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Indicators for Disaster Risk and Risk Management

Program for Latin America and The Caribbean

Suriname

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Environment, Rural Development and Disaster Risk Management Division

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ACRONYMS

AHP	Analytic Hierarchy Process
BPOA	Barbados Programme of Action
CCMF	Caribbean Centre for Money and Finance
CDEMA	Caribbean Disaster Emergency Management Agency
CELOS	Centre for Agricultural Research in Suriname
DDI	Disaster Deficit Index
DFID	Department of International Development
DIPECHO	Disaster Preparedness ECHO programme
DRM	Disaster Risk Management
ER	Economic Resilience
GDP	General Domestic Product
IDB	Inter-American Development Bank
IDEA	Institute of Environmental Studies
LDI	Local Disaster Index
MCE	Maximum Considered Event
NCCR	National Coordination Centre for Disaster Management
NGO	Non-Governmental Organization
NIMOS	Nationaal Instituut voor Milieu en Ontwikkeling Suriname
PAHO	Pan American Health Organization
PRA	Probabilistic Risk Assessment
PVI	Prevalent Vulnerability Index
RMI	Risk Management Index
UNISDR	UN International Strategy for Disaster Reduction
VCA	Vulnerability and Capacity Assessment

Executive Summary

I. Introduction

The Inter-American Development Bank developed a System of Indicators of Disaster Risk and Risk Management (hereafter the Indicators) during 2003-2005 in collaboration with the Institute of Environmental Studies (IDEA for its Spanish acronym). The general aim of the Indicators is to improve the understanding of disaster risk and risk management performance of the IDB borrowing member countries. The Indicators consist of four different components that represent vulnerability, risk, and risk management performance: the Disaster Deficit Index (DDI), the Local Disaster Index (LDI), the Prevalent Vulnerability Index (PVI) and the Risk Management Index (RMI).

The study of the Indicators was developed in Suriname during 2011 – 2012 within the IDB project 'Support for Improving Integrated Disaster Risk Management for Climate-Resilient Development **(**SU-T1054/KP-12512-SU)'. The Study includes the results of each sub-Indicators: DDI, PVI and RMI[1].

II. Study Results

Disaster Deficit Index: The DDI captures the probable public infrastructure damages caused by eventual Maximum Considered Event (MCE) with a return period of once every 50, 100 and 500 years, and the financial capacity to repair and reconstruct immediately once disaster hits (or economic resilience, ER, in this study). A DDI greater than 1.0 reflects the country's inability to cope with disasters even when having additional external resources. The greater the DDI, the greater the financial gap.

The result of this study indicates that the country made a favorable progress from 2000 to 2010 in terms of having sufficient financial resources to recover from a catastrophe. Most of these funds will come from budgetary reallocations and inter-temporary tax surplus. Figure A illustrates DDI_{100} values of the country from 2000 to 2010.

[1] The Local Disaster Index (LDI) was not included in the Suriname Indicator Study; the LDI requires data from DesInventar which doesn't exist in the case of Suriname.

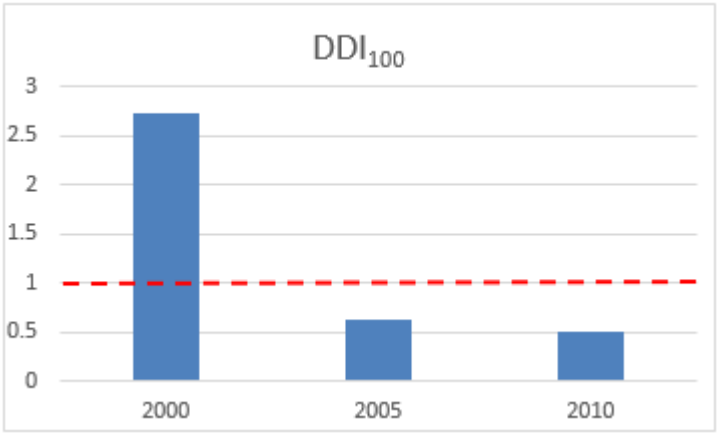


Figure A. DDI_{100} values of the country from 2000 to 2010

Prevalent Vulnerability Index: The PVI measures the vulnerability condition of a country. This indicator reflects the aspects of: (i) susceptibility due to the level of physical exposure of goods and people that causes direct impacts in case of hazard events; (ii) social and economic conditions that cause indirect impact; and (iii) lack of resilience to anticipate, to absorb consequences, to efficiently respond, and to recover from hazard events. These aspects are expressed as three sub-indicators: PVI_{ES}, PVI_{SF} and PVI_{LR}. PVI is the total value of these three sub-indicators, ranging from 0 (low vulnerability) to 300 (high vulnerability).

The result of the study shows that PVI slightly decreased from 1985 (109.29) to 2010 (90.81), meaning the country has a lower vulnerability condition. Among the three sub-indicators (Figure B), PVI_{SF}, a measure of socioeconomic fragility, at 32.83 (in 2010) was higher for Suriname than the LAC region average of 30.68 (in 2007). This suggests that the country has relatively weak socioeconomic conditions that may increase the negative impacts associated with hazardous impacts.

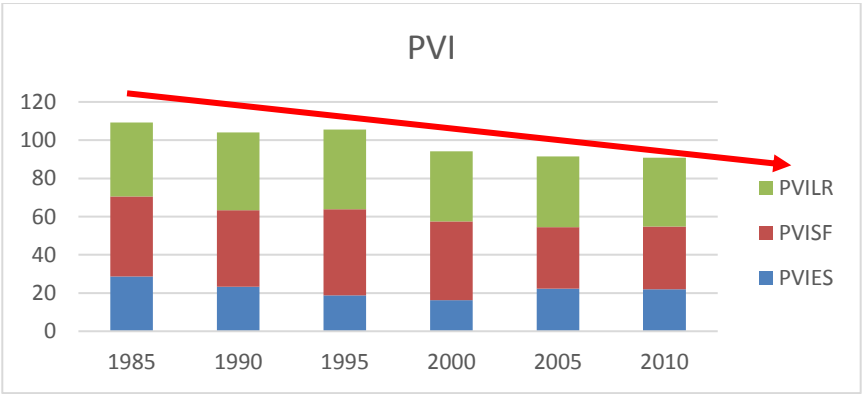


Figure B. Result of PVI (aggregated) from 1985 to 2010

Risk Management Index: The RMI measures the country's performance of risk management. This indicator includes the following four components: risk

identification (performance of scientific and academic institutions), risk reduction (engineering institutions), disaster management (civil protection institutions) and governance and financial protection (financial institutions). Each of these components are evaluated as the sub-indicators RMI_{RI}, RMI_{RR}, RMI_{DM}, and RMI_{PF}. RMI is the total value of these four sub-indicators ranging from 0 (minimum performance) to 400 (maximum performance).

The result of the study indicates that the RMI value has shown gradual increases between 2005 (27.36) to 2012 (71.44). However, the country's RMI value is much lower (worse) than the LAC region's average (33.12 in 2008). Specifically, the study reflects lower values in the areas of risk identification (RMI_{RI}), with Suriname scoring 17.21 (compared to the LAC average of 38.62 in 2012), and governance and financial protection (RMI_{FP}), where Suriname had a score of 5.25, less than a fourth of the LAC average in 2012 of 23.60.

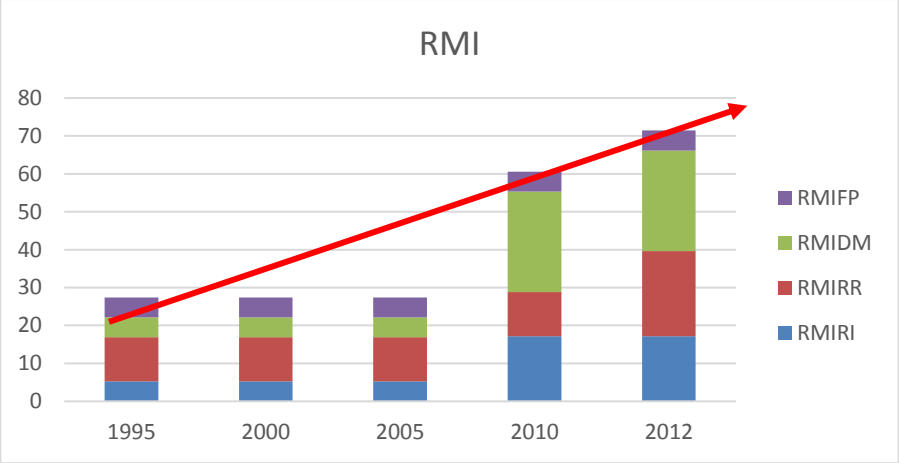


Figure C. Result of RMI (aggregated) between 1985 to 2010

III. Conclusions

The results of this study show Suriname's progress on disaster risk management. The DDI shows a positive progress from 2000 to 2010 in terms of the country's financial capacity to attend rehabilitation and reconstruction. The PVI has slightly decreased (improved) since 1985. Additionally, the country has improved the DRM performance from 2005 to 2010.

On the other hand, the results of the study, especially for PVI and RMI, indicate the need for additional efforts to improve the national capacity of disaster risk management. These include:

- Suriname's socioeconomic fragility should be reduced. This includes: poverty reduction, human security improvement, dependency and literacy

improvement, social disparities, unemployment, inflation, debt, and environmental deterioration reduction. Improvement of these factors may reduce not only the predisposition to be affected when faced with hazardous events but also, obviously, improve the country's socioeconomic condition.

- Improve the country's risk identification capacity necessary to plan and implement measures for disaster risk reduction. The efforts should include the development of disaster and loss inventory; hazard monitoring and forecasting and vulnerability/risk assessment.
- Increase the measures necessary for proactive disaster risk reduction and a risk transfer mechanism.

Introduction

The Inter-American Development Bank developed a System of Indicators of Disaster Risk and Risk Management (hereafter the Indicators) during 2003-2005 in collaboration with the Institute of Environmental Studies (IDEA for its Spanish acronym)[2]. The general aim of the Indicators is to improve the level of understanding of disaster risk and risk management performance of the borrowing member countries. The target users of the Indicators are both public and private sectors, especially for those who oversee planning and implementation for sustainable development of the countries.

Effective Disaster Risk Management (DRM) in general requires a multidimensional (cross-sectorial) approach that includes technical/science, engineering, socioeconomic development, and financial perspectives or approaches. To understand the level of disaster risk and risk management performance in a holistic manner, the Indicators consist of four different sub-indicators: the Disaster Deficit Index (DDI), the Local Disaster Index (LDI), the Prevalent Vulnerability Index (PVI) and the Risk Management Index (RMI). The DDI measures, from a macro-economic perspective, the country's financial capacity to attend for rehabilitation and reconstruction process when a disaster hits a country. The LDI identifies the extent of spreading damages resulting from small-scale (or frequent) disasters in a country. The PVI measures the vulnerability condition of a country. The RMI measures performance, or institutional capacity for managing the disaster risk at the national level.

Using the standard methodology of the Indicators[3], this Technical Note presents a summary of Suriname's results for the period of 1995 - 2012[4]. The Technical Note first reviews the characteristics of natural hazards in Suriname, then reviews the methodology and results of each sub-Indicators: DDI (Section 3), PVI (Section 4) and RMI (Section 5). The final section concludes and summarizes all results of the Indicators.

