

## Disaster Financial Preparedness Analysis Report

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This analysis report has been prepared by independent consultant Mr. Victor Cardenas, under the overall supervision and technical guidance of Ms. Rita Missal, UNDP Recovery Advisor a.i., Ms. Joana Sampainho, UNDP's Recovery Analyst, Mr. Sovanny Chhum, UNDP Cambodia Program Analyst, and in close collaboration with Mr. Sophal SAM, the National Project Coordinator in Cambodia.

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## Acronyms

AAL	Annual Average Loss
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
CBDRM	Community Based Disaster Risk Management
CCDM	Commune Committee for Disaster Management
CDMC	Community Disaster Management Committee
CRC	Cambodian Red Cross
DCDM	District Committee for Disaster Management
INC	Initial National Communication
IOs	International Organizations
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
Laos PDR	Lao People's Democratic Republic
MEF	Ministry of Economy and Finance
MoWRAM	Ministry of Water Resources and Meteorology
МРЖТ	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
NCDM	National Committee for Disaster Management
NGO	Non-governmental organization
PCDM	Provincial Committee for Disaster Management
PDNA	Post-Disaster Needs Assessment
SAR	Search and Rescue
SNC	Second National Communication
SPV	Special Purpose Vehicle
UNDP	United Nations Development Programme
UNDRR	UN Office for Disaster Risk Reduction
VDMG	Village Disaster Management Group
VDMT	Village Disaster Management Team

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## 1. Introduction

The Kingdom of Cambodia is located in the south of the Indochinese peninsula, bordered to the west and north by Thailand, to the east and southeast by Vietnam, on the north by Laos PDR, and to the south by the Gulf of Thailand.





Source: Author's elaboration with data from CartoDB using OpenStreetMap

It has a total area of 181,035 square kilometers (97.5% is land area and 2.5% are water areas), its population is 16.7 million (2020)<sup>2</sup>, it is divided into 24 provinces, and its capital is Phnom Penh.

Topographically, Cambodia is characterized by low, flat plains, surrounded in the north by the Dangrek mountain range and plateaus, and in the southwest by the coastal zone and the Cardamom Mountains that form natural boundaries.<sup>3</sup> It is one of the most forested countries in the region; however, the rate of deforestation continues to accelerate<sup>4</sup>.

Among its main hydrological characteristics is that approximately 80% of Cambodia's surface is located in the basin of:

- the Mekong River, the largest river in the country and the tenth largest in the world, with an extension
  of 500 kilometers in length. It enters the country from Laos and flows through the center-east through
  Kampong Cham province before joining the Tonle Sap Lake and the Bassac River in Phnom Penh,
  eventually reaching Vietnam and discharging into the South China Sea;
- Tonle Sap Lake (The Great Lake), one of the largest lakes in the world, which is located in the central western part of the lake and has a surface area of 2,590 km<sup>2</sup> in the dry season, expanding to some 24,605 km<sup>2</sup> during the wet season<sup>5</sup>; and

<sup>2</sup> World Bank (2020). Population, total - Cambodia. https://datos.bancomundial.org/indicador/sp.pop.totl?locations=KH

<sup>3</sup> Leng Heng An (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction. https:// www.adrc.asia/countryreport/KHM/2013/KHM\_CR2013B.pdf

<sup>4</sup> World Bank (n/d). Country Assessment Report for Cambodia, Strengthening of Hydrometeorological Services in Southeast Asia. World Bank, the United Nations Office for Disaster Risk Reduction (UNISDR), the National Hydrological and Meteorological Services (NHMS) and the World Meteorological Organization (WMO) with financial support from the Global Facility for Disaster Reduction and Recovery (GFDRR).

<sup>5</sup> Mekong River Commission (2020). Annual Mekong hydrology, flood and drought report 2019: Drought. in the Lower Mekong River Basin. Vientiane: MRC Secretariat. https://doi.org/10.52107/mrc.ajutoy

Figure 2. Geographical location of the water bodies in Cambodia



Source: Author's elaboration with data from Land and Water Area SEDAC – NASA

#### 1.1. Weather

The climate is tropical and humid with two seasons: the dry season, which occurs mainly in the northeast monsoon from November to April, and the rainy season (southwest monsoon) from May to November. The heaviest rainfall occurs in the months of September and October, accounting for 80% of the annual rainfall, while the months of July and August tend to be dry.<sup>6</sup> The average temperature ranges from 21 to 35 °C (69.8 to 95.0 °F).<sup>7</sup> Figure 3 shows the monthly mean daytime land surface temperature in Cambodia.





Source: Author's elaboration with data from MODIS-NASA

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<sup>6</sup> Asian Disaster Preparedness Center (ADPC) and UN Office for Disaster Risk Reduction (UNDRR), (2019). Disaster Risk Reduction in Cambodia. Status Report.

<sup>7</sup> Center for Excellence in Disaster Management & Humanitarian Assistance (2020). CAMBODIA Disaster Management Reference Handbook

## **2.** Economic impact of disasters

Due to its geographical and climatic conditions, Cambodia is one of the most disaster-prone countries in the world, ranking 15th out of 181 countries assessed in the WorldRiskIndex 2021<sup>8</sup>. The INFORM 2022 Global Risk Index<sup>9</sup> classifies it as "medium" risk, with an index of 4.8/10 (close to 0 less risky and near to 10 highly risky); however, it scores high on the indicators of "Lack of coping capacity" and "Socio-economic vulnerability."

Different types of hydrometeorological hazards, such as floods, droughts, typhoons, and lightning, occur in the country. Many local and national disaster events frequently occur because the influence of the Mekong River, on which dams have been built in its upper reaches. However, these dams restrict the flow of water that downstream countries depend on for agriculture, fishing, and human consumption. Unexpected releases of water and failures in dam operation may flood downstream communities, affecting the ecology<sup>10</sup> and agriculture<sup>11</sup>. Sites in the Dangrek Range and the Cardamom Mountains are especially vulnerable.<sup>12</sup>

According to EM-DAT,<sup>13</sup> from 1987 to 2021, there were 37 natural phenomena events that resulted in a disaster, with floods being the most frequent threat, representing 65% of the total number of events and responsible for the greatest number of deaths and amount of damage in the country. In second place and third place were typhoons and droughts, representing 16% and 19% respectively of the total number of registered events.

