



# **Indicators of Disaster Risk and Risk Management**

**Program for Latin America and  
the Caribbean**

**JAMAICA**

**Inter-American  
Development Bank**

Environment, Rural  
Development and  
Disaster Risk  
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(INE/RND)

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## 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. Subsequently, two additional countries were evaluated with the support of the Regional Policy 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 updated 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 Tobago<sup>1</sup>. In addition, Barbados and Panama 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-IDEA<sup>2</sup>.

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 seek 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.
- 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

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

<sup>2</sup> 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>

national levels. These particularly affect the more socially and economically fragile population and generate a highly damaging impact on the country's 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, "proxies" 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 detailed methodological explanations are not included 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.unalmzl.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; Cardona 2005; IDEA 2005).

# SYSTEM OF INDICATORS FOR JAMAICA

## 1 NATIONAL CONTEXT

Jamaica is an island nation of the Greater Antilles, 234 kilometres (145 mi) in length and as much as 80 kilometres (50 mi) in width, amounting to 11,100 km<sup>2</sup>. It is situated in the Caribbean Sea, about 145 kilometres (90 mi) south of Cuba, and 190 kilometres (120 mi) west of Hispaniola. Jamaica is the third largest island and the fourth largest country in the Caribbean. The island is home to the Blue Mountains and is surrounded by a narrow coastal plain. Most major towns and cities are located on the coast. Main towns and cities include the capital Kingston, Portmore, Spanish Town, Mandeville, Ocho Ríos, Port Antonio, Negril, and Montego Bay. The Kingston Harbour is one of the largest natural harbours in the world.

Figure 1 presents an estimative of population for the different parishes and their variation since 1980.

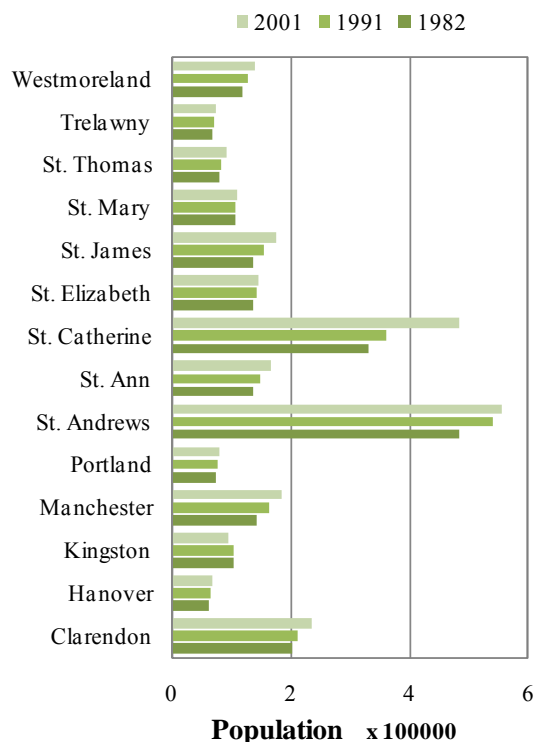


Figure 1. Population by parishes (Source <http://www.citypopulation.de/Jamaica.html>)

Regarding its economy, GDP of Jamaica is of the order of US\$11.4 billion in 2007; its growth rate has been 2% and -7% in 2005 and 2007 respectively. In this period, current account and trade balance have been in a deficit near to 15% and 20% of GDP respectively. The total public debt has been 127.5% of GDP, the total debt service as percentage of exports and income has been in the last years near to 17%. The inflation rate is over 17% and the unemployment rate is estimated on the order of 11.4 (April 2009). The gross capital formation as proportion of GDP has growth since 2000 and it is closer to 33% in 2006. The



exchange rate in 2008 fluctuates around J\$73 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 was around 11.3% in 2005. The percentage of population that live with less than two dollars is around 6% and the number of hospital beds per one thousand inhabitants is 1.4.

**Table 1. Main macroeconomic and social indicators**

<b>Indicator</b>	<b>2000</b>	<b>2005</b>	<b>2007</b>
GDP (USD million)	8,027.26	9,714.57	11,430.42
Trade balance (% GDP)	-4.58	-11.03	-15.25
Total debt service (% Exports and income)	15.4	16.31	17.31
Unemployment (%)	15.5	11.3	11.4
Population living lower the poverty line	6.19*	5.84*	**
Human Development Index	0.74	0.74	**

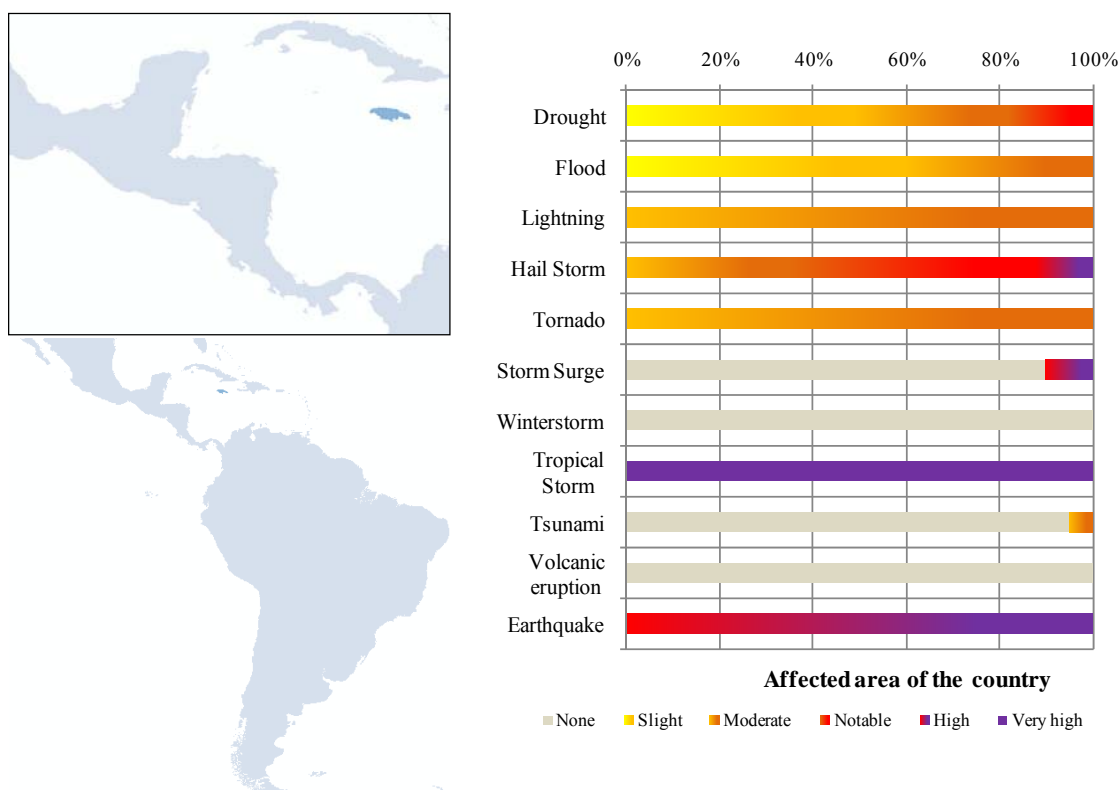
*Sources: The World Bank, ECLAC*

\* *Data of 1999 and 2004*

\*\* *Data not available*

## **2 NATURAL HAZARDS**

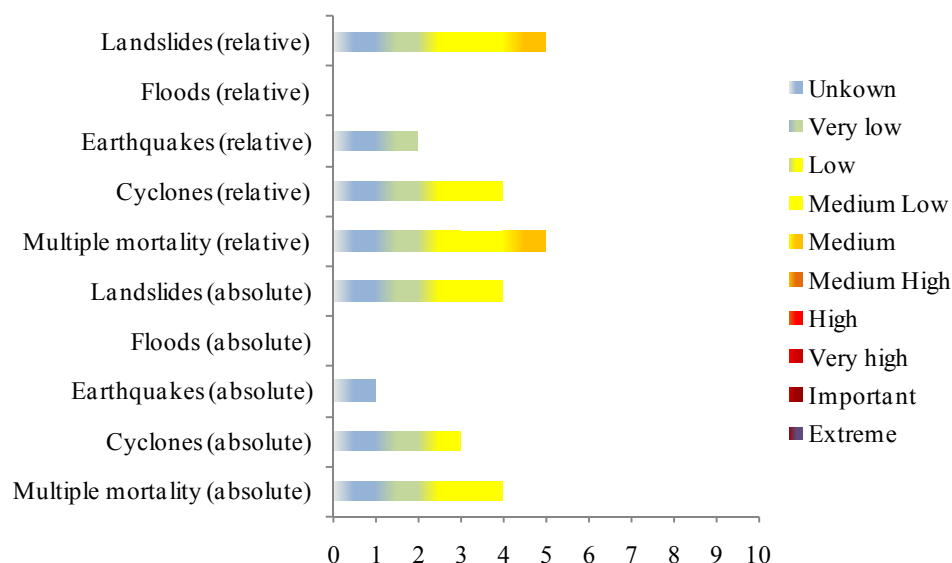
Figure 2 presents the percentages of the influence area and the severity level of the different hazards in the country. Likewise, Figure 3 presents the classification by mortality risk established by the International Strategy for Disaster Reduction, ISDR. These figures illustrate the events that can be considered as triggers for the estimation of the Disaster Deficit Index, DDI. 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 influence area by hazard. (Source: Munich Re<sup>3</sup>)**

The most important natural hazards to the country are earthquakes and tropical storms. These are extreme events that would cause the major losses in the future in Jamaica. There are other natural phenomena that have lower probability of affecting the country such as hail storms, tornados, storm surges, and lightning; however these hazards may cause significant local damage. In addition, the exposure of the country to droughts and floods is moderate to notable. This information is especially important for the estimation of the Disaster Deficit Index, DDI. On the other hand, the most recurrent and isolated phenomena, such as landslides and floods, cause frequent effects at the local level, without being noticed. These events have also great impacts on the population, and, if they are cumulative, can be important too. Information about these events is especially important for the estimation of the Local Disaster Index, LDI.

<sup>3</sup> <http://mrnathan.munichre.com/>



**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 deaths per year; the relative mortality risk index refers to the average of deaths in proportion to the national population. According to Figure 3, absolute values indicate that mortality risk is medium concentrated due to landslides and medium-low concentrated due to cyclones. Likewise, relative mortality risk shows that landslides are classified as medium-high, cyclones as medium-low and earthquakes as very low.

### **3 INDICATORS OF DISASTER RISK AND RISK MANAGEMENT**

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

#### **3.1 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 the 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 phenomenal 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 the entity responsible for recovery or as owner of the affected goods, may access or has available in the time 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 which they were taken; therefore, both the proxy of exposure as well as the available resources had 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. Likewise, 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 savings 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.

### 3.1.1 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 such 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 their variation over the most recent periods of analysis. Figure 5 presents a similar graphic regarding the exposed values for the whole country. The technique for the country's exposure estimation, vulnerability assessment and the hazard and risk models used are explained in Ordaz & Yamin (2004) and Velásquez (2009). These technical explanations are available in <http://idea.unalmz.edu.co>.