[2] 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", financed from the Government of Japan.
[3] This report does not include detailed methodological descriptions. For more information related to the methodology of the Indicators, see https://publications.iadb.org/handle/11319/5911
[4] The Local Disaster Index (LDI) was not included in the Suriname Indicator Study; the LDI requires data from DesInventar which dosen't exist in case of Suriname

1. NATIONAL CONTEXT

Suriname is located on the northern coast of South America. It is bordered by French Guiana on the east, by Brazil on the south, by Guyana on the west and by the Atlantic Ocean on the north. The total area of Suriname is about 164,000 km^2. Compared to many other countries in the world, the population density is low and is equivalent to about three inhabitants per km^2. Approximately 60-70% lives in the Coastal Plain, most of which is concentrated in the capital city of Paramaribo (BPOA, 2004).

Forest covers about 91% of the total land area of which about 14% is covered by sixteen protected areas (four Multiple-use Management Areas, one Nature Park and eleven Nature Reserves). Forests are one of the important natural resources in Suriname. Other important natural resources are gold, bauxite, kaolin, and hydrocarbons (NIMOS, 2005). Climate condition in Suriname is semi-humid influenced by the Inter Tropical Convergence Zone. Two rainy and two dry seasons are observed annually over the large part of the country.

Main industry of the country is agriculture, tourism and mining. The mining industry, which includes sub-sectors such as bauxite, gold, petroleum, and non-metallic minerals such as granites, has large potential for growth. The agricultural and tourism sectors also contribute to a certain extent to the country's foreign exchange earnings. With exception of bauxite and gold mining and forestry that are major economical activities in the interior of Suriname, large parts of the economic activities [5] are concentrated in the coastal zone, particularly in and around Paramaribo, given that a high percentage of the population is concentrated in the northern coastal plain of Suriname (NIMOS, 2005).

The country is divided into ten districts, which are divided into resorts (ressorten in Dutch), with a total of sixty-two resorts in the country. Paramaribo is the capital of the country, and it is the most populous district of Suriname with 242,946 inhabitants, while the least populated district is Coronie with 2,887 inhabitants. According to the statistics office of Suriname (Algemeen Bureau voor de Statistiek in Suriname), the estimated mid-year population for 2011 was put at 539, 912. Figure 1 presents the population in each district. Regarding the economy, the GDP of Suriname was US$4.35 billion in 2010; its growth rate was 4.6% and 4.1% in 2005 and 2010 respectively. During this period, current account and trade balance was in a deficit near to 8% and then increased to 15% of GDP respectively. The inflation rate was over

[5] The economic activities are driven by services, mainly based on imports of goods, banking, insurance, transport and communication and other sectors such as the wholesale and retail sectors. The agriculture sector is predominantly developed in the northwestern (rice and bananas) and north central (vegetables and fish) parts of Suriname.

9.9% in 2005 and increased to 17.7% in 2011, and the unemployment rate was 9% (2008). The gross capital formation as a proportion of GDP rose from 2000 and was closer to 25% in 2005[6]. The exchange rate in 2011 was 3.268 Surinamese dollars (SRD) per United States dollar (World Bank, Factbook CIA).

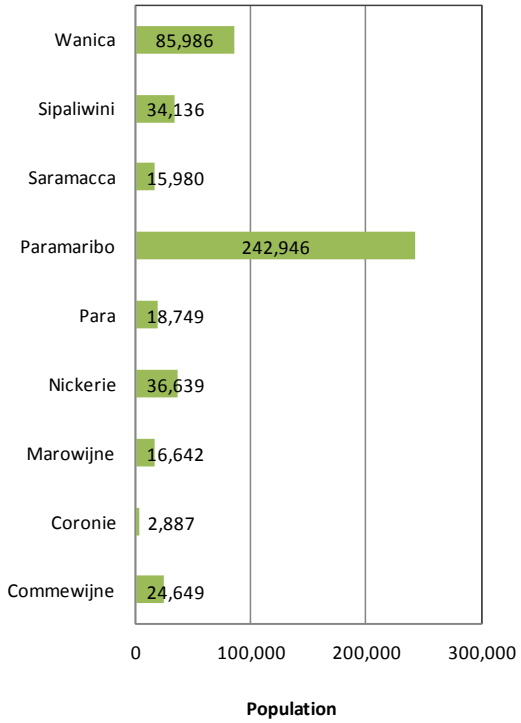


Figure 2. 2004 Population by districts (Source: Algemeen Bureau voor de Statistiek in Suriname [7])

Table 1 presents a summary of the macroeconomic variables of the country. With regard to social characteristics, the literacy rate of the population over 15 years old was around 89.6% in 2004. The number of hospital beds per one thousand inhabitants was 3.1 in 2007.

[6] There are no more recent figures available in the international databases.
[7] Latest data available at: http://www.statistics-suriname.org/index.php/statistieken/downloads/category/8-censusstatistieken-2004

Table 2. Main macroeconomic and social indicators

Indicator	2000	2005	2010
GDP (USD million)	1,078.40	1,793.78	4,350.52
Trade balance (% GDP)	3.6	-8.0	15
Unemployment (%)	**	12.1 (2006)	9 (2008)
Human Development Index	0.552	0.585	0.611

Sources: The World Bank, ECLAC, Factbook CIA
***No data available*

2. NATURAL HAZARDS

Figure 2 presents the classification by mortality risk for Suriname established by the United Nations International Strategy for Disaster Reduction, UNISDR. The most significant natural hazard for the country are floods which would cause the major losses in the future in Suriname. This information is especially important for the estimation of the Disaster Deficit Index, DDI. Appendix I presents a general description of the main country's hazard events.

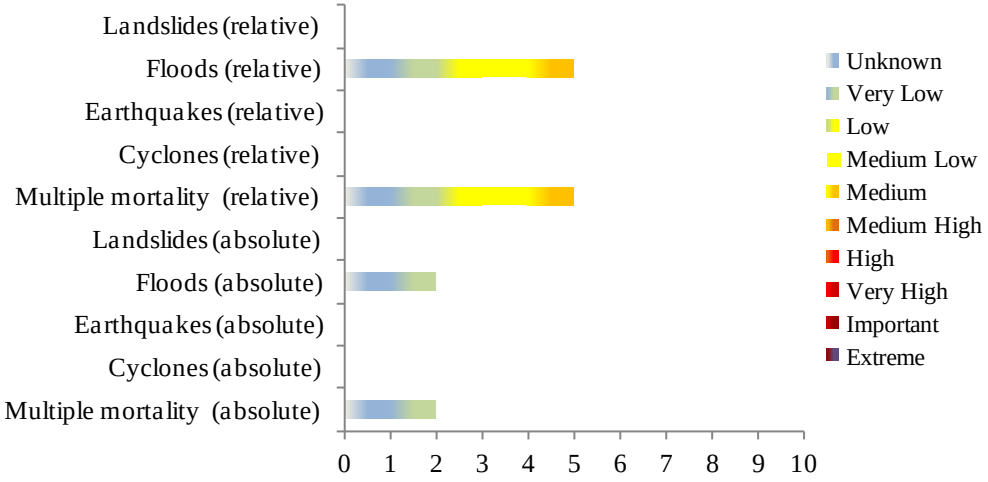


Figure 2. Classification by mortality risk (Source GAR, UN ISDR 2009)

The mortality risk index established by UNISDR is based on hazard modelling (tropical cyclones, flooding, earthquakes and landslides), taking into account the frequency and severity of the hazard events, the human exposure, 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. Low indices of 1 mean low mortality risk, with 10 as the maximum value meaning high mortality risk. According to Figure 2, relative values indicate that mortality risk is concentrated at a medium-high level due to

floods. Likewise, the absolute mortality risk shows that floods are classified as medium-low.

3. THE DISASTER DEFICIT INDEX (DDI)

3.1 METHODOLOGY

The DDI measures whether a country has sufficient financial resources or accesses to attend immediately an eventual catastrophic event. This index captures the ratio between the direct probable public infrastructure damages caused by eventual Maximum Considered Event (MCE, or return period of an event once every 50, 100 and 500 years) and the financial capacity to repair and reconstruct immediately once disaster hits (or economic resilience (ER) in this study).

Damages caused by the MCE are estimated with a probabilistic risk assessment (PRA) model, based on the function of (i) intensities and frequency of natural hazards, (ii) the public infrastructure exposed to natural hazards and (iii) the physical vulnerability of the public infrastructure that exposed to hazard impacts. The ER is obtained from an estimation of the possible internal and external financial resources or accesses that government should necessary to repair and reconstruct public infrastructure immediately after catastrophic event. A DDI greater than 1.0 reflects the country's inability to cope with disasters even having external resources as much as possible. The greater the DDI, the greater the financial gap.

Additionally, an evaluation of a complementary indicator, DDI'$_{CE}$ has been calculated 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 eventual extreme disasters (IDEA, 2005; Cardona, 2005). The DDI'$_{IS}$[8] is also estimated with respect to the amount of sustainable resources due to surplus; i.e. the saving which the government can employ to attend the impacts of disasters. The DDI'$_{IS}$ is the percentage of a country's potential savings at present value that corresponds to the pure risk premium.

[8] Surplus or savings of the country.

3.2 RESULTS - PROBABLE LOSSES DUE TO MCE

The MCE in this study was based on a coarse grain (indicative) and simplified evaluation of losses taking into account as reference the 2006's flooding. Neither non-economic values of properties nor economic value of time needed for restoration were included in the simplified model used. In the disaster risk model proposed for the evaluation of the MCE, the rainfall flood hazard was the only natural phenomena considered, taking into account the experience in the past recent events (See the Appendix I).

To estimate probable losses due to MCE, the total population of Brokopondo and Sipaliwini districts were considered as the exposed population in a simplified model in which hazard and vulnerability accounts for damage in the public and private property, livelihoods and infrastructure[9].

Figure 3 shows the result of the estimations of built areas in different components of the country and its variations in time (from 1995 to 2010). Using a standard cost per square meter of sample construction types, construction area, Figure 4 presents the approximated exposed values for the whole country[10]. The values of the built areas include (i) total value (public and private built areas), (ii) public value (the buildings of the government and public infrastructure) and (iii) low income value (buildings of the low-income socio-economic homeowners). The properties mentioned above usually are the sovereign or fiscal liabilities.

Table 2 shows the values of the potential losses for the country for the Maximum Considered Event, MCE, with 50, 100 and 500-year return periods. These estimations were made at the whole country level in the period of 1995, 2000, 2005 and 2010. In addition, Table 4 presents the values of pure premium or the required annual amount to cover possible future disasters in each period. The DDI and DDI' for 1995, 2000, 2005 and 2010 of analysis were calculated based on the estimates of the potential maximum losses and expected annual losses respectively (i.e. the numerator of the indicators).

[9] For more information related to the methodology of the Indicators, see https://publications.iadb.org/handle/11319/5911

[10] These technical explanations are available in http://idea.unalmzl.edu.co. See also Ordaz & Yamin (2004) and Velasquez (2009) for detail of this methodology.

