



Indicators for Disaster Risk and Risk Management

**Programme for Latin-America
and The Caribbean**

Belize

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1 INTRODUCTION

Disaster risk is not only associated with the occurrence of intense physical phenomenon but also with the vulnerability conditions that favour or facilitate disaster when such phenomenon occur. Vulnerability is intimately related to social processes in disaster prone areas and is usually related to the fragility, susceptibility or lack of resilience of the population when faced with different hazards. In other words, disasters are socio-environmental by nature and their materialization is the result of the social construction of risk. Therefore, their reduction must be part of decision making processes. This is the case not only with post disaster reconstruction but also with public policy formulation and development planning. Due to this, institutional development must be strengthened and investment stimulated in vulnerability reduction in order to contribute to the sustainable development process in different countries.

In order to improve disaster risk understanding and disaster risk management performance a transparent, representative and robust System of Indicators, easily understood by public policymakers, relatively easy to update periodically and that allow cluster and comparison between countries was developed by the Institute of Environmental Studies (IDEA in Spanish) of the National University of Colombia, Manizales. This System of Indicators was designed between 2003 and 2005 with the support of the Operation ATN/JF-7906/07-RG “Information and Indicators Program for Disaster Risk Management” of the Inter-American Development Bank (IDB).

This System of Indicators had three specific objectives: i) improvement in the use and presentation of information on risk. This assists policymakers in identifying investment priorities to reduce risk (such as prevention and mitigation measures), and directs the post disaster recovery process; ii) to provide a way to measure key elements of vulnerability for countries facing natural phenomena. It also provides a way to identify national risk management capacities, as well as comparative data for evaluating the effects of policies and investments on risk management; and iii) application of this methodology should promote the exchange of technical information for public policy formulation and risk management programs throughout the region. The System of Indicators was developed to be useful not only for the countries but also for the Bank, facilitating the individual

monitoring of each country and the comparison between the countries of the region.

The first phase of the Program of Indicators IDB-IDEA involved the methodological development, the formulation of the indicators and the evaluation of twelve countries from 1985 to 2000. Afterwards of two additional countries were evaluated with the support of the Policy Regional Dialogue on Natural Disasters. In 2008 a methodological review and the updating of the indicators for twelve countries was made in the framework of the Operation RG-T1579/ATN/MD-11238-RG. Indicators were updating to 2005 and for the most recent date according to information availability (2007 or 2008) for Argentina, Bolivia, Chile, Colombia, Ecuador, Jamaica, Mexico, Peru, Dominican Republic and Trinidad and Tobago¹. In addition, Barbados, Panama and Belize were included in the program. This report has been made using –with some adjustments that in each case are referenced– the methodologies formulated in the first phase of the Program of Indicators IDB-IDEA²

The System of Indicators abovementioned attempts risk and vulnerability benchmarking using relative indicators in order to facilitate access to relevant information by national level decision makers which facilitates the identification and proposal of effective disaster risk management policies and actions. Their underlying models search to represent risk and risk management at a national scale, allowing the identification of its essential economic and social characteristics and a comparison of these aspects and the risk context in different countries.

The System of Indicators proposed permits the benchmarking of the evaluations of each country in different periods. It assists the move toward a more analytically rigorous and data driven approach to risk management decision-making. This measurement approach enables:

- Representation of disaster risk at the national level, allowing the identification of key issues relating to their characterization from an economic and social point of view.

¹ Last period, in general, is considered tentative or preliminary because usually, most recent values are not totally confirmed and it is common that some of them change, such as it has been verified in this updating with values that were used in the previous evaluation (2005).

² More information and details of methodologies can be found in IDEA (2005). “System of Indicators of Disaster Risk and Risk Management: Main Technical Report”. Program of Indicators for Disaster Risk and Risk Management IDB – IDEA, Universidad Nacional de Colombia, Manizales. <http://idea.unalmz.edu.co>

- Risk management performance benchmarking of the different countries to determine performance targets for improving management effectiveness.

Due to a lack of parameters, the need to suggest some qualitative indicators measured on subjective scales is unavoidable. This is the case with risk management indicators. The weighting or pondering of some indices has been undertaken using expert opinion and informants at the national level. Analysis has been achieved using numerical techniques that are consistent from the theoretical and statistical perspectives.

Four components or composite indicators reflect the principal elements that represent vulnerability and show the advance of different countries in risk management. This is achieved in the following way:

1. The Disaster Deficit Index, DDI, measures country risk from a macro-economic and financial perspective when faced with possible catastrophic events. This requires an estimation of critical impacts during a given exposure time and of the capacity of the country to face up to this situation financially.
2. The Local Disaster Index, LDI, identify the social and environmental risk that derives from more recurrent lower level events which are often chronic at the local and sub national levels. These particularly affect the more socially and economically fragile population and generate a highly damaging impact on the countries development.
3. The Prevalent Vulnerability Index, PVI, is made up of a series of indicators that characterize prevailing vulnerability conditions reflected in exposure in prone areas, socioeconomic fragility and lack of resilience in general.
4. The Risk Management Index, RMI, brings together a group of indicators related to the risk management performance of the country. These reflect the organizational, development, capacity and institutional action taken to reduce vulnerability and losses, to prepare for crisis and efficiently recover.

In this way, the System of Indicators covers different aspects of the risk problematic and takes into account aspects such as: potential damage and loss due to the probability of extreme events, recurrent disasters or losses, socio-environmental conditions that facilitate

disasters, capacity for macroeconomic recovery, behaviour of key services, institutional capacity and the effectiveness of basic risk management instruments such as risk identification, prevention and mitigation measures, financial mechanisms and risk transfer, emergency response levels and preparedness and recovery capacity (Cardona 2008). Each index has a number of variables that are associated with it and empirically measured. The choice of variables was driven by a consideration of a number of factors including: country coverage, the soundness of the data, direct relevance to the phenomenon that the indicators are intended to measure, and quality. Wherever possible it is sought to use direct measures of the phenomena is wanted to capture. But in some cases, proxies³ had to be employed. In general it is sought variables with extensive country coverage but chose in some cases to make use of variables with narrow coverage if they measured critical aspects of risk that would otherwise be overlooked.

This report presents only the updated or new results for the country and there will be not found detailed methodological explanations because they are not the scope of this report. Information related to the methodology and the previous results of the System of Indicators can be found at: <http://idea.unalmz.edu.co>, where details on conceptual framework, methodological support, data treatment and statistical techniques used in the modelling are presented (Cardona et al 2003a/b; 2004 a/b).

2 NATIONAL CONTEXT

Belize (formerly British Honduras until the name of the country was changed in 1973) lies on the eastern or Caribbean coast of Central America, bounded on the north and part of the west by Mexico, and on the south and the remainder of the west by Guatemala. The inner coastal waters are shallow and are sheltered by a line of coral reefs, dotted with islets called 'cayes', extending almost the entire length of the country.

There is a low coastal plain, much of it covered with mangrove swamp, but the land rises gradually towards the interior. The Maya Mountains and the Cockscomb Range form the backbone of the southern half of the country, the highest point being Doyle's Delight (1124 meters above sea level) in the Cockscomb Range. The Cayo District in the west

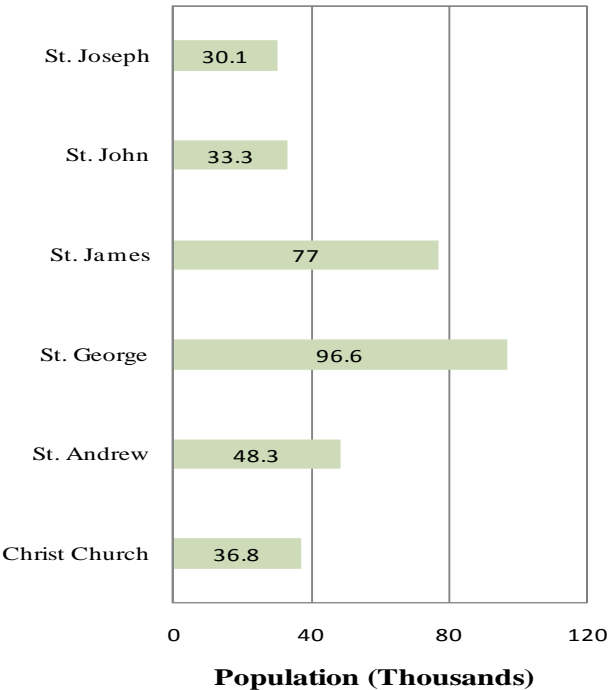
³ Due to the lack of detailed information for coarse grain results it is possible using alternative figures of other related data that reflect indirectly the information needed.

includes the Mountain Pine Ridge, ranging from 305 to around 914 metres above sea level. The northern districts contain considerable areas of tableland. There are many rivers, some of them navigable for short distances by shallow-draught vessels. A large part of the mainland is forest.

The area of the mainland and cayes is 8,867 square miles. The country's greatest length from north to south is 174 miles and its greatest width is 68 miles. The climate is subtropical, tempered by trade winds. Temperatures in coastal districts range from about 10 °C (50°F) to about 35.6°C (96°F); inland the range is greater. Rainfall varies from an average of 1,295 millimetres in the north to 4,445 millimetres in the extreme south. The dry season usually extends from February to May and there is sometimes a dry spell in August.⁴

Figure 1 presents an estimative of population in millions inhabitants for different zones in Belize for 2008.

Figure 1. Population of main territorial units



Source: Statistical Institute of Belize

Regarding to its economy, GDP at market prices of Belize is USD 1,358.7Million in 2008. In this period, current account and trade balance have been near to -4% of GDP in

⁴ The Belize Government Official Portal (www.belize.gov.bz)

2007. The rate of inflation slowed considerably from positive 6.4% in 2008 to a negative 1.1% in 2009. The unemployment rate is estimated of the order of 8.2% for 2008 according to the Statistical Institute of Belize. The exchange rate in 2010 fluctuates around BZD5\$1.97 per dollar. Table 1 presents a summary of macroeconomic variables of the country. Concerning the social characteristics of the country, the illiteracy rate of the population over 15 years old is around 5.3% in 2005. The number of hospital beds per one thousand inhabitants is 1.2.