Year	Event	Number of events	Deaths	Total Affected	Total adjusted damages ('000 US\$)
1987	Drought	1			
1991	Flooding	1	100	900,000	298,443
1004	Drought	1		5,000,000	182,810
1994	Flooding	1	506	29,000	
1996	1996 Flooding 1		59	1,300,000	2,591
1997	Typhoon	1	25		17
1999	Flooding	2	7	660,379	813
2000	Flooding	1	347	3,448,053	251,772
2001	Drought	1		300,000	
2001	Flooding	1	56	1,669,182	22,955

#### Table 1. Events by year and natural phenomenon in Cambodia, 1987 - 2021

8 Institute for International Law of Peace and Armed Conflict (IFHV) of the Ruhr-University Bochum, (2021). WorldRiskReport. https://weltrisikobericht.de//wp-content/uploads/2021/09/WorldRiskReport\_2021\_Online.pdf

9 INFORM RISk, https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk INFORM gives each country a risk score from 1 to 10 (1 being the lowest and 10 the highest) for each of the 3 risk dimensions it measures (hazards and exposure, vulnerability and lack of coping capacity), categories and risk components.

10 Eyler, Brian & Weatherby, Courtney (2020). How China Turned Off the Tap on the Mekong River. The Stimson Center. https:// www.stimson.org/2020/new-evidence-how-china-turned-off-the-mekong-tap/

11 Beech, Hannah (2019). 'Our River Was Like a God': How Dams and China's Might Imperil the Mekong. New York Times. https:// www.nytimes. com/2019/10/12/world/asia/mekong-river-dams-china. html.

12 Noourullah Noor, (n/d). Master's thesis: Disaster risk profile in Cambodia.

13 EM-DAT, https://public.emdat.be/data

Year	Event	Number of events	Total Deaths Affected		Total adjusted damages ('000 US\$)
2002	Drought	1		650,000	57,244
2002	Flooding	1	29	1,470,000	151
2004	Flooding	1			
200E	Drought	1		600,000	
2005	Flooding	1	16		
2006	Flooding	2	5	38,000	
2007	Flooding	1	2	19,000	1,307
2009	Typhoon	2	19	178,091	
2010	Flooding	1	8		86,986
2011	Flooding	1	247	1,640,023	627,615
2012	2012 Flooding		14	71,500	
2013	Flooding	1	200	1,500,000	581,587
2014	Flooding	1	45 530,4		2,289
2015	Flooding	1		22,000	
2015	Typhoon	1		6,300	
2016	Drought	1		2,500,000	
2018	Flooding	1		5,817	
2019	Flooding	1	12	435,000	
2020	Typhoon	2	38	759,360	104,698
2024	Flooding	3		13,225	
2021	Typhoon	1	1	501	
Total		37	1736	23,745,881	2,221,278

Source: Author's elaboration with information from EM-DAT.

Figure 4 shows the total damage inflation-adjusted to 2021 recorded in EM-DAT. Notably, the floods of 2011 and 2013 caused the most damage and losses.



#### Figure 4. Damage adjusted for natural phenomena events in Cambodia

Source: Author's elaboration with information from EM-DAT.

Disasters have caused great economic strain and loss of life, affected people's livelihoods and agricultural production, and damaged social infrastructure<sup>14</sup>.

The following are descriptions of the main hazards that occur in Cambodia and the disasters they have caused.

#### 2.1. Floods

While floods in Cambodia have beneficial effects on agriculture, ecology, and fisheries, in excess, they cause loss of life, destruction of crops and livestock, and damage to homes and community infrastructure (schools, health centers, irrigation canals, and roads and bridges).

Floods occur because of the lowlands and plains in its landscape. They are most common during the monsoon season, between June and November, usually after heavy rains, where the volumes of water flow during this period represent 80-90% of the total annual flow<sup>15</sup>. This mainly affects the provinces of Battambang, Kampong Chnang, Kampong Speu, Kampong Thom, Kampot, Kandal, Pursat, and Rattanakiri.

<sup>14</sup> Asian Disaster Reduction Center (ADRC), (n/d). Information on Disaster Risk Reduction of the Member Countries, Cambodia. https://www.adrc.asia/nationinformation.php?NationCode=116&Lang=en&NationNum=06

<sup>15</sup> Mekong River Commission, (n/d). Mekong Basin Hydrology. http://www.mrcmekong.org/mekong-basin/ hydrology/

#### Figure 5. Risk of flooding from rivers in Cambodia



Source: Author's elaboration with data from Land and Water Area SEDAC – NASA

In addition, Cambodia is one of the five countries located along the Mekong River, so the overflowing of its tributaries as well as those of the Tonle Sap Lake cause flooding in the provinces of Kampong, Cham, Kratie, Kandal, Prey Veng, Stung Treng, Svay Rieng, and Takeo<sup>16</sup>. Kandal, Takeo, Prey Veng and Cham, together with the capital Phnom Penh, are located in the lower area of the country, converge with the Mekong rivers and the Tonlé Sap lake, and are the provinces with the highest population density.

The above-mentioned flooding risk is illustrated in Figure 6. Risk of flooding is mainly attributed to the Mekong River and Tonlé Sap Lake, in conjunction with the population density in those areas.

<sup>16</sup> Leng Heng An (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction. https:// www.adrc.asia/countryreport/KHM/2013/KHM\_CR2013B.pdf

#### Figure 6. Map of flood risk in Cambodia



Source: Author's elaboration with data from Population Density, taken from Land and Water Area SEDAC - NASA

The flooding is exacerbated by the deforestation in the upper Mekong River basin. Flooding also occurs when dams built upstream fail or release water.

The biggest floods that have affected the country have been:

#### 2.1.1 Floods in 1996

Due to heavy rains in China, Vietnam, and Laos, the Mekong River overflowed its banks, flooding Cambodia's provinces of Kandal, Ratanakiri, Stung Treng, Prey Veng, Kampong Cham, and the capital, Phnom Penh. They affected 1.3 million people, 600,000 hectares of crops, 50,000 homes, and caused some roads to close, interrupting communication<sup>17</sup>. Damage estimates according to EM-DAT data were US \$1.5 (US \$2.5 million<sup>18</sup>).

#### 2.1.2 Floods in 2000

The National Committee for Disaster Management (NCDM) reported that the floods affected 750,618 families (3.4 million people), mainly farmers, the elderly and children, and caused the death of 347 people (80% were children). In addition, 102 irrigation projects, 988 schools, 121 health centres, 700 km of national roads, and 1,500 km of rural roads<sup>19</sup>, as well as many houses, were damaged. Total losses are estimated at US \$160 million<sup>20</sup> (US \$251.7 million<sup>21</sup>).

<sup>17</sup> OCHA Services, (1996). First Alert Cambodia Flooding October 7 1996. UN. https://reliefweb.int/report/cambodia/first-alert-cambodia-flooding-october-7-1996

<sup>18</sup> Figures adjusted to 2021.

<sup>19</sup> Susan Postlewaite, (2000). Floods affect nearly 3 million Cambodians. The Phnom Post. https://www.phnompenhpost.com/national/floods-affect-nearly-3-million-cambodians

<sup>20</sup> ADPC (2008). Impact of Disasters on Education Sector in Cambodia. Economic Institute of Cambodia (EIC). https://www. preventionweb.net/files/15375\_mdrdeducationcambodiafinalmar08.pdf

<sup>21</sup> Figures adjusted to 2021.