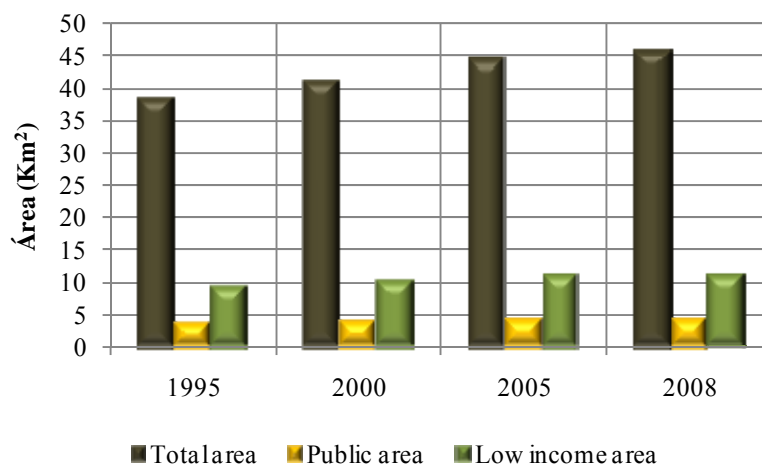


Figure 4. Total built areas by component in square km

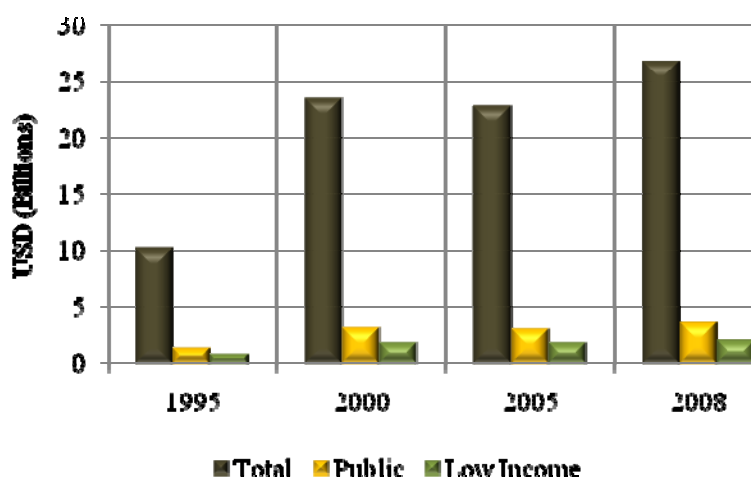


Figure 5. Exposed value by component in billion dollars

### 3.1.2 Estimation of the indicators

Table 2 shows the DDI for 1995, 2000, 2005 and 2008 for the Maximum Considered Event (MCE) of 50, 100 and 500 years of return period.<sup>4</sup>

Table 2. DDI for different return periods

DDI	1995	2000	2005	2008
DDI <sub>50</sub>	0.17	0.30	0.56	0.28
DDI <sub>100</sub>	0.47	0.74	1.35	0.73
DDI <sub>500</sub>	1.58	2.11	3.57	2.40

<sup>4</sup> Events that can occur in any moment and they have a probability of occurrence of 18%, 10% and 2% in 10 years.

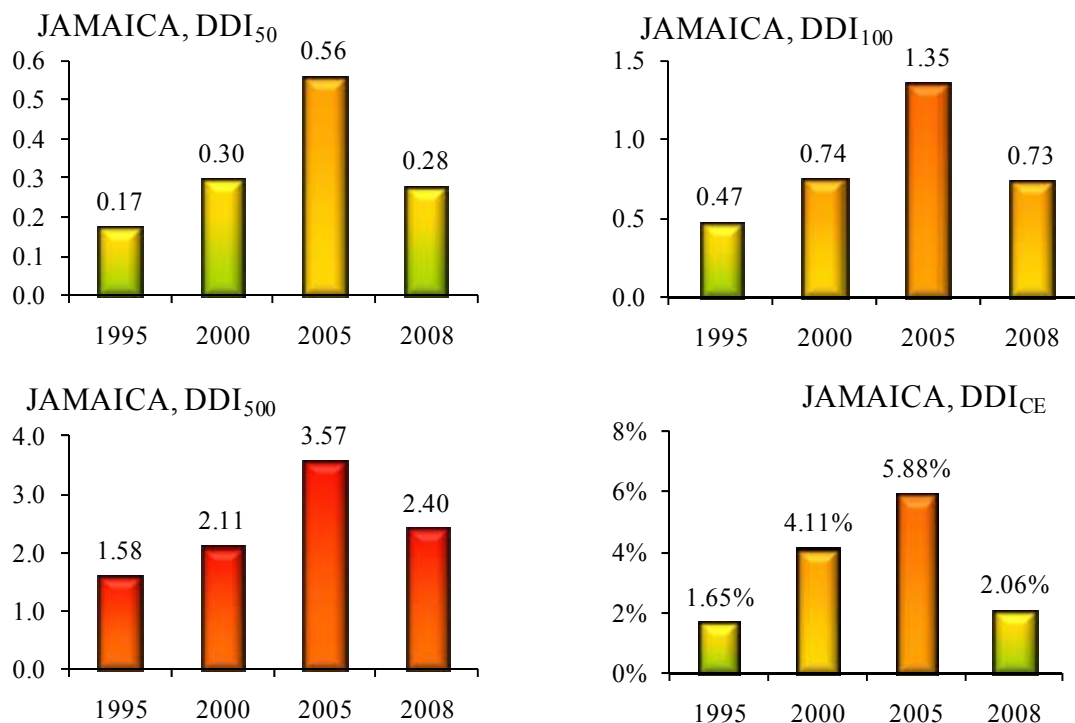
For extreme events in 500 years in all periods and for 100 years in 2005 the DDI is greater than 1.0; this means the country does not have enough resources to cover losses and/or feasible financial capacity to face losses and replace the capital stock affected. For maximum events in 100 and 50 years the country, in general, has 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. Table 3 shows DDI' values, which corresponds to annual expected loss related to capital expenditure (annual budget of investment), and related to possible savings for inter-temporal surplus to 10 years, expressed in percentages. DDI'<sub>CE</sub> illustrates that if contingent liabilities to the country were covered by insurance (annual pure premium), the country would have to invest annually close to 2% 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 2005 and 2008 savings were negative, that is, annual pure premium value would increase the deficit. Values of DDI'<sub>IS</sub> in 1995 and 2000 were lower which indicates that there would be annual average savings for covering the losses in the country.

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

<b>DDI'</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2008</b>
<b>DDI'<sub>CE</sub></b>	1.65%	4.11%	5.88%	2.06%
<b>DDI'<sub>IS</sub></b>	3.40%	2.73%	^D	^D

^D: negative values of inter-temporal surplus or lower inter-temporal surplus values than the expected annual loss, therefore deficit increasing

Figure 6 illustrates DDI and DDI' values related to capital expenditure. The graphics illustrate that for 500, 100 and 50 year of return period from 1995 to 2005 the DDI and the DDI'<sub>CE</sub> increased, but in 2008 it considerably decreased, although not to a value lower than in 1995.



**Figure 6.  $DDI_{50}$ ,  $DDI_{100}$ ,  $DDI_{500}$ ,  $DDI'_{CE}$**

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 exposure level of the country every five years, from 1980 to 2000. In addition, Table 4 shows the values of the pure premium, i.e. the required annual amount to cover future disasters in each period. The DDI and  $DDI'$  for the five year-period (1995 to 2008) 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 increase in the potential deficit due to disasters. Clearly, investments in mitigation (retrofitting of vulnerable structures) that would reduce potential losses; or increasing of insurance coverage of exposed elements that would enhance economic resilience, could be reflected in a future DDI evaluation for the country.

**Table 4. Probable loss and pure premium for DDI and DDI' calculations**

<b>L<sub>50</sub></b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2008</b>
Total – Million US\$	182.1	400.3	387.0	454.4
Government – Million US\$	20.8	48.0	46.7	54.9
Poor – Million US\$	26.3	58.1	56.3	66.1
Total - % GDP	3.54%	5.36%	4.12%	3.54%
Government - % GDP	0.40%	0.64%	0.50%	0.43%
Poor - % GDP	0.51%	0.78%	0.60%	0.52%
<b>L<sub>100</sub></b>				
Total – Million US\$	513.5	1,136.8	1,100.3	1,292.8
Government – Million US\$	54.5	120.9	117.0	137.6
Poor – Million US\$	83.7	185.9	180.0	211.6
Total - % GDP	9.98%	15.22%	11.71%	10.08%
Government - % GDP	1.06%	1.62%	1.25%	1.07%
Poor - % GDP	1.63%	2.49%	1.92%	1.65%
<b>L<sub>500</sub></b>				
Total – Million US\$	2,047.9	4,546.2	4,401.7	5,172.7
Government – Million US\$	231.3	529.1	513.9	604.1
Poor – Million US\$	387.6	886.7	861.2	1,012.3
Total - % GDP	39.80%	60.88%	46.84%	40.34%
Government - % GDP	4.50%	7.09%	5.47%	4.71%
Poor - % GDP	7.53%	11.88%	9.16%	7.89%
<b>L<sub>v</sub></b>				
Total – Million US\$	23.3	51.5	49.8	58.5
Government – Million US\$	3.3	7.6	7.3	6.5
Poor – Million US\$	3.9	8.7	8.5	7.6
Total - % GDP	0.45%	0.69%	0.53%	0.46%
Government - % GDP	0.06%	0.10%	0.08%	0.05%
Poor - % GDP	0.08%	0.12%	0.09%	0.06%

Table 5 presents possible internal and external funds that the government needs to access at the time 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.



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

<b>Funds</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2008</b>
Insurance premiums - % GDP	4.12	8.01	0.00	0.00
Insurance/ reinsurance.50 - <i>F1p</i>	1.9	8.5	0.0	0.0
Insurance/ reinsurance.100 - <i>F1p</i>	5.7	24.6	0.0	0.0
Insurance/ reinsurance.500 - <i>F1p</i>	25.5	113.3	0.0	0.0
Disaster reserves - <i>F2p</i>	0.0	0.0	3.8	\$ 5
Aid/donations.50 - <i>F3p</i>	9.1	20.0	19.4	22.7
Aid/donations.100 - <i>F3p</i>	25.7	56.8	55.0	64.6
Aid/donations.500 - <i>F3p</i>	102.4	227.3	220.1	258.6
New taxes - <i>F4p</i>	0.0	0.0	0.0	0.00
Capital expenditure - % GDP	8.51	5.31	2.86	5.32
Budgetary reallocations. - <i>F5p</i>	262.6	237.8	161.3	409.3
External credit. - <i>F6p</i>	0.0	46.6	0.0	0.0
Internal credit - <i>F7p</i>	0.0	46.6	0.0	0.0
Inter-temp surplus. d*- % GDP	4.12	8.01	-16.45	-6.63
Inter-temp surplus. - <i>F8p</i>	211.8	597.8	-1,546.0	-\$ 850
<b><i>ER</i>.<sub>50</sub></b>				
Total - Million US\$	274	359	184	437
Total - %GDP	5.32%	4.81%	1.96%	3.41%
<b><i>ER</i>.<sub>100</sub></b>				
Total - Million US\$	294	412	220	479
Total - %GDP	5.71%	5.52%	2.34%	3.74%
<b><i>ER</i>.<sub>500</sub></b>				
Total - Million US\$	391	672	385	673
Total - %GDP	7.59%	8.99%	4.10%	5.25%

The current results present some differences in comparison with those previously obtained in the first phase of the Program of Indicators IDB-IDEA for the preceding periods, due to, on the one hand, that improvements in the proxy of the exposed assets of the countries were made, and, on the other hand, that some indicators related to funds related to the economic resilience were adjusted in the original databases. Likewise, in some cases new data and sources of information of the Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (*Latin Macro Watch Country Tables*) were used. The previous version (IDEA 2005) took into account national government values and, within public corporations non-financial public sector; nevertheless in some cases that information was incomplete.