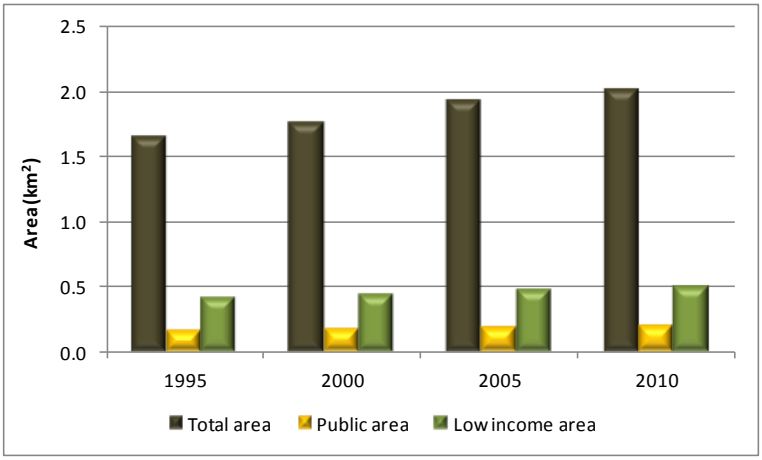


Figure 3. Total built areas by component in square km

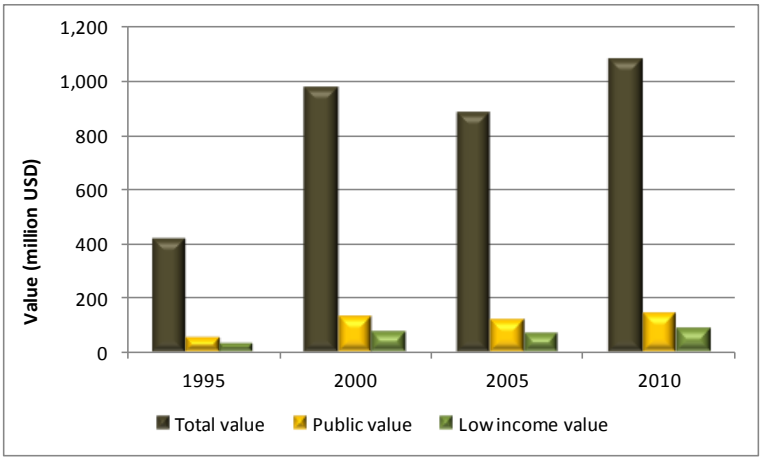


Figure 4. Exposed value by component ($US million)[11]

3.1 RESULTS - ECONOMIC RESILIENCE (ER)

Table 3 presents possible internal and external financial resources that the government should need to access for rehabilitation and reconstruction in case of a catastrophe. These values were estimated in terms of GDP for each fund, taking as reference the available economic information. The sum of these available or usable possible funds corresponds to the economic resilience. Due to the lack of financial information for the country in the international databases the indexes were not evaluated for 1995.

[11] Based on own calculations of the consultants using a methodology based on a proxy according to available population data and trends. The indicators in all cases are coarse grain evaluations

Table 2. Probable loss and pure premium for DDI and DDI' calculations

L_{50}	2000	2005	2010
Total – Million US$	76.9	68.8	83.9
Government – Million US$	24.3	21.9	26.9
Total - % GDP	15.70%	3.82%	3.11%
Government - % GDP	4.96%	1.22%	1.00%
L_{100}			
Total – Million US$	116.0	103.8	126.6
Government – Million US$	36.6	33.0	40.6
Total - % GDP	23.68%	5.77%	4.70%
Government - % GDP	7.48%	1.83%	1.51%
L_{500}			
Total – Million US$	153.3	137.2	167.3
Government – Million US$	48.4	43.6	53.6
Total - % GDP	31.29%	7.62%	6.21%
Government - % GDP	9.88%	2.42%	1.99%
Ly			
Total – Million US$	5.8	5.2	6.4
Government – Million US$	1.8	1.7	2.0
Total - % GDP	1.19%	0.29%	0.24%
Government - % GDP	0.38%	0.09%	0.08%

Table 3. Economic resilience (ER), funds and resources for DDI calculations

Funds	2000	2005	2010
Insurance premiums - % GDP	0.000	0.000	0.000
Insurance/ reinsurance.50 -***F1p***	0.00	0.00	0.00
Insurance/ reinsurance.100 -***F1p***	0.00	0.00	0.00
Insurance/ reinsurance.500 -***F1p***	0.00	0.00	0.00
Disaster reserves -***F2p***	0.00	0.00	0.00
Aid/donations.50 -***F3p***	3.85	3.44	4.20
Aid/donations.100 -***F3p***	5.80	5.19	6.33
Aid/donations.500 -***F3p***	7.66	6.86	8.37
New taxes -***F4p***	0.00	0.00	0.00
Capital expenditure - % GDP	2.60	4.40	4.61
Budgetary reallocations. -***F5p***	7,64	47,55	74,54
External credit. -***F6p***	0.00	0.00	0.00
Internal credit -***F7p***	0.00	0.00	0.00
Intertemporal surplus. *d**- % GDP	2.000	1.310	0.380
Intertemp surplus. -***F8p***	9.8	23.6	10.24
ER.50			
Total - Million US$	11	51	79
Total - %GDP	2.34%	2.83%	2.92%
ER.100			
Total - Million US$	13	53	81
Total - %GDP	2.74%	2.93%	3.00%
ER.500			
Total - Million US$	15	54	83
Total - %GDP	3.12%	3.02%	3.08%

3.2 RESULTS - DDI

Based on the estimations made in the Section 3.2 and 3.3, Table 4 shows DDI for 2000, 2005 and 2010 for the Maximum Considered Event (MCE) for 50, 100 and 500 years of return period[12].

Table 4. DDI for different return periods

DDI	2000	2005	2010
DDI_{50}	2.12	0.43	0.34
DDI_{100}	2.73	0.63	0.50
DDI_{500}	3.17	0.80	0.65

For extreme events with return periods of 500, 100 and 50 years in 2000 the DDI is greater than 1.0; this means the country would not have had enough resources to cover losses and/or feasible financial capacity to face losses and replace the capital stock affected. The periods of 2005 and 2010, the DDI was lower than 1.0, which means that the country would have had enough resources to cover the losses that could be generated by extreme events with return periods of 500, 100 and 50 years.

Table 5 shows DDI' values, which corresponds to annual expected loss related to capital expenditure (annual investment budget), and related to possible savings for intertemporal surplus[13] 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 1.6% of the capital expenditure to cover future disasters. The DDI' with respect to the amount of sustainable resources due to inter-temporal surplus (IDEA, 2005) indicates that for all the periods evaluated, with a non-significant percentage of the potential savings at present values would be possible for covering the average annual losses in the country.

The reduction of DDI and DDI' from 2000 to 2005 can be due to the economic situation that existed in the 1990's decade, which was characterized by near-hyperinflation, devaluation and subsequent depreciations of the exchange rate, dwindling international reserves and declining output, large swings in fiscal revenues and the overall fiscal imbalance caused by large fluctuations of world prices for bauxite and its derivates. In addition, a negative fiscal balance, due to the

[12] Events that can occur at any moment and which have a probability of occurrence of 2%, 10% and 18% in 10 years.
[13] The intertemporal surplus is the saving which the government can employ, calculated over a ten year period, in order to best attend the impacts of disasters (IDEA, 2005).

suspension of Dutch development aid and rapid price inflation and exchange rate depreciation, was followed by a very expansionary fiscal stance and the accommodating monetary policy (CCMF[14]). This situation started to change when stronger measures to restore macroeconomic stability were introduced. When a better macroeconomic stability exists, it is possible to have access to greater resources when a high impact event takes place and it is possible to count with surpluses that give a chance to invest in disaster risk reduction and protection which will be reflected in the values of DDI and DDI'.

Table 5. DDI' related to capital expenditure and intertemporal surplus

DDI'	2000	2005	2010
DDI_{CE}	14.4%	2.1%	1.6%
DDI_{IS}	18.8%	7.0%	19.9%

Figure 5 illustrates DDI and DDI' values related to capital expenditure, illustrating a decreasing (or being better) trend of both the DDI and the DDI'_{CE} from 2000 to 2010.

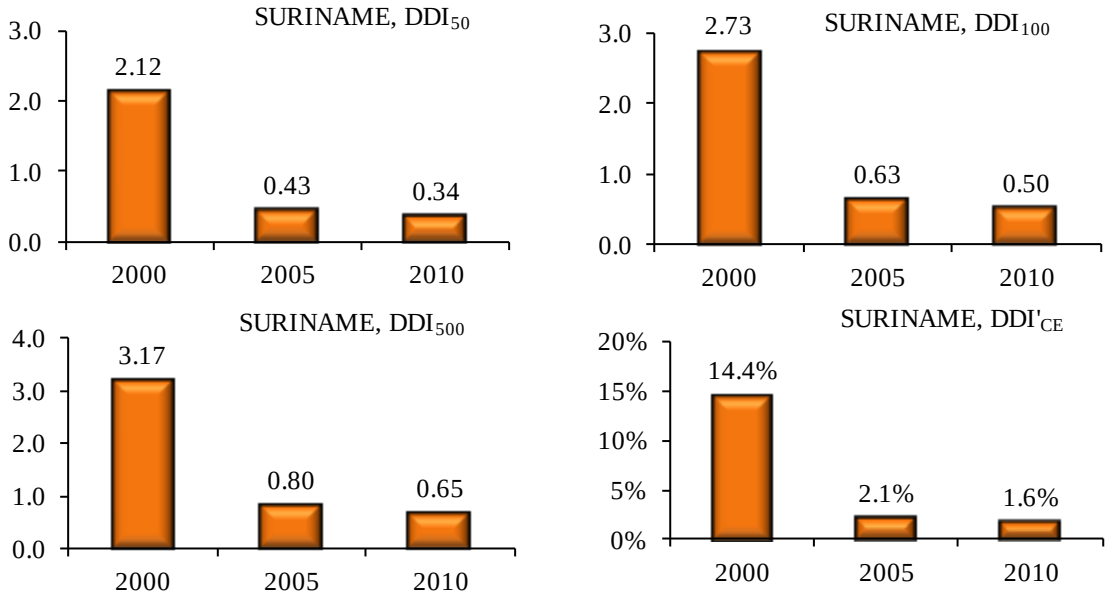


Figure 5. DDI_{50}, DDI_{100}, DDI_{500}, DDI'_{CE}

The result this study shows Surinam's DDI is below 1.0 in 2010 (0.34 DDI50, 0.50 DDI100 and 0.65 DDI500), which means the country has enough financial resources to recover any future catastrophe. Additionally, the country's DDI value is much lower

[14] Caribbean Centre for Money and Finance.
http://www.ccmf-uwi.org/files/publications/monograph_book/TFEOTCC_Update/9Suriname.pdf

(or better) than the LAC region average[15]. Note that DDI only measures the financial ability to deal with ex post disaster recovery and thus it doesn't measure the capacity to prevent/mitigate (or ex ante) disaster risk.

4. THE PREVALENT VULNERABILITY INDEX (PVI)

4.1 METHODOLOGY

The PVI measures the vulnerability condition of a country. This index characterizes predominating vulnerability conditions reflected in three aspects (or sub-indicators) which favour both direct impact and indirect and intangible impact in case of the occurrence of a hazard event. The three aspects of the PVI are: (i) susceptibility due to the level of physical exposure of assets and people that favours direct impact in case of hazard events (the sub-indicator of exposure and susceptibility, PVI_{ES}); (ii) social and economic conditions that favour indirect and intangible impact (the sub-indicator of social-economic fragility, PVI_{SF}); and (iii) lack of capacity to anticipate, to absorb consequences, to efficiently respond, and to recover (the sub-indicator of lack of resilience, PVI_{LR}). Each of these includes eight indicators shown in 4.1.1 – 4.1.3.