#### 2.1.3 Floods in 2001

The floods affected the provinces of Stung Treng, Kratie, and Kampong Cham, killing 56 people and affecting 1.6 million. Losses were estimated at US \$15 million (US \$22.95 million<sup>22</sup>).

#### 2.1.4 Floods in 2011

In August 2011, the Mekong River began to rise due to heavy rains from Typhoons Nesat and Nalgae in late September and early October, affecting 354,217 households (over 1.7 million people) in 18 provinces. 51,950 families were evacuated, 250 people were killed, and 23 were injured. Damaged infrastructure included 115 health clinics, 1396 schools, 363 km of national/provincial roads, 177 bridges/culverts (a total of 925 km), 1842 km of rural roads, 329 irrigation systems, 77,544 wells, and 579 contaminated community ponds. In addition, 10% of rice crops were damaged, and 6.6% were destroyed.<sup>23</sup>

Preliminary estimates indicate that direct damage to property and economic losses amounted to US\$624 million, as shown in Table 2, of which 75% corresponds to damage<sup>24</sup> and the remaining 25% to losses<sup>25</sup>.

Sector	Damages	Losses	Total Impact
Infrastructure	375.70	34.70	410.40
Transport	328.60	23.30	351.90
National/provincial roads	217.90	-	217.90
Rural roads	110.70	23.70	134.40
Rural water and sanitation	20.00	11.40	31.40
Irrigation / water management	27.10	-	27.10
Channels	5.90	-	5.90
Embankments	21.20	-	21.20
Social sectors	34.70	-	34.70
Education	20.00	-	20.00
Health	3.00	-	3.00
Accommodation	11.70	-	11.70
Productive sectors	40.80	138.50	179.30
Agriculture, Livestock and Fisheries	40.80	138.50	179.30
Total	451.20	173.20	624.40

#### Table 2. Damages and losses from the 2011 floods (millions of US \$)

Source: Asian Development Bank (2012). Flood Damage Emergency Reconstruction Project, Preliminary Damage and Loss Assessment.

<sup>22</sup> Figures adjusted to 2021.

<sup>23</sup> Asian Development Bank, (2012). Flood Damage Emergency Reconstruction Project, Preliminary Damage and Loss Assessment.

<sup>24</sup> Direct impact on assets, inventory, and property.

<sup>25</sup> Indirect impact refers to the decrease in production, reduction of income, and increase in expenses, while the economy and damaged assets recover.

#### 2.1.5 Floods of 2013

In the last quarter of 2013, a combination of successive typhoons, rising Mekong River levels, transboundary flash floods in western provinces, and above-average monsoon rains caused extensive flooding in Cambodia. The NCDM reported that the floods caused the deaths of 168 people (mostly children) and damages of approximately US \$356.23 million to infrastructure,<sup>26</sup> roads, agriculture, irrigation systems, and 377,354 households (1.8 million people) in 20 provinces, of which 4 are located along the Mekong River and Tonle Sap and were the most affected<sup>27</sup>.

The 2013 floods caused less damage than those of 2011, but the impacts were more significant due to a combination of factors such as geographical extent and intensity.

Table 3. Flood	damage and	losses 2013	(million US \$)
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Sector	Damages	Losses	Total Impact
Infrastructure	134.27	-	134.27
Transport	79.61	-	79.61
Rural water and sanitation	2.66	-	2.66
Irrigation / water management	52.00	-	52.00
Social sectors	16.47	38.36	54.83
Education	15.65	0.12	15.77
Health	0.17	0.09	0.26
Accommodation	0.65	0.55	1.20
Livelihoods	-	37.60	37.60
Productive sectors	2.54	164.59	167.13
Agriculture, Livestock and Fisheries	0.36	151.50	151.86
Industry and commerce	2.15	11.30	13.45
Tourism	0.03	1.73	1.76
Marketplace	-	0.06	0.06
Total	153.28	202.95	356.23

Source: Royal Government of Cambodia (2014). Cambodia 2013, Post-Flood Early Recovery Need Assessment Report.

#### 2.1.6 Floods 2018

In July 2018, heavy storms caused the Xepian-Xe Nam Noy dam in Laos PDR to break, flooding northern Cambodia. Given that these countries do not have a shared warning system, 25,000 people were affected, and approximately26 died<sup>28.</sup>

<sup>26</sup> Royal Government of Cambodia (2014). Cambodia 2013, Post-Flood Early Recovery Need Assessment Report. National Committee for Disaster Management (NCDM), Line Ministries and the technical and financial support of the United Nations Development Programme (UNDP) and other UN Agencies and Development Partners.

<sup>27</sup> Leng Heng An (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction. https:// www.adrc.asia/countryreport/KHM/2013/KHM\_CR2013B.pdf

<sup>28</sup> CNN (2018). Cambodia to evacuate 25,000 people downstream of collapsed Laos dam. Watson, Berlinger, Olarn and Westcott. https://edition.cnn.com/2018/07/26/asia/laos-dam-collapse-intl/index.html

The water reached 11.5 meters high, so 6,000 people were affected along the river basin in the Atteapeu area<sup>29</sup>.

#### 2.1.7 Floods 2019

Heavy rains in early September 2019 caused flooding along the Mekong River basin and around Tonlé Sap Lake in Stung Treng, Kratie, Tboung Khmum, Kampong Cham, Prey Veng, and Kandal provinces due to the impact of tropical storms Podul and Kajiki and depressions with heavy rainfall.<sup>30</sup>

The Provincial Committee for Disaster Management (PCDM) reported that 94,336 families were affected, and 13,808 households were evacuated in 6 provinces; 16 people died and 5 were injured. In addition, 191 houses, 311 schools, 155 pagodas, 33 health centers, 33,502 heads of livestock, 32,037 hectares (ha) of rice, 322 ha of nurseries, 1,613 ha of crops, 64 km of national roads, 941 km of dirt roads, 233 bridges, and 157 km of dams were damaged<sup>31</sup>.

Emergency assistance from government authorities, the Cambodian Red Cross, and non-governmental organizations, was distributed in Tbong Khmom, Kampong Cham, Kratie, and Stung Treng provinces<sup>32</sup>.

#### 2.1.8 2020 Floods

In October 2020, rain fell across much of the country; approximately 176,000 households and several roads, schools, health centers, and agricultural lands were affected in 14 provinces, mainly in Pursat, Battambang, Banteay Meanchey, and Pailin<sup>33</sup>.