Table 1. Main macroeconomic and social indicators

Indicator	2005	2007	2008
GDP (USD million)	1,114.9	1,276.8	1,358.7
Trade balance (% GDP)	-13.56	-4	**
Total debt service (% Exports and income)	34.5	69.3	10.5
Unemployment (%)	11	8.5	8.2
Population living lower the poverty line	**	**	**
Human Development Index	0.770	0.772	**

** Data not available

** Without data

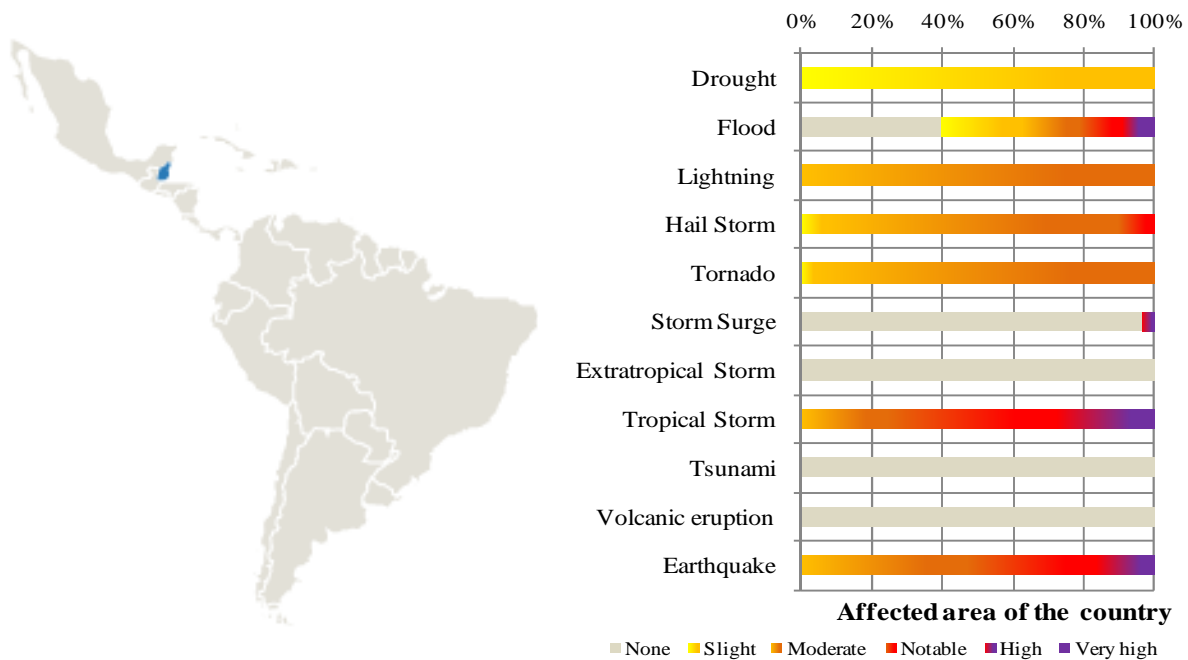
Sources: The World Bank, ECLAC

⁵ Belize dollar

3 NATURAL HAZARDS

Figure 2 are presented the percentages of the influence area and the severity level of the different hazards in the country. Likewise, Figure 3 presents the classification by mortality risk established by the International Strategy for Disaster Reduction, ISDR. These figures illustrate the events that can be considered as triggers for the estimation of the Disaster Deficit Index, IDD. Other frequent and punctual phenomena as landslides and floods, less visible at national level are the causes of recurrent effects at local level and may have an important accumulative impact. For this reason they are considered in the estimation of the Local Disaster Index. Appendix I presents a general description of the country's hazards.

Figure 2. Percentage of the influence area by hazard



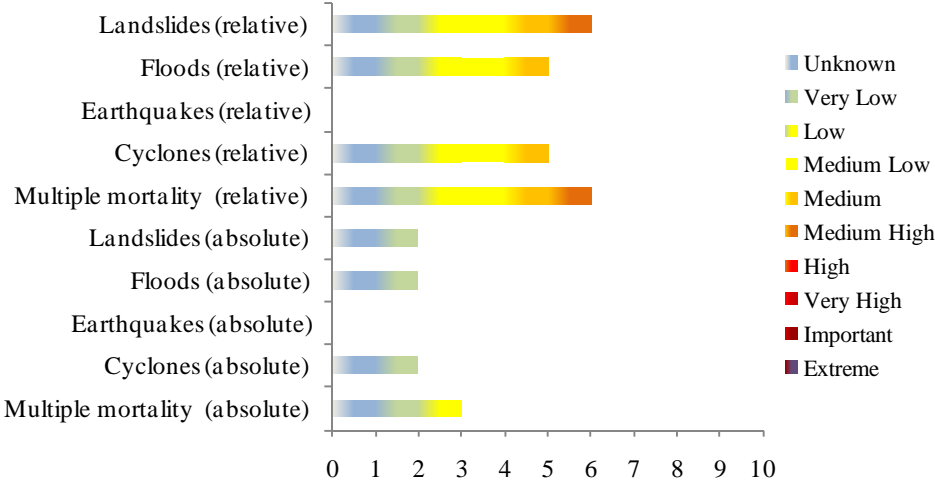
Source: Munich Re⁶

The most important natural hazards to the country are the earthquakes, tropical storms and hail storms. These are the extreme events that would cause the major losses in the future in Belize. There are other natural phenomena that have lower probability of affecting country such as lightning, floods, tropical storms, drought, and hail storms however they

⁶ <http://mrnathan.munichre.com/>

are able to cause significant local damages. This information is especially important for the estimation of the Disaster Deficit Index, DDI. On the other hand, most recurrent and isolated phenomena, such as landslides and floods, cause frequent effects at the local level, without be noticed. These events have also great impacts over population, and, if they are accumulative, can be important too. Information about these events is especially important for the estimation of the Local Disaster Index, LDI.

Figure 3. Classification by mortality risk



Source: ISDR 2009

The mortality risk index established by the International Strategy for Disaster Reduction – ISDR, is based on hazard modelling (tropical cyclones, flooding, earthquakes and landslides), taking into account the frequency and severity of the hazard events, the human exposition and the vulnerability identification. The absolute mortality risk index refers to the average of dead people per year; the relative mortality risk index refers to the average of dead people in proportion to the national population. Low indexes 1 mean low mortality risk and 10 is the maximum value. According to Figure 3, relative values indicate that mortality risk is medium-high concentrated due to landslides and medium concentrated due to floods and cyclones, earthquakes does not have any participation in the absolute index. Likewise, absolute mortality risk shows that landslides, floods and cyclones are classified as very low and earthquakes do not have any participation.

4 INDICATORS OF DISASTER RISK AND RISK MANAGEMENT

A summary of the results obtained from the System of Indicators application for Belize for the period 2001-2005 and later to 2005, as far as information allows, is presented in this section. These results are useful in order to analyze risk and risk management performance in the country, based on information supplied by different national institutions.

4.1 DISASTER DEFICIT INDEX (DDI)

The DDI measures the economic loss that a particular country could suffer when a catastrophic event takes place, and the implications in terms of resources needed to address the situation. This index captures the relationship between the demand for contingent resources to cover the losses that public sector must assume as result of its fiscal responsibility caused by the Maximum Considered Event (MCE) and the public sector's economic resilience (ER).

Losses caused by the MCE are calculated with a model that takes into account, on the one hand, different natural hazards, -calculated in probabilistic terms according to historical registers of intensities of the phenomena- and, on the other hand, the current physical vulnerability that present the exposed elements to those phenomena. The ER is obtained from the estimation of the possible internal or external funds that government, as responsible of the recovering or as owner of the affected goods, may access or has available in the moment of the evaluation. For this update, both MCE and ER were evaluated again for all periods because some changes were detected in the previous values of the databases from they were taken; therefore, both, the proxy of exposition as the available resources suffered some modifications.

A DDI greater than 1.0 reflects the country's inability to cope with extreme disasters even by going into as much debt as possible. The greater the DDI, the greater the gap. Now then, an estimation of a complementary indicator, DDI'CE has been made, to illustrate the portion of a country's annual Capital Expenditure that corresponds to the expected annual loss or the pure risk premium. That is, what percentage of the annual investment budget would be needed to pay for future disasters (IDEA 2005; Cardona 2005). The DDI'IS is also estimated with respect to the amount of sustainable resources due to inter-temporal surplus; i.e. the saving which the government can employ, calculated over a ten year period,

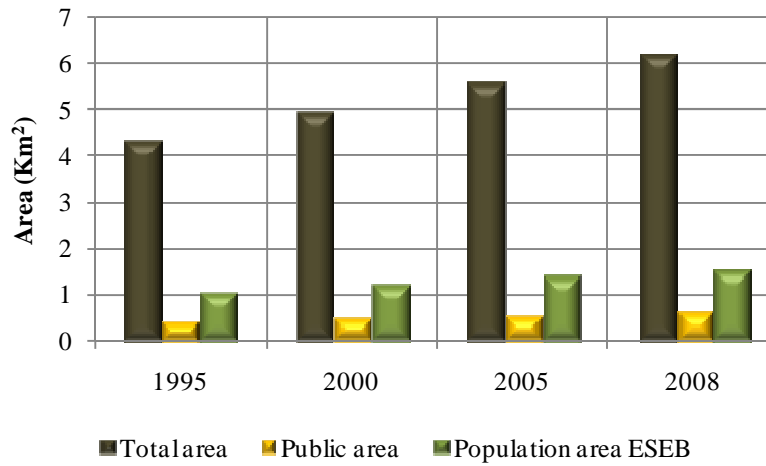
in order to best attend the impacts of disasters. The DDI'IS is the percentage of a country's potential savings at present values that corresponds to the pure risk premium.