In combination of the value of each indicator and their respective weights which were obtained using the Analytic Hierarchy Process (AHP), the PVI value is calculated according to a standard methodology[16] ranging 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. PVI can be useful to institutions related to housing and urban development, environment, agriculture, health and social care, economics and planning, among others.

4.1.1 Indicators of exposure and susceptibility PVI_{ES}

The PVI_{ES} represents the population, assets, investments, productions and livelihoods exposed to natural hazards and susceptible to socioeconomic activities. The PVI_{ES} includes the following indicators:

[15] The average DDI100 value of the LAC region in 2008 is 1.9. This value includes AR, BA, BL, BO, CH, CO, CR, DO, ES, GU, HA, HO, JA, ME, NI, PE, PN and TT. Note that the Indicator is applied mainly to the LAC countries with the exception of only some Asian and European countries.
[16] see https://publications.iadb.org/handle/11319/5911

- 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

4.1.2 Indicators of socio-economic fragility PVI_{SF}

The PVI_{SF} represents the country's conditions of poverty, human insecurity, dependency, illiteracy, social disparities, unemployment, inflation, debt, and environmental deterioration that relates to the subject of socio-economic fragility. These indicators reflect relative weaknesses and conditions of deterioration which would increase the direct effects associated with hazardous phenomena. 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. The indicators included in the PVI_{SF} 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 the Gini index
- SF4. Unemployment, as % of total labor force
- SF5. Inflation, food prices, annual %
- SF6. Dependency of GDP growth on 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[17] predisposition of society to be affected when faced with a hazardous phenomenon, whatever the nature and intensity of these events is. The predisposition to be affected is a vulnerability condition (IDEA, 2005), 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, in the case of exposure (as reflected by the PVI_{ES}), it is possible to suggest that certain variables reflect a

[17] This is also defined as inherent vulnerability. It means that socio-economic conditions peculiar to the communities favour or facilitate the occurrence of such effects.

comparatively unfavourable situation, supposing that the natural hazards exist as a permanent external factor, irrespective of their exact characteristics.

4.1.3 Indicators of resilience (lack of) PVI_{LR}

The PVI_{LR} represents human development levels, human capital, economic redistribution, governance, financial protection, collective perceptions, preparedness to face crisis situations, and environmental protection that captures, in a macro fashion, the capacity to recover from or absorb the impact of hazardous events. The indicators include[18]:

- 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]

4.2 Results - Estimation of indicators

Table 6 and Figure 6 show the total PVI, $PVI_{ES,}$ PVI_{SF} and PVI_{LR} corresponding to the years 1985, 1990, 1995, 2000, 2005 and 2010.

Table 6. PVI values

	1985	1990	1995	2000	2005	2010
PVI_{ES}	28.715	23.310	18.710	16.307	22.373	22,013
PVI_{SF}	41.851	39.956	45.116	41.121	32.011	32,828
PVI_{LR}	38.717	40.835	41.730	36.753	37.057	35,965
PVI	36.428	34.700	35.185	31.394	30.481	30,269

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

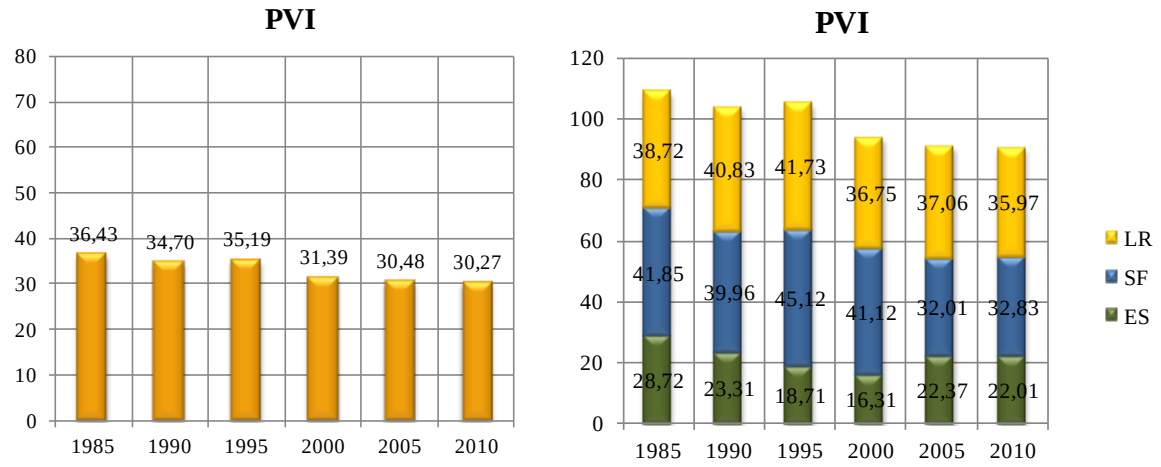
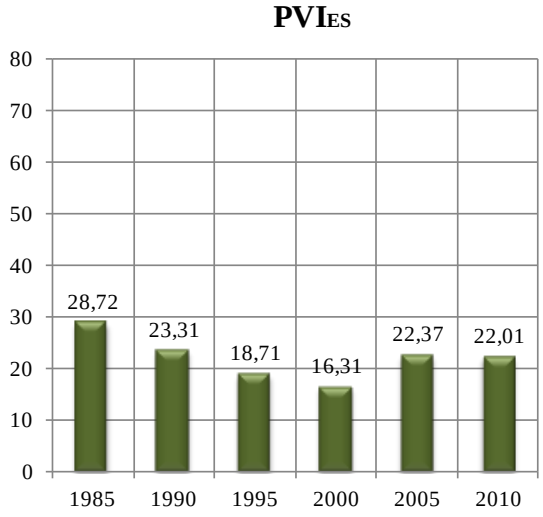


Figure 6. PVI

4.2.1 Results – PVI_{ES}

Figure 7 shows the original values obtained from international statistics or databases related to the PVI_{ES} and their respective weights which were obtained using the Analytic Hierarchy Process (AHP).



	1985	1990	1995	2000	2005	2010	W_{AHP}
ES.1	0.99	1.61	1.34	1.39	1.22	0,91	5.01
ES.2	3.79	2.94	1.89	1.91	1.71	1,37	12.37
ES.3	12.05	13.04	13.97	14.96	16.00	16,82	8.99
ES.4	18.87	18.27	19.08	15.69	13.03	13,03	25.39
ES.5	63.35	70.31	78.81	105.89	143.78	143,78	12.35
ES.6	76.64	86.49	50.06	52.93	75.58	91,54	11.71
ES.7	18.81	10.77	15.26	12.36	24.85	24,85	12.38
ES.8	0.40	0.44	0.44	0.43	0.35	0,41	11.82

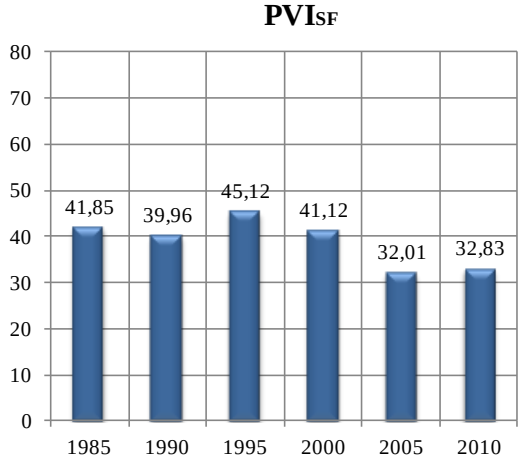
Figure 7. PVI_{ES}

Vulnerability due to exposure and susceptibility in the country was almost constant in all periods with some slight variations. The poverty-population (ES4) is the indicator with the highest weight, therefore this is most likely the one which supplies the major contribution to the decreasing of the total index, especially from 1985 to 2000, along with the decrease in vulnerability indicators such as urban growth (ES2),

imports and exports of goods and services (ES6), gross domestic fixed investment (ES7) and arable land and permanent crops (ES8). In 2005 the PVI_{ES} increased due to the increase in population density (ES3), an important increase in capital stock and the ES6 which had similar values to 1985.

4.2.2 Results – PVI_{SF}

Figure 8 shows non-scaled sub-indicator values which compose the $PVI_{SF,}$ and their respective weights, which were obtained using the AHP.



	1985	1990	1995	2000	2005	2010	WAHP
SF.1	16.75	16.49	15.63	13.53	11.60	10,20	20.91
SF.2	67.30	61.34	59.80	57.06	56.02	53,88	8.50
SF.3	52.80	52.80	52.80	52.88	52.80	52,80	16.40
SF.4	19.60	15.70	8.40	13.80	9.50	9,00	12.52
SF.5	10.87	21.74	235.56	59.40	9.90	6,94	9.44
SF.6	9.13	8.71	14.88	11.16	5.42	10,91	9.58
SF.7	10.63	9.73	7.87	6.73	6.81	7,50	9.63
SF.8	25.80	25.80	25.80	25.89	25.89	25,89	13.02

Figure 8. PVI_{SF}

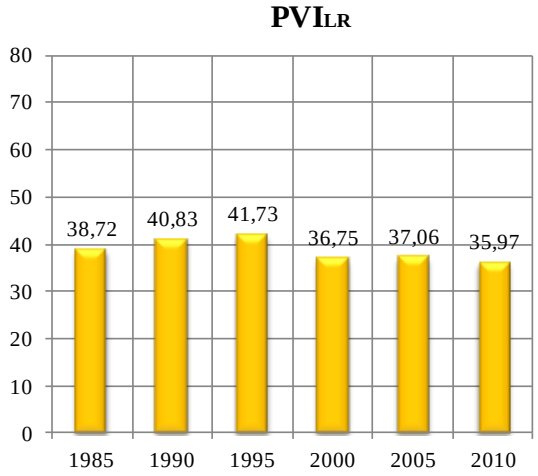
The most notable increase can be seen however in the 1990s decade, since, as the values of the sub-indicators reflect, contributing to these high values was the hyperinflation in the country (SF5 changed from 10.87 in 1985 to 235.56 in 1995), which derived from near-hyperinflation, devaluation and subsequent depreciations of the exchange rate, dwindling international reserves and declining output, the large swings in fiscal revenues and the overall fiscal balance caused by the large movements of world prices of bauxite and its derivates. In addition, the negative fiscal balance was due to the suspension of Dutch development aid and rapid price inflation and exchange rate depreciation, followed by a very expansionary fiscal stance and the accommodating monetary policy (CCMF[19]). This situation started to change when stronger measures to restore macroeconomic stability were introduced as can be seen in the values for inflation (SF5) for the subsequent periods. Although the weight for this sub-indicator is not the most important, the huge changes in the values carried the fluctuation over into the total index. On the other hand, the other

[19] Caribbean Centre for Money and Finance.
http://www.ccmf-uwi.org/files/publications/monograph_book/TFEOTCC_Update/9Suriname.pdf

sub-indicators presented slight variations from 1985 to 2010 which could also contribute to the PVI_{SF} variation.

