ISSN 0511-5728
The West Indian Journal of Engineering
Vol.39, No.1, July 2016, pp.32-43

Risk Perception in a Multi-Hazard Environment: A Case Study of Maraval, Trinidad

Hector Martin[a,Ψ], Myrna Ellis[b] and Charmaine Delpesh[c]

[a]Department of Civil and Environmental Engineering, The University of the West Indies, St Augustine, Trinidad and Tobago, West Indies; E-mail: Hector.Martin@sta.uwi.edu

[b]Department of Management Studies, The University of the West Indies, St Augustine, Trinidad and Tobago, West Indies, West Indies; E-mail: myrnad4ellis@gmail.com

[c]Department of Civil and Environmental Engineering, The University of the West Indies, St Augustine, Trinidad and Tobago, West Indies; E-mail: Charmaine.O'Brien-Delpesh@sta.uwi.edu

[Ψ] *Corresponding Author*

(Received 31 March 2015; Revised 23 February 2016; Accepted 7 April 2016)

Abstract: *An in-depth understanding of perceptions of risk arising from hazards is critical to reducing the socio-economic impacts of hazards. How risk is perceived determines the pivotal decision elements in planning mitigation strategies, which in turn guide policy development and funding allocation. Despite the extreme vulnerability of small island developing states (SIDS) to the impacts of hazards, little is known about how SIDS populations perceive risk in multiple-hazard prone communities. Thus, to determine how risk is perceived and the factors influencing this perception, a survey of 119 persons in Maraval, Trinidad was undertaken. Analysis of variance (ANOVA) and regression analysis showed that risk perception of flooding is influenced significantly by previous experience. Hence, to minimise the development of inappropriate cultural norms, communities must be reminded of the dangers associated with occupying hazard-prone locations. High risk perception towards landslides, storms and earthquakes is significantly affected by low levels of income and education. This suggests that disseminating scientific information through educational programs should change people's beliefs about a hazard, and lead to the adoption of appropriate mitigation strategies. However, this educational initiative should be appropriate, given the preferred data reception mode of each of the income levels. The model did not show any significant relationship between risk perception and demographics such as age, sex or occupation.*

Keywords: *Risk perception, Demographic factors, Disaster, Hazards, Caribbean, Maraval, Trinidad*

1. Introduction

In 2011, 332 disasters were registered globally, less than the average annual disaster frequency of 384 observed between the years 2001 to 2010 (Guha-Sapir et al. 2012). Despite this downward trend in frequency, the economic impacts of disasters, estimated US$ 366.1 billion in 2011, continue to rise (Guha-Sapir et al. 2012). These statistics highlight the importance of understanding the appropriateness of measures used to minimise the socio-economic impact of natural disasters. The usual response focusses on structured engineering measures. However, as a stand-alone measure, these are not sufficient to prevent loss from repeated occurrences, particularly in a multi-hazard environment (Ho et al. 2008). An examination of the complicated interaction between nature and the society, which focusses on local, long-term needs, can reduce the impact of disasters in a sustainable manner (Smith and Petley 2009). This, however, cannot be done without an understanding of the risk exposure of communities.

Risk is the possibility of loss or injury (Webster 2015). Risk may be neutralised through pre-emptive action (Business Dictionary 2013). It can be reasoned that the extent and degree of pre-emptive actions are influenced by how a risk is perceived. Pre-emptive actions will address issues such as who should be targeted, the most appropriate mode of communication, and the most opportune time for action. Risk perception refers to the subjective awareness or discernment of the potential harm or loss caused by a hazard and is based on the integration of risk information such as risk events, risk communication and various influencing factors (Seol 2005). It is therefore an important determinant of an individual's behaviour toward, judgement about and preferences regarding risk (Plapp 2001; Slovic 1992; Oliver-Smith 1996). This information can be important when assessing why some types of adjustment are made whereas others are not, or why one public policy is adopted over another (Drabek 1986).

The emergence of risk perception studies is mainly motivated by the observation that there are significant differences between experts' "objective" assessments of risk and lay persons' "intuitive judgments" of risk (i.e., risk perception): the latter of these two views is usually estimated higher than the former (Barker et al. 2009). Thus, it is essential to understand how an individual perceives risk and its determining factors for improving risk communications and designing effective mitigation policies (Ho et al. 2008). This brings into focus individuals and their social, economic, and demographic characteristics which shape their likely responses. These factors were taken into consideration to determine their effect on the perceived risk for the various hazard exposures in Maraval, Trinidad.

In the Caribbean, there is the anomalous situation where severity of impact is not directly proportional to magnitude of events (Martin, Lewis, and Martin 2012). This demonstrates the need for further studies focusing on non-structural measures. Despite the region's low resilience to disasters (ECLAL 2010), only a few studies have been undertaken on disaster management (Peters and McDonald 2011; Mycoo 2011; Li et al. 2012; Boruff and Cutter 2007; Charles and Vermeiren 2002; Rozdilsky 2001).

An even wider knowledge gap emerges as it pertains to risk perceived by a population, as there is no documentary evidence of any such studies. This work addresses this gap, through the assessment of the risk perceived by the population residing in Maraval, Trinidad. Between 2010 and 2014, this community has experienced approximately 20 incidents of flooding and landslides. The aim of this study was to investigate how the type of natural hazard and the Maraval population's characteristics influence risk perception. The objectives were to:

1. Determine how a population perceives the risks associated with natural hazards—tropical storms, earthquakes, floods and landslides; and
2. Determine the population characteristics that are strongly related to people's attitudes and subsequently their vulnerability to natural hazards.

2. Description of Maraval

A community in the suburbs of the capital, Port of Spain, Maraval, with an estimated population of 10,000 (CSO 2012), has been experiencing rapid population growth fuelled by emigration from adjacent towns. This has resulted in accelerated unplanned settlements especially on the hillsides which trigger a chain reaction of deforestation, soil erosion, landslides and consequently flooding. This problem has been further complicated by the fact that policies governing hillside development, such as the National Hillside Development Policy 2000, have only recently—2014, taken effect. In addition, the National Physical Development Plan has not been updated since the early 1980's and expired in 2000. The result is rapid growth in informal housing through squatting and more illegal development of formal settlements within Maraval.

