PMG (Pooled Mean Group) estimations are applied in this analysis. Lastly, the Hausman Test is conducted to decide between the MG and PMG estimators. The results have provided the dynamic relationships (short-run and the long-run relationships) between the variables tested.

[1] Secretariat, U.C.C., 2005. Climate Change: Small Island Developing States.

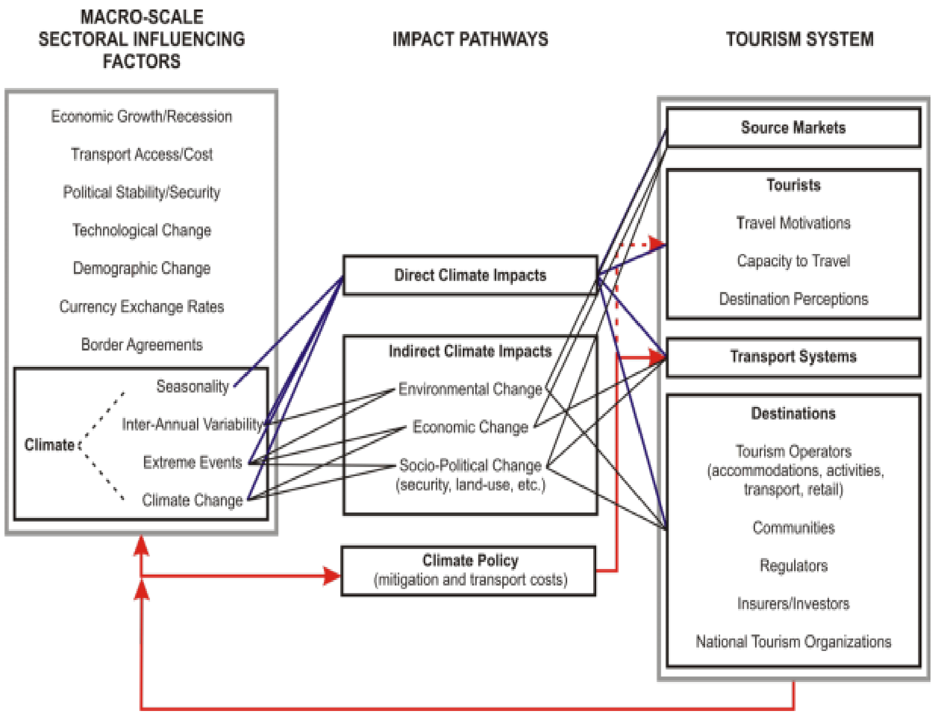
[2] UNEP Islands website 1996

The paper is organized as follows: Section 2 provides a review of the literature followed by an overview of climate change in SIDS. Section 4 presents the model and the data used and in Section 5 the empirical results are provided. Concluding remarks and policy implications are included in section 6.

## 2.0 LITERATURE REVIEW

In the literature, the concept of climate change and its impact on tourism has been sparsely discussed. Most studies relates to the tourism sector and its impact on the economy of the countries. Very rarely studies have included the climate change factor in the modeling process. Hence, it was seen that there was a gap in the literature in terms of including climate variables in the regression equation to investigate their impact on the tourism industry. Various climate indicators can be included in the modeling process. For instance as identified by Stern, 2006; Hamilton and Lau, 2004, the climatic factors that have the most impact on tourism are temperature, sunshine, radiation, precipitation, wind, humidity and fog. These climate proxies are crucial and have serious impact on the tourism sector. Hence, it is very important that these elements be investigated as they form an important resource for tourism.

As pointed out by Scott et al, 2010, the link between climate and tourism is multi-layered and highly complex. The figure below shows how climate change can influence different subsectors of tourism directly or indirectly.