The DDI for 2008 was calculated based on the most recent available information on exposed elements, references of the built 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 yet been incorporated in the databases. This means that the recent results of DDI may vary once the data is consolidated. Nonetheless, in conclusion, based on the results obtained, the country has improved its economic resilience, as 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 its 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 country's existing budget restrictions.

### **3.2 LOCAL DISASTER INDEX (LDI)**

The LDI captures simultaneously the incidence and uniformity of the distribution of local disaster effects; i.e. it accounts for the relative weight and persistence of the disaster effects at parish scale. The total LDI is obtained by the sum of three LDI's that are calculated based on the information available in the DesInventar database<sup>5</sup> regarding deaths, affected people and economic losses in each parish of the country. If the relative value of the index is high, the uniformity of the magnitude and distribution of the effects of various hazards among parishes is greater. A low LDI value means low spatial distribution of the effects among the parishes where events have occurred. The range of each LDI is from 0 to 100 and the total LDI is the sum of the three components. A low LDI value (0-20) means high concentration of small disasters in few parishes and a low spatial distribution of their effects between the parishes where they had taken place. Medium LDI values (20-50) means that the concentration of small disasters and the distribution of their effects are intermediate; high LDI values (greater than 50) indicate that the majority of parishes suffer small disasters and their effects are similar in all affected parishes. High values reflect that vulnerability and hazards are generalized in the territory.

The original methodological formulation of the LDI (IDEA 2005) included the effects of all the events (both small and big) occurred in the country; i.e. both effects of small and frequent events and extreme and rare events. During the first evaluation made in 2005, it was considered that reflecting the influence of extreme events was not the objective of this indicator. A recommendation for a further evaluation, as in the current case, was to take into account only the small and moderate events. Thus, this updating excludes extreme events from the database through statistical identification of outliers (Marulanda and Cardona 2006).

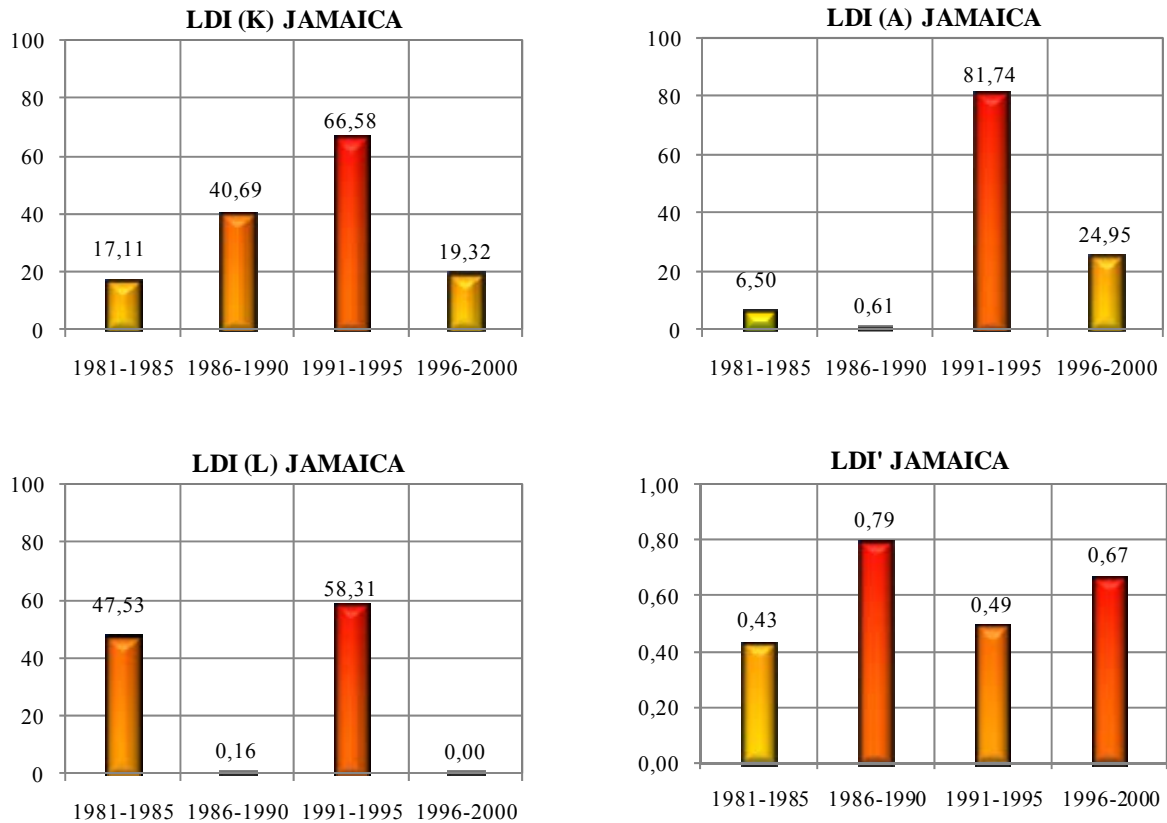
In a complementary manner, the LDI' has been formulated, which measures the concentration of aggregate losses at parish level. Its value is between 0.0 and 1.0. A high LDI' value means that high economic losses concentration due to small disasters has occurred in few parishes. For example, an LDI' equal to 0.43 and 0.79 means that approximately 10% of parishes of the country concentrates approximately 35% and 70% of the losses respectively. Table 6 shows LDI for deaths, affected people and losses, as well as total LDI and LDI' for all the events that took place in the country in the periods 1981-1985, 1986-1990 y 1995-2000. Details of these abovementioned technical issues are available in the Main Technical Report of the System of Indicators (IDEA 2005).

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<sup>5</sup> The DesInventar database was developed in 1994 by the Network for Social Studies in Disaster Prevention in Latin America <http://www.desinventar.org>

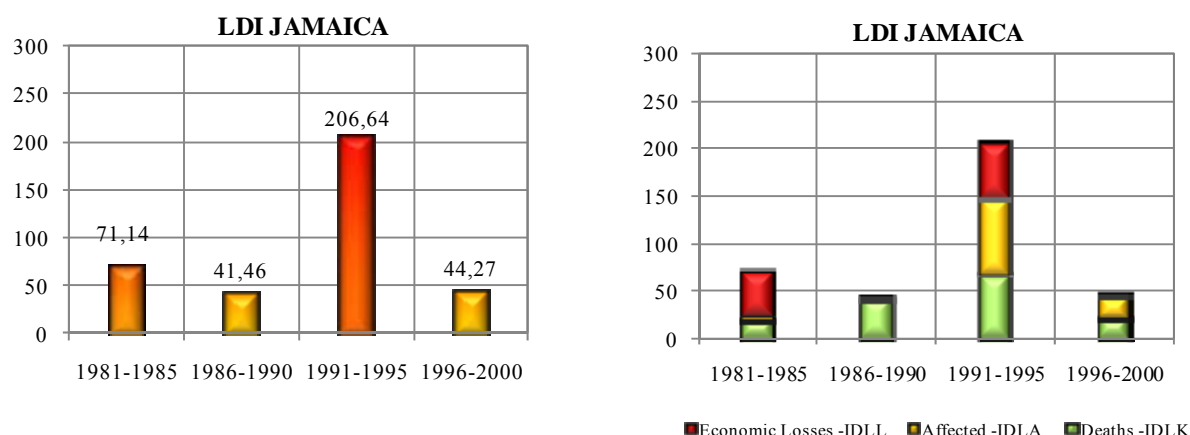
**Table 6. LDI values**

	1981-1985	1986-1990	1991-1995	1996-2000
<b>LDI<sub>K</sub></b>	17.11	40.69	66.58	19.32
<b>LDI<sub>A</sub></b>	6.50	0.61	81.74	24.95
<b>LDI<sub>L</sub></b>	47.53	0.16	58.31	0.00
<b>LDI</b>	71.14	41.46	206.64	44.27
<b>LDI'</b>	0.43	0.79	0.49	0.67



**Figure 7. LDI for deaths (K), affected people (A) and losses (L), and LDI'**

Figure 7 illustrates LDI values, according to the type of effects in different periods. The LDI for deaths and the LDI for affected people between 1991 and 1995 indicate that low scale disasters caused deaths and affected in a more regular and uniform way in the territory in this period than in the others. During the periods 1981-1985 and 1986-1990 people affected were concentrated in a smaller group of parishes. The same happened to deaths between 1981 and 1985 and 1996-2000. Incidence and persistence in economic losses was lower in the period from 1986 to 1990 and the period from 1996 to 2000 than in the other two periods, as the effects were concentrated in few parishes and type of events. It can also be seen from the results of the LDI' which presents the greatest values for those periods; i.e. they are the periods with the highest loss concentration.



**Figure 8. Total LDI and aggregated presentation**

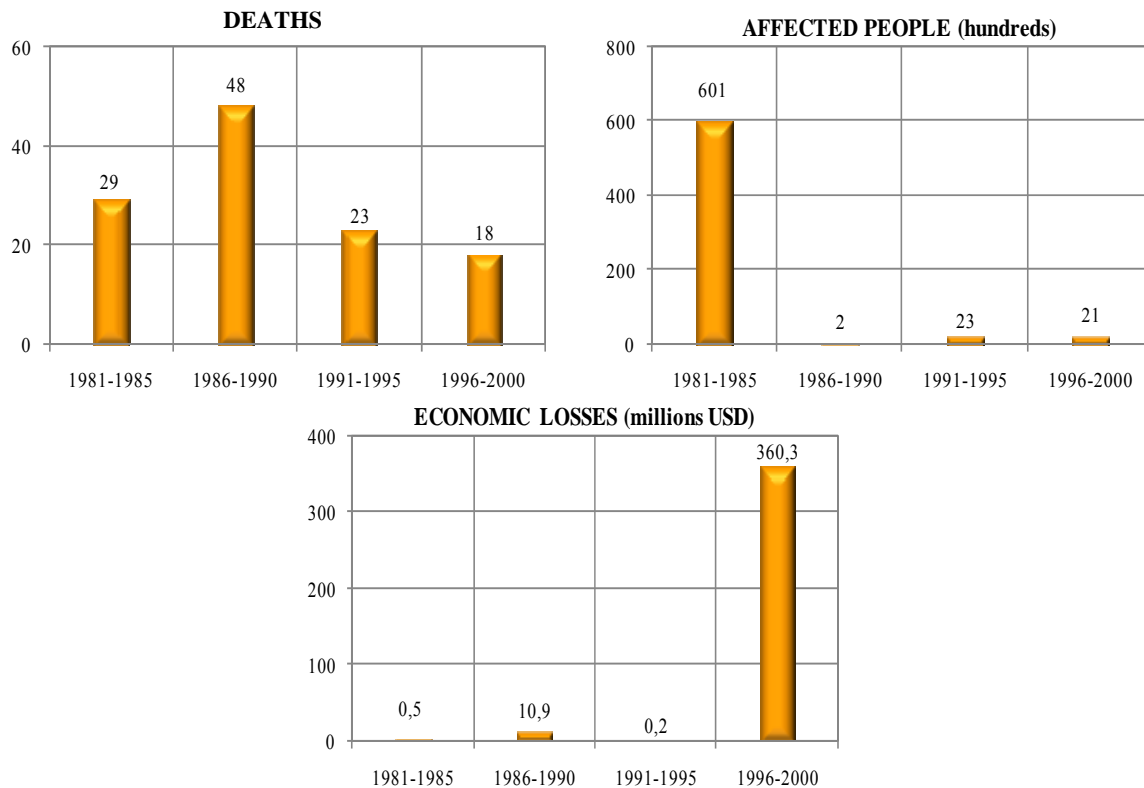
In general, as the LDI values illustrate in Figure 8, low scale disasters have caused more regular and distributed effects between all parishes of the country at the beginning of 1990's than in the 1980's. That is to say, the concentration of effects between parishes decreased for that period; and at the end of the 1990's this regularity decreased, i.e. there was a greater concentration.