These dynamic pressures have created unsafe conditions in which buildings with poor infrastructure, which do not adhere to building codes and regulations, are being erected in unsafe locations along the hillsides. This is compounded by low income groups who are without access to suitable land tenure. Disasters are hence being designed by unregulated human action and national disaster legislation is outdated and insufficient to deal with the onslaught. Figure 1 shows a Hazard Map of Trinidad and Maraval.

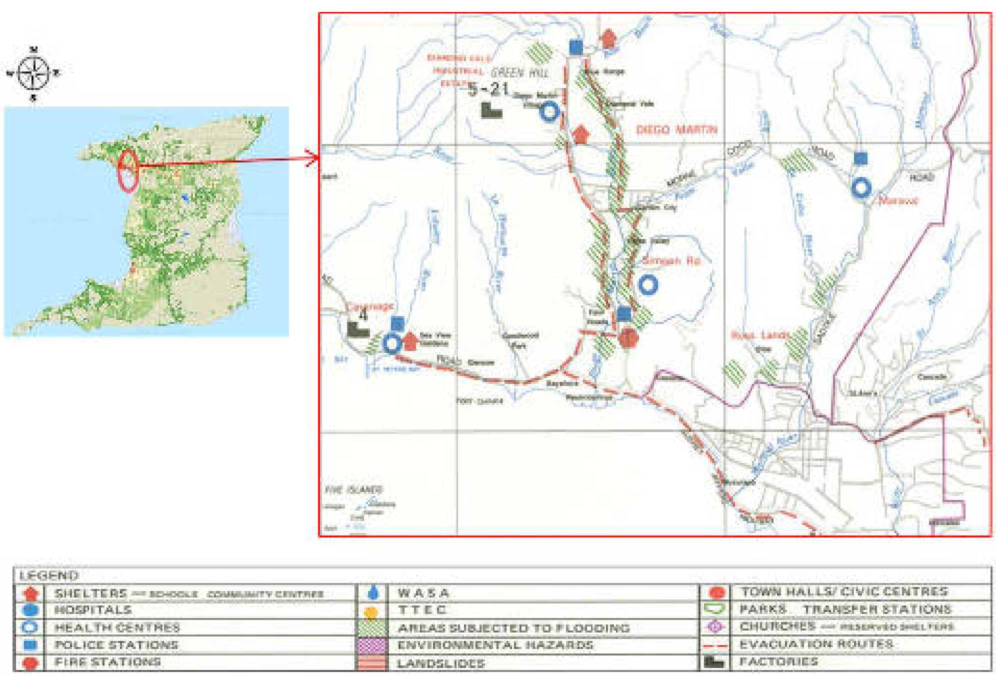

Figure 2. Hazard Map of Trinidad and Maraval Source: ODPM (2015)

Maraval has experienced flooding and landslides of greater frequency and intensity between 2009 and 2011 (La Rose 2011). Between 2010 and 2012 the Office of Disaster Preparedness (ODPM) recorded five (5) landslides in the Upper La Sieva Area, in which homes were destroyed, access roads were blocked and lives were lost (see Figure 2). Flooding was recorded mainly along the Saddle Road: The Maraval River burst its banks causing roads to be washed away and 100 homes built along the river banks were inundated with flood waters and destroyed (La Rose 2011).

Figure 2. Flood damage in Maraval, 2011

3. Decision Theory in Disaster Management

Rational economic decision theory assumes perfect information and perfect markets. This theory should therefore result in consistent preferences. However, in disasters no two situations are the same and information is often unreliable. These imperfect signals limit the applicability of this theory, as it is often the case that the perceived benefits of effective hazard adjustments are lower than their true social benefits. As a result, demand is often insufficiently understood and supply inadequately catered to. This is the consequence of decision makers' inability to cope rationally with low-probability, high consequence events (Mileti 1999). For example, if decision makers purchase insurance only because they are at risk, only those most likely to make claims will purchase policies.

Despite these shortcomings in explaining behaviour, classical decision theory has had significant impacts on decision making models, such as utility theory. The attractiveness in this theory resides in idea that a person’s choice is based on a maximisation of preference. However, utility theory is limited to the satisfaction of the Neumann and Morgenstern (1953) axioms of transitivity for accurate predictions. Simon's (1991) concept of "bounded rationality" maintains that people are limited to being able to deal with relatively little information and relatively few concepts. Thus, although they cannot be completely rational in terms of classical theory, they can take a rational approach. The application of subjective estimates of probabilities as surrogates for uncertain or missing data to determine the utility for each alternative choice has been used. Therefore, bounded rationality leads people to underestimate the risks of natural hazards, which in turn lead to under-adjustment, followed by a crisis orientation after a disaster strikes (Mileti 1999).

Subjective expected utility theory may work well in static environments but is poorly suited to extreme environmental decisions, which must be made under conditions of severe uncertainty. Under these conditions decision makers have a tendency to rely on standard operating procedures, incremental changes, and short-term feedback (Kunreuther et al. 1978).

Attitude theory assumes people's behavioural intentions are determined by their belief and attitude towards the behaviour and their subjective norm for that behaviour, including how it is viewed by others (Fishbein and Stasson 1990). It is therefore likely that values, attitudes and practices will lead to great losses for those affected, because neither is readily changeable.

These theories suggest that it is important to assess what people believe about natural hazards and mitigation actions; whether people's beliefs will make a difference in adopting and implementing mitigation; and assuming that belief makes a difference, how beliefs can be changed to increase the adoption and implementation of effective measures.

4. Factors Affecting Risk Perception

Knowledge is the body of truths, information or awareness that humans have acquired or constructed (Savin-Baden and Major 2013). It is this awareness of the elements of the environment through physical sensation which defines how one perceives risk. Since knowledge is acquired through experience and education, risk perception is mainly influenced by people’s ability to understand and respond to risk. Past experience of a disaster and cultural values affect how people perceive and understand risk, thus each individual will identify risk differently, as their perceptions are based on their preferred ways of life (Kellens et al. 2011). One’s experientially gained knowledge determines the “affect heuristic” of a person. This is a mental shortcut driven by emotion that enables people to make decisions quickly. This is often based on positive and negative feelings associated with particular risks (Alhakami and Slovic, 1994).

Multiple socio-demographic characteristics of people, such as age (Zhai and Suzuki 2009; Armas and Avram 2008), education (Raine 1995), gender (Flynn, Slovic, and Mertz 1994), income, ethnicity (Flynn, Slovic, and Mertz 1994), length of residency as well as religion (Alshehri, Rezgui and Li 2013) also affect risk perception. These various studies often provide conflicting findings on risk perception. Since, there is no definitive, accepted view of factors affecting risk perception further work in this area is needed.