4.2.3 Results – PVI_{LR}

Figure 9 shows the figures for non-scaled sub-indicators which compose the PVI_{LR}, and their respective weights, which were obtained using the AHP.



	1985	1990	1995	2000	2005	2010	WAHP
LR.1	0.79	0.72	0.74	0.76	0.64	0,68	21.91
LR.2	0.73	0.72	0.74	0.74	0.78	0,78	10.53
LR.3	16.13	16.13	15.48	16.98	15.86	16,03	13.56
LR.4	8.38	8.38	8.38	10.43	10.34	9,87	15.05
LR.5	0.92	0.99	1.10	1.39	2.02	2,07	12.90
LR.6	0.56	0.58	0.62	0.74	0.79	0,81	3.70
LR.7	5.70	5.70	3.10	3.90	3.20	2,60	9.17
LR.8	52.06	52.06	52.06	52.06	52.41	52,41	13.18

Figure 9. PVI_{LR}

The result of PVI_{LR} slightly decreased between 1995 and 2010. The most considerable changes were found between 1995 and 2000, where the indicators of Human Development Index (LR1), social expenditure (LR3), governance index (LR4), insurance of infrastructure and housing (LR5), television sets (LR6) and hospital beds (LR7) increased their values, thus positively reducing this lack of resilience.

In summary, the result of the study shows the total PVI value slightly decreased from the year 1985 (36.43) to 2010 (30.27), meaning the country has a lower vulnerability. Among three factors above indicated, the county's socioeconomic fragility (32.83 in 2010) is higher than the LAC region average (30.68 in 2007)[20], which means the country has some relatively weak conditions that increase the negative impacts associated with hazardous impacts. The conditions include countries' high poverty rate, human insecurity, dependency, illiteracy, social disparities, unemployment, inflation, debt, and environmental deterioration.

[20] This value includes AR, BA, BL, BO, CH, CO, CR, DO, ES, GU, HA, HO, JA, ME, NI, PE, PN and TT.

5. THE RISK MANAGEMENT INDEX (RMI)

5.1 Methodology

The RMI measures the country's performance of risk management. The "performance" of RMI includes both the national and local institutions related to DRM and communities. This index consists of four components that are necessary for public policies on DRM: Risk identification (RI), Risk reduction (RR), Disaster management (DM) and Governance and financial protection (FP).

Each component (or public policy) is evaluated with 6 sub-indicators that characterize the management performance in the country (See 6.1.1 – 6.1.4). Assessment of each sub-indicator is made using five performance levels: *low, incipient, significant, outstanding and optimal,* which corresponds to a range from 1 to 5 based on the pre-established levels (targets) or desirable referents (benchmarking) [21].

With specific weight settings in each of the four components through a non-lineal aggregation model (a unique calculation including fuzzy-sets and centroid evaluation methodology to adjust subjectivity of the interviewer raised by the linguistic interview), the RMI measures its value (or each country's DRM performance) from 0 (minimum) to 100 (maximum). Total RMI is the average of the four composed indicators that represent each public policy.

5.1.1 Indicators of risk identification (RMI_{RI})

The subject of risk identification needs to recognize the hazard and risk existence, dimension it (measurement) and represent it by means of models, maps and indices that are useful for decision making of stakeholders and individuals. Concretely, this should include the evaluation of hazards, the different aspects of vulnerability when faced with these hazards, and estimations regarding the occurrence of possible consequences during a particular period of exposure. On these bases, the indicators that represent the RMI_{RI} are the following:

- RI1. Systematic disaster and loss inventory
- RI2. Hazard monitoring and forecasting
- RI3. Hazard evaluation and mapping

[21] see https://publications.iadb.org/handle/11319/5911

- RI4. Vulnerability and risk assessment
- RI5. Public information and community participation
- RI6. Training and education on risk management

5.1.2 Indicators of risk reduction (RMI_{RR})

Risk reduction refers in this study to the actions necessary for avoiding or reducing the economic, social, and environmental impact due to an eventual hazard event. RMI_{RR} implies the importance of development planning to reduce existing risk conditions through corrective and prospective interventions. The aspect of risk reduction should also include both structural and non-structural measures. 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

5.1.3 Indicators of disaster management (RMI_{DM})

Disaster management refers in this study to providing appropriate post-disaster response and recovery including the intervention of both public institutions and communities. In other words, the RMI_{RM} seeks the effectiveness in terms of the organization capacity and the planning operativity in case of disasters. The indicators that represent the RMI_{DM} are the following:

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

5.1.4 Indicators of governance and financial protection (RMI_{FP})

Governance and financial protection is fundamental for sustainable development and economic growth. This implies, on one hand, co-ordination between different social actors necessary for implementing DRM by different disciplinary approaches, values, interests, and strategies. On the other hand, governance depends on an adequate allocation and use of financial resources for DRM. The indicators that represent the RMI_{FP} are the following:

- FP1. Interinstitutional, multisectorial 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

5.2 Institutional Organisation

Before the major flood event in 2006 there was little awareness about risk management in Suriname, thus, little information related to events. After 2006, the National Coordination Centre for Disaster Management (NCCR) was established, in response mainly to the need for having a proper response in occurrences with a high number of casualties, especially accidents (planes, autobus, chemical-industrial, etc.).

The institution in charge of planning and conducting operations related to the different types of disasters in Suriname is the Nationaal Coördinatie Centrum voor Rampenbeheersing, NCCR established in 2006. While the NCCR was created as a special division of the Ministry of Defence, there is no specific legislation that defines an institutional structure for disaster management. However, there is a proposal for a National Disaster Management Lawin the Council of Ministries, and it is expected that it will be sent to the National Assembly for legal and constitutional consideration. The NCCR started as an inter-institutional commission with two main goals: (i) the designing of a national disaster plan, and (ii) the creation of a centre for emergency response to disasters. Currently, the NCCR plans, co-ordinates and implements national safety measurements based on legislation on other laws of the constitution such as the law of the national army, such as the law for regional development and the law for defence. It is assigned to co-ordinate, and to operate from the NCCR

Centre in close co-operation operationally and logistically with the structures of the Ministry of Regional Development, as is shown in Figure 10.

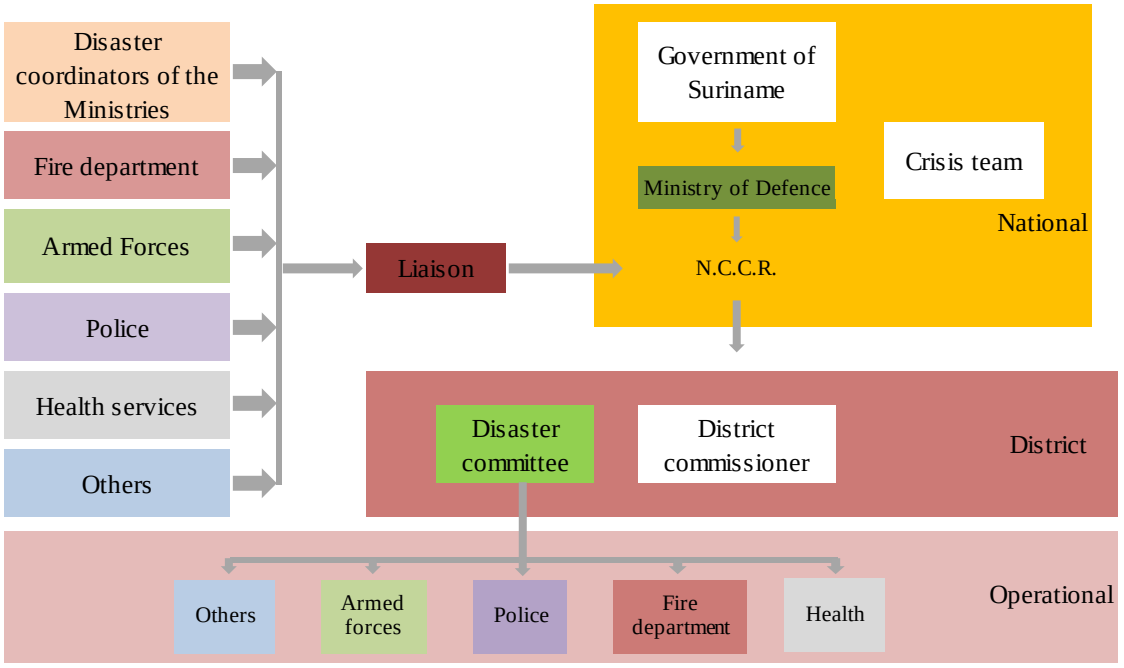


Figure 10. National Disaster Management Structure (Source: Slijngard, 2011)

The NCCR Centre receives hands-on support from representatives from various ministries, the NGO Interior Network (NGOs working in the Interior), the Suriname Red Cross, PAHO, and the Medical Mission. Co-ordinating meetings are held periodically with all main co-ordinating and support organizations.

The NCCR is committed to design proposals, plans, and procedures as tools of disaster management in order to structure and guide emergency action. The primary plans and procedures are the collection and analysis of demographic data, monitoring and analysis of social developments to identify possible increase of vulnerability; development of policies and decision-making in order to prevent or mitigate risk; monitoring of development and implementation of protection mechanisms for vital infrastructure; management and maintenance of policies related to disaster management; development of standard safety measurements, and performing as co-ordinator and facilitator regarding the possible risks that can exist.

Figure 11 shows the organizational structure of the NCCR in Suriname. This figure explains the arrangement of all positions within the structure of the NCCR.

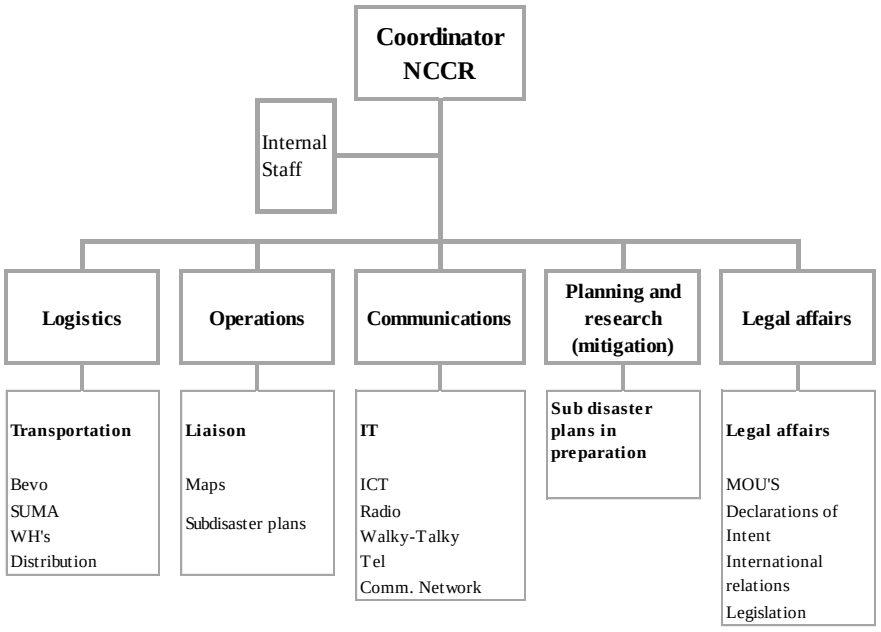


Figure 11. NCCR organization structure (Source: Slijngard, 2011)

The NCCR staff is divided into specialised units:

- Logistics Unit: responsible for emergency response, provision of food and work material
- Operations Unit: implements and executes plans set out by the planning and research unit.
- Communications Unit: arranges for all possible communication systems for the divisions
- Planning and Research: responsible for research on hazards; organization of information sessions for vulnerable communities.
- Legal Unit: co-ordinates all legal affairs for the division.