Table 7 shows the values of total deaths, total affected people and total economic losses in US dollars for the four periods evaluated.

**Table 7. Total of deaths, affected people and losses**

	1981-1985	1986-1990	1991-1995	1996-2000
<b>Total deaths</b>	29	48	23	18
<b>Total affected people</b>	60.086	194	2.301	2.114
<b>Total losses (USD)</b>	\$511.748	\$10.862.892	\$152.922	\$360.259.173

Figure 9 shows these values in order to illustrate changes from one period to another. Deaths decreased for the 1990's and affected people was very high for the period 1981-1985; but for the last three periods the values are relatively low. However, economic losses were high for the period 1996-2000. Taking into account the results of the LDI<sub>L</sub> and the LDI' for this period, it can be seen that the economic losses were very concentrated either spatially or by type or event.



**Figure 9. Total deaths, affected people and losses**

It should be taken into account that the LDI has been built based on the effects presented in different type of events. Notwithstanding, it is important to indicate that the LDI is a measure that combines persistence, incidence and regularity of events in a territorial level. That is the reason why to determine the index, values have been normalized on the basis of the area of the parishes.

These indices are useful for economic analysts and sectoral officials, related to the promotion of rural and urban policy development, because they can detect the persistency and accumulation of effects of local disasters. They can stimulate the consideration of risk problems in territorial planning at the local level and the intervention and protection of hydrologic basins, and they can justify resource transfers to the local level with specific goals of risk management and the creation of social security nets.

### **3.3 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 exposure 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 as various values of the databases that were not known, are either currently available or have been modified as a 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 in order to standardize the values of the subindicators in a uniform manner for old and new countries evaluated.

### **3.3.1 Indicators of exposure and susceptibility**

In the case of exposure and/or physical susceptibility,  $PVI_{ES}$ , 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 Km<sup>2</sup>)
- ES4. Poverty-population below US\$ 1 per day PPP
- ES5. Capital stock, million US\$ dollar/1000 km<sup>2</sup>
- 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, regardless of 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.

### **3.3.2 Indicators of socio-economic fragility**

Socio-economic fragility,  $PVI_{SF}$ , 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 intrinsic <sup>6</sup> predisposition of society when faced with a dangerous phenomenon, regardless of 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.

### 3.3.3 Indicators of resilience (lack of)

The lack of resilience,  $PVI_{LR}$ , seen as a vulnerability factor, may be represented at all levels by means of the complementary or inverted<sup>7</sup> 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]
- 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, regardless of 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.

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<sup>6</sup> 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.

<sup>7</sup> The symbol [Inv] is used here to indicate a reverse or inverted dealing of the variable ( $\neg R = 1 - R$ ).

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.

### 3.3.4 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 8 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 to use the same value in all periods, in order to avoid affecting relative value of indices and with the hope that in future the value of these subindicators will be published.

Table 8. PVI values

	1995	2000	2005	2007
<b><math>PVI_{ES}</math></b>	49,834	45,855	51,018	53,551
<b><math>PVI_{SF}</math></b>	38,237	35,326	35,571	35,129
<b><math>PVI_{LR}</math></b>	66,928	65,732	61,475	65,440
<b>PVI</b>	<b>51,666</b>	<b>48,971</b>	<b>49,355</b>	<b>51,374</b>

Figure 10 shows non-scaled subindicators values that compose  $PVI_{ES}$  and their respective weights, which were obtained using Analytic Hierarchy Process (AHP).

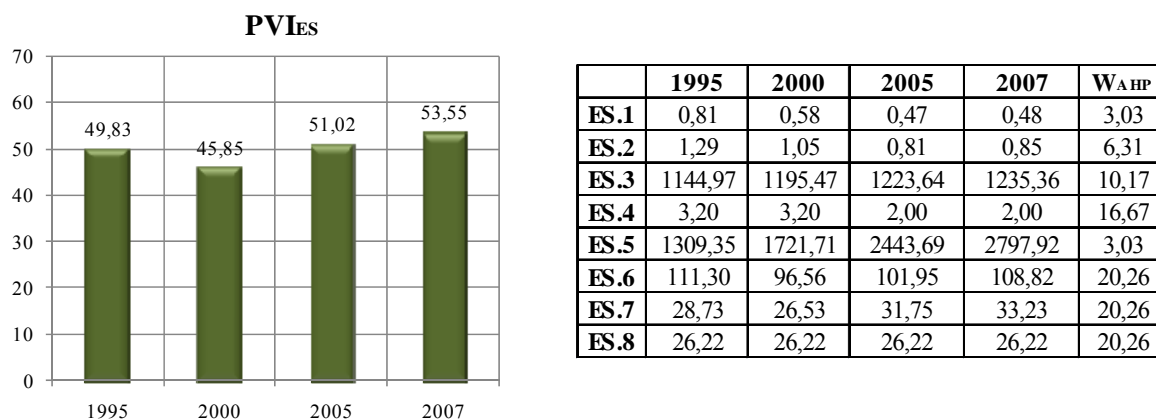


Figure 10.  $PVI_{ES}$

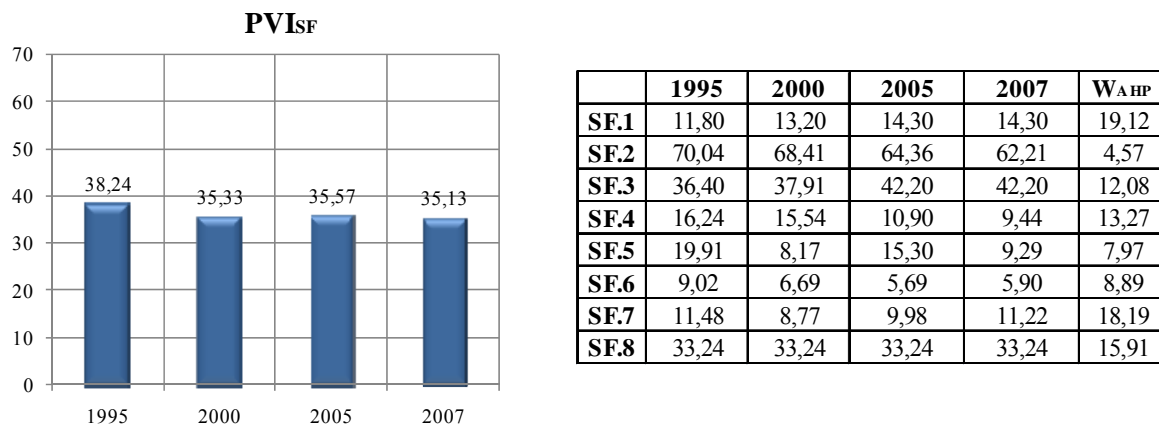
Vulnerability due to exposure and susceptibility in the country has been similar during all periods, having slight variations over time. Subindicators that compose the  $PVI_{ES}$  have increased with the time; some of them had a reduction which allows a total lower value of the  $PVI_{ES}$  in 2000. Indicators such as imports and exports of goods and services (ES6) and gross domestic fixed investment (ES7), because of their weight, have an important influence



in the  $PVI_{ES}$  when they decrease. In 2005 and 2008 the increasing was caused by ES6, ES7, because they have an important participation in the total weight.

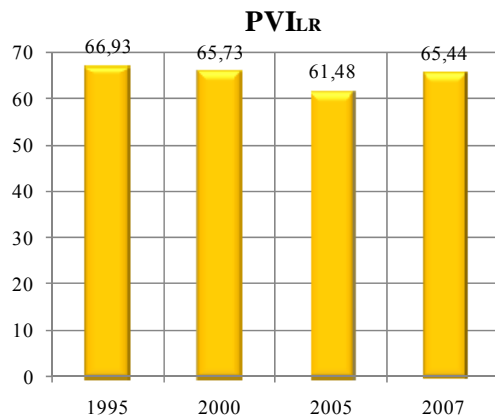
Figure 11 shows non-scaled subindicators values that compose  $PVI_{SF}$  and their respective weights, which were obtained using Analytic Hierarchy Process (AHP).

Vulnerability due to socio-economic fragility did not have very significant changes in the periods evaluated. In 2000 it decreased with respect to 1995 due to important positive changes of subindicators, such as dependents as proportion of working age population (SF2), unemployment (SF4), inflation (SF5), dependency of GDP growth of agriculture (SF6) and debt servicing (SF7). This in spite of the increase in the Human Poverty Index (SF1) and the social disparity (SF3), and their weight have an important influence in the total values. The Human induced Soil Degradation (SF8) maintained the same value for all the years. The value of the total  $PVI_{SF}$  had a very slight increase in 2005 in comparison with 2000. The causes of this change was the increase in the Human Poverty Index (SF1), the social disparity (SF3), inflation (SF5) and the debt servicing (SF7); although other indicators decreased and the assigned weight did not strongly affect the total value. In 2007 the vulnerability decreased to the same value as in 2000, due to subindicators with the greatest weights maintaining the same value as in 2005; and the others presented notable changes that could reach a reduction in the index. Vulnerability due to socio-economic fragility is at a high level compared with the other countries of the region and it has been decreasing during the last years.



**Figure 11.  $PVI_{SF}$**

Figure 12 shows the figures of non-scaled subindicators that compose  $PVI_{LR}$  and their respective weights, which were obtained using Analytic Hierarchy Process (AHP).