Source: Scott et al, 2010

As highlighted by Wall et al, (1994), climate variability also influences various facets of tourism operations such as water supply and quality, heating– cooling costs, snowmaking requirements, irrigation needs, pest management, and evacuations and temporary closures. An international survey of 66 national tourism and meteorological organizations found that a large majority (81 per cent) felt weather and climate were major determinants of tourism in their nation. Burton (1995) and Bonnyface et al, (1994), argued that climate is among the most dominant factors affecting global tourist flows.

Some studies done on this topic include that of Koenig and Abegg, 1997, who investigated the effect of climate change on tourism for the case of Switzerland. In their study, the effect of forecasted changes in temperature on the ski industry was analysed. The analysis revealed that with prevailing temperature and a snow line of 1,200 m, there was an 85 % chance that there would be snow to keep the industry functioning. However, if temperatures were to increase by

$2^{0}$C, then only 65% of all Swiss ski areas would be snow reliable. This would clearly have serious implications for the growth of that sector of the industry.

## 3.0 METHODOLOGY

The main purpose of this investigation is to analyse the impact of climate change on tourist arrival in the short run and long run in 20 small island developing states for the period 1995-2015. Based on the principles of some earlier studies like Johnson and Ashworth (1990), Song and Witt (2000), Bigano et al (2006) and Sookram (2009), a tourism demand model is used to determine the variables that affect tourism demand in the SIDS countries. The tourism demand model is augmented by incorporating two climate variables in the form of temperature and precipitation (rainfall). The following functional form applies to the "Tourism- climate" model used in this research:

TOU = *f* (GDP, CPI, OP, TEM, RAIN)

Because of the variance stabilizing properties of log transformation, the log values of the variables are used. In fact, logged variables yield a more clear-cut interpretation of the coefficients in terms of percentage change.

*Converting all the variables in logarithmic terms yields:*

$$\mathrm{lnTOU}_{it} = \alpha_0 + \beta_1\, lnGDP_{it} + \beta_2\, lnCPI_{it} + \beta_3\, lnOP_t + \beta_4 lnTEM_{it} + \beta_5\, lnRAIN_{it} + \varepsilon_{it}$$

Where,

$\mathrm{lnTOU}_{it}$ is the log of total tourist arrivals in country i

$\mathrm{LnGDP}_{it}$ is the log of Real Gross Domestic Product in country i

$\mathrm{lnCPI}_{it}$ is the log of consumer price index in country i

$\mathrm{lnOP}_{t}$ is the log of the price of oil for transport cost

$\mathrm{lnTEM}_{it}$ is the log of temperature in country i
$\mathrm{lnRain}_{it}$ is the log of rainfall (precipitation) in country i

$\beta_1 \ldots \beta_5$ represent the parameter estimates and $\varepsilon_{it}$ is the random disturbance term. The key data sources are obtained from the World Development database. Data for temperature and rainfall has been obtained from the Mauritius Meteorological office of Mauritius and for the other countries the data is obtained from the world development indicators.

The methodology used is the Panel autoregressive distributed lag (ARDL) approach to cointegration proposed by Pesaran et al. (1999). In fact this methodology is chosen based on several deliberations. First, as shown by Pesaran et al. (2001), the ARDL models yield consistent estimates of the long run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(1) or I(0). Second, this technique generally provides unbiased estimates of the long run model and valid t-statistics even when some of the regressors are endogenous (Harris and Sollis, 2003). Inder (1993) and Pesaran (1997) have shown that the inclusion of the dynamics may help correct the endogeneity bias.

Thus, this paper sought to investigate the short-run and long-run relationship between climate change and tourism to ascertain consensus on the climate and tourism relationship. Then, the MG (Mean Group) and PMG (Pooled Mean Group) estimations are applied in this analysis. Lastly, the Hausman Test is conducted to decide between the MG and PMG estimators.