4.1.1 Reference parameters for the model

Even though there is not detailed data useful for modelling public and private inventories, it is possible to use general information about built areas and/or on the population to make estimations of these inventories of exposed elements. This technique or proxy method allows a coarse grain assessment of the volume and cost of the exposed elements required for the analysis. The parameters for shaping a homogeneous and consistent information structure for the project specific objectives are detailed below. They are the cost of square meter of some construction classes, built area –in each city related to the number of inhabitants– and distribution of built areas in basic groups for analysis –as the public and private components–, which would be in charge or would be fiscal liabilities of the government in case of disaster. In addition, the rest of private goods, that constitute capital stocks, are considered as well to provide a general view of the potential impact in the country.

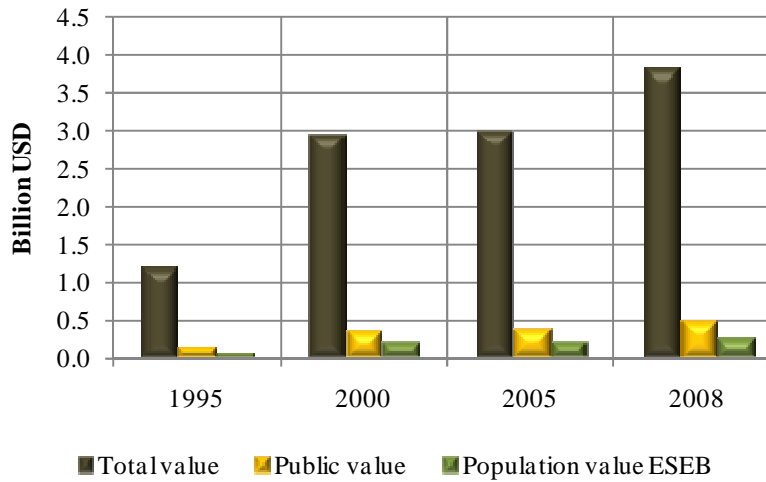
Figure 4 shows estimations of built areas in different components and its variations in time (since 2000 to 2008). Figure 5 presents a similar graphic similar regarding the exposed values for the whole country. The technique for country's exposure estimation, vulnerability and hazard assessment and risk models used are explained in Ordaz & Yamin (2004) and Velasquez (2009). These technical explanations are available in <http://idea.unalmzl.edu.co>

Figure 4. Total built areas by component in square km



Source: Author's data

Figure 5. Exposed value by component in billion dollars



Source: Author's data

The construction area values are related to the total exposure (public and private), the government buildings and infrastructure (public) and the low-income socio-economic strata (ESEB, estratos socio-economicos de bajos ingresos, in Spanish). The sovereign or fiscal liabilities are usually the public and the property of the low-income householders.

4.1.2 Estimation of the indicators

Table 2 shows DDI for 2000, 2005 and 2008 for the Maximum Considered Event (MCE) of 50, 100 and 500 years of return period.⁷

Table 2. DDI for different return periods

<i>DDI</i>	2000	2005	2008
<i>DDI50</i>	1.37	2.53	2.82
<i>DDI100</i>	2.35	4.17	4.59
<i>DDI500</i>	2.94	4.35	4.59

Source: Author's data

For extreme events in 50, 100 and 500⁸ years in each period the country has not had the capacity to cover reconstruction costs using its own funds or with the resources that the government could have accessed if it would be necessary, that is, values greater than 1.0 means the country does not have enough resources to cover losses and/or feasible financial capacity to face losses and replace the capital stock affected. Table 3 shows DDI' values, which corresponds to annual expected loss related to capital expenditure (annual budget of investment), and related to possible saving for inter-temporal surplus to 10 years, expressed in percentages. DDI'CE illustrates that if contingent liabilities to the country were covered by insurance (annual pure premium), the country would have to invest annually close to 14% of 2008's capital expenditure to cover future disasters. The DDI' with respect to the amount of sustainable resources due to inter-temporal surplus indicates that for all the periods evaluated there would not be annual average savings for covering the losses in the country and it would represent a deficit (Δ D).

Table 3. DDI' related to capital expenditure and inter-temporal surplus

<i>IDD'</i>	2000	2005	2008
<i>IDD_{CE}</i>	6%	13%	14%
<i>IDD_{IS}</i>	Δ D	Δ D	Δ D

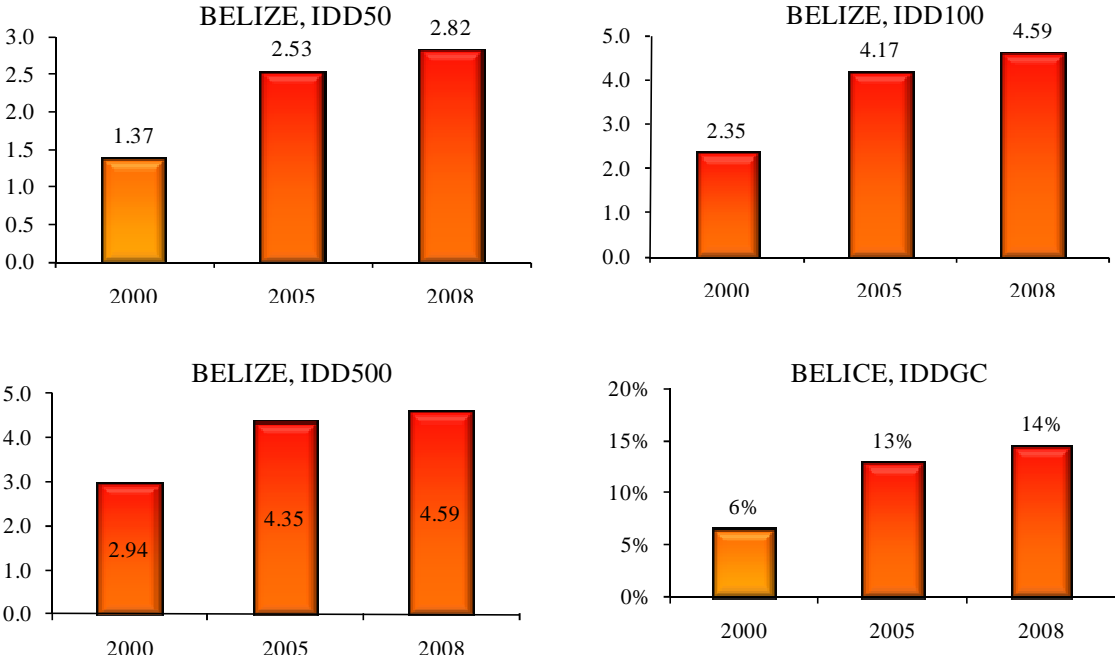
Source: Author's data

⁷ Events that can occur in any moment and they have a probability of occurrence of 2%, 10% and 18% in 10 years.

⁸ Events that can occur in any moment and they have a probability of occurrence of 2%, 10% and 18% in 10 years.

Figure 6 illustrates DDI and DDI' values related to capital expenditure. Graphics illustrate that in 2005 DDI increased in comparison to 2000. From 2000 to 2005 it also increased but in a more slight way. In the same way, DDI' according to the budget of investment had great values, especially for the last two years of analysis.

Figure 6. DDI₅₀, DDI₁₀₀, DDI₅₀₀, DDI'_{CE}



Source: Author's data

Due to the importance of the numbers used to evaluate the DDI and the DDI' in each period and considering the extreme disasters of reference. Table 4 shows the values of the potential losses for the country for the Maximum Considered Event, MCE, with 50, 100 and 500 year return period. This estimation in retrospective took into account the exposition level of the country for 2000, 2005 and 2008. In addition, Table 4 presents the values of the pure premium that means the required annual amount to cover future disasters in each period. The DDI and DDI' for three years of analysis were calculated based on the estimations of the potential maximum losses and expected annual losses respectively (numerator of the indicators).

These indicators can be estimated every five years and can be useful to identify the reduction or increasing of the potential deficit due to disasters. Clearly, investments in mitigation (retrofitting of vulnerable structures) that reduce potential losses or increasing of insurance coverage of exposed elements what enhance the economic resilience, could be reflected in a future more favourable DDI for the country.

Table 4. Probable loss and pure Premium for DDI and DDI' calculations

L₅₀	2000	2005	2008
Total – Million US\$	112.2	113.6	143.9
Government – Million US\$	22.3	22.6	28.6
Poor – Million US\$	87.2	88.5	112.2
Total - % GDP	13.49%	10.19%	10.70%
Government - % GDP	2.68%	2.03%	2.13%
Poor - % GDP	10.48%	7.93%	8.34%
L₁₀₀			
Total – Million US\$	194.7	197.2	249.7
Government – Million US\$	43.0	43.6	55.3
Poor – Million US\$	154.4	156.6	198.6
Total - % GDP	23.40%	17.68%	18.56%
Government - % GDP	5.17%	3.91%	4.11%
Poor - % GDP	18.56%	14.04%	14.76%
L₅₀₀			
Total – Million US\$	765.7	782.1	998.9
Government – Million US\$	164.5	166.9	211.6
Poor – Million US\$	166.4	168.7	214.0
Total - % GDP	92.03%	70.14%	74.27%
Government - % GDP	19.78%	14.97%	15.73%
Poor - % GDP	20.00%	15.13%	15.91%
L_v			
Total – Million US\$	8.1	8.2	10.3
Government – Million US\$	2.0	2.0	2.5
Poor – Million US\$	6.1	6.1	7.8
Total - % GDP	0.97%	0.73%	0.77%
Government - % GDP	0.24%	0.18%	0.19%
Poor - % GDP	0.73%	0.55%	0.58%

Source: Author's data

Table 5 presents possible internal and external funds that the government needs to access in the moment of the evaluation to face the losses in case of an extreme disaster. The sum of these available or usable possible funds corresponds to the economic resilience

between 1995 and 2008 every five years. Based on these estimations (denominator of the indicator) the DDI was calculated for the different periods.