	1995	2000	2005	2007	W <sub>AHP</sub>
LR.1	0,73	0,74	0,74	0,74	20,79
LR.2	0,72	0,74	0,73	0,73	6,84
LR.3	4,33	5,66	9,99	4,70	16,56
LR.4	0,52	0,52	0,48	0,48	11,63
LR.5	1,21	1,23	1,23	1,23	10,45
LR.6	0,59	0,71	0,70	0,70	4,43
LR.7	2,22	1,12	1,70	1,40	10,05
LR.8	42,34	42,34	44,70	44,70	19,25

Figure 12. PVI<sub>LR</sub>

Vulnerability due to lack of resilience is the complementary or the inverted treatment 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, few changes either increasing or decreasing the PVI<sub>LR</sub> point out that resilience has faintly changed over time. For 2005 a slight decrease indicates that actions promoted to strengthening the security levels were improved; but in 2007 it grew indicating that those actions were scarce. In comparison to the other countries of the region, Jamaica has a high PVI<sub>LR</sub>. The general value of this indicator is high and is the one with more contribution to the country's vulnerability. Figure 13 shows total PVI obtained with average of its component indicators, and its aggregated presentation in order to illustrate their contributions.

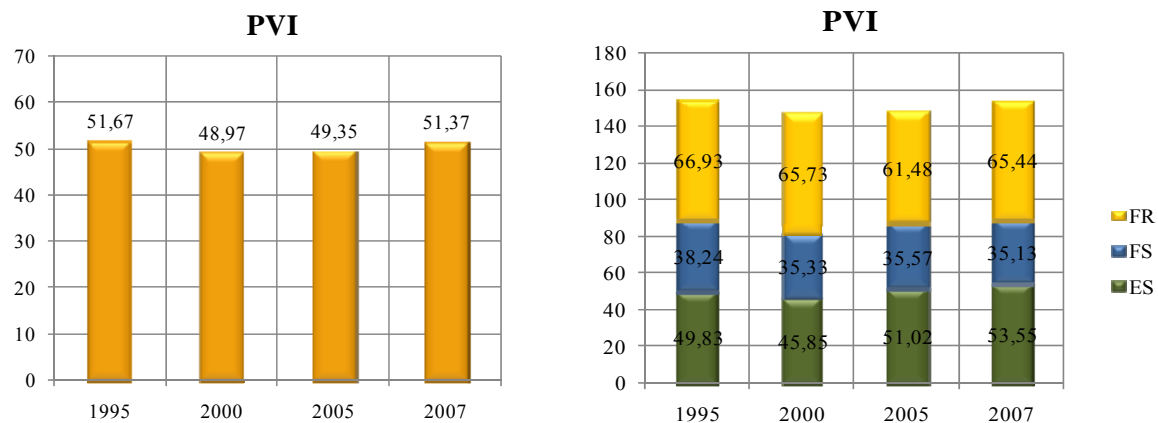


Figure 13. PVI

PVI figures illustrate a reduction in the prevalent vulnerability in 2000 and 2005, due to the decreasing of the three components of the index. In 2007, the PVI increased due to the growing of the exposure and susceptibility and the lack of resilience. The growth in the index shows risk prevention-mitigation has been little considered, regarding both physical and socio-economic vulnerability reduction in the country. Comparing the three indicators, the lack of resilience is the indicator with the greatest contribution to prevalent vulnerability; a situation that also occurs 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, and economics and planning, to mention a few.

### **3.4 RISK MANAGEMENT INDEX (RMI)**

The main objective of RMI is to measure the performance of risk management. This index is a qualitative measurement of risk based on pre-established levels (targets) or desirable referents (benchmarking) towards which 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 governance and financial protection (FP).

Estimation of each public policy takes into account six 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, allows the comparison and identification of results or achievements towards which 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. The total RMI is the average of the four composed indicators that represent each public policy. When the value of the RMI is high, performance of risk management in the country is better.

#### **3.4.1 Institutional Organisation**

According to ISDR (2009), in Jamaica a national project of risk mitigation is being developed. The Law of preparation for disaster situation has been valid since 1993. It is implementing mapping of floods, earthquakes and landslides. Various initiatives on disaster risk exist in systems of information management and national public opinion sensitization.

Table 9 summarizes successes reached in implementation of the priorities of the Hyogo Framework for Action. Appendix II gives more details about the advance in each priority and their basic indicators.

**Table 9. Progress in the implementation of the priorities of the Hyogo Framework for Action**

<b>Priority</b>	<b>Progress (2005-2006)</b>
1) Ensure that Disaster Risk Reduction is a national priority with a strong institutional basis for implementation	Incorporation of hazards information in the development processes at national and local level. Preparation of guidelines to develop initiatives in high risk areas.
2) Identify, assess and monitor disaster risks and enhance early warning	Mitigation plans are improved through the use of scientific data and application of technology, computers and installed software in 13 parishes.
3) Use knowledge, innovation and education to build a culture of safety and resilience at all levels	Use of all available media to disseminate information at various levels of population. Development of disaster plans and incorporation of different programs to sensitize people to disaster preparedness. Establishment of a channel of communication between the National Disaster Organization, the local authority and the schools. Establishment of vulnerability assessment methodologies and models for hazard impact analysis.
4) Reduce the underlying risk factors	Significant strides in Environmental Management.
5) Strengthen disaster preparedness for effective response at all levels	Integration of damage assessment information in reconstruction and rehabilitation processes and in national development planning. Training of people for damage estimation.

Source EIRD. See: <http://www.eird.org/perfiles-paises/index.htm>

### **3.4.2 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 existence<sup>8</sup>, dimension it (measurement) and represent it, for example, by means of models, maps and indices 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

<sup>8</sup> 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.

### **3.4.3 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 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

### **3.4.4 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

### **3.4.5 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

### 3.4.6 Estimation of Indicators

RMI results have been obtained from detailed surveys designed for 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 1990, 1995, 2005 and 2008 are presented. Overall, experts involved in the new evaluation suggested avoiding use the qualifications made for 2000 due to their lack of objectivity. Accordingly this year has not been included in this report<sup>9</sup>.

Table 10 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 10. RMI values**

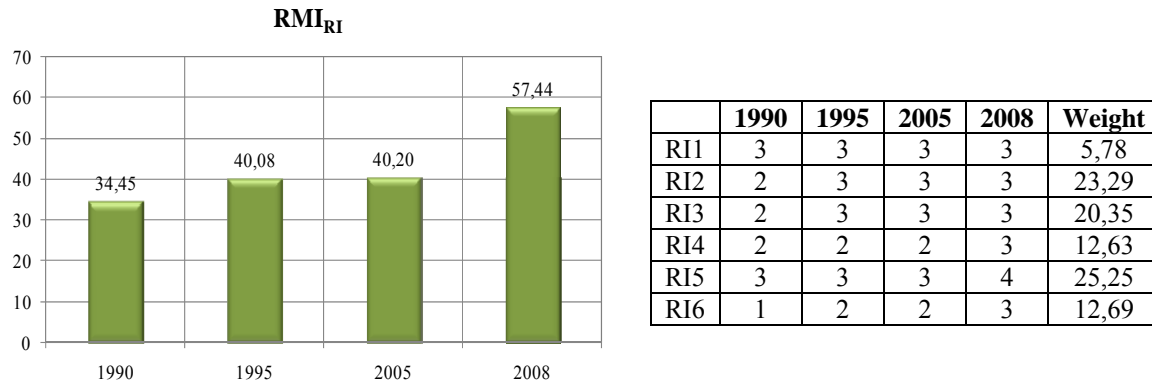
Index	1990	1995	2005	2008
$RMI_{RI}$	34,45	40,08	40,20	57,44
$RMI_{RR}$	30,40	30,46	17,21	33,25
$RMI_{DM}$	51,10	55,64	57,26	57,26
$RMI_{FP}$	35,55	36,89	13,39	23,67
<b>RMI</b>	<b>37,87</b>	<b>40,77</b>	<b>32,01</b>	<b>42,90</b>

Figure 14 shows the qualification of subindicators<sup>10</sup> which composed  $RMI_{RI}$  and its respective weights, obtained using Analytic Hierarchy Process (AHP).

Management related to risk identification has a continuing progress over time. From 1990 to 2008 it can be observed that the country had a level of improvement from incipient to significant in hazard monitoring and forecasting (RI2), hazard evaluation and mapping (RI3) and vulnerability and risk assessment (RI4). In public information and community participation (RI5) it passed from significant level of performance to optimal. And in training and education in risk management (RI6) it passed from low to significant. The advance was notable from 2005 to 2008, especially due to the increase from incipient to significant of the vulnerability and risk assessment (RI4) and the RI6; and the improvement from significant to outstanding in the RI5. The latter had a significant weight and it influenced in a remarkable way the  $RMI_{RI}$ .

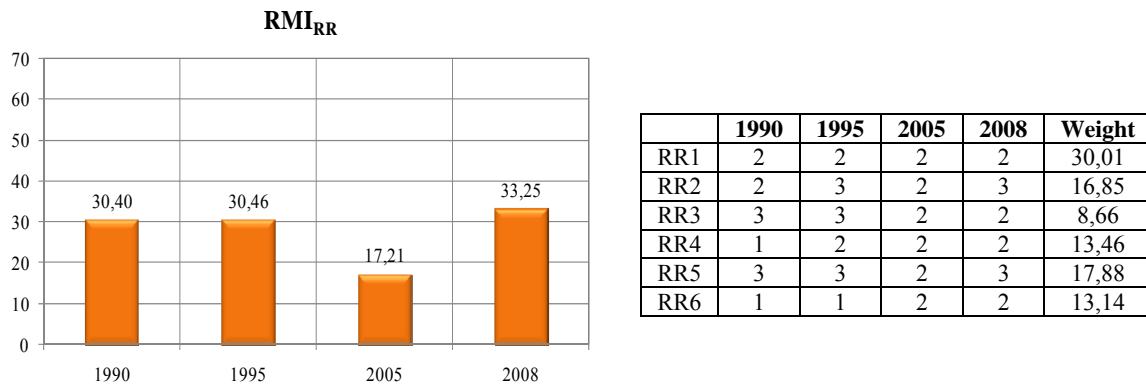
<sup>9</sup> This situation was also detected by the consultant team in the previous evaluation. It was recommended that a future evaluation should not be done by officials that could defend the *status quo* and self qualified very favorable. Taking into account the evaluation of the Hyogo Framework and the review of experts, it was considered that the less objective evaluation was made for 2000 in the previous evaluation (IDEA 2005; Cardona 2005).

<sup>10</sup> Qualification is linguistic and it does not use defined numbers. With reference to the tables: 1: *low*, 2: *incipient*, 3: *significant*, 4: *outstanding* and 5: *optimal*



**Figure 14. RMI<sub>RI</sub>**

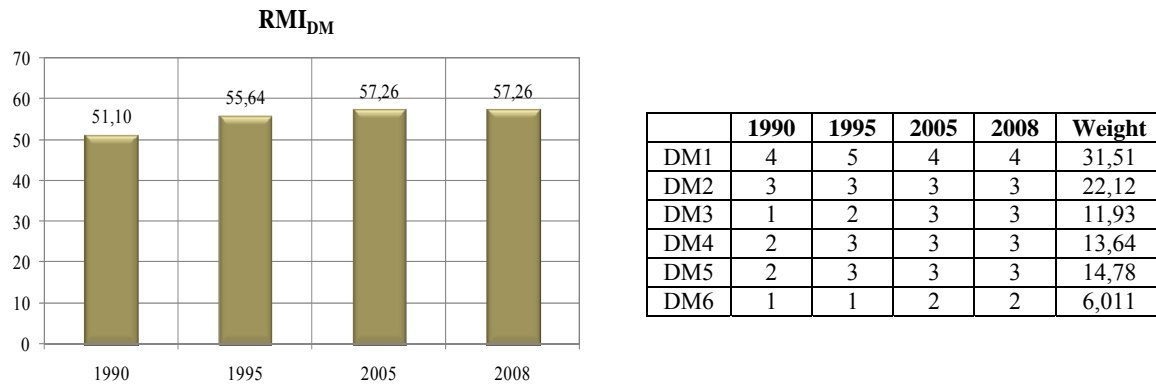
Figure 15 shows subindicators qualifications which composed RMI<sub>RR</sub> and its respective weights, obtained using Analytic Hierarchy Process (AHP).