5. Method

Linear regression analysis can be applied to quantify the strength of the relationship between dependent variable Y and the independent variable X_k, to assess which X_k may have no relationship with Y at all, and to identify which subsets of the X_k contain redundant information about Y. The test for significance of regression is a test to determine whether a linear relationship exists between the dependent variable Y and a subset of independent variables $x_1, x_2, \ldots, x_k$. The appropriate hypotheses are:

$$H_0: \beta_1 = \beta_2 = \ldots = \beta_k = 0$$
$$H_1: \beta_j \neq 0 \text{ for at least one } j$$

Rejection of $H_0: \beta_1 = \beta_2 = \ldots = \beta_k = 0$ implies that at least one of the independent variables $x_1, x_2, \ldots, x_k$ contributes significantly to the model. The significance $P \leq 0.05$ was used to express H_1 true. If (H_1) true, (H_0) will be rejected. Standardised β coefficients refer to how many standard deviations a dependent variable Y will change, per standard deviation increase in the predictor variable x_k. Hence, standardisation of the coefficient indicates which of the independent variables has a greater effect on the dependent variable, particularly when the variables are measured in different units of measurement.

5.1 Data collection

119 residents were surveyed to determine whether population characteristics and type of hazard actually influence risk perception. Convenience sampling of respondents was employed, based on their availability. Snowballing was then used in some cases and residents referred interviewers to residents. Similar to studies conducted by Martin and Lewis (2016), the internal reliability of the instrument was tested using Cronbach alpha. The questionnaire which comprised of 4 categories to capture (i) demographics; (ii) past experience; (iii) risk perception; and (iv) mitigation/ preparedness was adapted from Bird (2009), Ogston (2005) and Ho et al. (2008). Table 1 shows a list of risk perception, mitigation/preparedness items.

The questionnaire's quality and appropriateness to the local context were verified through a pilot study, which targeted academics, practitioners, and persons from the community. Respondents were asked to rate the risk level of each of four hazardous events (earthquakes, floods, landslides, and storms) in Maraval. Statistical Package for the Social Sciences (SPSS) was utilised to conduct stepwise regressions. Stepwise regression has the advantage of utilising forward inclusion and backward exclusions of independent variables at the same time to determine the most significant relationship with the dependent variable (George and Mallery 2010; Martin and Lewis 2013).

5.2 Data Analysis

R^2 measures the proportion of the total variation about the mean of the risk perception variable explained by the regression model. R^2 can vary from 0 to 1, with a value of 1 indicating that the prediction explains all of the variations in the data (Draper and Smith 1981). The adjusted R^2 is a modified version of R^2 based on the number of predictors in the model. The adjusted R^2 increases only if the new term improves the model more than would be expected by chance.

Table 1: Risk perception, mitigation/preparedness items

Risk Perception	
The area that I live in may be affected by a natural hazard	1 Strongly disagree----5 strongly agree
The threat posed by each of the natural hazards to your area	1 Unlikely ---------------5 most likely
The frequency of the occurrence of the following hazardous events	1 Never -----------------5 always
The likelihood of occurrence of a disaster when the event occur	1 Unlikely ---------------5 most likely
Damage to property	1 Unlikely ---------------5 most likely
Loss of life	1 Unlikely ----------------5 most likely
Water pollution	1 Unlikely ----------------5 most likely
Damage to crops/livestock	1 Unlikely ----------------5 most likely
Mitigation and Preparedness	
In relation to each hazard/disaster score the level of your knowledge	1 No knowledge -------------5 expert knowledge
What was the source of your information	Brochures, television, internet, at school, a training course
Do you know the mitigation actions you can clearly adopt?	1 Not clear at all-------5 very clear
Having experienced a disaster, how would you score you preparedness if it were to re-occur?	1 Not prepared---------5 very well prepared
Your level of insurance coverage owned	No insurance, contents only, house only, house & contents only, house/ contents/ life
Your awareness in case of an emergency	
Numbers to call	1 Unaware ------------------- 5 fully aware
Organisations to contact	1 Unaware -------------------- 5 fully aware
Shelters to go to	1 Unaware -------------------- 5 fully aware

The between-group degree of freedom is the number of groups minus one, and the within-group degree of freedom is the number of subjects minus the number of groups minus one (George and Mallery 2010). Utilising F statistics tables, and based on the degrees of freedom, the critical F for the evaluation was determined.

Analysis of Variance (ANOVA) was used for comparing sample means to see if there was significant evidence to infer that the means of the corresponding population distributions also differ. The null hypothesis (H_0) and the alternative hypothesis (H_1) were developed in determining the significance as follows:-

H_0 There is no significant difference between the respondent groups and risk perceived.

H_1 There is significant difference between the respondent groups and risk perceived.

Significance $P \leq 0.05$ was used to express H_1 true. If (H_1) true, (H_0) was rejected. Once it was determined that the risk rating differed among the groups within a demographic background item, Least Square Difference LSD post-hoc test was used to determine which groups significantly differed from the others with respect to the mean ratings.

6 Results

6.1 Sample Characteristics

The reliability of the instrument obtained from the Chronbach's alpha is 0.812, values above 0.7 are deemed adequate (George and Mallery 2010). Of the 119 persons sampled, 55% were male and 45% were female. The respondents fell into the following age brackets 16-30 (22.7%); 31-45 (28.6%); 46-60 (27.7%); >60 (15%); and ≤ 15 (6%). 70% of all respondents had attained an education above secondary level. Of this total, 53% were educated at tertiary level. The primary level accounted for 13% and other represented 8%. 38.7% of the respondents were professionals, 21.8% were self-employed, 14% students, 12% retired, and the remaining unemployed. 36.1% of the respondents reported income of US$790-US$1422, 24.4% of persons earned less than US$790, and the remaining population accounting for less than US$1422/month.