#### Table 4. Impact of floods on Cambodia's provinces, October 2020

Household saffected	Displaced households	Deaths	Houses affected	Affected health centers	Schools affected	Length of path concerned (m)	Agricultural land affected (ha)
175,872	14,299	38	161,552	22	686	2,148,433	329,754

Source: CFE-DM, (2020). Cambodia, Disaster Management Reference Handbook.

#### 2.2. Droughts

The frequency of droughts in Cambodia varies from place to place and occurs mainly as a result of the delayed onset of rainfall and its irregular occurrence, further aggravated by the limited coverage of irrigation facilities (currently about 20%)<sup>34</sup> and by the construction of dams upstream of the Mekong River which correlate with reduced water availability, as large-scale artificial irrigation is not yet feasible in the country.

Figure 7 presents anomalies in vegetation in March 2021 against their historical average. The lowest level of vegetation was located in the northern zone, which can be attributed to the drought in that zone.

33 Idem

<sup>29</sup> Asian Disaster Preparedness Center (ADPC) and UN Office for Disaster Risk Reduction (UNDRR), (2019). Disaster Risk Reduction in Cambodia. Status Report.

<sup>30</sup> Mekong River Commission (2020). Annual Mekong hydrology, flood and drought report 2019: Drought. in the Lower Mekong River Basin. Vientiane: MRC Secretariat. https://doi.org/10.52107/mrc.ajutoy

<sup>31</sup> Idem

<sup>32</sup> CFE-DM, (2020). Cambodia, Disaster Management Reference Handbook.

<sup>34</sup> Leng Heng An, (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction.

#### Figure 7. Drought-prone communes in Cambodia



Source: Author's elaboration with data from USDA, NASA, University of Maryland, and Global Agriculture Monitoring

Droughts severely affect the agricultural productivity of rural populations, especially rice production, which depends on rainfall or river-fed irrigation, increasing the vulnerability of households and contributing to widespread food shortages.

Droughts are the second most damaging and loss-causing hazard in Cambodia, estimated to account for nearly onefifth of rice losses between 1997 and 2010.

Periods of drought have frequently followed a destructive flood, causing deaths and considerable economic losses. Prey Veng, Kandal, Kampong Cham, Svay Rieng, Banteay Meanchey and Kampong Speu are the most drought-prone provinces<sup>35</sup>.

#### 2.2.1 Drought in 2001

The 2001 drought affected 300,000 people in the provinces of Kampong Cham, Kampong Chhnang, Kampong Speu, Kampong Speu, Kampong Thom, Kampot, Kandal, Kep, Koh Kong, Kratie, Phnom Penh, Preah Sihanouk, Prey Veng, Pursat, Svay Rieng, Takeo<sup>36</sup>.

#### 2.2.2 Drought in 2002

In 2002, drought caused damage in 10 provinces: Takeo, Kampot, Kampong Speu, Kampong Chhnang, Kandal, Prey Veng, Phnom Penh, Otdar Meanchey, Banteay Meanchey, Pursat, and Battambang. It affected 442,419 families (2,047,340 people). The total economic loss was estimated at US\$ 38 million<sup>37</sup> (US\$ 57.24 million<sup>38</sup>).

<sup>35</sup> Royal Government of Cambodia (2014). Cambodia 2013, Post-Flood Early Recovery Need Assessment Report. National Committee for Disaster Management (NCDM), Line Ministries and the technical and financial support of the United Nations Development Programme (UNDP) and other UN Agencies and Development Partners.

<sup>36</sup> Noourullah Noor, (n/d). Master's thesis: Disaster risk profile in Cambodia.

<sup>37</sup> United Nations Convention to Combat Desertification (UNCCD), (2019). Drought Initiative-Cambodia. https://knowledge.unccd. int/sites/default/files/country\_profile\_documents/1%2520FINAL\_NDP\_Cambodia%255B1157%255D.pdf

<sup>38</sup> Figures adjusted to 2021.

#### 2.2.3 Drought in 2009

Severe droughts in 2009 affected 13 provinces, where 57,965 hectares of rice crops were damaged and 2,621 hectares were destroyed<sup>39</sup>.

#### 2.2.4 Drought in 2010

In 2010, severe droughts in 12 provinces of the country destroyed 2,934 hectares of rice, and 14,103 hectares were affected along with 5,415 hectares of secondary crops<sup>40</sup>.

#### 2.2.5 Drought in 2011

In 2011, the drought affected 3,659 hectares of rice and destroyed 53 hectares<sup>41</sup>.

#### 2.2.6 Drought in 2012

In 2012, droughts in 11 provinces affected 14,190 hectares of rice and destroyed 3,151 hectares<sup>42</sup>.

#### 2.2.7 Drought of 2015-2016

The effects of El Niño in 2015 and 2016 in Cambodia resulted in less rainfall, as well as delayed rainfall, causing drought to affect 2.5 million people in 25 provinces. Significant damage was done to crops and people in poor communities who depend on rainfall to irrigate their crops. In addition, health centers reported an increase in cases of disease<sup>43</sup> linked to drought.

Particularly, the 2016 droughts were considered the worst droughts in the last five decades<sup>44</sup>, as they caused the Mekong River to reach its lowest level, 30-50% lower compared to the average every year. This mainly affected the population of Banteay Meanchey, Battambang, Pursat, and Kampong Speu provinces.

#### 2.2.8 Drought of 2018 to 2019

From late 2018 to July 2019, rains failed to occur across the country, resulting in droughts in some regions due to the delayed start of the rainy season and shortage of river water availability. According to the Japan Meteorological Agency, the characteristics of the El Niño Southern Oscillation caused these conditions<sup>45</sup>.

In 2019, the amount of water in the Tonle Sap was low, affecting the fishing activity of communities. Some districts, towns, and provinces experienced domestic water shortages, such as Khemarak Phumin's town of Koh Kong, Stung Staung of Kampong Thom province, Stung Maung Russey and Stung Sangker of Battambang, Ta Pon reservoir of Koh Kong, Stung Mongkulborey, and the Trapaing Thmar reservoir of Bateaymeanchey.

The drought extended to the rainy season due to the delay in the onset of the rains, so the agricultural sector suffered losses in 16 provinces, as 324,641 ha of rice and 44,734 ha of other crops were affected.

<sup>39</sup> United Nations Convention to Combat Desertification (UNCCD), (2019). Drought Initiative-Cambodia. https://knowledge.unccd. int/sites/default/files/country\_profile\_documents/1%2520FINAL\_NDP\_Cambodia%255B1157%255D.pdf

<sup>40</sup> Idem

<sup>41</sup> Cambodia National Committee for Disaster Management (2014). Country Report of Cambodia Disaster Management. . https:// www.adrc.asia/ countryreport/KHM/2013/KHM\_CR2013B.pdf.

<sup>42</sup> Idem

<sup>43</sup> CFE-DM, (2020). Cambodia, Disaster Management Reference Handbook.