### 3.1 Mean Group (MG) estimator[3]

The first technique (MG) introduced by Pesaran and Smith, (1995) calls for estimating separate regressions for each country and calculating the coefficients as unweight means of the estimated coefficients for the individual countries. This does not impose any restrictions. It allows for all coefficients to vary and be heterogeneous in the long-run and short-run. The MG estimator has the least restrictive procedure and it allows for heterogeneity of all the parameters where no cross-country restriction is imposed. The MG estimator derives the long-run parameters from autoregressive distribution lag (ADRL) models for individual countries. The MG estimator

3 & 4: Adapted from "**Panel ARDL Using E-Views 9 ~ Meo School of Research**"

estimates separate regressions for each and every country. Yet, it has computing averages of the country-specific coefficients, which will provide consistent estimates of the long-run coefficients.

The ARDL is as following:

$$Y_{it} = a_i + \gamma 1\, Y_{i,t-1} + u_{it}$$

for country $i$, where $i$= 1,2,…, N.

The long-run parameter $\theta_i$ for the country i is:

$$\theta_i = \frac{\beta_i}{1-\gamma_i}$$

And the MG estimators for the whole panel will be given by:

$$\hat{\theta} = \frac{1}{N}\sum_{i-1}^{N} \theta_i \qquad \hat{a} = \frac{1}{N}\sum_{i-1}^{N} a_i$$

### 3.2 Pooled Mean Group (PMG) model[4]

The main characteristic of PMG is that it allows short-run coefficients, including the intercepts, the speed of adjustment to the long-run equilibrium values, and error variances to be heterogeneous country by country, while the long-run slope coefficients are restricted to be homogeneous across countries. This is particularly useful when there are reasons to expect that the long-run equilibrium relationship between the variables is similar across countries or, at least, a sub-set of them. The short run adjustment is allowed to be country-specific, due to the widely different impact of the vulnerability to financial crises and external shocks, stabilization policies, monetary policy and so on. However, there are several requirements for the validity, consistency and efficiency of this methodology. First, there need to be a long-run relationship among the variables of interest which requires the coefficient on the error–correction term to be negative. Second, an important assumption for the consistency of the ARDL model is that the resulting residual of the error-correction model be serially uncorrelated and the explanatory variables can be treated as exogenous. Such conditions can be fulfilled by including the ARDL (p,q) lags for the dependent (p) and independent variables (q) in error correction form. Lastly, the relative size of T and N is crucial, since when both of them are large this allows us to use the dynamic panel technique, which helps to avoid the bias in the average estimators and resolves the issue of heterogeneity. Eberhardt and Teal (2010) argue that the treatment of heterogeneity is central to understanding the growth process. Therefore, failing to fulfil these conditions will produce inconsistent estimation in PMG.

The unrestricted specification for the ARDL system of equations for $t$ = 1,2, …, T, time periods and $i$= 1, …, N countries for the dependent variable Y is:

$$Y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=1}^{q} \gamma_{ij} x_{i,t-j} + \mu_i + \varepsilon_{it}$$

Where $X_{i,t-j}$the (k x 1) is vector of explanatory variables for group $i$ and $\mu_i$ represents fixed effect.

The model can be reparametrized as a VECM system:

$$\Delta y_{it} = \theta_i \left( y_{i,t-1} - \beta' X_{i,t-1} \right) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta \mathrm{y}_{i,t-j} + \sum_{j=1}^{q-1} \gamma'_{ij} \vartriangle X_{i,t-j} + \mu_i + \varepsilon_{it}$$

Where $\beta_i$ are the long-run parameters and $\theta_i$are the equilibrium or error-correction parameters.

The PMG restriction is that the elements of $\beta$ are common across countries:

$$\Delta y_{it} = \theta_i \left( y_{i,t-1} - \beta' X_{i,t-1} \right) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta \mathrm{y}_{i,t-j} + \sum_{j=1}^{q-1} \gamma'_{ij} \vartriangle X_{i,t-j} + \mu_i + \varepsilon_{it}$$

All the dynamics and the ECM terms are free to vary in PMG. Under some regularity assumptions, the parameter estimates of the PMG model are consistent and asymptotically normal for both stationary and non-stationary regressors. In the selection of lag length, both MG and PMG estimations require selecting the appropriate lag length for the individual country equations. The selection is made using the: (1). Schwarz Bayesian Criterion (SBC) and (2) Akaike Information Criterion (AIC).