**Figure 15. RMI<sub>RR</sub>**

Management related to risk reduction indicates that in the country in 2005 there was a significant reduction in the RMI<sub>RR</sub> due to the change from a significant level to incipient in hydrological basin intervention and environmental protection (RR2), implementation of hazard-event control and protection techniques (RR3) and updating and enforcement of safety standards and construction codes (RR5). In 2008 the index had a significant increase compared to 2005 because of the improvement from incipient to significant level of subindicators RR2 and RR5.

Figure 16 shows subindicators qualifications which composed RMI<sub>DM</sub> and its respective weights, obtained using Analytic Hierarchy Process (AHP).



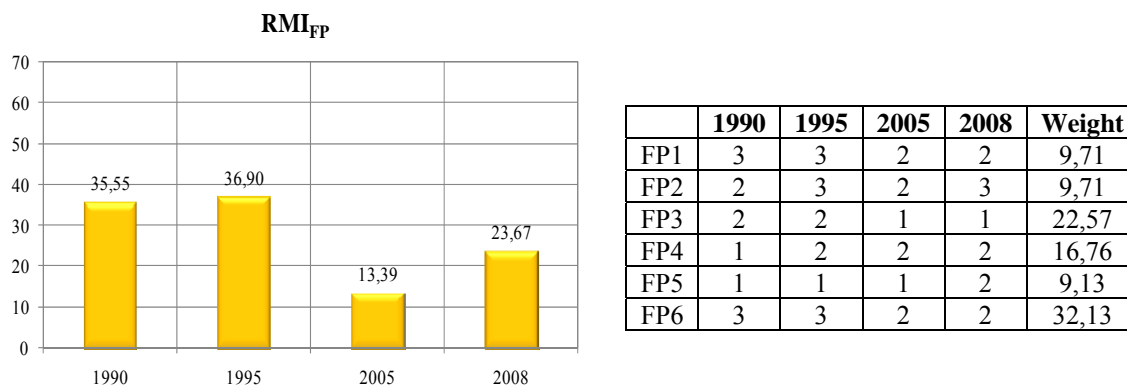
**Figure 16. RMI<sub>DM</sub>**

Management related to disaster management indicates a progressive but slight advance from 1990 to 2008. From 1985 to 1990 the increase was made by simulation, updating and test of interinstitutional response (DM4) and community preparedness and training (DM5), passing from a low level to incipient level of performance; endowment of equipments, tools and infrastructure (DM3) that increased from low to incipient; and organization and coordination of emergency operation (DM1) that changed from outstanding to optimal. Furthermore, it has a very important assigned weight; hence the reason why it importantly influences the total value of the index. In 2005 the DM1 decreased from a performance level of optimal to outstanding; nevertheless, DM3 and rehabilitation and reconstruction planning (DM6) increased, and this made the total index increase slightly. For the next year, 2008, the total value remains as it was in 2005.

Figure 17 shows subindicators qualifications which composed RMI<sub>FP</sub> and its respective weights, obtained using Analytic Hierarchy Process (AHP).

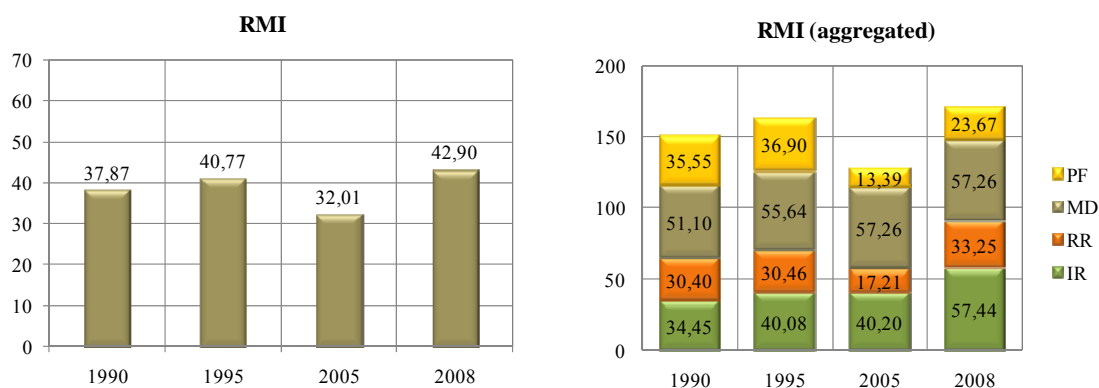
Management related to financial protection and governance for risk management indicates that in 2005, the country had a setback in its performance in many of the policies related to this index. It passed from significant to incipient in interinstitutional, multisectoral and decentralizing organization (FP1), reserve funds for institutional strengthening (FP2) and housing and private sector insurance and reinsurance coverage (FP6). In addition, the budget allocation and mobilization (FP3) passed from incipient to low. Taking into account that the FP3 and FP6 had important weights in the total index it contributes to the notable decreasing of the RMI<sub>FP</sub>. In 2008 the index rose again due to the increase from incipient to significant of reserve funds for institutional strengthening (FP2); and from low to incipient of insurance and coverage and loss transfer strategies of public assets (FP5); and, although this subindicators did not have a high weight, RMI<sub>FP</sub> had a positive variation for 2008.





**Figure 17. RMI<sub>FP</sub>**

Figure 18 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 18. Total RMI**

In the RMI graphics it is possible to observe that disaster risk management, in general, had a gradual advance since 1990 to 2008. Indicators which vary more considerably in the first years have been the RMI<sub>RI</sub> of risk identification, RMI<sub>DM</sub> of disaster management and RMI<sub>FP</sub> for governance and financial protection. From 1995 to 2005 the Risk Management Index diminishes, particularly due to the notable decrease of the RMI<sub>FP</sub> of financial protection and of the RMI<sub>RR</sub> of risk reduction. In 2008 RMI of financial protection and risk reduction were recovered and presented a higher performance in comparison with previous years, even though the financial protection have not achieved its value of 1995. On the other hand, risk identification attained a higher value compared to 2005 and slightly higher than in 1995. Progressive variation in RMI illustrates a general advance of the country in risk management. Nevertheless, the country's RMI average represents a current significant level of performance, as can be deduced from the value of 43 in the Figure 18. This implies there is still much work to be done in order to achieve sustainability in risk management at high performance levels.

Table 11 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.

**Table 11. Differences between first and last period for RMI subindicators functions performance**

Values of the performance functions of subindicators								
1995	RI.1	45	RR.1	17	DM.1	94	FP.1	45
	RI.2	45	RR.2	45	DM.2	45	FP.2	45
	RI.3	45	RR.3	45	DM.3	17	FP.3	17
	RI.4	17	RR.4	17	DM.4	45	FP.4	17
	RI.5	45	RR.5	45	DM.5	45	FP.5	5
	RI.6	17	RR.6	5	DM.6	5	FP.6	45
	RMI <sub>RI</sub>	40.08	RMI <sub>RR</sub>	30.46	RMI <sub>DM</sub>	55.64	RMI <sub>FP</sub>	36.89
	RMI	40.77						
2008	RI.1	45	RR.1	17	DM.1	77	FP.1	17
	RI.2	45	RR.2	45	DM.2	45	FP.2	45
	RI.3	45	RR.3	17	DM.3	45	FP.3	5
	RI.4	45	RR.4	17	DM.4	45	FP.4	17
	RI.5	77	RR.5	45	DM.5	45	FP.5	17
	RI.6	45	RR.6	17	DM.6	17	FP.6	17
	RMI <sub>RI</sub>	57.44	RMI <sub>RR</sub>	33.25	RMI <sub>DM</sub>	57.26	RMI <sub>FP</sub>	23.67
	RMI	42.90						
Change	RI.1	0	RR.1	0	DM.1	-17	FP.1	-28
	RI.2	0	RR.2	0	DM.2	0	FP.2	0
	RI.3	0	RR.3	-28	DM.3	28	FP.3	-12
	RI.4	28	RR.4	0	DM.4	0	FP.4	0
	RI.5	32	RR.5	0	DM.5	0	FP.5	12
	RI.6	28	RR.6	12	DM.6	12	FP.6	-28
	RMI <sub>RI</sub>	17.36	RMI <sub>RR</sub>	2.79	RMI <sub>DM</sub>	1.62	RMI <sub>FP</sub>	-13.22
	RMI	2.13						

In summary, the previous table shows that during the period 1995-2008 there was a throwback in some issues of risk management in Jamaica. According to each composed indicator, the only one that presented somewhat of an advance was the risk identification (RI) with better improvements in public information and community participation (RI5) that meant a change of 32, that is an advance from significant to outstanding in this activity. Likewise, vulnerability and risk assessment (RI4) and training and education in risk management had a change of 28 that meant an improvement from incipient to significant.

Regarding risk reduction, there were not advances in the majority of the activities, with the exception of reinforcement and retrofitting of public and private assets, that presented a small change of 12, i.e. an improvement from low performance level to incipient; and the implementation of hazard-event control and protection techniques that had a negative

process and had a qualification of 28. Similarly, disaster management showed slight changes in the endowment of equipments, tools and infrastructure (DM3) with a change of 28 and rehabilitation and reconstruction planning with a positive change of 12. But the organization and coordination of emergency operations (DM1) showed a negative change and shifted from optimal to outstanding.

With relation to the governance and financial protection, the advance was also negative. The two activities in which the values moved from significant to incipient were the interinstitutional, multisectoral and decentralizing organization (FP1) and the housing and private sector insurance and reinsurance coverage (FP6). The setbacks of these two subindicators considerably influenced in the total RMI<sub>FP</sub>, so, it obtained a decrease in 2008.

#### **4 CONCLUSIONS**

The DDI illustrates economic implications of a major disaster, estimated on the basis of the potential of feasible extreme events; LDI identifies social and environmental risk as result of the recurrence of small events; PVI accounts for susceptibility and aggravation factors of the direct effects of the disasters due to deficiencies in development; and RMI indicates what has been achieved and what needs to be done in order to improve risk management.

From these results it is possible to conclude that in Jamaica there was a decrease of DDI and an increase in the PVI from 2005 to date. The LDI is lower in 2000 than in the middle of 1990's and this means that there is a concentration of effects and losses due to small disasters, despite the efforts and investments made in recent years. The RMI is now better than before and with these results it is possible to conclude that Jamaica has an improved disaster risk performance. Notwithstanding, the effectiveness of risk management is incipient and therefore it is necessary to improve the capacity to anticipate, cope and recover.