<sup>44</sup> Noourullah Noor, (n/d). Master's thesis: Disaster risk profile in Cambodia.

<sup>45</sup> Mekong River Commission (2020). Annual Mekong hydrology, flood and drought report 2019: Drought. in the Lower Mekong River Basin. Vientiane: MRC Secretariat. https://doi.org/10.52107/mrc.ajutoy

#### 2.3. Typhoons

Typhoons are the costliest weather threat affecting East Asia and the Pacific. Some typhoons and tropical depressions that reach Indochina do not weaken over land and produce torrential rains and heavy flooding in Cambodia, which is compounded when it hits during the flood season, causing heavy rainfall<sup>46</sup>.

Between September 29th and October 5th, 2009, Cambodia was hit by Typhoon Ketsana, affecting 14 provinces, killing 43 people, and injuring 67 more. In addition, it destroyed the homes and livelihoods of approximately 49,000 families (180,000 people, equivalent to 1.4 percent of Cambodia's total)<sup>47</sup>.

The greatest damage and losses occurred in Stung Treng, southern Preah Vihear, northern Kampong Thom and the western Siem Reap provinces. Additionally, flash floods submerged parts of Ratanak Kiri, Mondul Kiri, Kratie, Oddar Meanchey, Banteay Meanchey, Battambang, Kampong Cham, Kampong Chhnang, Preah Sihanouk, and Kampot provinces, exacerbating their destructive impact<sup>48</sup>.

Total damages and losses caused by Typhoon Ketsana were estimated at US \$132 million (US \$58 million in damages and US \$74 million in losses).

#### Table 5. Summary of damages and losses caused by Typhoon Ketsana, 2009 (millions of US \$)

Sector	Damages	Losses	Total Impact
Infrastructure	17.23	11.48	28.71
Transport	14.39	11.08	25.47
Rural water and sanitation	0.06	0.39	0.46
Irrigation / water management	2.78	0.01	2.79
Energy	0.03	0.01	0.03
Social sectors	39.55	3.33	42.88
Education	24.21	3.29	27.50
Health	0.06	0.04	0.10
Housing	15.28	-	15.28
Productive sectors	1.05	59.01	60.06
Agriculture, Livestock and Fisheries	0.09	56.42	56.51
Industry and commerce	0.96	2.59	3.55
Transversal Sector	0.21	0.10	0.31
Environment	0.03	0.10	0.13
Public Administration	0.17	0.00	0.18
Total	58.04	73.93	131.96

Source: Cambodian National Committee for Disaster Management (2020). Cambodia Post-Ketsana Disaster Needs Assessment. Royal Government of Cambodia with support from the World Bank, GFDRR, UN System, ADB and ADPC.

48 Idem

<sup>46</sup> Leng Heng An (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction. https:// www.adrc.asia/countryreport/KHM/2013/KHM\_CR2013B.pdf

<sup>47</sup> Royal Government of Cambodia (2010). Cambodia Post-Ketsana Disaster Needs Assessment, Part I: Main Report. World Bank, GFDRR, UN System, ADB and ADPC, under the leadership of the Cambodian National Committee for Disaster Management. Cambodian National Committee for Disaster Management (2020). Cambodia Post-Ketsana Disaster Needs Assessment. Royal Government of Cambodia with support from the World Bank, GFDRR, UN System, ADB and ADPC.

The greatest impact was on the productive sector, agriculture, livestock, and fisheries. Particularly in the agricultural sector, the typhoon affected 10 provinces, destroying 40,136 hectares and damaging 67,355 hectares of rice crops. Total damages and losses in the agriculture, livestock and fisheries subsectors amounted to US \$56 million. Damages and losses in the industry and commerce subsectors amounted to US \$3.5 million and mainly affected micro and agribusinesses, which play a crucial role in the country's economic development.

In the infrastructure sector, total damages and losses amounted to US \$28.7 million, most of which were concentrated in the transportation subsector (US \$25.5 million). Urban, national, provincial, and rural road networks were damaged in 18 provinces. In addition, the greatest losses were derived from vehicle operating costs and prolonged travel times for cargo and passengers due to deteriorated road conditions.

In the social sectors, damages and losses amounted to US \$42.8 million, with the education subsector being the most affected (US \$24 million), followed by housing (US \$18.5 million). Schools (12% of all schools in the country) suffered the most damage and losses. In the case of housing, the most affected provinces were Kampong Thom, Preah Vihear, Ratanak Kiri, and Kratie<sup>49</sup>.

#### 2.4. Rays

Lightning poses a risk to people, livestock, and property (houses and infrastructure) in rural areas. The estimated average annual mortality rate in Cambodia from this hazard is 7.8 deaths per million people, which is among the highest in the world<sup>50</sup>.

- In 2011, lightning killed 165 people and injured 149 more;
- In 2012, 101 people died and 72 were injured<sup>51</sup>;
- During the 2016 storms, lightning killed 108 people, injured 105, damaged 9 homes, and killed 40 head of livestock<sup>52</sup>;
- According to the NCDM, in May 2018, lightning caused the death of more than 50 people and 50 head of cattle, in addition to destroying more than 2 thousand homes<sup>53</sup>.

#### 2.5. Volcanic eruptions

The danger of volcanic eruption in Cambodia is classified as "very low"<sup>54</sup>. Yeak Loam Lake is a volcanic crater lake (north-eastern Cambodia); However, there are no active volcanoes in the country and no records of volcanic disasters.

#### 2.6. Landslides

Cambodia has experienced landslides; it lost an estimated 2.5 km<sup>2</sup> of land between 1988 and 2015 due to this hazard. DRR agencies estimate that around 1,000 properties located near the banks of the Mekong River in Phnom Penh are at risk of landslides. In 2008, the property of 61 families in Russei Keo was damaged, and 4 more properties were damaged in 2009.

Landslides have also occurred in Kampong Cham along the banks of the Mekong River. In the 2011 floods, 28 houses and a stretch of road were washed into the river.

<sup>49</sup> Cambodian National Committee for Disaster Management (2020). Cambodia Post-Ketsana Disaster Needs Assessment. Royal Government of Cambodia with support from the World Bank, GFDRR, UN System, ADB and ADPC.

<sup>50</sup> Open Development Cambodia, (2016). Disasters. https://opendevelopmentcambodia.net/topics/disasters/

<sup>51</sup> Leng Heng An, (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction.

<sup>52</sup> OpenDevelopment Cambodia, (July 20, 2016). Disasters. https://opendevelopmentcambodia.net/topics/ disasters/

<sup>53</sup> Khouth Sophak Chakrya (May 21, 2018). Lightning strikes death toll continues to rise. The Phnom Penh Post. https://www. phnompenhpost.com/national/lightning-strikes-death-toll-continues-rise

<sup>54</sup> ThinkHazard!. https://thinkhazard.org/es/report/44-cambodia/VA

In Roka Thom, landslides have occurred during the flood season. Additionally, these events have been associated with the dredging of the Mekong River for sand to be used in the construction industry. As a result, the government stopped licensing sand dredging companies. However, it is believed that many companies still operate illegally<sup>55</sup>.