The meteorological service in tandem with the University of Suriname sends information to the NCCR, and at present, data exist about some extreme hazardous events, as well as a monitoring of some hazards in some hydrographic basins, but this does not cover the entire country. Additionally, some hazard maps were developed before 2010, sporadically, by individual consultants, and maps using probabilistic techniques were generated in the context of the establishment of the base-line data of the country (a CDEMA project).

Under a DIPECHO action plan, and starting in 2006, the Suriname Red Cross aimed to do vulnerability assessments in some communities (VCA: Vulnerability and Capacity Assessment). Some of these communities are: District Nickerie (Wageningen, Post Utrecht, Henar and Zaaizaad Bedrijf); District Paramaribo (Beekhuizen and Davis Buiten); District Commewijne (Zoelen, Ellen, Marienburg, Kronenburg); District Para (Bernarddorp, Hollandse Kamp, Coropina Driehoek, Matta and Wit Santi); District Sipaliwini from Pokigron up to Nieuw Aurora (projects at the beginning of implementation).

In regard to educational outreach, there have been some curricular adjustments at primary and secondary level. With the participation of the Red Cross of Suriname, some teaching guides have been produced. DIPECHO VIII: DPP (training of children and teachers working with Ministry of Education + Red Cross).

In Suriname there is also a Ministry of Spatial Planning, Land and Forest Management (RGB, created in 2000), which is responsible for the issuance of land.

The National Institute for Environment and Development in Suriname (NIMOS), which is part of the Ministry of Labour, Technological Development and Environment, is the organization engaged in giving advice on permit applications, handling environmental complaints, and monitoring mining activities. Besides NIMOS there is also the Centre for Agricultural Research in Suriname (CELOS), which is part of the University of Suriname, which is engaged in promoting reforestation and water-related management and planning. In Suriname, an Environmental and Social Impact Study is mandatory for some projects (classified according to NIMOS´ parameters). NIMOS is the responsible of environmental issues, including basin management. There is no national law regarding the protection of natural resources in the area of hydrographic basins, but the Constitution of the Country establishes natural resources protection as a mandate. There is a proposal for new legislation regarding environmental management not already promulgated.

Legislation about the management of disaster-prone (such as swamp areas) and human settlement in hazardous areas does not exist. Nevertheless, the Regional Development Ministry implements programmes for relocation from areas prone to natural hazards (conducted by District Commissioners).

The Ministry of Public Works (OW) is the authority that provides building permits in Suriname. This Ministry contains the departments of drainage works, construction and housing and planning authority. Common licenses are: (i) building permits, (ii)

permits for the hardening of the street verge, (iii) development permits, and (iv) watering works.

There are no norms regarding the retrofitting of public and private assets (including a quantification of public assets or their vulnerability).

Suriname has a National Emergency Plan organized in interdepartmental commissions. This plan includes activities not only for emergency entities, but also for governmental institutions such as Ministries. There is no National Law or similar legal instrument for supporting the Plan. There is a flood warning system that operates for the city of Paramaribo. All organizations have their own protocols, there are no inter-institutional protocols formally established. The Red Cross has emergency and contingency plans (draft), and in the agricultural sector there is an emergency plan draft, not formally approved, and there is no legal regulation about the mandatoriness of such plans in the country. There is no legislation about the compulsory nature of emergency plans.

In partnership with the Red Cross, community training activities are regularly programmed and implemented. After the flooding of 2006, some organizations such as the Fire Department, the Red Cross, and others have done community programmes, but this is not an integrated exercise. Other NGOs and the Red Cross prepare and implement training courses. In relation to climate change, Suriname has various UN-financed programmes for community preparedness and training. Some of the communities with DIPECHO Projects are: District Nickerie (Wageningen, Post Utrecht, Henar and Zaaizaad Bedrijf); District Paramaribo (Beekhuizen and Davis Buiten); District Commewijne (Zoelen, Ellen, Marienburg, Kronenburg); District Para (Bernarddorp, Hollandse Kamp, Coropina Driehoek, Matta and Wit Santi); District Sipaliwini from Pokigron up to Nieuw Aurora (projects in the beginning of implementation). And the projects of Department for International Development – DFID in: District Coronie, District Saramacca, District Sipaliwini, and cross-border villages at the borders of French Guiana and Suriname.

5.3 Results – RMI

RMI results have been obtained from detailed opinion surveys completed by national experts and representatives of various institutions related to risk management. The surveys were performed with the support of an external expert consultant, the NCCR, the Association of Indigenous Village Leaders in Suriname (VIDS), the Suriname Red Cross Society, the University of Suriname, the Ministry of Agriculture, the Academic Hospital Paramaribo, the Ministry of Education, the Ministry of

Regional Development, the Ministry of Finance and the Meteorological Service, who had suitable knowledge about disaster risk management in the country. Thus, this index reflects performance of risk management based on evaluations of academics, professionals, and officials of the country. Results for 1995, 2000, 2005, 2010, and 2012 are presented below.

Table 7 and Figure 12 show the total RMI and its components, for each period. These are risk identification, RMI_{RI}, risk reduction, RMI_{RR}, disaster management, RMI_{DM}, and governance and financial protection, RMI_{FP}.

Table 7. RMI values

Year	1995	2000	2005	2010	2012
RMI_{RI}	5.25	5.25	5.25	17.21	17.21
RMI_{RR}	11.63	11.63	11.63	11.63	22.45
RMI_{DM}	5.25	5.25	5.25	26.51	26.51
RMI_{FP}	5.25	5.25	5.25	5.25	5.25
RMI	6.84	6.84	6.84	15.15	17.86

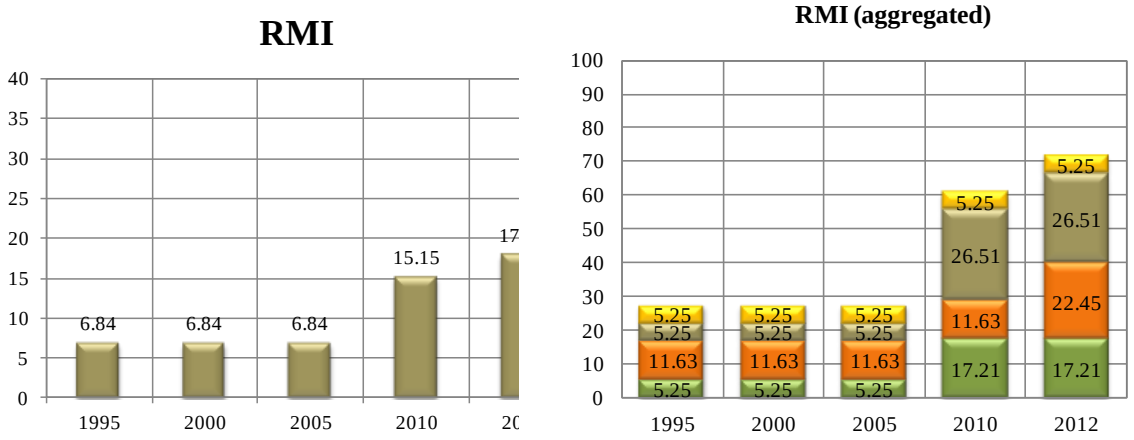
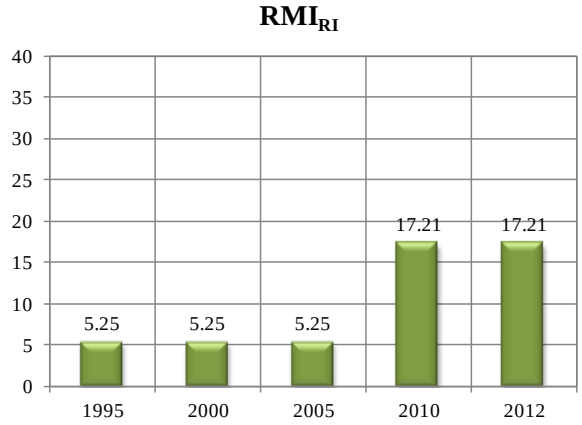


Figure 12. Total RMI

These results indicate that disaster risk management in Suriname has been in notable enhancement between 2005 and 2010. Indicators which vary more considerably have been the RMI_{DM} of disaster management and RMI_{RR} of risk reduction. The progress in RMI illustrates an favourable advance of the country in risk management. However, much work is still should be done to achieve better performance levels in risk management. 5.3.1 – 5.3.4 review the results of each sub-indicator.

5.3.1 Results - RMI_{RI}

Figure 13 shows the results of[22] RMI_{RI} with its respective weights obtained using Analytic Hierarchy Process (AHP). The results show a significant improvement between 2005 and 2010. The status for each sub-indicator is described below.



Ind.	1995	2000	2005	2010	2012	Weight
RI1	1	1	1	2	2	13.56
RI2	1	1	1	2	2	18.14
RI3	1	1	1	2	2	15.06
RI4	1	1	1	2	2	20.95
RI5	1	1	1	2	2	15.13
RI6	1	1	1	2	2	17.16

Figure 13. RMI_{RI}

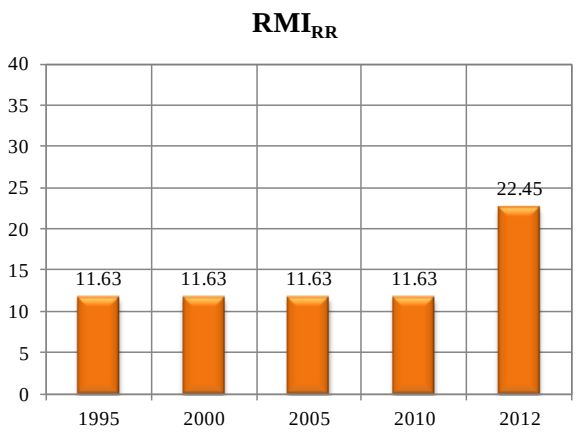
From 1995 to 2005 there were no changes in the management related to risk identification but from 2005 to 2010 an increase from low to incipient in all the sub-indicators that compose the RMI_{RI} can be observed in the country. Activities in this risk identification were generated from concern after the major flood event of 2006; before this 2006 there was apparently a general belief that such disasters did not occur in Suriname. The main advances in each sub-indicator are: collection of records related to the occurrence of events in the country (systematic disaster and loss inventory, IR1), though there is still no systematization of the economic, social, and environmental effects; in hazard monitoring and forecasting (IR2); the information and monitoring of some hazards in some hydrographic basins are developed by the meteorological service and the University of Suriname in conjunction with the NCCR. The network does not cover all of the country. In relation to hazard evaluation and mapping (IR3), some qualitative hazard maps were developed, and information about the areas most affected by floods, as well as scientific and popular information exists. Regarding the vulnerability and risk assessment sub-indicator (RI4), action plans for vulnerability and risk evaluation made by the Suriname Red Cross are intended to be implemented and developed in the different communities of the country. This is a first step to achieve the subject of the indicator. Concerning public information and community participation (IR5),

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

the plans proposed by the Suriname Red Cross under the DIPECHO action plans related to community preparedness and training, could be consider also a first step to cover this item, as well as training and education in risk management (RI6). Although the advances are still incipient in risk identification, the process has already started, which is an advantage in improving performance through the reinforcement of the existing activities, and the creation or development of new activities.