DDI for 2008 was calculated based on the most recent available information on exposed elements, references of the build areas and their cost values. They have been established according to still tentative data and statistical information that may change in the future. In addition, the economic resilience (denominator of the index) was estimated in terms of GDP for each fund taking as reference economic information available for 2006 and 2007 due to current gaps; i.e. information that have not been incorporated yet in the databases. This means that the recent results of DDI may vary once the data will be consolidated.

Table 5. Economic resilience, funds and resources for DDI calculations

Funds	2000	2005	2008
Insurance premiums - % GDP	0.000	0.0	0
Insurance/ reinsurance.50 - <i>F1p</i>	0.0	0.0	0.0
Insurance/ reinsurance.100 - <i>F1p</i>	0.0	0.0	0.0
Insurance/ reinsurance.500 - <i>F1p</i>	0.0	0.0	0.0
Disaster reserves - <i>F2p</i>	0.0	0.0	\$ 0
Aid/donations.50 - <i>F3p</i>	5.6	5.7	7.2
Aid/donations.100 - <i>F3p</i>	9.7	9.9	12.5
Aid/donations.500 - <i>F3p</i>	38.3	39.1	49.9
New taxes - <i>F4p</i>	0.0	0.0	\$ 0
Capital expenditure - % GDP	14.880	5.7	5
Budgetary reallocations. - <i>F5p</i>	74.3	38.1	43
External credit. - <i>F6p</i>	0.0	0.0	0.0
Internal credit - <i>F7p</i>	0.0	0.0	0.0
Inter-temp surplus. d*- % GDP	-0.070	-3.1	-2.38
Inter-temp surplus. - <i>F8p</i>	-0.6	-34.8	-\$ 32
<i>ER</i>.50			
Total - Millions US\$	80	44	50
Total - %GDP	9.60%	3.93%	3.71%
<i>ER</i>.100			
Total - Millions US\$	84	48	55
Total - %GDP	10.10%	4.30%	4.11%
<i>ER</i>.500			
Total - Millions US\$	113	77	93
Total - %GDP	13.53%	6.93%	6.89%

Source: Author's data

As conclusion of the obtained results, nonetheless the country has improved its economic resilience, as it can be seen in the reduction of DDI values in the last years, disasters in general, imply an obligation or non explicit contingent liability that can mean an impact to fiscal sustainability, given that the most of the resources that government could access represent own funds and new possible debts. In other words, government retains significant losses and its financing represent a high opportunity-cost given other needs of investment and the existent country's budget restrictions.

4.2 PREVALENT VULNERABILITY INDEX (PVI)

PVI characterizes predominating vulnerability conditions reflected in exposure in prone areas, socioeconomic fragility and lack of social resilience; aspects that favour the direct impact and the indirect and intangible impact in case of the occurrence of a hazard event. This index is a composite indicator that depicts comparatively a situation or *pattern* in a country and its causes or factors. This is so to the extent that the vulnerability conditions that underlie the notion of risk are, on the one hand, problems caused by inadequate economic growth and, on the other hand, deficiencies that may be intervened via adequate development processes. PVI reflects susceptibility due to the level of physical exposition of goods and people, PVI_{ES} that favours direct impact in case of hazard events. It also reflects social and economic conditions that favour indirect and intangible impact, PVI_{SF} . And it reflects lack of capacity to anticipate, to absorb consequences, to efficiently respond and to recover, PVI_{LR} (IDEA 2005; Cardona 2005).

PVI varies between 0 and 100, a value of 80 means very high vulnerability, from 40 to 80 means high, from 20 to 40 is a medium value and less than 20 means low. In the new phase of the Program of Indicators, for the countries already evaluated, the PVI was calculated again for all the periods due to various values of the databases that were not known, currently are available or have been modified as result of revisions that were made after the previous evaluation of the index. Modifications in maximum and minimum reference values were also made for this new evaluation to standardize the values of the subindicators in a uniform form for old and new evaluated countries.

4.2.1 Indicators of exposure and susceptibility

In the case of exposure and/or physical susceptibility, PVIES, the indicators that best represent this function are those that represent susceptible population, assets, investment, production, livelihoods, essential patrimony, and human activities. Other indicators of this type may be found with population, agricultural and urban growth and densification rates. These indicators are detailed below:

- ES1. Population growth, avg. annual rate, %
- ES2. Urban growth, avg. annual rate, %
- ES3. Population density, people (5 km²)
- ES4. Poverty-population below US\$ 1 per day PPP
- ES5. Capital stock, million US\$ dollar/1000 km²
- ES6. Imports and exports of goods and services, % GDP
- ES7. Gross domestic fixed investment, % of GDP
- ES8. Arable land and permanent crops, % land area.

These indicators are variables that reflect a notion of susceptibility when faced with dangerous events, whatever the nature or severity of these. “To be exposed and susceptible is a necessary condition for the existence of risk”. Despite the fact that in any strict sense it would be necessary to establish if the exposure is relevant when faced with each feasible type of event, it is possible to assert that certain variables comprise a comparatively adverse situation where we suppose that natural hazards exist as a permanent external factor, even without establishing precisely their characteristics.

4.2.2 Indicators of socio-economic fragility

Socio-economic fragility, PVISF, may be represented by indicators such as poverty, human insecurity, dependency, illiteracy, social disparities, unemployment, inflation, debt and environmental deterioration. These are indicators that reflect relative weaknesses and conditions of deterioration that would increase the direct effects associated with dangerous phenomenon. Even though such effects are not necessarily accumulative and in some cases may be redundant or correlated, their influence is especially important at the social and economic levels. Those indicators are the following:

- SF1. Human Poverty Index, HPI-1.

- SF2. Dependents as proportion of working age population
- SF3. Social disparity, concentration of income measured using Gini index.
- SF4. Unemployment, as % of total labour force.
- SF5. Inflation, food prices, annual %
- SF6. Dependency of GDP growth of agriculture, annual %
- SF7. Debt servicing, % of GDP.
- SF8. Human-induced Soil Degradation (GLASOD).

These indicators are variables that reflect, in general, an adverse and intrinsic⁹ predisposition of society when faced with a dangerous phenomenon, whatever the nature and intensity of these events. “The predisposition to be affected” is a vulnerability condition although in a strict sense it would be necessary to establish the relevance of this affirmation when faced with all and individual feasible types of hazard. Nevertheless, as is the case with exposure, it is possible to suggest that certain variables reflect a comparatively unfavourable situation, supposing that the natural hazards exist as a permanent external factor irrespective of their exact characteristics.

4.2.3 Indicators of resilience (lack of)

The lack of resilience, PVILR, seen as a vulnerability factor, may be represented at all levels by means of the complementary or inverted¹⁰ treatment of a number of variables related to human development levels, human capital, economic redistribution, governance, financial protection, collective perceptions, preparedness to face crisis situations, and environmental protection. This collection of indicators on their own and particularly where they are disaggregated at the local level could help in the identification and orientation of actions that should be promoted, strengthened or prioritized in order to increase human security.

- LR1. Human Development Index, HDI [Inv]
- LR2. Gender-related Development Index, GDI [Inv]
- LR3. Social expenditure; on pensions, health, and education, % of GDP [Inv]

⁹ Also it is denominated as inherent vulnerability. It means, own socio-economic conditions of the communities that favour or facilitate the occurrence of effects on them.

¹⁰ The symbol [Inv] is used here to indicate a reverse or inverted dealing of the variable ($\neg R = 1 - R$).

- LR4. Governance Index (Kaufmann) [Inv]
- LR5. Insurance of infrastructure and housing, % of GD [Inv]
- LR6. Television sets per 1000 people [Inv]
- LR7. Hospital beds per 1000 people [Inv]
- LR8. Environmental Sustainability Index, ESI [Inv]

These indicators are variables that capture in a macro fashion the capacity to recover from or absorb the impact of dangerous phenomena, whatever their nature and severity. “To not be in the capacity to” adequately face disasters is a vulnerability condition, although in a strict sense it is necessary to establish this with reference to all feasible types of hazard. Nevertheless, as with exposure and fragility it is possible to admit that certain economic and social variables reflect a comparatively unfavourable situation supposing that natural hazards exist as permanent external factors without establishing their precise characteristics.

4.2.4 Estimation of indicators

In general, PVI reflects susceptibility due to the degree of physical exposure of goods and people, PVI_{ES} , that favour the direct impact in case of hazard events. In the same way, it reflects conditions of socioeconomic fragility that favour the indirect and intangible impact, PVI_{SF} . Also, it reflects lack of capacity to absorb consequences, for efficient response and recovering, PVI_{LR} . Reduction of these kinds of factors, as the purpose of the human sustainable development process and explicit policies for risk reduction, is one of the aspects that should be emphasized. Table 6 shows the total PVI and its components related to exposure and susceptibility, socio-economic fragility and lack of resilience. It is important to point out that, for participation of subindicators which do not have a recent value, we opted using the same value in all periods, in order to avoid affecting relative value of indices and hopping in future the value of these subindicators will be published.