#### 2.7. Climate change

Disasters in Cambodia have been exacerbated by the impacts of climate change. Floods, droughts, and typhoons are increasing in frequency and causing severe damage,<sup>56</sup> affecting food security (as almost 90% of the population is engaged in agricultural activities and approximately 80% relies on subsistence crops), livelihoods, health care, and education<sup>57</sup>.

In Cambodia, rising temperatures, changing sea levels, and changing hydrological cycles are expected to reduce the productivity of agriculture, fisheries, and labor<sup>58</sup>.

Although flood and drought disasters are frequent in Cambodia, global warming may increase the country's wet season rainfall and decrease it during the dry season, in addition to the high spatial and temporal variability<sup>59</sup> in loss and damages recurrency.

The Initial National Communication (INC) and the Second National Communication (SNC) indicate that Cambodia's average surface temperature has increased by 0.8°C since 1960 and is projected RCP2.6 Ensemble 28.12 °C (27.70 °C to 28.48 °C) RCP8.5 Ensemble 28.99 °C (28.35 °C to 29.87 °C)<sup>60</sup>, depending on location. The rate of temperature increase is higher in low altitude areas than in high altitude areas<sup>61</sup>. However, Cambodia is projected to experience warming of 3.1°C by the 2090s, against the baseline conditions over 1986–2005 under the highest emissions pathway, RCP8.5.

An increase in temperature is likely to affect agricultural productivity. According to the International Rice Research Institute, rice grain yield decreases by 10% for every 1°C increase in minimum (night) temperatures during the dry season along the growing period<sup>62</sup>.

Additionally, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) shows that global sea level rise is projected to be between 18 cm and 50 cm by 2100 according to SRESB1 and SRESA2, respectively.

<sup>55</sup> People in Need (2015). Urbanizing disaster risk, vulnerability of the urban poor in Cambodia to flooding and other hazards. Project funded by Disaster Preparedness Program of European Commission Humanitarian Aid and Civil Protection (DIPECHO). The project is implemented by a consortium of five international organizations: ActionAid, DanChurchAid/ Christian Aid, Oxfam, People in Need and Save the Children.

<sup>56</sup> National Committee for Disaster Management (NCDM) (2014). Cambodia: Climate change action plan for disaster management sector 2014-2018. https://www.preventionweb.net/english/policies/v. php?id=64963&cid=29.

<sup>57</sup> Center for Excellence in Disaster Management & Humanitarian Assistance (2020). CAMBODIA, Disaster Management Reference Handbook

<sup>58</sup> CFE-DM, (2020). Cambodia, Disaster Management Reference Handbook.

<sup>59</sup> World Bank (n/d). Country Assessment Report for Cambodia, Strengthening of Hydrometeorological Services in Southeast Asia. World Bank, the United Nations Office for Disaster Risk Reduction (UNISDR), the National Hydrological and Meteorological Services (NHMS) and the World Meteorological Organization (WMO) with financial support from the Global Facility for Disaster Reduction and Recovery (GFDRR).

<sup>60</sup> https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-projections

<sup>61</sup> Royal Government of Cambodia (2013). Cambodia Climate Change Strategic Plan 2014 - 2023 National Climate Change Committee.

<sup>62</sup> Idem

#### 2.8. Road network: National and rural roads

Cambodia has four main growth sectors: agriculture, tourism, manufacturing (garments for export), and commercial and residential construction. However, these are all dependent on transportation for economic growth<sup>63</sup>.

Road Length (ir	ו Kms)					Paved with	
Category	Total Length	Share in Network (%)	Number of Road Lines	Number of Bridges	Bridge Length (m)	DBST, Asphalt Concrete, or Cement Concrete (%)	Agency
Natonal (1 digit)	2,254	4	9	589	17,643	100	MPWT
National (2 digit)	5,007	8	66	395	8,892	74	MPWT
Provincial (3 & 4 digit)	10,863	15	627	1,368	26,032	36	MPWT
Rural Roads	47,920	74	15,209	2,128	30,245	5	MRD
Total	66,044	100	15,911	4,480	82,812		

#### Table 6. Cambodia Total Road Network

Notes: MPWT: Ministry of Public Works and Transport; MRD: Ministry of Rural Development

Sources: MPWT (2022) & MRD (2020)

Taken from: ADB-UNDP-TA 9955 REG: Building Disaster-Resilient Infrastructure through Enhanced Knowledge, Output 3: Resilient Recovery Capacity Enhanced. Consultancy Deliverable Report – Delivery 3

Cambodia's road network was largely destroyed during the 1970s and 1980s, mainly because the civil war, and has grown in recent years, increasing from 46,245 kilometers in 2013 to 63,072 kilometers in 2019. However, rural roads comprise about 74% of the network, and of these, only 5% are paved, even though 79% of the country's population lives in rural areas<sup>64</sup>.

The infrastructure sector (transport, water and sanitation, irrigation and energy) is vulnerable to the impacts of natural disasters due to Cambodia's topography and tropical climate, and the transport sector in particular is aggravated by the large proportion of unpaved and poorly maintained roads, with recurrent flooding along the Mekong River and its tributaries and the Tonle Sap Lake affecting the country's road network.

Figure 8 shows Cambodia's road network, with primary roads in red and secondary roads in purple, as well as flooding zones shaded in blue. Most of the roads are susceptible to flooding, as they are located within the areas that are covered by water.

<sup>63</sup> Asian Development Bank (ADB), (2011). Cambodia: Transport sector assessment, strategy, and road map. Mandaluyong City, Philippines: Asian Development Bank, 2011.

<sup>64</sup> World Bank (2020). Cambodia Road Connectivity Improvement (P169930), Project Information Document (PID). https://documents1.worldbank.org/curated/en/875471585044674723/pdf/Project-Information-Document-Cambodia-Road-Connectivity-Improvement-P169930.pdf

#### Figure 8. Cambodia road network and flood zones.



Source: Author's elaboration with data from OpenStreetMap, gROADS del SEDAC, and Land and Water Area SEDAC – NASA

The following table shows the amount of damage and losses in the transport sector due to the typhoon Ketsana (2009) and floods (2011 and 2013).