5.3.2 Results - RMI_{RR}

Figure 14 shows sub-indicator qualifications that composed the RMI_{RR} and their respective weights, obtained using the AHP.



Ind.	1995	2000	2005	2010	2012	Weight
RR, 1	1	1	1	1	1	27.19
RR, 2	2	2	2	2	3	16.44
RR, 3	2	2	2	2	2	10.13
RR, 4	1	1	1	1	1	13.65
RR, 5	2	2	2	2	2	18.58
RR, 6	1	1	1	1	1	14.01

Figure 14. RMI_{RR}

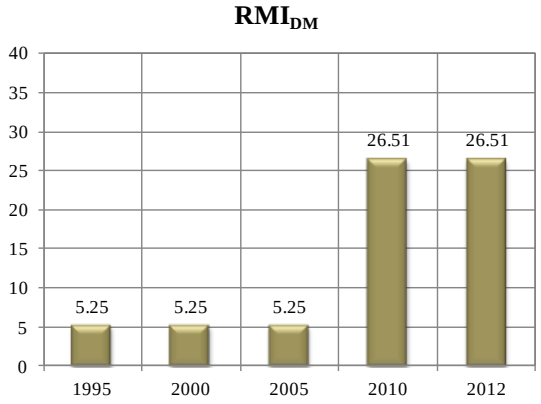
Management related to risk reduction indicates that in the country there was an increase in the RMI_{RR} from 2010 to 2012. Before 2010 management related to risk reduction did not present any significant advance. The indicators of risk consideration in land use and urban planning (RR1), housing improvement and human settlement relocation from prone-areas (RR4), and reinforcement and retrofitting of public and private assets (RR6) maintained the same low performance level during all the periods evaluated. The implementation of hazard-event control and protection techniques (RR3) and updating and enforcement of safety standards and construction codes (RR5) maintained the same incipient performance level. The hydrographic basin intervention and environmental protection (RR2) indicator improved its performance, changing from an incipient to a significant level.

Regarding the performance of risk reduction in the country there are direct activities that should be addressed to achieve formal risk reduction. Indeed, at present there are entities in Suriname responsible for the issuance of land titles (Ministry of Spatial Planning, Land and Forest Management –RGB, created in 2000–); advice on licence applications, handling environmental complaints, and monitoring mining activities (National Institute for Environment and Development in Suriname (NIMOS) that comprises a part of the Ministry of Labour, Technological Development and Environment); the promotion of reforestation and water basin management and

planning (Centre for Agricultural Research in Suriname (CELOS) of the University of Suriname); the implementation of programmes for relocation from risk-prone areas (Regional Development Ministry), for providing building licences in Suriname (Ministry of Public Works). However, it is necessary to consider and to tackle important and direct issues on risk reduction, since no considerable activities in physical planning for reducing disaster risk have been done, and there has not yet been promulgated a national law for environmental management or legislation for the treatment of disaster-prone areas, nor for human settlement or for retrofitting of public and private assets.

5.3.3 Results – RMI_{DM}

Figure 15 shows sub-indicator qualifications that composed the RMI_{DM} and their respective weights, obtained using the AHP.



Ind.	1995	2000	2005	2010	2012	Weights
DM,1	1	1	1	3	3	20.93
DM,2	1	1	1	2	2	25.30
DM,3	1	1	1	1	1	11.57
DM,4	1	1	1	2	2	15.52
DM,5	1	1	1	2	2	16.44
DM,6	1	1	1	1	1	10.24

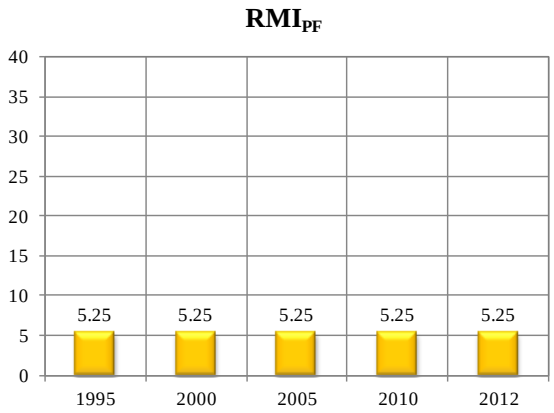
Figure 15. RMI_{DM}

Performance related to disaster management indicates a remarkable advance from 2005 to 2010; the previous periods maintain the same low performance level. In 2010 the organization and coordination of emergency operations (DM1) reached a significant level. This improvement is given by the creation of the National Coordination Center for Disaster Management (NCCR) after the floods of 2006, relying on an institutional structure for disaster management. The emergency response planning and implementation of warning systems (DM2), the simulation, updating and test of interinstitutional response (DM4) and the community preparedness and training (DM5) reached an incipient performance level. The progress in these subindicators was given by the creation of a National Emergency Plan organized in interdepartmental commissions that includes activities for emergency entities and for governmental institutions and flooding warning system for the city of Paramaribo, some sporadic simulations exercise have been done and community training activities had been regular programmed and implemented. Nevertheless, although draft emergency and contingency plans from the Red Cross of Suriname and draft emergency plan from the agriculture sector, they have not been formally approved due to the absence of legislation about the obligatory nature of emergency plans. The endowment of equipments, tools and infrastructure (DM3) and the rehabilitation and reconstruction planning (DM6) maintained the same low level. In the case of DM3, even though there is a National Emergency Operation Centre, it is located only in Paramaribo, and there are institutions with their own resources and inventory but there has not existed a centre composed of different inventories. For

DM6, no relevant improvement exists, and recovery plans are developed only when a disaster happens. The performance level in these mentioned indicators has not been greater because it is necessary to strengthen the activities that exist and to generate new issues that can help to improve the management related to disaster management.

5.3.4 Results – RMI_{PF}

Figure 15 shows sub-indicator qualifications that composed the RMI_{FP} and their respective weights, obtained using the AHP.



Ind.	1995	2000	2005	2010	2012	Weights
FP,1	1	1	1	1	1	26.23
FP,2	1	1	1	1	1	12.20
FP,3	1	1	1	1	1	16.77
FP,4	1	1	1	1	1	12.72
FP,5	1	1	1	1	1	12.53
FP,6	1	1	1	1	1	19.54

Figure 16. RMI $_{FP}$

Results related to financial protection and governance for risk management indicate that the country has not developed significant structural approaches to these issues. There is a disaster fund but with limited resources; other funds exist in the country but they do not directly address investment in risk reduction or disaster management, and are used for humanitarian activities.

The result of the study indicates the RMI value has been in a gradual advance from 2005 (6.84) to 2012 (17.86). However, the country's RMI value is much lower (or worse) than the Latin-American and Caribe (LAC) region's average (33.12 in 2008); especially in the area of risk identification (country 17.21; LAC average 38.62, both in 2012)[23] and governance and financial protection (country 5.25; LAC average 23.60, both in 2012). The reason of these unfavorable results could be because disaster risk management is a new issue for the country; before the major flood in 2006, affected nearly 50,000 people in the country, there was little awareness about risk management in Surinam. Even NCCR was just recently established after the flood in 2006.

[23] This value includes AR, BA, BO, CH, CO, CR, DO, ES, GU, HA, JA, ME, NI, PE, PN and TT.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of this study show the country's progress on Disaster Risk Management: DDI shows a positive progress from 2000 to 2010 in terms of the country's financial capacity to attend for rehabilitation and reconstruction. The PVI had slightly decreased (or improved) since 1985. Additionally, the country had improved the DRM performance 2005 to 2010, especially due to the framework for activities related to preparedness, risk reduction and risk identification. The financial protection and governance remained at the same level and have not contributed to the improvement on risk management in the country.

On the other hand, the absolute value of each indicator remains a great challenge for further improvement: RMI performance, for example, has a value of 17.86 in 2012 which is much lower than the average of LAC countries' average (33.12 in 2008). DRM seems to be a new development issue for the country. The result of the Indicators, especially PVI and RMI indicate some additional efforts necessary to improve the national capacity of disaster risk management. These may include:

- Suriname's socioeconomic fragility should be reduced. This includes: poverty reduction, human security improvement, dependency and literacy improvement, social disparities, unemployment, inflation, debt, and environmental deterioration reduction. Improvement of these factors may reduce not only the predisposition to be affected when faced with hazardous events but also, obviously, improve the country's socioeconomic condition.
- Improve the country's risk identification capacity necessary to plan and implement measures for disaster risk reduction. The efforts should include the development of disaster and loss inventory; hazard monitoring and forecasting and vulnerability/risk assessment.
- Increase the measures necessary for proactive disaster risk reduction and a risk transfer mechanism.

The results of this study could be an input for a disaster risk management plan of the country, or to identify the need to improve some of the issues facing disaster risk management in the country.

This study didn't include LDI because the country doesn't provide data for (or doesn't participate in) DesInventar or a database registered historical disaster events of the country. It could be recommendable to to build this disaster database or DesInventar because these will be useful not only for historical disaster impact analysis but also

for national and local development planning including land-use and environmental planning.

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APPENDIX I
NATURAL HAZARDS OF THE COUNTRY

Suriname is a country that is not characterized by the presentation of important natural hazards such as hurricanes, volcanic eruptions, earthquakes, and extensive droughts. The country is affected by coastal and rainfall flooding, and by the emerging and likely future consequences of climate change.

The climate in Suriname is one of a semi-humid type, influenced by the up and down movement of the Inter Tropical Convergence Zone (ITCZ). Hence, two rainy and two dry seasons are observed annually over the largest part of the country. Average annual rainfall in the coastal area measures about 1,500 mm and increases in the southern direction to about 2,500 mm. The abundant rainfall in Suriname has resulted in many rivers, swamps, and creeks flowing generally in the south-north direction to the Atlantic Ocean. In the coastal zone, surface freshwater resources are used for agricultural purposes, whilst groundwater, derived from various aquifers, is used for potable purposes. In the interior upland of the Suriname River, a single man-made lake has been built for generating hydroelectricity. The dominant features of the coastal zone are its fertility, the low topography, the concentration of about 90% of human activities, such as agriculture (rice and banana) and small industries, and highly important ecosystems (NIMOS, 2005).

In Suriname the coastal zone ecosystems are divided into estuarine and freshwater ecosystems. Population growth, agriculture and urbanization can worsen the impacts on the existing water resources of the country. Although greater human settlements and infrastructure are far from the ocean shoreline leaving an essential strip along the coast untouched, some locations as Nw. Nickerie, Coronie, Commewijne and Paramaribo do not present this characteristic, thus, anthropogenic impacts have resulted in some ecosystem diversification of these parts of the coastal zone and in increased erosion, resulting in ecological consequences. The beaches can suffer from erosion, and furthermore, sea-level rise with all its impacts on the coastal zone of Suriname certainly affect the nutrient rich ground adversely. Climate change will also have many indirect impacts on the global economy that will affect Suriname, but will also have more direct impacts such as Suriname's agricultural economy through increasing variability and severity in precipitation, leading to increased flood risk and also sea-level rise, thus increasing pressure on Suriname's coastal defences and land drainage and irrigation infrastructure (NIMOS, 2005) and the potential flooding of large residential areas in North Paramaribo and other coastal towns.