Making the comparison of trends in indicators it is possible to conclude that the System of Indicators presents results that are 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 by the central government with the participation of different sectoral agencies, parishes and communities; and, thus achieve a further progress and greater sustainability. Decision makers and stakeholders, besides identifying the weaknesses as reflected in the indicators, must take into account other characteristics that are not revealed or expressed by the evaluation presented. 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 to assist in the formulation of general recommendations for planning.

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## **APPENDIX I**

### **NATURAL HAZARDS OF THE COUNTRY**

#### **AI.1 SEISMIC HAZARD**

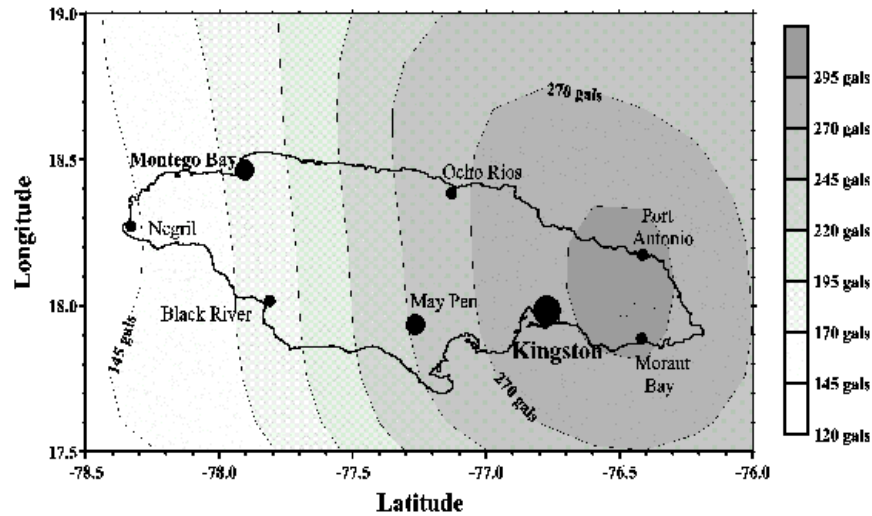
##### **Sub-Regional Tectonics**

Jamaica is associated with the Gonave micro-plate, which is demarcated by the Oriente Fracture Zone (OFZ) to the north, the Walton (WFZ) and Enriquillo Fault Zones (EFZ) to the south and the Cayman Spreading Centre (CSC) to the west. The OFZ, spanning a distance of over 1000 kilometres, from south of Grand Cayman to the north coast of Haiti, is known to be a left-lateral strike-slip fault which means there is a relative westerly drift of Cuba (on the North American Plate) with respect to Jamaica. The Walton and Enriquillo Faults are also left-lateral strike-slip features that separate the Gonave sliver from the Caribbean Plate to the south. Measurements made using Global Positioning System (GPS) indicate 18 mm/year of lateral strain and 3mm/yr of convergence on the OFZ near south-eastern Cuba, and 8-11 mm/yr on Jamaica.

##### **Local Tectonics**

Jamaica itself is traversed by a number of geological faults that feature Quaternary left-lateral offsets. In eastern Jamaica there is the Plantain Garden fault that runs into the Yallahs, Blue Mountain, Wagwater and Silver Hill faults, which together control the tectonics of the Blue Mountain block. In western Jamaica the topography is influenced by the South Coast, Spur Tree and Montpelier-Newmarket faults that exhibit large downthrows to the south and west, respectively. Earthquakes occurring across the country today predominantly exhibit strike-slip faulting, which mirrors the movements along the OFZ.

Figure A.1. shows a seismic hazard map for Jamaica with a 10% probability of exceedance in 50 years. In this map the peak ground acceleration (PGA) in eastern Jamaica is approximately 30%g and it has a gradual decrease to less than 14% g in western Jamaica. The values for the Kingston Metropolitan area are approximately 28% g.



**Figure A.1 Horizontal ground acceleration with a 10% probability of exceedance in 50 years. Contour interval is 25 gals (or 2.5%g). Source: OAS<sup>11</sup>**

An average intensity earthquake of MM 7 can be expected in Jamaica, or even bigger, every 33 years. Although, the time in between seismic events has been 1 to 82 years there is a historical incidence of twenty earthquakes in a century. The biggest earthquake occurred in 1692 when Port Royal was destroyed, and in 1907 when Kingston city was severely damaged. The 1907 earthquake was followed by a huge fire.<sup>12</sup>

**Table A 1. Seismic events occurred in Jamaica Source: USGS<sup>13</sup>**

Year	Month	Day	Latitude	Longitude	Magnitude	Depth
1691			18.3	-70.4	7.7	33
1842			19.5	-71.5	7.7	33
1899	6	14	18	-77	7.8	60
1900	6	21	20	-80	7.9	60
1907	1	14	18.2	-76.7	6.5	
1910	1	1	16.5	-84	7.5	60
1916	4	24	18.5	-68	7.2	80
1946	8	4	19.3	-69	8.1	60
1946	8	8	19.5	-69.5	7.9	25
1971	6	11	18	-69.8	6.5	57
1984	6	24	18	-69.3	6.6	20
1992	5	25	19.6	-77.9	6.9	23

<sup>11</sup> Unit of Sustainable Development and Environment. Organization of American States, OAS.

<http://www.oas.org/cdmp/document/kma/seismic/kma3.htm>

<sup>12</sup> Earthquake Unit. University of the West Indies, at Mona, Jamaica. <http://www.mona.uwi.edu/earthquake>

<sup>13</sup> U.S. Geological Survey. <http://earthquake.usgs.gov>

## **AI.2 TSUNAMI HAZARD**

In the past 500 years there have been ten confirmed earthquake-generated tsunamis in the Caribbean Basin, with four causing fatalities. An estimated 350 people in the Caribbean were killed by these events.

All known sources capable of causing tsunamis occur within striking distance of the Eastern Caribbean, and there are also distant sources across the Atlantic. Since the islands lie in an area of relatively high earthquake activity for the Caribbean, the most likely tsunamis to affect the region are those which can be triggered by shallow earthquakes (<50km depth), in the region, greater than magnitude 6.5. The recurrence rate for tsunamis in the Caribbean is approximately one destructive tsunami per century for local earthquakes and one destructive tsunami per 200 years for distant earthquakes.<sup>14</sup>

## **AI.3 HYDROMETEOROLOGICAL HAZARDS**

Precipitation in Jamaica varies seasonally and spatially. Long term mean annual rainfall is 1,981 mm. the heaviest rainfall is concentrated over the Blue Mountains. they receive over 5,080 mm of rain annually whereas the city of Kingston receives less than 762 mm. Kingston and most of the southern coast is located in the rain shadow of the blue mountains and receive much less rain than the northern coast. Island wide long term mean annual rainfall exhibit a marked bi-modal pattern with the primary maximum in October and secondary in may. The drier months are January, February, March and July. The island regularly comes under the influence of tropical storms and hurricanes during the period July to November, primarily resulting in flood producing rainfall of high intensity and magnitude.<sup>15</sup>

The official hurricane season in the Greater Caribbean region begins the first of June and lasts through November 30, with 84 percent of all hurricanes occurring during August and September. The greatest risk in Mexico and the western Caribbean is at the beginning and end of the season, and in the eastern Caribbean during mid-season.

Every year over 100 tropical depressions or potential hurricanes are monitored, but an average of only ten reach tropical storm strength and six become hurricanes. These overall averages suggest that activity is uniform from year to year but historical records indicate a high degree of variance, with long periods of resting and activity. The Atlantic basin has the widest seasonal variability. In 1907, for example, not a single tropical storm reached hurricane intensity, while in 1969, there were 12 hurricanes in the northern Atlantic (NOAA 1987).

Hurricanes are by far the most frequent hazardous phenomena in the Caribbean. In the last 250 years the West Indies has been devastated by 3 volcanic eruptions, 8 earthquakes, and

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<sup>14</sup> The University of the West Indies. <http://www.uwiseismic.com>

<sup>15</sup> Water Resources Authority, Jamaica. <http://www.wra.gov.jm>



21 major hurricanes. If tropical storms are also taken into account, the Greater Caribbean area has suffered from hundreds of such events.

Hurricane Gilbert struck the Caribbean and the Gulf Coast of Mexico in 1988, causing comprehensive damage in Mexico, Jamaica, Haiti, Guatemala, Honduras, Dominican Republic, Venezuela, Costa Rica, and Nicaragua. Arriving in Saint Lucia as a tropical depression, it resulted in damage estimated at US\$2.5 million from the flooding and landslides caused by the heavy rain (Caribbean Disaster News No.15/16, 1988).

The physical variations in this hurricane resulted in different types of damage. It was considered a "dry" hurricane when it struck Jamaica, discharging less precipitation than would be expected. Thus, most of the damage was due to wind force which blew away roofs. Serious flooding due to storm surge and heavy rains was not a problem. Landslides occurred at high elevations where most of the rainfall was concentrated.

The biggest disasters occurred have been caused by hurricane *Gilbert* in 1988, where 49 people died and 810,000 resulted affected. And flood in 1991, which affected 551,340 people. The most expensive damage estimated were due to the flood in 2002, which affected 1,000 people and caused damage estimated in 1,000 million dollars. In 2004, Jamaica was affected by several hurricanes and storms.<sup>16</sup>

**Table A.2. Hurricanes in Jamaica. Source: OAS<sup>17</sup>**

Year	Dead	Losses
1722	400	Great lost (26 ships)
1780	300	Agriculture had 100% of damage, \$70 millions.
1786	-	£ 700,000 in one parish
1880	30	£125,000.00
1903	65	-
1903?	142	Extended damage
1944	26	-
1951	152	-
1979	-	-
1988	46	25% of housing damaged

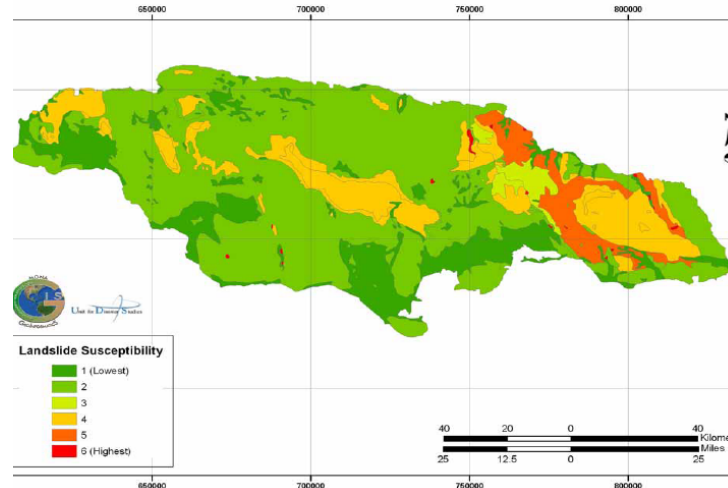
#### **AI.4 HAZARD OF LANDSLIDES**

Eastern Jamaica represents extremely steep and rugged topography with the crest of the Blue Mountain Range reaching 2254 m within about 10 km of the coast. Landscape in eastern Jamaica is geologically young (Quaternary). It is seismically most active part of the island and appears to be undergoing neotectonic uplift. Watersheds are relatively small and steep. Rivers flow through steep canyons onto alluvial/debris fans before emptying into the Caribbean Sea. With the exception of alluvial fans, flat areas are rare in the parishes of Portland, St. Thomas, and Upper St. Andrew. Communities have settled on fans and development activities are hindered by a lack of flat land. Landslides are common and are