Table	<b>7.</b>	Summary	y of da	mages	and	losses	from	Typhoon	Ketsana	(2009)	and	floods	(2011	and
2013	) in	Cambod	lia (mil	lion US	\$)									

	Typhoon 2009			Flood 2011			Flood 2013		
Sector	Damages	Losses	Total Impact	Damages	Losses	Total Impact	Damages	Losses	Total Impact
Transport (% total impact) 14.4 (56%)		11.08 (44%)	25.47 (100%)	328.6 (93%)	23.3 (7%)	351.9 (100%)	79.6 (100%)	-	79.6 (100%)
Total sectors	58.0	73.9	132.0	451.2	173.2	624.4	153.3	203.0	356.2
Transport as % of Total	25%	15%	19%	73%	13%	56%	52%	0%	22%

Source: Source: Asian Development Bank (2012). Flood Damage Emergency Reconstruction Project, Preliminary Damage and Loss Assessment / Royal Government of Cambodia (2014). Cambodia 2013, Post-Flood Early Recovery Need Assessment Report / Cambodian National Committee for Disaster Management (2020). Cambodia Post-Ketsana Disaster Needs Assessment. Royal Government of Cambodia with support from the World Bank, GFDRR, UN System, ADB and ADPC.

The 2013 floods caused damage to 440 km of national, provincial, and urban roads, and 1,557 km of rural roads administered by the Ministry of Rural Development (MRD). The most affected provinces were: Battambang, Banteay Meanchey, Siem Reap, Kampong Cham, and Prey Veng. Damage to rural infrastructure was significant<sup>65</sup>.

<sup>65</sup> Royal Government of Cambodia (2014). Cambodia 2013, Post-Flood Early Recovery Need Assessment Report. National Committee for Disaster Management (NCDM), Line Ministries and the technical and financial support of the United Nations Development Programme (UNDP) and other UN Agencies and Development Partners.

Road classification	Length (km)	Infrastructure (number)	Administration	
		Bridges: 18		
National	64.7	Pipe culverts: 40 Box culverts: 6	MPWT	
Provincial	310			
From the city				
		Bridges: 28		
		Pipe culverts: 404		
Rural roads	1,557	Pipe culverts: 404	MRD	
		Drawer culverts: 115		
		Channels (Spillways): 8		

#### Table 8. Damage caused to highways and roads by the 2013 floods.

Source: Royal Government of Cambodia (2014). Cambodia 2013, Post-Flood Early Recovery Need Assessment Report.

During the 2014 floods, the infrastructure sector incurred about 86% of the total damage, mainly to roads, water and irrigation. There was also an increase in economic losses due to the disruption of connectivity that affected market access for key goods, such as agricultural products<sup>66</sup>.

<sup>66</sup> Kingdom of Cambodia. 2014. Post-Flood Early Recovery Need Assessment Report.

### 3. Local Legal and institutional arrangement for disasters management

#### 3.1. Local arrangement

In 1995, Sub-Decree No.54 ANKR-BK established the National Committee for Disaster Management (NCDM)<sup>67</sup>, with the objectives of providing timely and effective assistance<sup>68</sup> to victims during an emergency and developing preventive measures<sup>69</sup> to reduce loss of life and infrastructure. The Prime Minister serve as the chair, and the committee consists of 22 members from different Ministries, the Cambodian Armed Forces, and the Civil Aviation Authority, as well as representatives from the Cambodian Red Cross Society<sup>70</sup>.

In addition, several sub-decrees have been issued to strengthen the NCDM<sup>71</sup>:

- No. 30 ANKR.BK, dated April 9, 2002, established the organizational and operational structure of the disaster management mechanism from the national level down to the commune and village levels through the National and Sub-National Committees for Disaster Management;
- No. 61 ANKR.BK of June 2006 mandated the establishment of the Community Disaster Management Committee (CDMC);
- NCDM Direction No. 315, dated July 21, 2010, established the Village Disaster Management Team (VDMT) for the implementation of Community Based Disaster Risk Management (CBDRM).

NCDM mandates include<sup>72</sup> :

- Implementing prevention and mitigation strategies to reduce the impact of disasters and issuing policies and recommending guidelines for emergency and disaster management, such as emergency management plans and procedures.
- Building an effective system for disaster prevention, effective response, and rapid disaster recovery by strengthening national and provincial level coordination, as well as institutional and human resource capacities.
- Making recommendations to the government on issues and policies related to adequate disaster preparedness, emergency response, and rehabilitation (e.g., funding, human resources, equipment, etc.).
- Conducting education, awareness, and community participation programs in emergency management.
- Collection, analysis, and dissemination of research data on floods, droughts, storms, wildfires, epidemicprone areas, and other hazards in the development of emergency preparedness and response plans.

#### The organizational structure of the NCDM is presented in Figure 9.

- 67 Disaster Management status of the Kingdom of Cambodia (n.d.). http://afeo.org/wp-content/uploads/2019/03/BEC-Disaster-Management-System-in-Cambodia.pdf
- 68 NCDM contacts national and international agencies working on the emergency in Cambodia.
- 69 Emergency preparedness is about strengthening the capacity of its member agencies and promoting self-reliance at the national and provincial levels.
- 70 Asian Disaster Reduction Center (ADRC), (n/d). Information on Disaster Risk Reduction of the Member Countries, Cambodia. https://www.adrc.asia/nationinformation.php?NationCode=116&Lang=en&NationNum=06
- 71 Leng Heng An (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction. https:// www.adrc.asia/countryreport/KHM/2013/KHM\_CR2013B.pdf
- 72 Disaster Management status of the Kingdom of Cambodia (n.d.). http://afeo.org/wp-content/uploads/2019/03/BEC-Disaster-Management-System-in-Cambodia.pdf

#### Figure 9. Organizational structure of the NCDM



Source: FAO, UNICEF and WFP, (2020). Roadmap - Developing a risk-informed and shock-responsive social protection System, Cambodia.

The NCDM has a Secretariat that directs, coordinates, and serves as a focal point for disaster management information and issues, as well as provides support to the NCDM. In addition, as part of the decentralization process, disaster management institutions such as the Provincial Committee for Disaster Management (PCDM), District Committee for Disaster Management (DCDM), and Commune Committee for Disaster Management (CCDM), have been established to spearhead disaster management at their respective levels. The Village Disaster Management Group (VDMG) is the lowest level body for disaster management.

The NCDM General Secretariat is assigned the following responsibilities<sup>73</sup> :

- Ensure the continuity and functioning of the NCDM administration;
- Conduct research on floods, droughts, storms, wildfires, epidemic-prone areas, and other hazards and prepare emergency preparedness and response plans;
- Instruct the provincial/municipal, district, commune, disaster management committee, and relief communities on the work and technical skills required for collecting disaster data for damage and needs assessment and preparing rehabilitation and reconstruction programmes for damaged infrastructure in coordination with concerned institutions, UN agencies, International Organizations (IOs), and Non-Governmental Organization (NGOs);
- Formulate a technical training program for officials who perform Disaster Management functions in the provinces, municipalities, districts, precincts, and relief communities within the framework of training within and outside the country;
- Coordinate work with relevant ministries/institutions, local authorities, UN agencies, IOs, and NGOs to evacuate vulnerable people to shelters and provide security, public education, emergency response, and other programmes;
- Provide feedback on Disaster Management related documents and letters of consent;
- Summarize the report and submit it to the National Disaster Management Committee.