In addition, large-scale deforestation may enhance surface runoff and erosion of the area, resulting in degradation of the soil and consequently poor growth of vegetation in the area. The main direct causes of deforestation are: (i) mining that alters the environment with contamination of rivers, destruction of ecosystems, depredation of the fauna, invasion of lands, displacement of indigenous and maroon villages, and

introduction of diseases, and (ii) logging., Even though the country does not have an large quantity of wood with important economic value compared to other South American countries, logging has been intense, and has entailed construction of new secondary roads in the forest without any planning, creating artificial lakes and destroying parts of the jungle. It has also brought deterioration of water and forest quality, decrease of tiers, destruction of subsistence farms and restriction in the access of communities to hunting, fishery and farming areas, as well as soil erosion, run-off increase and alteration of drainage systems. In turn, fluvial systems are disturbed by the ecosystem change and the deposit of silt, provoking loss of fish population and hindering shipping. A third (iii) main cause of deforestation was the construction in 1963 of the Afobaka dam by Suralco, to give electricity to the aluminium plant, causing half of Saramacca land (nearly 1560 km^2) to be flooded, and displacing 6000 inhabitants.[24]

Accretion and erosion of the coast both affect the ecosystem of the coast in one way or another. In the case of accretion swamp water may become fresher during wet seasons, and hypersaline during the dry season. Erosion of the coast, in contrast, may increase the influence of seawater on the freshwater swamps, creating thereby conditions for the development of saline lagoons. The continuous coastal erosion seems to be stocked at those locations where agricultural areas were created after deforestation of the coastal forests. Owing to this erosion, permanent loss of land and episodic flooding of the immediate area are observed annually. This has resulted in the establishment of dykes and dams in some regions of the country as Nickerie, Coronie and Commewijne. However, both dykes as well as dams pose problems due to weak construction and the lack of maintenance. When these defences are breached or overtopped, as happens occasionally, tidal flooding by saline water causes damage to agricultural areas as well as to infrastructure such as roads and housing. Flooding also results from riverbank erosion by the strong tidal currents, and subsequent dyke failures, especially for the districts of Commewijne and Nickerie (NIMOS, 2005).

The largest part of the population of Suriname is concentrated on the coast (about 80%), followed by the southern hinterland. The population in the hinterland (especially the Amerindians and the Maroons) are settled along the upper courses of rivers, creeks and streams. The villages found at lower elevations of the river terraces are vulnerable to floods. Increased water levels of the rivers and creeks have led to emergency situations in the recent past in the country: in May 2006 a large-scale inundation in the hinterland of the country occurred due to heavy and sustained rainfall in the central, south, and south-east mountain ranges of Suriname that caused water levels in the major rivers in central and east Suriname to rise extraordinarily. Calculations based on the water-level rise in the lake suggest that in the first days of May 2006, between 3000 and 8000 m^3 per second were added, most of which must have come through the Suriname River. The volume of water must have been at least three times the maximum that was on record. The floods of 2006 affected approximately 22,000 people. The negative impact on the development of the communities was very high in terms of food guaranty, housing and economic activity.

[24] World Rainforest Movement. http://www.wrm.org.uy/

Villages and agriculture lands were under water, resulting inter alia in the disruption of food supply and temporary loss of sources of income. Figure 17 shows the affected communities in the country during the floods in May 2006, and Figure 18 shows the central affected area.

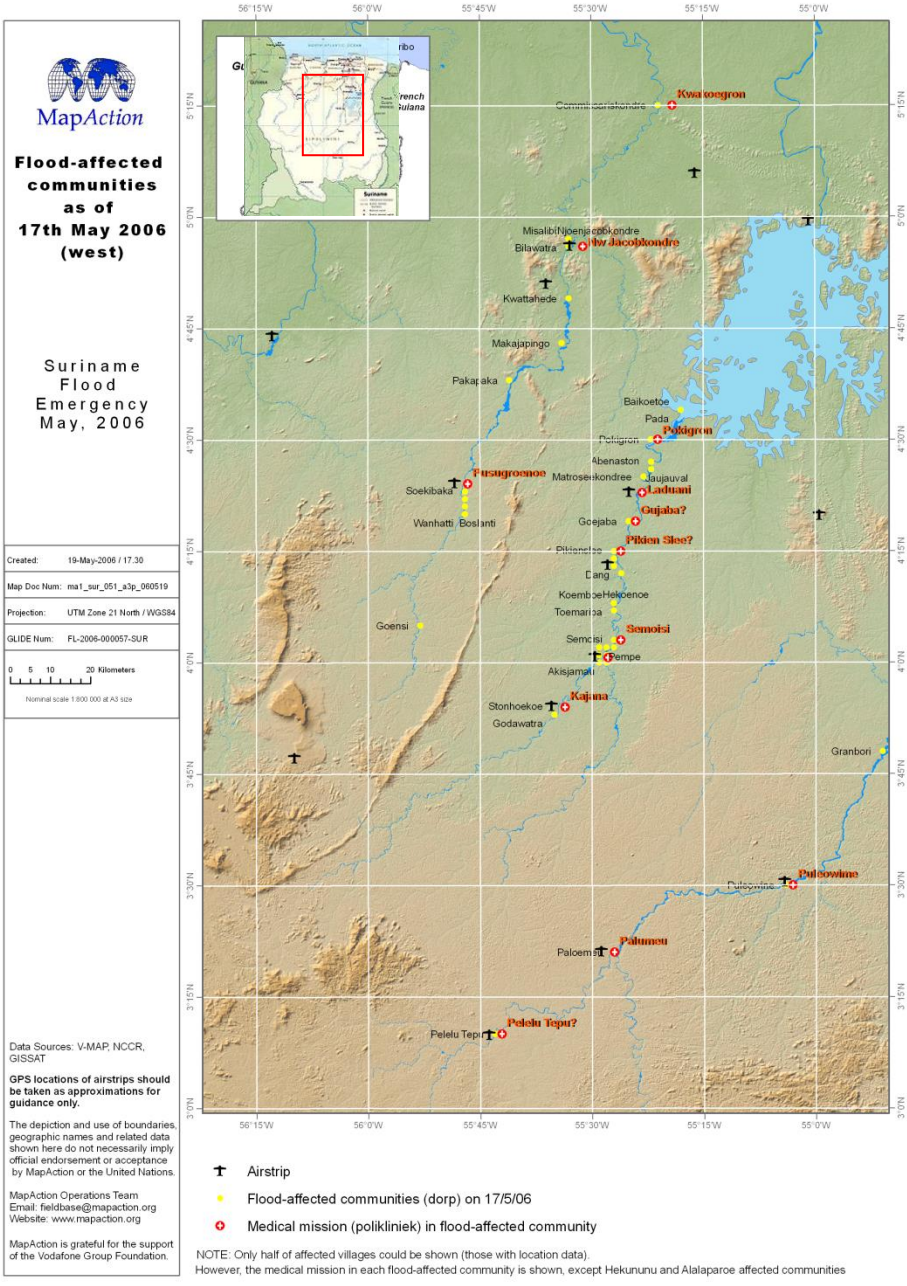

Figure 17. Affected communities in Suriname on May 2006. Adapted from the source: www.mapaction.org

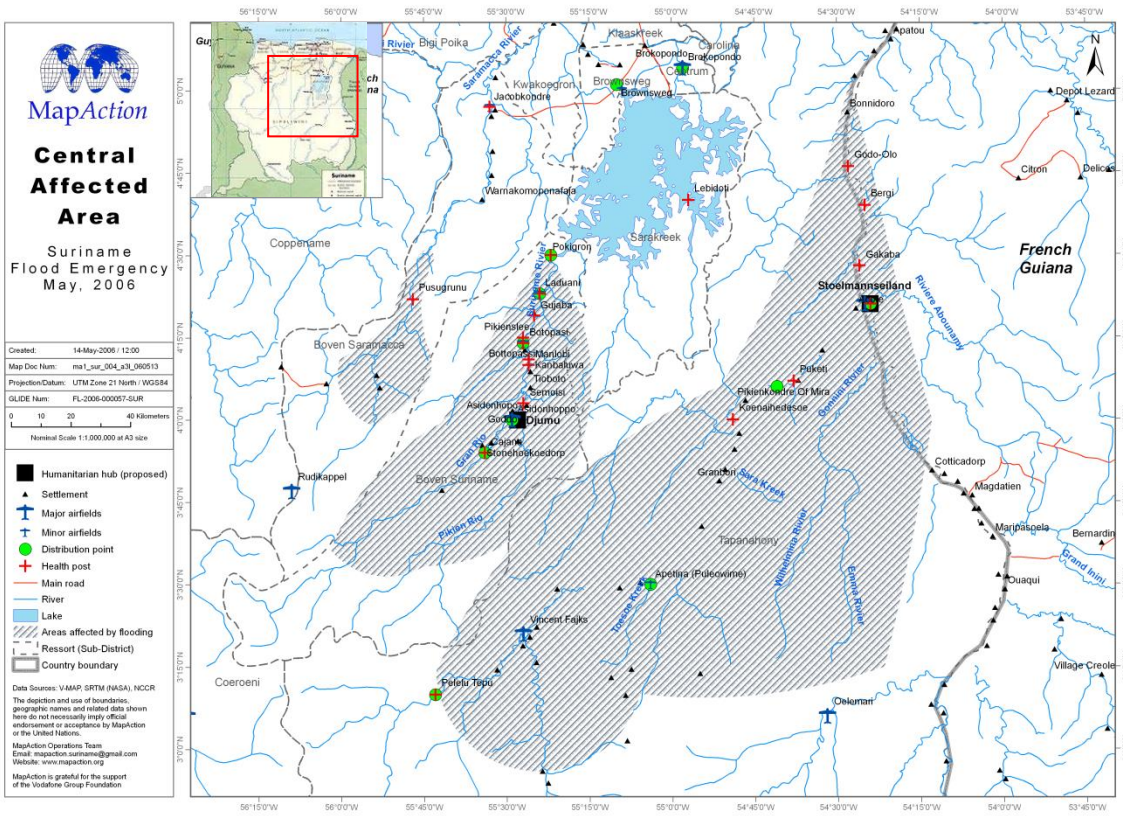

Figure 18. Central affected area in Suriname in May 2006. Adapted from the Source: www.mapaction.org

In the report from the series studies and perspectives of the Economic Commission for Latin America and the Caribbean entitled: *Suriname: the impact of the May 2006 floods on sustainable livelihoods* can be found a detailed analysis of the floods of May 2006 in the country, the socio-economic impact and the actions necessary to take to stimulate economic recovery of the affected communities.

Floods in late May 2008 resulted from a period of constant rainfall that affected several villages located on the northern part of the Marowijne River. Villages located north of the Suriname River were reported flooded, and as the water receded it became clear that many crops, on which the population relied, were destroyed. The most affected areas were in the Southern region of Suriname: Tapanahoni, Lawa, upper Marowijne and Coeroeni area. In comparison with the flooding of May 2006, the response was better on this occasion; people made early attempts to protect their personal property by moving household items to higher ground. In addition, other families elevated their houses. However, due to extremely high water levels, the damage was extensive.