To determine the extent to which disasters are on the minds of residents of Maraval, they were asked if they ever experienced a disaster. 60.5% of the respondents had past experiences with a disaster, while 39.5% had no prior experience. Of those who experienced disasters, 75.0% experienced flooding, 33.3% experienced landslides, 8.3% experienced storms and 22.2% experienced earthquakes. Landslides and flooding are localised events, were more frequent than all other hazards in this study, while storms and earthquakes usually affect wider areas. So once earthquakes and storms are experienced by one person it should have been experienced by all, unless there have been no recent events in the area. Hence, those who reported experiencing earthquakes and storms may be older and residing in the community longer than the other respondents. When asked to identify the natural disaster posing the greatest threat, 30.3% indicated that floods posed the greatest threat, 28.6% indicated landslides, 9.2% indicated storms and 5% indicated earthquakes. This sense of dread is being associated with frequency and past experience as the area is known to be frequently affected by floods and landslides.

When questioned about the likelihood of a disaster, most respondents (37.6%) stated that the most likely disaster was flooding, 27.7% indicated landslides, 6.7% indicated storms and 5.9% indicated earthquake. When asked about their level of preparedness for a disaster, 31.9% stated they were unprepared for the onset of another disaster, while 2.5% felt that they were well prepared and the remaining percent was uncertain. This was also reflected in the fact that 52.9% had no insurance at all, while only 0.8% had their house, contents of the home and life insured. When asked to rate their level of knowledge of each type of disaster on a scale of 1 to 5, 12.5% of the respondents indicated they were extremely knowledgeable about floods, 8.4% about landslides, 7.6% about storms and 7.6% about earthquakes. Knowledge is regarded here as facts, information, and skills acquired through experience or education. Most of their knowledge about disasters was received via the television (75.6%) and the internet (42.0%).

6.2 Risk Perception Toward Flooding

Damage to property, frequency of floods and past experience with floods were the three factors that significantly affect risk perception about floods. The R^2 (.373) and the adjusted R^2 (.329) suggest a correlation of risk perception among these three factors. The ANOVA values .000 suggest that the model chosen was significant at the 95% confidence level (see Table 2 and Table 3).

Using β unstandardised and the equation $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$, it can be stated that risk perception towards floods = 2.495 + .396 damage to property - .219 frequency of flood + .723 affected by flood in the past. This implies that risk perception towards floods is directly proportional to the likelihood of damage to property, and past experience with flood. However, it is inversely proportional to the frequency of floods. As the frequency of flood increases, the likelihood of damage to property from flood increases. Consequently, residents may judge that a flood is more likely to occur if they have experienced numerous floods in the past or if they suffered severe losses in a recent flood event.

However, the feeling of dread may be diminished particularly if losses in prior events were not significant. Experience or association-based processing in the context of risk can be beneficial (Slovic and Weber 2002). It enables humanity to evolve and survive over time and remains the most natural and most common

Table 2. Flooding model summary and ANOVA

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Damage to property	.493	.243	.227	1.069
Frequency of flooding	.559	.313	.281	1.030
Affected by floods in the past	.611	.373	.329	.995

Model	Sum of squares	Df	Mean square	F
Regression	25.343	3	8.448	8.533
Residual	42.572	43	.990	p-value
Total	67.915	46		0.000

Table 3. Regression Coefficients for perceived flood risk

Model	Unstandardised β	Std. Error	Standardised β	t	P-value.
(Constant)	2.495	.498		5.010	.000
Damage to property	.396	.094	.508	4.204	.000
Frequency of flooding	-.219	.099	-.266	-.2.203	.033
Affected by flood in the past	.723	.355	.246	2.038	.048

way to respond to threat, even in the modern world

This system transforms uncertain and threatening aspects of the environment into affective responses (e.g., fear, dread, anxiety) and thus represents risk as a feeling, which indicates whether it is safe to walk down a dark street or drink strange-smelling water (Loewenstein et al. 2001). Continued experiences of threatening situations have led to the development of mitigation strategies as a way to cognitively adapt (Lima et al. 2005), as individuals tend to be better informed and prepared (Baan and Klijn 2004). Generally, regions with low levels of flood risk perception and a low degree of preparedness for coping with flood events tend to experience flood damage levels above average – their vulnerability to flood events is usually high (Messner and Meyer 2005). Hence, a vulnerability factor with regard to risk perception and preparedness of communities and individuals might exist. Of these factors the model suggests that the "potential of damage to property" which has the largest beta (.508) has the most significant influence on risk perception toward floods.

6.3 Risk Perception toward Landslides

The results of risk perception toward landsides show that there are four main factors of significance. They are: "knowledge about landslides", "likelihood of landslides occurring", "level of insurance of house contents" and "income level". The R^2 (.826) and the adjusted R^2 (.802) values suggest a co-linearity between these factors and risk perception toward landslides. That is, an indication that the predictor variables have non-zero correlations with each other (Thomas 2006). The ANOVA value of .000 shows the overall model significance (see Table 4 and Table 5).

The significance of the coefficients and beta (influence) values can be expressed in the following equation: $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4.$ Risk perception toward landslides =-.229 + .514 knowledge of landslides + .579 contents insured + .299 likelihood of landslide occurring - .286 income. This implies that the risk perception toward landslide is directly proportional to one's knowledge of landslides, the extent of insurance of house contents and the likelihood of a landslide occurring but is inversely proportional to income. Knowledge is one of the most influential factors impacting perceived risk towards landslide. The rationalist's viewpoint is that at least some of our knowledge is derived from reason alone, and that reason plays an important role in the acquisition of all of our knowledge.

Table 4. Landslide model summary and Anova

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Knowledge of landslides	.827	.683	.667	.919
Contents insured	.865	.748	.729	.831
Likelihood of landslide occurring	.896	.802	.781	.745
Income	.909	.826	.802	.709

Model	Sum of squares	Df	Mean square	F
Regression	88.127	5	17.625	35.028
Residual	18.618	37	.503	P-value
Total	106.744	42		.000

Table 5. Regression Coefficients for perceived landslide risk

Model	Unstandardised β	Std. Error	Standardised β	t	P-value
(Constant)	-.229	.571		-.402	.069
Knowledge of landslides	.514	.109	.456	4.728	.000
Contents insured	.579	.225	.199	2.572	.014
Likelihood of landslide occurring	.299	.086	.298	3.482	.001
Income	-.286	.128	-.168	-2.230	.032

There is clearly a limit to what we can learn through abstract thought, which is why empiricists hold that all of our knowledge is ultimately derived from our senses or our experiences. Both views, combined, suggest that perception will affect the stimulus perceived in the first instance, and then the ways in which that stimulus is understood, processed, and finally the response to it. This supports the most influential variable "Contents insured". The equation also reveals that the lower one's income level (social status) is, the greater one's risk perception toward landslides is likely to be. A Marxist view suggests that low-income groups reside in substandard housing and are least able to deal with the adverse effect of hazards. Conversely, higher-income groups can afford mitigation measures, such as retaining walls, to reduce risk.