### 3.3 Error Correction Term

According to Banerjee et al (1998), the error correction term indicates the speed adjustment to restore equilibrium in the dynamic model. The error correction coefficient shows how quickly variables converge to equilibrium and it should have a statically significant coefficient with a negative sign. The highly significant Error Correction Term further confirms the existence of a stable long-run relationship.

### 3.4 The Hausman Test

In Hausman (1978), the hypothesis of homogeneity of the long-run policy parameters cannot be assumed as priori. The effect of heterogeneity on the means of the coefficients can be determined by Hausman-type test. If the parameters are in fact homogenous, the PMG estimates are more efficient than MG. In other word, the efficient estimator under the null hypothesis, which is PMG is preferred. However, if the null hypothesis is rejected, then the efficient estimator MG, is preferred.

## 4.0 EMPIRICAL ANALYSIS AND RESULTS

TABLE 2: Empirical Results of MG and PMG (Dependent variable: LnTOU)

| | Variable | PMG | MG |
|---|---|---|---|
| LONG RUN RESULTS | LnGDP | 0.094677*** | 0.476340*** |
| | LnCPI | -0.016691** | -0.129412** |
| | LnOP | 0.247264 | 0.683242 |
| | LnTEMP | -0.160487* | -0.239502*** |
| | LnRain | -0.886017*** | 0.839617 |
| SHORT RUN RESULTS | ECT | -0.102974*** | -0.080850*** |
| | D(LnGDP) | 0.003240* | 0.012307 |
| | D(LnCPI) | -0.002286* | -0.034718 |
| | D(LnOP) | -0.042060*** | -0.061616 |
| | D(LnTEMP) | -0.272483 | -0.056051 |
| | D(LnRain) | -0.529347 | 0.256717 |
| | Constant | 2.785921*** | 1.001717*** |
| | No. Countries | 20 | |
| | No. Observations | 420 | |
| | Hausman test Prob> *chi 2* | 0.2153 | |

*Note: D is first difference operator; *** , ** and * indicate 1%, 5% and 10% per cent level of significance; PMG means pooled mean group; MG means mean group; ECT is error correction term. Dependent variable: Tourists arrival (lnTOU) Independent variable: Real GDP (lnGDP),Oil Price (lnOP), temperature (lnTEM) andRain (lnRAIN)*

The empirical results of MG and PMG are shown in table 2. The best combination of ARDL is chosen based on the smallest values of AIC and SBC. The calculated Hausman Test has a p-value of 0.2153. Here it can be concluded that the null hypothesis is rejected and the PMG estimator is preferred. Hence, the results of the PMG will be analysed. The error correction term is -0.1030, which is significantly negative under 1% significance level. This indicates that the speed of adjustment of PMG model is around -0.1030. This result is in line with (Bannerjee) and confirms the existence of a stable long-run relationship

An examination of the long run results indicates that the coefficient estimates are generally in agreement with expectations and, of importance, the results obtained for the climate variables are significant. Both the climate change proxies show a negative and significant impact on tourism. Hence, rising temperature and more rainfall both have inverse effects on tourist arrivals. Referring to the literature on tourism demand, it can be noted that tourists prefer dry holiday locations rather than wet ones (Lise and Tole, 2002).