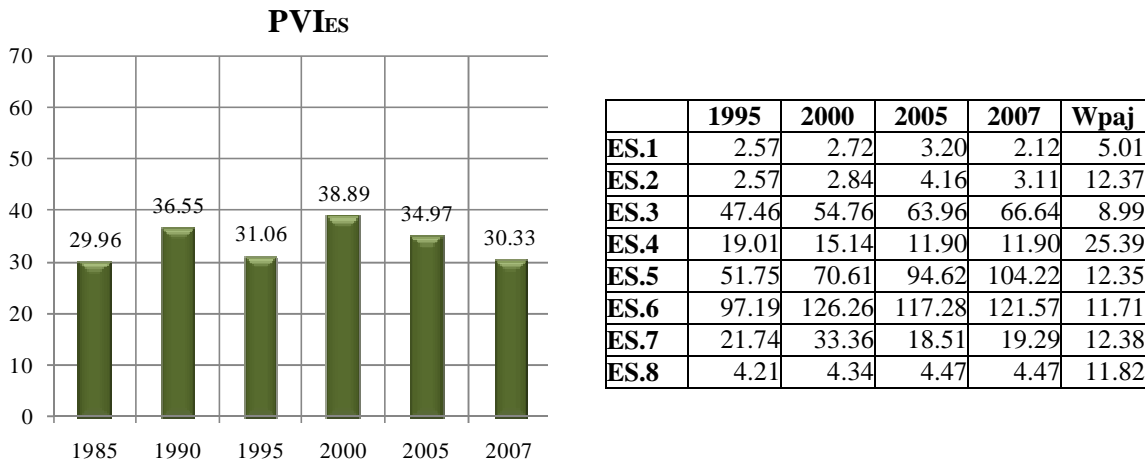
Table 6. PVI values

	1985	1990	1995	2000	2005	2007
PVI_{ES}	29.963	36.554	31.061	38.891	34.967	30.327
PVI_{SF}	36.847	34.357	37.448	31.604	38.022	46.200
PVI_{LR}	63.961	63.232	61.685	58.719	51.988	51.986
PVI	43.590	44.714	43.398	43.071	41.659	42.838

Source: Author's data

Figure 7 shows non scaled subindicators values that compose PVI_{ES} and their respective weights, which were obtained using Analytic Hierarchy Process (AHP).

Figure 7. PVI_{ES}

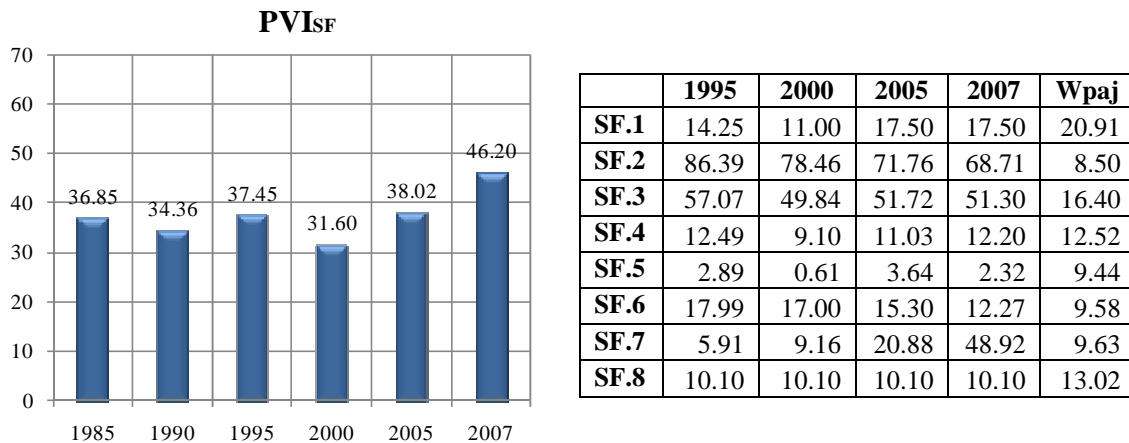


Source: Author's data

Vulnerability due to exposure and susceptibility in the country was relatively constant in all the periods. There is an increasing in 2000 compared to the previous period but after 2000 the indicator presents a slight diminish. These changes can be specially due to the decreasing of the percentage of poor population (ES4), that besides is the indicator with a higher weight assigned (represent the fourth part within the weights). Other indicators also presented a slight decrease but other, on the contrary were higher, what did not allow the greater declining of the index due to exposure and susceptibility. Nevertheless, it is detected a decrease in the urban growth but a constant increase in population density that can reflect the migration phenomena of the country to populated areas.

Figure 8 shows non scaled subindicators values that compose PVISF and their respective weights, which were obtained using Analytic Hierarchy Process (AHP).

Figure 8. PVI_{SF}

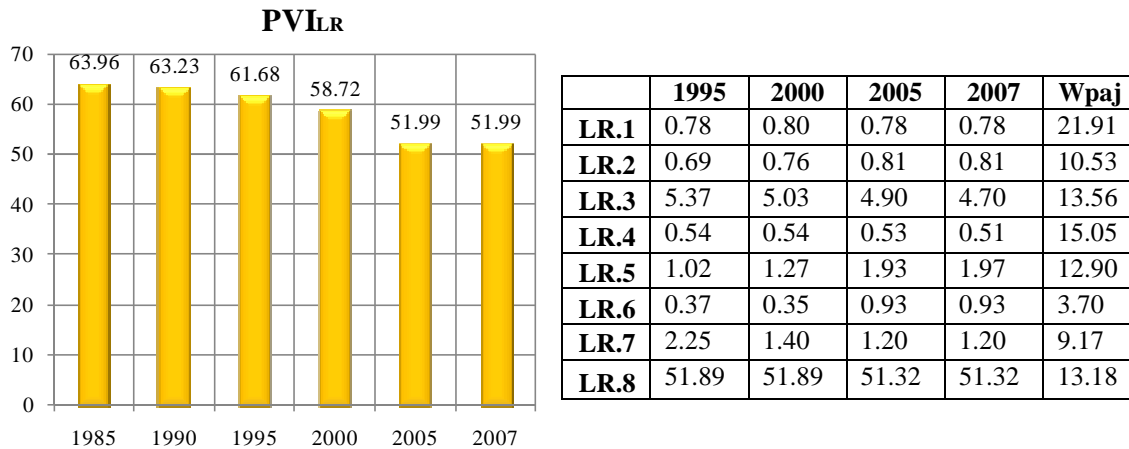


Source: Author's data

Vulnerability due to socio-economic fragility in the country presented a gradual increase since 2000 to 2007. The majority of the indicators presented a notable growth from 2000 to 2005. Those indicators were the Human Poverty Index (SF1), social disparity (SF3), unemployment (SF4), inflation (SF5) and debt servicing (SF7). Some indicators like dependents as proportion or working age population (SF2) and dependency of GDP growth of agriculture (SF6) decreased, nevertheless their change was not very high and their weights neither very high. From 2005 to 2007, the growth of the indicators was slighter with exception of the debt servicing (SF7) that increase the double compared with the previous period (2005). When a follow up with indicators is made it can be observed the relation between the increasing of the human poverty index and unemployment. In general, the level of vulnerability due to socio-economic fragility of the country is high if it is compared with the other countries of the region.

Figure 9 shows the figures of non scaled subindicators that compose PVILR and their respective weights, which were obtained using Analytic Hierarchy Process (AHP).

Figure 8. PVI_{LR}

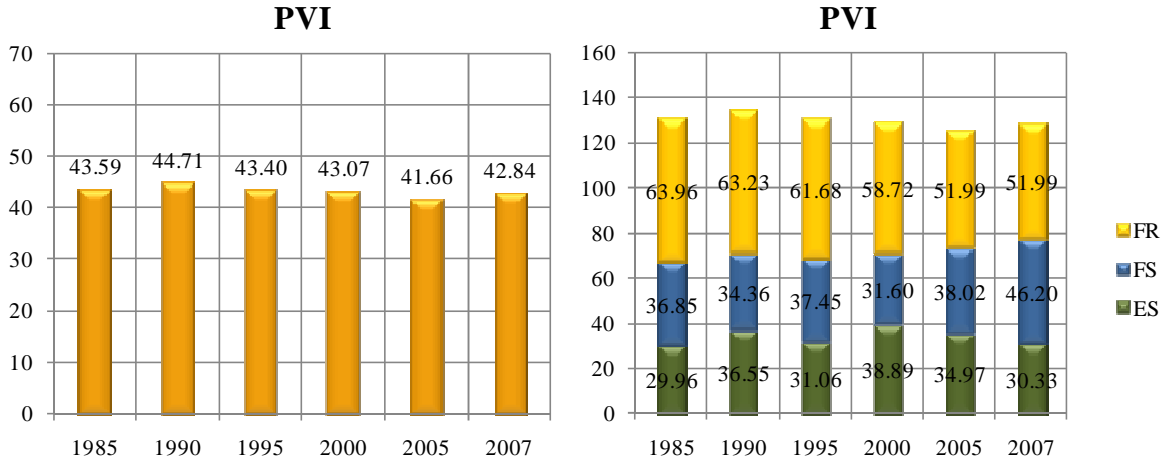


Source: Author's data

Vulnerability due to lack of resilience is the complementary or the inverted lecture of resilience or capacity, obtained for the subindicators selected. In this case most of the subindicators show relative steady values in all the periods. For this reason, slight decrease is detected in the PVILR; this indicates that resilience is going up for the last two years of evaluation. In comparison to the other countries of the region, Belize has medium vulnerability due to lack of resilience; the general indicator value is high and this is the indicator with the greatest contribution to the country's vulnerability.

Figure 10 shows total PVI obtained with average of its component indicators, and its aggregated presentation in order to illustrate their contributions.

Figure 9. PVI



Source: Author's data

PVI figures illustrate that prevalent vulnerability is constant and do not have notable changes through the years. Comparing the three indicators, the lack of resilience is the indicator with the greatest contribution to prevalent vulnerability; situation that occur also in other countries in the region. In general, this indicator has the main incidence in developing countries.