<sup>16</sup> Organization of American States, OAS. Department of Sustainable Development. <http://www.oas.org/dsd>

<sup>17</sup> Idem

perhaps the most widespread hydrogeologic hazard on human timescale causing land degradation thus affecting land productivity. Bedrock structure strongly influences slope stability. Landslides preferentially occur in locations where the direction of dip of bedding in the shale and sandstone sequence daylights in slope faces. Landslides occurred both in the landscape modified for human use as well as on slopes under dense forest cover.<sup>18</sup>



**Figure A.2 Landslide hazard zonation Source: Ahmad, 2003**

## **AI.5 HAZARD OF DROUGHTS**

Jamaica is particularly vulnerable to the drought hazard. The country lies within the tropics and so is dependent on more than one rainy season. A deficiency in any season can produce a damaging drought. Moreover, the increase in Jamaica's population due to urbanization, has led to a great increased demand for an already limited supply of water as well as the limited and poor national water storage systems.<sup>19</sup>

<sup>18</sup> Department of Geography and Geology, The University of the West Indies at Mona, Jamaica. <http://www.mona.uwi.edu>

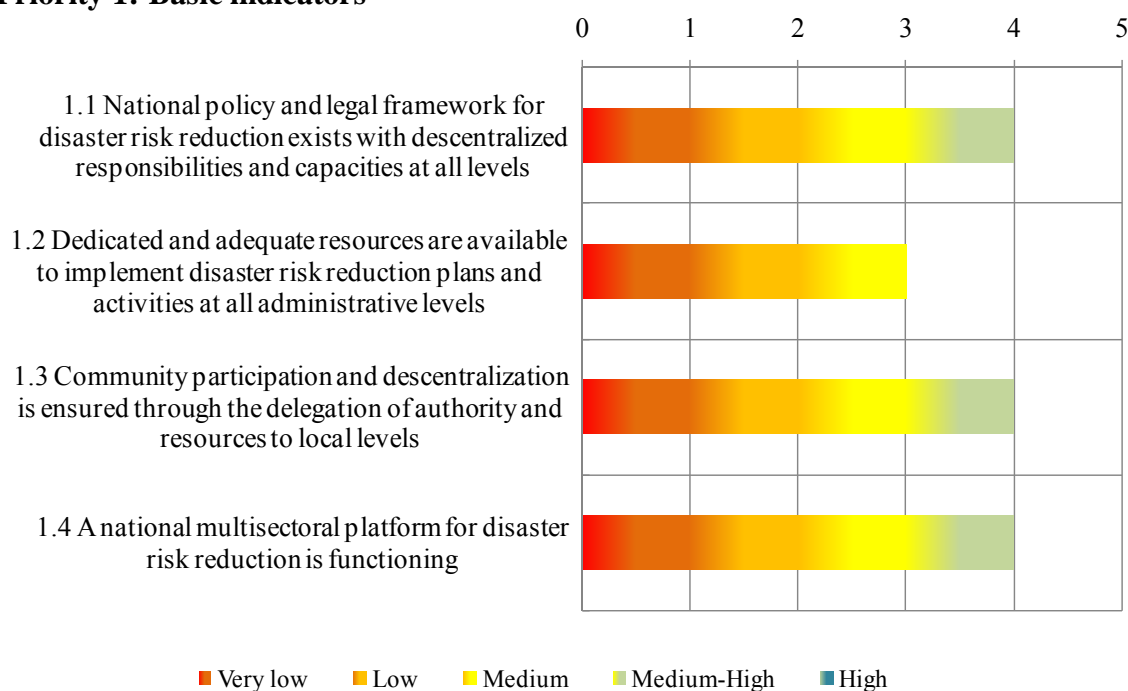
<sup>19</sup> Office of Disaster Preparedness and Emergency Management, OPDEM. <http://www.opdem.org.jm>

## ANEXO II

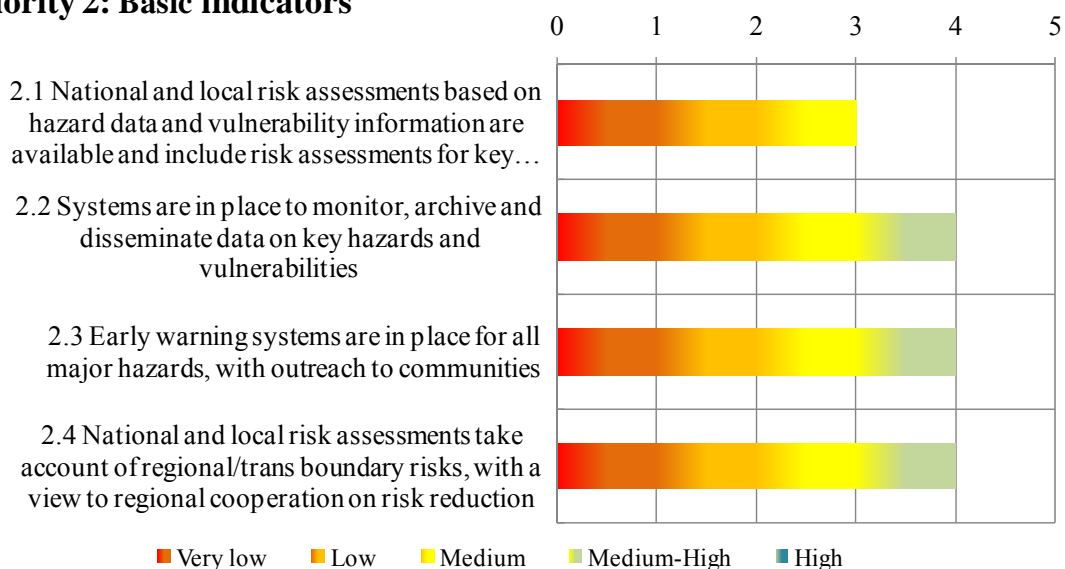
### A.II NATIONAL PROGRESS REPORT ON THE IMPLEMENTATION OF THE HYOGO FRAMEWORK: 2007-2009

1. Ensure that Disaster Risk Reduction is a national priority with a strong institutional basis for implementation
2. Identify, assess and monitor disaster risks and enhance early warning
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels
4. Reduce the underlying risk factors
5. Strengthen disaster preparedness for effective response at all levels

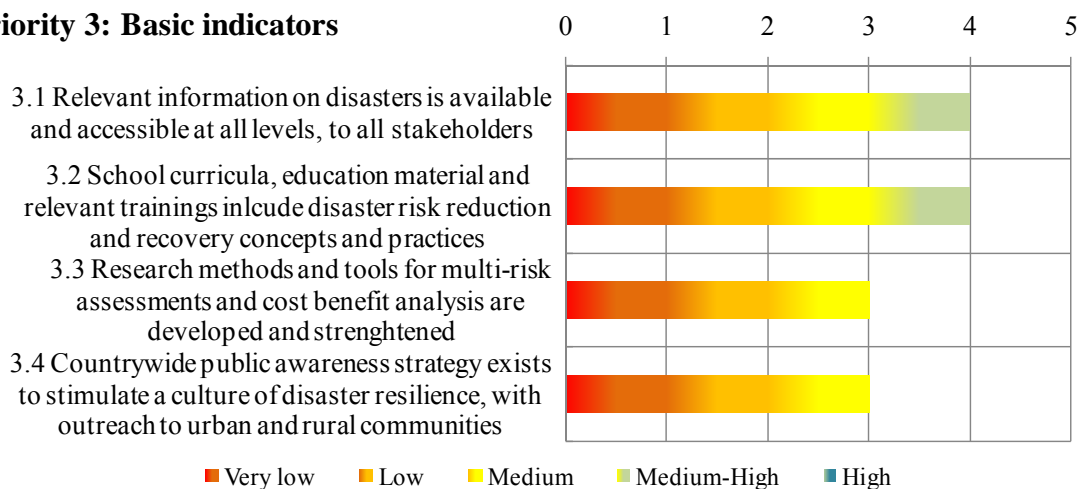
#### Priority 1: Basic indicators



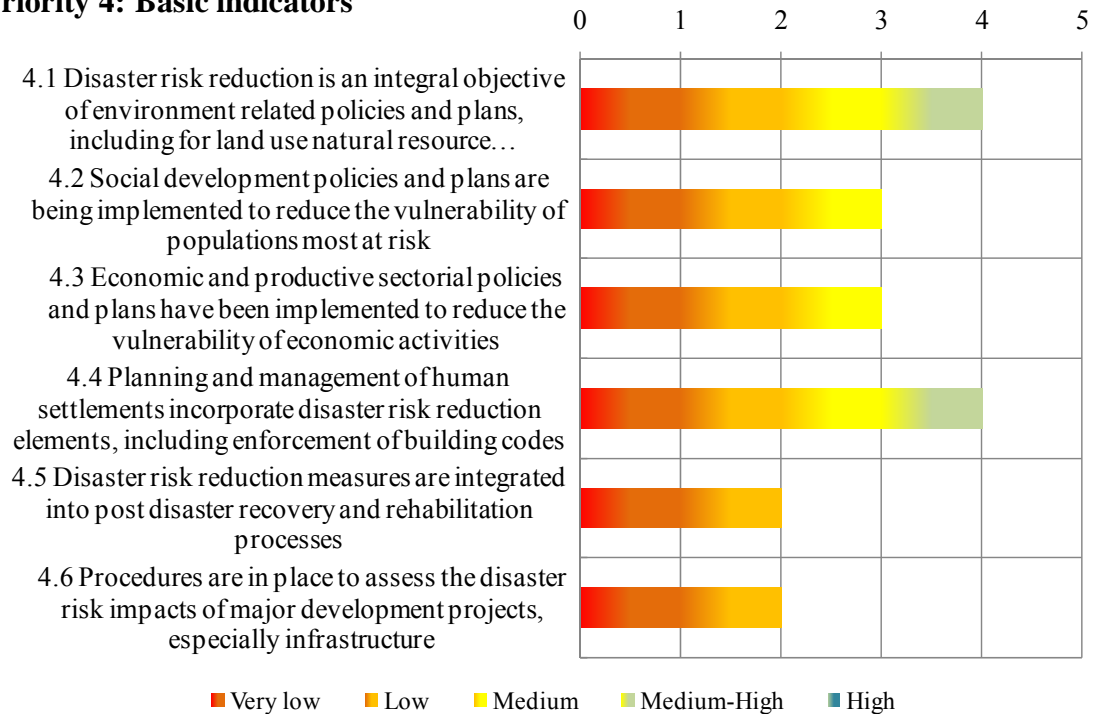
## Priority 2: Basic indicators



## Priority 3: Basic indicators



#### Priority 4: Basic indicators



#### Priority 5: Basic indicators