This can be explained by the fact that small islands developing states faces particular damage from global warming – storm surges, rising sea levels, beach erosion and coral bleaching which directly and indirectly affect tourism. Also, these small nations are among the most vulnerable to climate change impacts, which will become even more critical if no appropriate action is taken. Another growing concern is the increasing number and severity of extreme weather events—with all they entail in terms of loss of life and damage to property and infrastructure that can easily cripple small economies. SIDS is among the countries least responsible for climate change. Consequently, they strive not only to support the process directly but also to ensure that proper international action is taken to limit emissions of greenhouse gases and to adapt to climate change. Many SIDS, sea-related tourism has become a mainstay of the economy. In most SIDS, narrow coastal plains provide attractive locations for human settlements and a variety of infrastructure – social services, tourism facilities, airports, port facilities, roads and vital utilities – to support economic and social needs. Hence, if no actions are taken, climate change will have devastating effect on the economy of the countries (UNFCCC, 2005).

Now, referring to the long run results, it can be seen that an increase in the country's GDP has a positive effect on tourist arrivals. For instance, a 1% increase in GDP leads to a 0.095% increase in tourists' arrival. This may be explained by the fact that tourists prefer to go to countries with well-established economic environment. Inflation however is seen to discourage tourist arrivals. A 1% increase in price level reduces tourism demand by 0.017%.

In addition to the ARDL results, our next set of findings report the short run estimates. The fact that the variables in the model are cointegrated provides support for the use of an ECM representation in order to investigate the short run dynamics. Estimation results are presented in Table 2 above. In terms of the short run relationships it is observed that the climate variables are negative but not significant. The signs of the short run dynamics are maintained for real GDP and Inflation to the long run. The other variables are as per prior expectations. Hence, it is noted that climate change has a long term impact on tourism demand.

**4.2 Granger Causality Test**

Some further tests were performed. For instance, the Granger causality test indicates that the real GDP has a positive and significant long run effect on tourism and vice versa. Hence, a bi directional causality is observed between these two variables. This result is in line with Fauzel et al (2016), and confirms the tourism led hypothesis specifying that a direct link between tourism development and economic growth. Tourism is vital to most SIDS, either current or potential, with huge economic impact and importance; for many SIDS it is their largest source of foreign exchange and the driver of their development. Achieving levels of sustainability in tourism development has long-term benefits to investor, hotel chains and local stakeholders (Manning, 2016). Another causality effect is observed between real GDP and Inflation. Here, a uni directional causality flowing from real GDP to inflation is observed in the long run.

## 5.0 Conclusions

Tourism is a crucial element of economic growth for small island developing states. However, climate change can negatively impact on tourism demand and thus leads to various negative effects on the economy of these countries mainly in terms of low growth rates and loss of employment. The purpose of this study was to estimate the impact of climate change on the tourism sector for twenty SIDS. For the investigation a typical tourism demand function was used, with tourist arrival as the dependent variable and augmented with two climate variables namely temperature and precipitation (rainfall). The panel ARDL was used. The results show that there is a negative effect of both the temperature and precipitation variables on tourists' arrival. Further analysis of the results shows that there is a bi directional causality between tourism demand and real GDP. Also, a uni directional causality is obtained flowing from real GDP to inflation. It can further be concluded that the effect of climate change will continue to affect the tourism sector in the coming years. Hence, responses to climate change and sea-level rise should be coordinated and integrated with existing policies of socio-economic development and environmental conservation to facilitate sustainable development. Therefore, based on precautionary and anticipatory approaches, various strategies should to be developed by researchers and policymakers to address the environmental issues as it has important social and economic impacts on SIDS.

## References

Ashley, C., De Brine, P., Lehr, A. and Wilde, H., 2007. *The role of the tourism sector in expanding economic opportunity*. Cambridge: John F. Kennedy School of Government, Harvard University.

Banerjee, A., Dolado, J. and Mestre, R., 1998. Error-correction mechanism tests for co-integration in a single-equation framework. *Journal of time series analysis*, *19*(3), pp.267-283.

Bigano, A., Bosello, F., Roson, R. and Tol, R.S., 2006. Economy-wide estimates of the implications of climate change: A joint analysis for sea level rise and tourism.