PVI illustrates relationship between risk and development, either because the development model adopted reduces it or increases it. This aspect makes evident the convenience of explicit risk reduction measures; because development actions do not reduce vulnerability automatically. This evaluation can be useful to institutions related to housing and urban development, environment, agriculture, health and social care, economics and planning, to mention some.

4.3 RISK MANAGEMENT INDEX (RMI)

The main objective of RMI is measurement or performance of risk management. This index is a qualitative measurement of risk based on pre-established levels (targets) or desirable referents (benchmarking) towards risk management should be directed, according to its level of advance. For RMI formulation, four components or public policies are considered: Risk identification (RI), risk reduction (RR), disaster management (DM) and Governability and financial protection (FP).

Estimation of each public policy takes into account 6 subindicators that characterize the performance of management in the country. Assessment of each subindicator is made using five performance levels: low, incipient, significant, outstanding and optimal, that corresponds to a range from 1 to 5, where 1 is the lowest level and 5 the highest. This methodological focus allows using each reference level simultaneously with the “performance objective” and, thus, lets the comparison and identification of results or achievements towards governments should direct their efforts of formulation, implementation and evaluation of policies in each case.

Once performance levels of each subindicator have been evaluated, through a non-linear aggregation model, the value of each component of RMI is determined (IDEA 2005; Cardona 2005). The value of each composed element is between 0 and 100, where 0 is the minimum performance level and 100 is the maximum level. Total RMI is the average of the four composed indicators that admit each public policy. When value of RMI is high, performance of risk management in the country is better.

4.3.1 Institutional framework¹¹

Belize is involved in several regional disaster mitigation initiatives. The country makes part of the Caribbean Disaster Emergency Response Agency (CDERA) that was established in 1991. Besides, the country has been financed since 1994 by the European Community Humanitarian Office (ECHO) to invest in prevention, mitigation and preparedness operations. In 2002, the Caribbean Community Climate Change Centre (CCCCC) was established and its goal is to coordinate regional responses to manage climate change.

On the other hand, additional to the regional programmes and approaches, the Government of Belize has established organizations and initiatives. In 1999 the National Emergency Management Organization (NEMO) was established in response to the devastation left by Hurricane Mitch in 1998. Its charge is to preserve life and property and to mitigate the negative impacts of an event. The Belize Red Cross Society that focuses in promoting humanitarian values, disaster response, disaster preparedness and health and community care.

¹¹ www.etudescaribeennes.revues.org

Likewise, the country passed the Disaster Preparedness and Response Act of 2000, the drafting of the National Hazard Mitigation Policy in 2003, the establishment of National Building Standards, the Hurricane Rehabilitation and Disaster Preparedness Project, and the Hurricane Preparedness Project by the Belize City Drainage Works.

4.3.2 Indicators of risk identification

The identification of risk generally includes the need to understand individual perceptions and social representations and provide objective estimates. In order to intervene in risk it is necessary to recognize its existence¹², dimension it (measurement) and represent it by means of models, maps, indexes etc. that are significant for society and decision makers. Methodologically, it includes the evaluation of hazards, the different aspects of vulnerability when faced with these hazards and estimations as regards the occurrence of possible consequences during a particular exposure time. The measurement of risk seen as a basis for intervention is relevant when the population recognizes and understands that risk. The indicators that represent risk identification, RI, are the following:

- RI1. Systematic disaster and loss inventory
- RI2. Hazard monitoring and forecasting
- RI3. Hazard evaluation and mapping
- RI4. Vulnerability and risk assessment
- RI5. Public information and community participation
- RI6. Training and education on risk management

4.3.3 Indicators of risk reduction

Risk management aims particularly to reduce risk. In general, this requires the execution of structural and non structural prevention-mitigation measures. It is the act of anticipating with the aim of avoiding or diminishing the economic, social and environmental impact of potentially dangerous physical phenomena. It implies planning processes but, fundamentally, the execution of measures that modify existing risk conditions through

¹² That is to say, it has to be a problem for someone. Risk may exist but not perceived in its real dimensions by individuals, decision makers and society in general. To measure or dimension risk in an appropriate manner is to make it apparent and recognized, which in itself means that something has to be done about it. Without adequate identification of risk it is impossible to carry out anticipatory preventive actions.

corrective and prospective interventions of existing and potential future vulnerability, and hazard control when feasible. The indicators that represent risk reduction, RR, are the following:

- RR1. Risk consideration in land use and urban planning
- RR2. Hydrological basin intervention and environmental protection
- RR3. Implementation of hazard-event control and protection techniques
- RR4. Housing improvement and human settlement relocation from prone-areas
- RR5. Updating and enforcement of safety standards and construction codes
- RR6. Reinforcement and retrofitting of public and private assets

4.3.4 Indicators of disaster management

Disaster management should provide appropriate response and recovery post disaster and depends on the level of preparation of operational institutions and the community. This public policy searches to respond efficiently and appropriately when risk has been materialized and it has not been possible to impede the impact of dangerous phenomena. Effectiveness implies organization, capacity and operative planning of institutions and other diverse actors involved in disasters. The indicators that represent the capacity for disaster management, DM, are the following:

- DM1. Organization and coordination of emergency operations
- DM2. Emergency response planning and implementation of warning systems
- DM3. Endowment of equipments, tools and infrastructure
- DM4. Simulation, updating and test of inter institutional response
- DM5. Community preparedness and training
- DM6. Rehabilitation and reconstruction planning

4.3.5 Indicators of governance and financial protection

Governance and financial protection is fundamental for the sustainability of development and economic growth in a country. This implies, on the one hand, coordination between different social actors that necessarily are guided by different disciplinary approaches, values, interests and strategies. Effectiveness is related to the level of interdisciplinarity and integration of institutional actions and social participation. On the other hand, governance

depends on an adequate allocation and use of financial resources for the management and implementation of appropriate strategies for the retention and transference of disaster losses. The indicators that represent governance and financial protection, FP, are the following:

- FP1. Interinstitutional, multisectoral and decentralizing organization
- FP2. Reserve funds for institutional strengthening
- FP3. Budget allocation and mobilization
- FP4. Implementation of social safety nets and funds response
- FP5. Insurance coverage and loss transfer strategies of public assets.
- FP6. Housing and private sector insurance and reinsurance coverage

4.3.6 Estimation of the indicators

RMI results have been obtained from detailed surveys made to experts and representatives of different institutions related to risk management. Thus, this index reflects performance of risk management based on evaluations of academic, professional and officials of the country. Results for 1995, 2000, 2005 and 2010 are following presented below.

Table 7 shows total RMI and its components, for each period. These are risk identification, RMI_{IR} , risk reduction, RMI_{RR} , disaster management, RMI_{DM} , and governance and financial protection, RMI_{FP} .

Table 7. RMI values

	1990	1995	2000	2005	2010
RMI	31.08	31.08	36.40	36.40	36.40
RMI_{RI}	12.93	12.93	28.89	28.89	28.89
RMI_{RR}	30.22	30.22	30.22	30.22	30.22
RMI_{DM}	50.08	50.08	50.08	50.08	50.08
RMI_{FP}	-	-	-	-	-

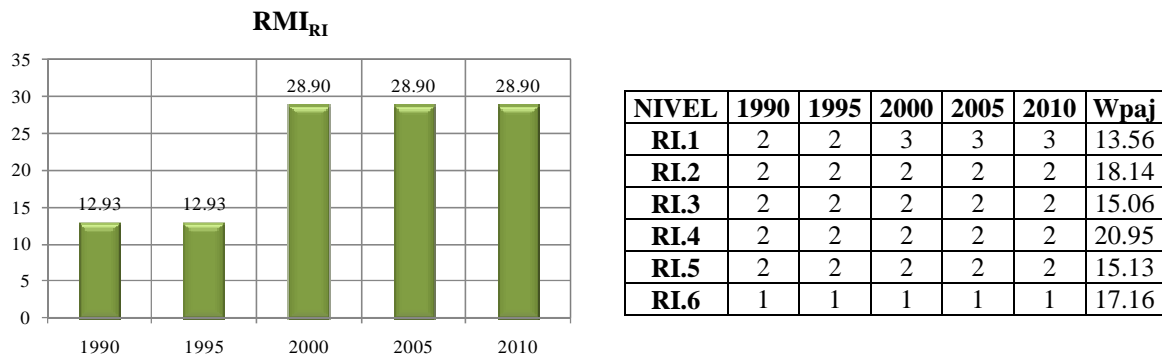
Source: Author's data

Figure 11 shows the qualification of subindicators¹³ that composed RMI_{RI} and its respective weights, obtained using Analytic Hierarchy Process (AHP).

¹³ Qualification is linguistic and it does not use defined numbers. In meanings in the tables are: 1: *low*, 2: *incipient*, 3: *significant*, 4: *outstanding* and 5: *optimal*

Management related to risk identification has a notable progress from 1995 to 2000 and it is due to the improvement of level from incipient to significant of the indicator of systematic disaster and loss inventory. The other indicators remain the same performance level. Risk management related to risk identification does not present any change during the last three periods due to there is not any improvement since 2000 of any of the indicators.