6.4 Risk Perception Toward Storms

Risk perception toward storms is significantly affected by the likelihood of storms occurring, knowledge of storms and income. The R^2 (.676) and the adjusted R^2 (.636) values suggest a co-linearity between these factors and risk perception toward storms. The ANOVA value of .000 shows the overall model significance at the 95% confidence level. Again, using the equation: $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3,$ risk perception toward storms = .765 + .544 likelihood of the storm + .351 knowledge of storms - .353 income (see Table 6 and Table 7). From this it can be stated that risk perception toward storms is directly proportional to likelihood of storms occurring and knowledge of storms but inversely proportional to income. Therefore, the lower one's income, the greater one's perceived risk posed by storms.

Slovic (1997) states that individuals with high income levels generally have low risk perceptions since high income individuals can afford effective mitigation strategies that would lessen the cost of recovery. On record, there are no occurrences of storm events (of the order of magnitude of hurricanes) experienced by the island. Interestingly, unlike all the other hazards, there was no account of damage to property or importance placed on possible losses through the purchase of insurance. It means that mitigation measures for this hazard are likely to be inexpensive, as the perceived losses are not viewed as important. Knowledge of storms will play an important role for hazards that are very low in probability, as uncertainty in information about preparation, responding, and possible impact, makes responders and citizens vulnerable to injury, death, disruption and other adverse effects of disasters.

Table 6. Storm model summary and ANOVA

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Likelihood of storm occurring	.711	.505	.486	.920
Knowledge of storms	.773	.598	.566	.845
Income	.822	.676	.636	.774

Model	Sum of squares	Df	Mean square	F
Regression	30.036	3	10.012	16.695
Residual	14.393	24	.600	P-value
Total	44.429	27		.000

Table 7. Regression Coefficients perceived storm risk

Model 3	Unstandardised β	Std. Error	Standardised β	t	P-value
(Constant)	.765	.540		1.417	.169
Likelihood of storm occurring	.544	.106	.615	5.127	.000
Knowledge of storms	.351	.118	.353	2.985	.006
Income	-.353	.147	-.291	-2.406	.024

6.5 Risk Perception Toward Earthquakes

In the case of earthquakes, the model yielded three factors that significantly affected risk perception. These are: "knowledge of earthquakes", "damage to property" and "education". Once again, the R^2 (.585) and the adjusted R^2 (.547) values suggest a co-linearity between these factors and risk perception toward earthquakes. The ANOVA value of .000 shows the overall model significance at the 95% confidence level (see Table 8 and Table 9).

Using the equation: $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$, risk perception toward earthquake = 1.177 + .702 knowledge of earthquakes + .344 damage to property - .680 education. This implies that as one's knowledge of earthquakes and damage to property increases, risk perception toward earthquake increases, but the lower the level of education the higher one's perception of risk toward earthquakes. That is, risk perception toward earthquakes is inversely proportional to educational level. This may seem conflicting with past risk perception findings (Pilisuk and Acredolo 1988), but persons of low levels of education are usually those of lower social and economic status and are unable to afford appropriate mitigation measures. Since, residents with lower education and income levels are more vulnerable to the negative impacts, their awareness is higher. Education, when it is confined to school education, can provide useful information. However, other sources of information exist, and family and community education may play the most vital role in decision making and actions taken (Shaw et al. 2004). This informal social influence on hazard adjustment is prevalent when people do not have an opportunity to learn directly from their physical environment or their own experiences (Mileti 1999).

Table 8. Earthquake Model Summary and ANOVA

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Knowledge of earthquakes	.604	.365	.346	1.020
Damage to property	.691	.477	.446	.939
Education	.765	.585	.547	.849

Model	Sum of squares	Df	Mean square	F
Regression	32.575	3	10.858	15.065
Residual	23.064	32	.721	P-value
Total	55.639	35		.000

Table 9. Regression Coefficients for Perceived Earthquake Risk

Model	Unstandardised β	Std. Error	Standardised β	t	P-value
(Constant)	1.177	.537		2.191	.036
Knowledge of earthquakes	.702	.131	.671	5.368	.000
Damage to property	.344	.098	.417	3.506	.001
Education	-.680	.235	-.368	-2.891	.007

6.6 Demographic Factors and Risk Perception

No significant relationship was found between demographic factors of age, sex or occupation and risk perception. This is rather contrary to previous findings noted by Peacock et al (2005) and Kellens et al. (2011).

7. Discussions

7.1 Past Experience

From the model, having been affected by flooding in the past was the most significant factor influencing risk perception. This is further supported by the fact that the other two factors, "frequency of flooding in your area" and "most likely impact of flooding being damage to property" are related to past experience with flooding. This study has drawn a similar conclusion to that of Ho et al. (2008), that is, victims with more experience of disasters felt their life was more seriously threatened and had a greater sense of fear than those with less experience resulting in a higher risk perception. Experience influencing risk perception was only directly observable with flooding hazards.

Hence, the type of hazard and the frequency of occurrence is a significant factor in determining how an individual will perceive related risk. Further, Ogston (2005) identified several determinants of the perception of flood risk and disaster preparedness. These include past experience with hazard events, the length of time that an individual has lived in a community, the levels of education and the age of the individual. Ogston (2005) highlighted that recent experience with disaster leads to individuals being more knowledgeable and more sensitive to that type of extreme hazard event. Victims with more disaster experience perceived a higher occurrence rate of disasters, and saw them as being more life threatening, and had a greater sense of dread (Ho et al. 2008).

Since experientially derived knowledge is often more compelling and more likely to influence behaviour than abstract knowledge (Epstein 1999), people must be reminded of their own experiences in order to convince them of the need to adopt mitigation measures. The literature has shown that the continued experience of threatening situations has led to the development of mitigation strategies as a way to cognitively adapt to the situation (Lima et al. 2005).

7.2 Social Factors

Low levels of education and low income are two characteristics associated with low social status. The model yielded results which indicate that risk perception towards landslide, storms and earthquake is significantly affected by income and education, since the β (standardised) values in each of these cases were negative. Negative values imply an inverse relationship, i.e. high risk perception is significantly affected by low levels of income and education.