Boniface B, Cooper C (1994) The geography of travel and tourism. Butterworth-Heinemann: London.

Burton R (1995) Travel Geography. Longman, Essex, England.

De Freitas, C. R. 2003. Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *International Journal of Biometeorology*, Vol. 48, pp. 45-54.

Eberhardt, M. and Teal, F., 2011. Econometrics for grumblers: a new look at the literature on cross-country growth empirics. *Journal of Economic Surveys*, *25*(1), pp.109-155.

Fauzel, S., Seetanah, B. and Sannassee, R.V., 2016. Analysing the impact of tourism foreign direct investment on economic growth Evidence from a small island developing state. *Tourism Economics*, p.1354816616664249.

Harris, R. and Sollis, R., 2003. *Applied time series modelling and forecasting*. Wiley.

Hamilton, J.M. and M.A. Lau (2004), "The role of climate information in tourism destination choice", Working Paper FNU56, Hamburg University Centre for Marine and Climate Research, Hamburg.

Hausman, J.A., 1978. Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, pp.1251-1271.

Inder B. (1993). Estimating long-run relationships in Economics, a comparison of different approaches. Journal of Econometrics, 57(1–3), 53–68.

Johnson, P. and J. Ashworth (1990), "Modelling tourism demand: A summary review", *Leisure Studies*, 9 (2): 145-161.

Koenig, U. and B. Abegg (1997), "Impacts of climate change on winter tourism in the Swiss Alps", *Journal of Sustainable Tourism* 5 (1): 46 – 58. The Challenge of Sustainable Tourism in Small Island Developing States (SIDS) Author: Edward W. (Ted) Manning, Ottawa.

Lise, W., and R. S. J. Tol. 2002. Impact of climate on tourist demand. *Climatic Change*, Vol. 55, pp. 429–449.

Manning, E. W., Hanna, M., Vereczi, G. & Manning, M. E., (1999) *Taller Sobre Indicadores de Turismo Sostenible para el Caribe y Centroamerica (Workshop on Indicators of Sustainable Tourism for the Caribbean and Central America*.) *Cozumel, Mexico.* Madrid, World Tourism Organization.

Oppenheimer, M. and Petsonk, A., 2005. Article 2 of the UNFCCC: historical origins, recent interpretations. *Climatic change*, *73*(3), pp.195-226.

"Preliminary review of the economic impact of climate change on Caribbean Tourism: what is at risk and adapting for sustainable tourism development", presentation given by Ms. Marlene Attzs at the Organization of American States Meeting on Adaptation to Climate Change in the Caribbean, Tourism Sector Workshop held in Grenada, in May 2002.

Rughooputh, S.D., SIDS and Climate Change Indicators.

Scott, D. and Lemieux, C., 2010. Weather and climate information for tourism. *Procedia Environmental Sciences*, *1*, pp.146-183.

Song, H. and S.F. Witt (2000), "Tourism demand modelling and forecasting", *Modern Econometric Approaches*, Oxford, Pergamon.

Secretariat, U.C.C., 2005. Climate Change: Small Island Developing States.

Sem, G., 2007. Vulnerability and Adaptation to Climate Change in Small Island Developing States, Background paper for the expert meeting on adaptation for Small Island developing States. In *Secretariat of the United Nations Framework Convention on Climate Change*.

Sookram, S., 2009. The impact of climate change on the tourism sector in selected Caribbean countries. *Caribbean Development Report*, *2*(30), pp.204-225.

Stern, N. (2006), "The economics of climate change", *The Stern Review*, Cambridge University Press, Cambridge, United Kingdom.

Wall, G. and Badke, C., 1994. Tourism and climate change: an international perspective. *Journal of Sustainable Tourism*, *2*(4) perspective. *Journal of Sustainable Tourism*, *2*(4), pp.193-203.