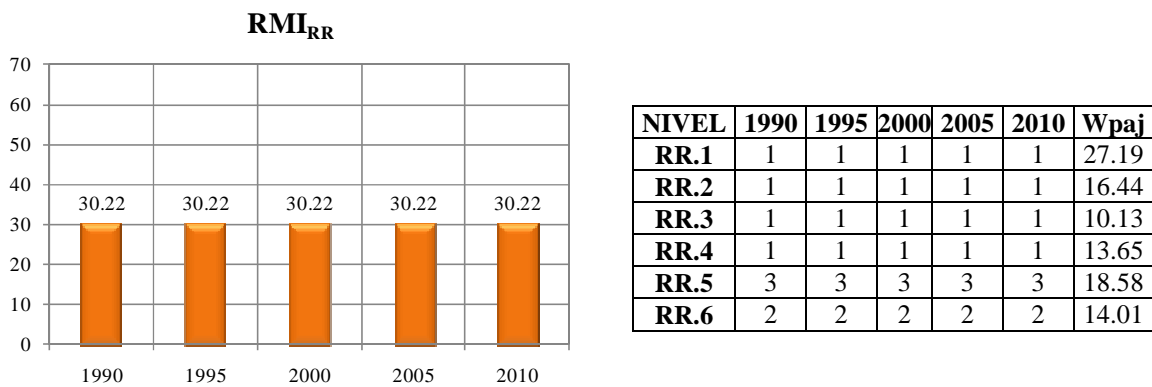
Figure 10. RMI_{RI}



Source: Author's data

Figure 12 shows the qualification of subindicators that composed RMI_{RR} and its respective weights, obtained using Analytic Hierarchy Process (AHP).

Figure 11. RMI_{RR}

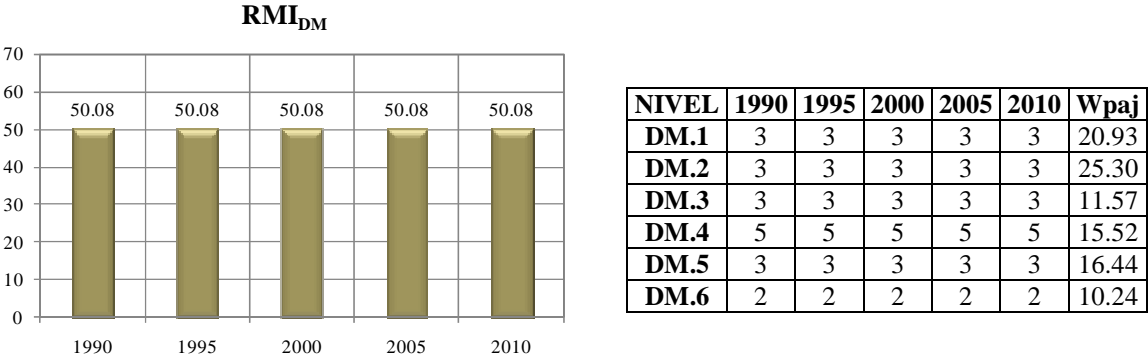


Source: Author's data

Management related to risk reduction indicates that the country has not had progress during the years of evaluation. The level of the total index is low and it is necessary to have efficient actions to improve the performance of the risk management in relation with the risk reduction.

Figure 13 shows subindicators qualifications which composed RMIDM and its respective weights, obtained using Analytic Hierarchy Process (AHP).

Figure 12. RMI_{DM}



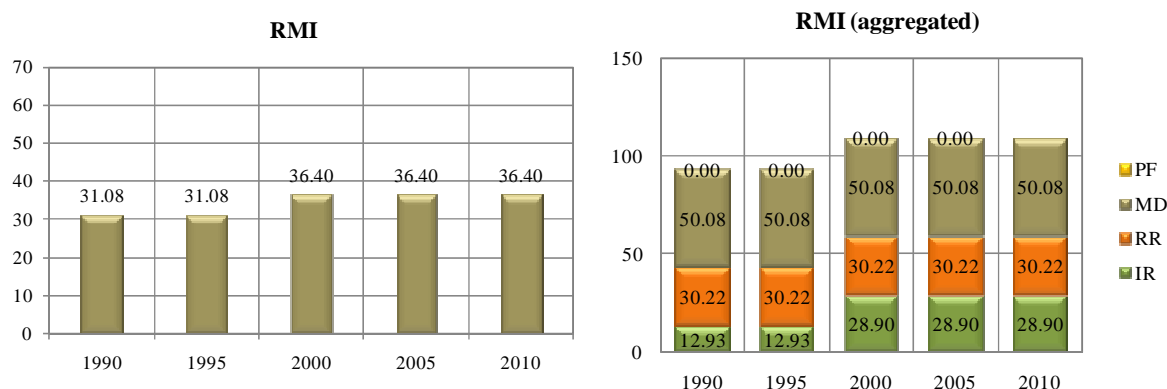
Source: Author’s data

Management related to disaster management indicates that the country has not had progress during the years of evaluation. The level of the total index is medium and it is necessary to have efficient actions to improve the performance of the risk management in relation with the disaster management. Nevertheless, it is important to point out that the indicator of simulation, updating and test of inter institutional response (DM4) presents the higher level of performance since 1990.

Management related to financial protection and governance did not have any qualification for Belize. Reason why the evaluation of the total RMI was made based only in the indicators of risk identification, risk reduction and disaster management.

Figure 14 shows the total RMI value obtained from the average of the component indicators and its aggregated version with the objective of illustrating their contributions.

Figure 13. Total RMI



Source: Author's data

In the RMI graphics is possible to observe that disaster risk management, in general, has a slight advance since 1995 to 2000. The indicators maintain the same performance level during the years of evaluation with exception of the RMIRI that present a progress for 2000. The RMIDM is the public policy that has presented the greatest performance level in comparison the other public policies. Nevertheless, and, in comparison with other countries of Latin-America and the Caribbean, Belize has a medium risk management qualification. This implies there is still so much work to do in order to achieve sustainability in risk management in high performance levels.

Table 8 presents, in a more illustrative form, the changes of the performance levels of the indicators that composed the aspects of the four policies related with risk management, between the first and the last period.

In summary, the table shows that during the period 1995-2008 there were not important advances in risk management in Belize. The indicator that greatest improvements presented was the risk identification (RI) with the best progress in systematic disaster and loss inventory (RI1), and no other indicator presented an advance. The indicators related with risk reduction and disaster management did not present any evolution during the years of evaluation.

Table 8. Differences between first and last period for RMI subindicators functions performance

Values of performance functions of the subindicators								
1990	RI.1	17	RR.1	5	DM.1	45	FP.1	-
	RI.2	17	RR.2	5	DM.2	45	FP.2	-
	RI.3	17	RR.3	5	DM.3	45	FP.3	-
	RI.4	17	RR.4	5	DM.4	93	FP.4	-
	RI.5	17	RR.5	45	DM.5	45	FP.5	-
	RI.6	5	RR.6	17	DM.6	17	FP.6	-
	RMI _{RI}	12.93	RMI _{RR}	30.22	RMI _{DM}	50.08	RMI _{FP}	-
	RMI	31.08						
2010	RI.1	45	RR.1	5	DM.1	45	FP.1	-
	RI.2	17	RR.2	5	DM.2	45	FP.2	-
	RI.3	17	RR.3	5	DM.3	45	FP.3	-
	RI.4	17	RR.4	5	DM.4	93	FP.4	-
	RI.5	17	RR.5	45	DM.5	45	FP.5	-
	RI.6	5	RR.6	17	DM.6	17	FP.6	-
	RMI _{RI}	28.89	IGR _{RR}	30.22	RMI _{DM}	50.08	RMI _{FP}	-
	RMI	36.40						
Change	RI.1	28	RR.1	0	DM.1	0	FP.1	-
	RI.2	0	RR.2	0	DM.2	0	FP.2	-
	RI.3	0	RR.3	0	DM.3	0	FP.3	-
	RI.4	0	RR.4	0	DM.4	0	FP.4	-
	RI.5	0	RR.5	0	DM.5	0	FP.5	-
	RI.6	0	RR.6	0	DM.6	0	FP.6	-
	RMI _{RI}	15.96	IGR _{RR}	0	RMI _{DM}	0	RMI _{FP}	-
	RMI	5.32						

Source: Author's data

5 CONCLUSIONS

DDI illustrates economic implications of a great disaster, estimated with base in the potential of feasible extreme events; PVI accounts for susceptibility and aggravation factors of the direct effects of the disasters due to deficiencies in development; and RMI points out what has been achieved and what is intended to do for improving risk management. And in the case of RMI the country has not presented notable advances during the periods of evaluation.

In the case of Belize, the Local Disaster Index, LDI, that captures the relevance of small and moderate local disasters, was not calculated due to the lack of availability of the DesInventar database at the time of the indicators assessment and the development of this project report. This indicator should be evaluated in the next future due to its relevance and in order to have a complete picture of the country's risk conditions using the complete set of indicators.

From these results it is possible to have as conclusions that in Belize there was an increase of DDI from 2000 to 2008. The PVI is from 1985 basically the same but with a slight reduction.

Making the comparison of trends in indicators is it possible to conclude that the system of indicators presents results generally consistent or appropriate to the reality of the country. In any case, it is important to disaggregate these indicators and identify areas where improvements can be made through actions, projects and specific activities that can make the central government with the participation of different sectoral agencies, municipalities and communities, and, thus, achieve a further progress and greater sustainability. Decision makers and stakeholders, besides identifying weaknesses indicators must take into account other characteristics that are not revealed or expressed with the evaluation obtained. Indicators provide a situational analysis from which it is possible to extract a set of actions that must be done without details for a strategic plan, which should be the next step. The aim of the indicator system is helping to formulate general recommendations for planning.

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APPENDIX I

NATURAL HAZARDS OF THE COUNTRY

AI.1 SEISMIC HAZARD

Central America is an ample region of tectonic interaction, in which the Caribbean, North American, Cocos and Nazca plates interact. Most of the territory is located on the Caribbean plate. To the north, in Guatemala, the introductory interaction of the Caribbean and North American plates is transcurrent, generating a lateral dip fault zone, with a capacity to generate highly destructive earthquakes, whose principal characteristic is the Chizoy-Polochic and Motagua systems. To the south, in Costa Rica, there is the "triple point" or zone of convergence of the Cocos, Caribbean and Nasca plates in the region of Golfo Dulce, and the deformed belts of the north and south of Panama.