Education has been found to play an important role in accounting for a sense of control over hazards. People with more years of education had a higher sense of controllability, regardless of the type of hazard and were more likely to adopt preparatory measures than those with lower levels (Ho et al 2008). It is this knowledge coupled with experience which is emphasised in the concept of bounded rationality, which explains that the choice and decisions of people often undercompensate in their responses when faced with hazards (Winchester 1996; Smith 2001).

7.3 Economic Factors

Economic factors are related to income. The negative β (standardised) value shows an inverse relationship. High perception of risk toward storms and landslides is significantly influenced by low income levels. Although most households adopt extremely limited mitigation strategies, low income households have significant vulnerabilities due to their ill-preparation and are constrained by their socioeconomic conditions. Local communities need to pay extra attention to developing specific adjustment measures and encouraging mitigation activities for lower-income households (Sah 2007).

7.4 Demographic Factors

The model did not show any significant relationship between demographics such as age, sex, occupation and risk perception. However, it can be argued that social and economic statuses are both subsets of demographics. In that case, demographic factors do significantly influence risk perception. However, not all demographic factors will fall into this category, according to the model, since no correlation was found between sex, age or occupation.

This finding should be accepted, as it was previously noted by Nordenstedt and Ivanisevic (2010) that other underlying factors, such as value, are more likely to account for demographic variations in risk perception. Nordenstedt and Ivanisevic (2010) argue that demographic factors are insufficient to explain the complex structure of social groups, which in turn might lead to ineffective decision-making. Drabek (1986) and Gardner et al. (1996) believed otherwise, and showed correlations between risk perception and factors such as age, gender, socio-economic status, race and ethnicity. As explained, men tend to judge risk as being smaller than do women (Flynn et al. 1994; Slovic 1997). Females are physically more vulnerable than males and thus females are more sensitive to risk (Ferraro 1995) and appear to be more risk-averse (Peacock et al. 2005).

8. Conclusion

In designing strategies to reduce vulnerability and to improve disaster preparedness of a community, policy makers should involve the people living in the disaster-prone area. Secondly, the risk perception of the targeted group, as well as the influencers of their risk perception should be known (Plapp 2001). The degree of public awareness of risk is a necessary condition to engage in disaster risk reduction. People are more vulnerable when they are not aware of the hazards that pose a threat to their lives. The adjustments people make in response to threats depend on how they perceive those threats and the associated risks (Pan 2012). Knowing how risk is perceived can help government understand how to initiate behavioural change towards hazards and through what medium this initiative would be most appropriate.

It is against this background that this study gains particular significance: the purpose of this study was to determine whether risk perception of natural hazards such as floods, landslides, storms and earthquake is influenced by economic, demographic and social factors or past experience with disasters. The study revealed that risk perception is influenced by three of these factors – social, economic, and past experience. The results also revealed that having knowledge about a type of hazard had a significant effect on risk perception of that hazard. In advising the government on where to place its efforts, the main area would be education about natural hazards, since the findings showed that knowledge of a natural hazard significantly affects risk perception. Government should embark on an education campaign through its schools from primary level upward. Disseminating scientific information would presumably change people's beliefs about a hazard and in turn lead to the adoption of appropriate mitigation strategies. Television and internet should be the main media through which this education and information dissemination occurs, since the study showed that the knowledge gained by most respondents concerning natural hazards and their effects was via television and the internet. Thus, the level of risk awareness depends largely upon the quantity and quality of available information.

In addition, this study has shown that the factors that had a significant effect on risk perception of natural hazards are the frequency of the event, and perceptions about the damage that the hazard will most likely cause. Perception is the individual and private mental process of organising all the received external impulses (Armas 2008) which in risk analysis, involves a high degree of insupportable decision-making which is often subjective and blind to certain realities.

People's ideas about risk and their practices in relation to disasters are the tools used to measure and chart vulnerability. In order to entirely assess a region's vulnerability, one must first understand the risk perception of its people. This is the initial stage in developing and improving the adaptive capacity of the region or community (Meheux et al. 2007). If a set of variables are correlated to a phenomenon (such as perception), it does not necessarily imply that these variables are the causes of that phenomenon. This can be illustrated in the results reported—risk perception is significantly related to the income or education level of respondents because those with low income and/or educational levels tend to live in vulnerable neighbourhoods (the cause of the higher degree of risk perception).

Even though no relationship was found between demographic factors and risk perception, there were conflicting views within the literature, thereby prompting further investigation. The view from the Caribbean region, in particular Maraval, Trinidad, was explored on risk perceived by portions of its population and the relationship between perceptions and respondents' characteristics. In addition, a person's inaction towards a hazard even when their perception is high is not well understood, and as such further work is needed to investigate this anomaly.

Nevertheless, this work relies on internal knowledge of the respondents which was assumed to be equal in contribution. Further, the use of snowballing may have resulted in respondents referring others, with a similar mindset to their own. The influence of NGOs has been assumed constant.

References:

Alhakami, A. S. and Slovic, P. (1994), "A psychological study of the inverse relationship between perceived risk and perceived benefit", *Risk Analysis*, Vol.14, No.6, pp.1085-1096.

Alshehri, S. A., Rezgui, Y. and Li, H. (2013), "Community resilience factors to disaster in Saudi Arabia: the case of Makkah Province", In: *Disaster Management and Human Health Risk III. WIT Transactions on the built environment*, Vol.133, pp.359-368, Accessed 1 December 2015, from http://www.witpress.com/Secure/elibrary/papers/DMAN13/DMAN13032FU1.pdf

Armaş, I. (2008) (Eds), *The Natural Risk Perception: Earthquakes, Floods, Landslides*, University of Bucharest, Bucharest, p.217.

Armas, I., and Avram, E. (2008), "Patterns and trends in the perception of seismic risk. Case study: Bucharest Municipality/Romania", *Natural Hazards*, Vol.44, No.1, pp.147-161

Baan P.J.A. and Kljin F. (2004), "Flood risk perception and implications for flood risk management in the Netherlands", *International Journal of River Basin Management,* Vol.2, No.2, pp.113-122.

Baker, J., Douglass Shaw, W., Bell, D., Brody, S., Riddel, M., Woodward, R.T. and Neilson, W. (2009), "Explaining subjective risks of hurricanes and the role of risks in intended moving and location choice models", *Natural Hazards Review*, Vol.10, No.3, pp.102-112.