The territory of Belize stands on the North American plate. The principal tectonic characteristics provide a hazard to that country with the interaction of the Caribbean and North American plates, which is transcurrent, with important fault systems such as Motagua in Guatemala and the Walton undersea fault to the southeast of the country, which may generate high-magnitude earthquakes (7+). The subduction zone, or Mesoamerican trench, does not represent an important seismic source for Belize, since it is some 400 km to the west of the country.

Important historical events

The following are some of the principal seismic events which have affected Belize. The information was obtained mainly from the US Geological Survey, and from seismic records from other countries, recording events also felt in Belize.

All the earthquakes presented below events which mostly affected the territory of other countries, but due to their magnitude and intensity, were felt and recorded in Belize.

February 4th, 1976

The epicentre was at coordinates 15.32° north and 89.1° west, at a depth of 5 km and a magnitude of 7.5 mb Gs.

August 20th, 1977

The epicentre was at 16.7° north and 86.61° west, at a depth of 36 km and a magnitude of 6.1 UKPAS.

August 9th, 1980

The epicentre was 15.9° North and 88.52° West, at a depth of 22 km, and a magnitude of 6.7 UKBRK.

September 18th, 1991

The epicentre was at 14.65° north and 90.99° west, depth of 5 km and a magnitude of 6.2MwHRV

July de 1997

The epicentre was at 16.16° north and 87.92° west, depth of 33 km, magnitude of 6.1MwGS

May 28th, 2009

310 km north-west of Tegucigalpa, Honduras, at a depth of 10 km and a magnitude of 7.3Mw. Belize suffered power cuts and severe damage to housing.

AI.1 HYDROMETEOROLOGICAL HAZARDS

Belize's Caribbean coast is a territory which has been much affected by hurricane. In 1961 a hurricane completely destroyed the then-capital, Belize City, obliging survivors to move to the centre of the country, to what is now the capital of Belize, Belmopan.

Below we present the information on hurricanes which have had the most impact on Belize territory since 1960, in the Atlantic hurricane seasons.

Hurricane Hattie (1961)



Image of the track of hurricane Hattie

Hurricane Hattie-Simone forms part of the hurricane season in the Atlantic from 1961. It was a Category 5 hurricane on the Saffir-Simpson scale, and it affected Belize, Honduras and Guatemala. The hurricane developed, and affected Central America between October 27 and November 1, 1961. Winds of up to 300 km an hour and pressures of 92kPa were recorded.

In its track across Central America, it is estimated that it caused 319 deaths, and damage of US\$440,000,000, at present value. Its passage over Belize City caused the destruction of 75% of its houses and shops.

Hurricane Fifi (1974)



Satellite image of hurricane Fifi

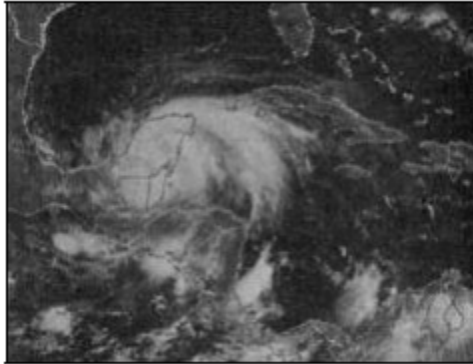


Image of the track of hurricane Fifi

Hurricane Fifi belongs to the 1974 Atlantic Ocean hurricane season. It crossed the Atlantic as hurricane Fifi, and reached the Pacific, where it was renamed hurricane Orlene. Hurricane Fifi-Orlene developed between September 14 and 22, 1974, from a tropical wave in the Caribbean. It struck Belize territory on September 19 as a Category 2 hurricane, on the Saffir-Simpson scale, with sustained winds of 175 kph, and pressures of 970 mb.

Hurricane Fifi cause damage totalling US\$900,000,000 (USD-1974), in Central America, that is, US\$4,000 million in present value. The event was catalogued as the 4th most deadly in history, with 8,000-10,000 fatalities.

Hurricane Hermine (1980)



Satellite image of hurricane Hermine



Image of the track of hurricane Hermine

Hermine belongs to the 1980 Atlantic Ocean hurricane season, and it developed on September 20-25, 1980, from a tropical wave coming from Africa.

On September 22, it touched the mainland in Belize with sustained winds of 110 kph and a minimum pressures of 990 mb. It is estimated that there were major floods in Honduras and Belize, but there are no records of damage estimates.

Hurricane Keith (2000)

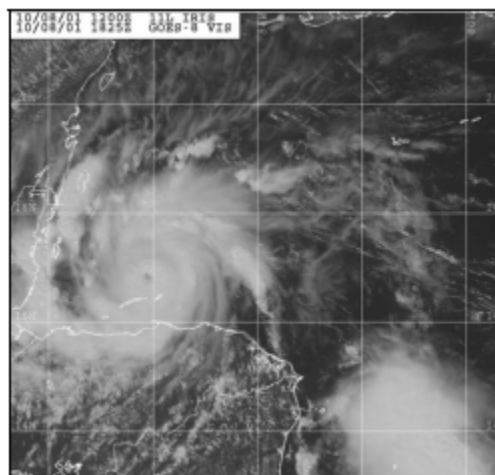


Image of the track of hurricane Keith

Hurricane Keith belongs to the 2000 Atlantic Ocean hurricane season. It developed between September 28 and October 6, 2000, with maximum sustained winds of 193 kph (Category 4 on the Saffir-Simpson scale) and minimum pressures of 941 mb.

Hurricane Keith touched land in Belize on October 1, where it weakened down to Category 1. It is estimated that the total damage caused by hurricane Keith in Belize was US\$225,000,000 (US\$-2000)

Hurricane Iris (2001)



Satellite image of hurricane iris

Hurricane Iris belongs to the 2001 Atlantic Ocean hurricane season. It developed between October 4-9, 2001, with Category 4 on the Saffir-Simpson scale and sustained winds stronger than 230 kph.

In Belize, it arrived at Monkey River Town on October 9. 23 people reportedly died, 20 of them on the coast. The damage caused by hurricane Iris in Belize totaled an estimated US\$66.2 million (US\$-2001).

Although quantitative information is quite limited - in a few cases only, there are data of milliliters of water, records obtained described the zones involved and the infrastructure affected. Most of the phenomena with considerable impact in the zone are related to Hurricanes which have passed through Central America, cold fronts (polarthrust), tropical waterway waves, convective and orographic processes, the synoptic position of the inter-tropical convergence zone, and episodes of El Niño/La Niña/ENOS.

There follows information on some of the most important storms which have affected Belize between 1900 and 2009. The information was taken from the emergency events database (EM-DAT) website:

1931 The storm occurred on September 10, leaving estimated damage of US\$7.5 million, and an estimated 1,500 fatalities

1961 The storm occurred on October 30, leaving damage estimated at US\$60,000,000, with an estimated 275 fatalities.

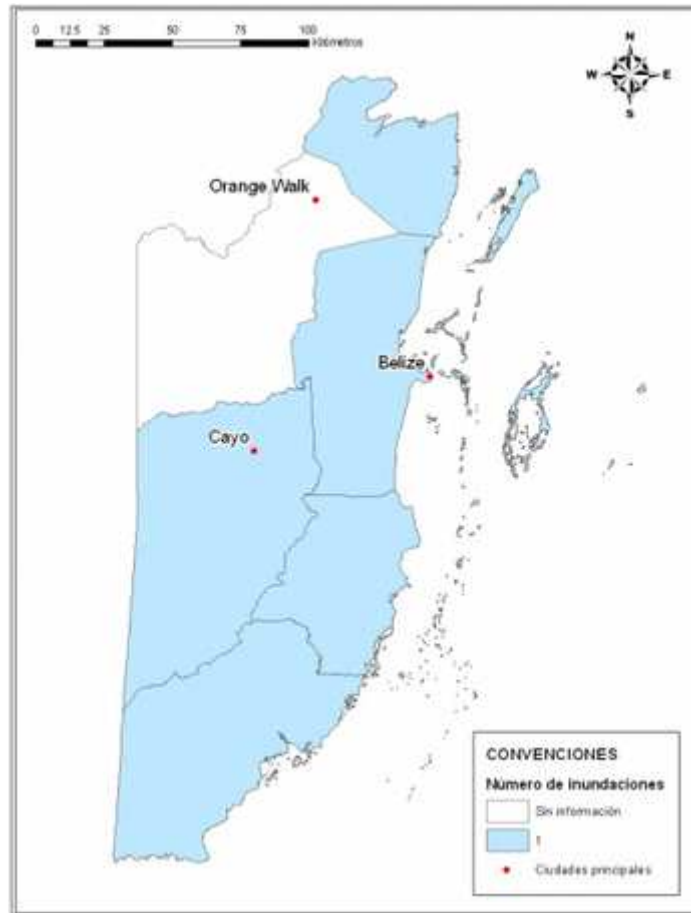
1974 The storm occurred on September 2, leaving damage of US\$4,000,000, and an estimated 70,000 persons affected.

2000 The storm occurred on September 30, leaving material damage of US\$277.5 million, with 14 fatalities, and 62,570 persons directly affected.

2001 The storm occurred on October 8, leaving material damage of US\$250 million. There were 30 fatalities, and 20,000 people were affected.

AI.3.1 HAZARD OF FLOODING

The catalogue of floods for Belize has six events in total reported between 1979 and 2008. As there are few records of flooding, an average value of events per year as a functional duration could not be obtained. Figure shows the number of floods recorded by district.



Number of floods by district in Belize

The following is information about the most important floods which have occurred in Belize between 1900 and 2009. The information was taken from the emergency events database (EM DAT).

1979 December, with approximately 17,000 affected

1995 October, with 2,600 directly affected direct economic loss over 0.5 million dollars.

2008 October 19, 2008, with 1 death, 38,000 affected, and US\$9.7 million in material losses