Bird, D.K. (2009), "The use of questionnaires for acquiring information on public perception of natural hazards and risk mitigation: A review of current knowledge and practice", *Natural Hazards and Earth System Sciences*, Vol.9, pp.1307-1325.

Boruff, B.J. and Cutter, S.L. (2007). "The environmental vulnerability of Caribbean Island nations", *Geographical Review,* Vol.97, No.1, pp.24-45.

Business Dictionary (2013), *Definition of Risk*, Accessed 1 December 2013, from http://www.businessdictionary.com/definition/calculated-risk.html.

CSO (2012), *Annual Statistical Digest*, Central Statistical Office, Government of Trinidad and Tobago, Port of Spain.

Charles, R. and Vermeiren, J.C. (2002), "Towards a solution for coastal disasters in the Caribbean", *Proceedings of the Coastal Disasters Conference. Solutions to Coastal Disasters '02*, June 2013, Accessed June 2013, from http://ascelibrary.org/doi/abs/10.1061/40605%28258%296.

Drabek, T. (1986), *Human System Responses to Disaster: An Inventory of Sociological Findings*, Springer-Verlag, New York.

Draper, N and Smith, H. (1981), *Applied Regression Analysis*, 2nd edition, John Wiley and Sons, New York.

ECLAC (2010), "HAITI: ECLAC worried about poverty levels in Haiti; raises other regional concerns", *Caribbean Daily News*. Accessed December 2012, from http://www.caribbeandailynews.com/?p=8898

Epstein RM. (1999), "Mindful practice", *Journal of the American Medical Association*, Vol.282, No.9, pp. 833-839.

Ferraro, K.F. (1995), *Fear of crime: Interpreting Victimization Risk*, SUNY Press, New York.

Fishbein, M. and Stasson, M. (1990), "The role of desires, self-predictions, and perceived control in the prediction of training session attendance", *Journal of Applied Social Psychology,* Vol.120, No.3, pp.173-198

Flynn, J., Slovic, P., and Mertz, C.K. (1994), "Gender, race, and perception of environmental health risks", *Risk Analysis*, Vol.14, No.6, pp.1101-1108 (doi: 10.1111/j.1539-6924.1994.tb00082.x).

Gardner, G.T. and Stern, P.C. (1996), *Human Reaction to Environmental Hazards: Perceptual and Cognitive Processes in Environmental Problems and Human Behavior*, Geographical Association, Allyn and Bacon, USA, p.161-198.

George, D. and Mallery, P. (2010), *IBM SPSS Statistics 19 Step by Step: A Simple Guide and Reference*, 12th Edition, Prentice Hall, Boston, MA.

Guha-Sapir D., Vos, F., Below R., and Ponserre, S. (2012), *Annual Disaster Statistical Review 2011*: *The Numbers and Trends*, CRED, Brussels.

Ho, M., Shaw, D., Lin, S. and Chiu, Y. (2008), "How do disaster characteristics influence risk perception?" *Risk Analysis,* Vol.28, No.3, pp.635-643.

Kunreuther, H. (1978), *Disaster Insurance Protection: Public Policy Lessons*, John Wiley & Sons, Canada.

Kellens, W., Zaalberg, R., Neutens, T., Vanneuville, W. and De Maeyer, P. (2011), "An analysis of the public perception of flood risk on the Belgian coast", *Risk Analysis*, Vol.31, No.7, pp.1055-1068

La Rose, M. (2011), "Maraval Clean-up", *Trinidad and Tobago Newsday*, Accessed 21 August 2013, from www.newsday.co.tt

Li, Y., Ahuja, A., and Padgett, J. (2012), "Review of methods to assess, design for, and mitigate multiple hazards", *Journal of Performance of Constructed Facilities*, Vol.26, No.1, pp.104-117.

Lima, M.L., Barnett, J. and Vala, J. (2005), "Risk perception and technological development at a societal level", *Risk Analysis*, Vol.25, No.5, pp.1229-1239.

Loewenstein, G.F., Weber, E.U., Hsee, C.K., and Welch, E. (2001), “Risk as feelings”, *Psychological Bulletin,* Vol.127, pp.267-286.

Martin, H., and Lewis, T. (2013), "Pinpointing safety leadership factors for safe construction sites in Trinidad and Tobago", *Journal of Construction Engineering and Management*, Vol.140, No.2, pp.1-10 (10.1061/(ASCE)CO.1943-7862.0000795, 04013046).

Martin, H., Lewis, T. and Martin, N. (2012), “A critical review of Haiti earthquake of 2010: Key development problems and focused solutions”, *Proceedings of IIIRR*, Kumamoto City, Japan, August, pp.1-8.

Martin, H., Lewis, T and Peterson, A. (2016), “Factors affecting the choice of construction project delivery in developing oil and gas economies”, *Architecture Engineering and Design Management*, Vol. 12, No.3, pp.70-188. (doi.org/10.1080/17452007.2016.1151762)

Meheux, K., Dominey-Howes, D. and Lloyd, K. (2007). “Natural hazard impacts in small island developing states: A review of current knowledge and future research needs”, *Natural Hazards*, Vol.40, No.20, pp.429-446.

Messner, F. and Meyer, V. (2005), “Flood damage, vulnerability and risk perception: Challenges for flood damage research”, *UFZ-Diskussionspapiere*, No. 13/2005, Accessed 30 September 2015, from: http://www.econstor.eu/bitstream/10419/45258/1/489068715.pdf

Mileti, D. (1999), *Disasters by Design*: *A Reassessment of Natural Hazards in the United States*, Joseph Henry Press: Washington, D.C.

Mycoo, M. (2011), “Natural hazards risk reduction: Making St Lucia safe in an era of increased hurricanes and associated events”, *Natural Hazards Review*, Vol.12, No.1, pp.37-45

Neumann, J.V., and Morgenstern, O. (1953), *Theory of Games and Economic Behavior*, Princeton University Press, Princeton, NJ.

Nordenstedt, H. and Ivanisevic, J. (2010), “Values in risk perception - Studying the relationship between values and risk perception in three countries”, *Journal of Disaster Risk Studies*, Vol.3, No.1, pp.335-245.

ODPM (2012), *Hazard Maps*, Office of Disaster Preparedness and Emergency Management, Accessed 18 November 2015, from http://www.odpm.gov.tt/node/245

ODPM (2015), *Disaster Response Map*, Office of Disaster Preparedness and Emergency Management, Accessed 30 September 2015, from http://www.odpm.gov.tt/node/133

Ogston, D.J. (2005), *Perception of Natural Hazard Risk and Preparedness: A Case Study of St. John Baptiste, Manitoba*, MA. Thesis, Department of Environment and Geography, University of Manitoba, Winnipeg.

Oliver-Smith, A. (1996), “Anthropological research on hazards and disasters”, *Annual Review of Anthropology*, Vol.25, pp.303-328.

Pan, A. (2012), “A Study on residents’ risk perception in abrupt geological hazard”, *Journal of Risk Analysis and Crisis Response*, Vol.12, No.1, pp.44-55.

Peacock, W.G., Brody, S.D. and Highfield, W. (2005), “Hurricane risk perceptions among Florida’s single family homeowners”, *Landscape and Urban Planning*, Vol.73, No.2/3, pp.120-135.

Peters, E.J. and McDonald, C. (2011), “The contributions and performances of Grenadian main NGOs after a natural disaster”, *International NGO Journal*, Vol.6, No.3, pp.62-70.

Plapp, T. (2001), “Perception and evaluation of natural risks. Interim report on first results of a survey in six districts in Germany”, *Risk Research and Insurance Management*, Working Paper No.1

Raine, L.M. (1995), *The Determinants of Risk Perceptions of Tsunamis in Oahu, Hawaii: Public Health Implications*, Doctor of Public Health Thesis, University of Hawaii, Order No. 9615547, Accessed 2 February 2016, from http://search.proquest.com/docview/304198233?accountid=45039

Pilisuk, Marc, and Acredolo, Curt. (1988), "Fear of technological hazards: One concern or many?." *Social Behaviour*, Vol.3, No.1, pp.17-24.

Rozdilsky, J.L. (2001), “Second hazards assessment and sustainable hazards mitigation: Disaster recovery on montserrat”, *Natural Hazards Review*, Vol.2, No.2, pp.64-71.

Sah, J. P. (2007), “A comparison of the adoption of adjustments between earthquake and flooding threats”, Paper presented at the *2nd International Conference on Urban Disaster Reduction*, Taiwan, November, pp.1-11.

Savin-Baden, M., and Major, C. (2013), *Qualitative Research: The essential guide to theory and practice*, Routledge, London

Seol, M-S. (2005), *Perception of Safety and Usability of Powered Hand Tools*, MSc. Thesis, College of Engineering and Mineral Resources, West Virginia University, Morgantown

Shaw, R., Kobayashi, K.S.H. and Kobayashi, M. (2004), “Linking experience, education, perception and earthquake preparedness”, *Disaster Prevention and Management*, Vol.13, No.1, pp.39-49.

Simon, H. (1991), "Bounded rationality and organisational learning", *Organisation Science,* Vol.2, No.1, pp.125-134 (doi:10.1287/orsc.2.1.125).

Slovic P. (1992), *Perception of Risk: Reflections on the Psychometric Paradigm, Social Theories of Risk*, Praeger Publishers, Westport, CT.

Slovic, P. (1997), *Risk Perception and Trust. Fundamentals of Risk Analysis and Risk Management*. Lewis Publishers, New York

Slovic, P., and Weber E.U. (2002), “Perception of risk posed by extreme events”, Paper presented at *the conference on Risk Management Strategies in an Uncertain World*, Palisades, New York, April, pp.1-21.

Smith, K. (2001), *Environmental Hazards: Assessing Risk and Reducing Disasters*, 3rd edition, Routledge, London.

Smith, K. and Petley, D.N. (2009), *Environmental Hazards: Assessing Risk and Reducing Disaster*, Routledge, New York.

Thompson, B. (2006), *Foundations of Behavioral Statistics: An Insight-Based Approach*, Guilford Press, New York

Webster, M. (2015), *Definition of Risk*, Accessed 2 February 2015, from http://www.merriam-webster.com/dictionary/risk .

Winchester, P. (1996), *Cyclone vulnerability and housing policy: In the Krishna Delta, South India*, PhD dissertation, School of Development Studies, UEA.

Zhai, G. F., and Suzuki, T. (2009), “Risk perception in Northeast Asia”, *Environmental Monitoring and Assessment*, Vol.157, No.1-4, pp.151–167.

Authors’ Biographical Notes:

Hector Martin *is Lecturer in the Department of Civil and Environmental Engineering at The University of the West Indies, St. Augustine, Trinidad and Tobago. He is a member of the Association of Professional Engineers of Trinidad and Tobago (MAPETT), a member of the American Society of Civil Engineers (MASCE), registered engineer with the Board of Engineers of Trinidad and Tobago (REng), and a certified project management professional (PMP) with the Project Management Institute. He holds a BSc. in Civil Engineering and MSc (Eng) in Construction Engineering and Management. Mr Martin is presently pursuing a PhD in Construction Management.*

Myrna Ellis *is a graduate student in the Department of Management Studies at The University of the West Indies (UWI), St. Augustine, Trinidad and Tobago. She is a member of the Trinidad and Tobago Tour Guide Association. She holds a Bachelor of Science degree in Chemistry from The University of the West Indies, a Master of Science degree in Environmental*

Science and Management from The University of Trinidad and Tobago (UTT), and a postgraduate diploma in Educational Technology. She is presently pursuing an MSc in Tourism Development and Management at The UWI. She has experience as a chemist in the energy sector, and automotive industry. She has been an educator for 18 years.

Charmaine Delpesh *holds a Master of Science degree in sedimentology from University of Waterloo, Canada. She worked at the Institute of Marine Affairs (IMA) for 20 years, rising to the position of Officer-in-Charge of the Environmental Research Programme. Mrs. O'Brien-Delpesh is currently Lecturer in Coastal Engineering and Management at The University of the West Indies. She has coordinated a number of environmental impact assessment studies in Trinidad and Tobago as well as the wider Caribbean on the laying of gas pipelines and telephone cables in the marine and coastal environment, seawall and jetty construction, sedimentation of ports and beach restoration. Mrs. O'Brien-Delpesh also provides advice to Government agencies on issues such as coastal erosion, setback distance, dredging and reclamation, beach sand mining and coastal protection structures, laws relating to coastal erosion and accretion.*

■