<sup>73</sup> Leng Heng An (2014). Country Report of Cambodia Disaster Management. Assistant to Secretary General, National Committee for Disaster Management (NCDM), Royal Government of Cambodia & Visiting Researcher of Asian Disaster Reduction. https:// www.adrc.asia/countryreport/KHM/2013/KHM\_CR2013B.pdf

#### Figure 10. Organizational structure NCDM General Secretariat



Source: Proclaim 23 Bro.Kor.Bor.Sor on Organization and functioning of subordinate offices of NCDM, 6 March 2020.

The NCDM Secretariat General has the following responsibilities<sup>74</sup> :

- Ensure the sustainability of the administrative process of the NCDM.
- Prepare documents, norms, legal frameworks, policies, action plans, projects, programs, drafts, documents for national, regional and international meetings.
- Coordinate with ministries, institutions, the armed forces, local authorities at all levels, other relevant public sectors, the private sector, civil society in the implementation of the disaster management framework.
- Coordinate international cooperation as well as ASEAN affairs on disaster management.
- Scientific and technical research related to the causes and consequences of disasters.
- Estimate the damage, loss and needs of the disaster, including gender work.
- Collect and manage of disaster data.
- Develop disaster management work plans and seek cooperation from international development partners, public sector, private sector, civil society and other sources.
- Develop a campaign forum on exercises related to disaster preparedness and response.
- Raise a budget for expenditures, implementation of the disaster management action plan and the operation of the NCDM.
- Organize meetings, make minutes and report of the NCDM.
- Monitor, control, summarize the situation and disaster management activities on a monthly, quarterly, semi-annual and annual basis for the NCDM.
- Perform other duties assigned by the NCDM.

<sup>74</sup> Disaster Management status of the Kingdom of Cambodia (n.d.). http://afeo.org/wp-content/uploads/2019/03/BEC-Disaster-Management-System-in-Cambodia.pdf

#### 3.1.1 Sub-national level

Disaster management committees were established at the provincial, district, and communal levels, retaining similar governance structures and officials at all levels.

- 1. The tasks of the Provincial/Municipal Committee for Disaster Management are as follows:
  - Implement the National Policy for Disaster Management;
  - Prepare guidelines and support the activities of the District/Precinct Disaster Management Committee;
  - Make recommendations to the NCDM on the activities of the concerned institutions and Cambodian Red Cross (CRC), Assistance of National Organizations, and IOs involved in disaster prevention, preparedness, emergency response, and rehabilitation;
  - Write a report and submit it to the NCDM on the damage, and make a proposal for a budget, equipment, materials, means of transport, and intervention force for disaster response;
  - Carry out the training program in order to strengthen the technical capacity of disaster management officials, as well as public education programs in the communities.
- 2. The duties of the District/ Precinct Disaster Management Committee are to:
  - Implement the National Policy involved in Disaster Management;
  - Select the officials who will participate in the Disaster Management training course at the National or Provincial/Municipal level;
  - Prepare and disseminate disaster-related information;
  - Submit the damage and needs report to the Provincial/Municipal Committee for Disaster Management;
  - Direct operations during a disaster, including relief assistance, evacuation, sheltering, and medical supplies;
  - Submit the summary report of the relief operation and assistance to the Provincial/Municipal Disaster Management Committee.

#### 3.1.2 Legal System

The Disaster Management Act, passed in July 2015, formalized the NDMC's role as the lead administrator and coordinator of disaster activities. It focuses on risk identification and mitigation campaigns, defines the roles and responsibilities of ministries and other institutions to improve inter-ministerial coordination and develop disaster risk reduction, response, and recovery strategies; and establishes how these activities will be funded<sup>75</sup>.

The regulation guarantees the budget for the NCDM and national or sub-national authorities for the implementation of disaster management in Cambodia. It also includes a guideline for setting aside assets to be used by the public and private sectors, the armed forces, civil society, and other institutions for emergency response<sup>76</sup>.

The constitution states that only the King can declare a national state of emergency, which the Disaster Management Act defines as an event that is beyond the capacity of local authorities. A Governor may recommend that a municipality or province be declared in a State of Emergency if several conditions are demonstrated that all relate to ex-post destruction<sup>77</sup>.

<sup>75</sup> Noor, N. (n/d). Master's Thesis: Disaster Risk Profile in Cambodia. University of Oviedo - Department of Medicine Emergency and Disaster Research Unit.

<sup>76</sup> Asian Disaster Preparedness Center (ADPC) and UN Office for Disaster Risk Reduction (UNDRR), (2019). Disaster Risk Reduction in Cambodia. Status Report.

<sup>77</sup> FAO, UNICEF and WFP, (2020). Roadmap - Developing a risk-informed and shock-responsive social protection System, Cambodia.

## **3.2. Public finance management and disaster finance preparedness**

After the consultation meetings with the Government of Cambodia (GoC) through the Ministry of Economy and Finance (MEF), the Ministry of Public Works and Transport (MPWT), the Ministry of Rural Development (MRD), and the Ministry of Water Resources and Meteorology (MoWRAM), the pre-disaster and post-disaster budget flow was analyzed, in particular the funding for post-disaster recovery.

The financing of disaster losses rests on two fundamental sources: the national budget and the support of international entities, also known as international partners (donors, multilateral and bilateral).

With respect to budgetary resources, each fiscal year, resources are allocated to the main ministries involved in disaster risk management, and these are earmarked under two budget headings: emergency response and maintenance.

However, in the face of the onslaught of natural phenomena, the most severe events quickly exhaust the resources originally budgeted, so an inter-ministerial committee (usually composed of MEF, MPWT, MRD, and MoWRAM) convenes to prioritize funding needs, based on a preliminary estimate of losses and damages, in order to address the remaining events.

The inter-ministerial committee, depending on the severity of the catastrophic event, makes budget reallocations to the ministries and, through the MEF, approaches the international community to request support. International partners also evaluate the severity of the event and, in collaboration with the government authorities (MEF, MPWT, MRD and MoWRAM), decide how and in what amounts they can support, as well as establish a work program.

For this phase of the disaster, depending on the severity of the event, there may or may not be support from international partners, and assistance to victims and the emergency are a priority. The MEF, within the scope of its powers, allows the ministries involved to execute the available budget in an expeditious manner, facilitating time cuts and authorizations in the procedures for the exercise of spending, which can be made after the emergency.

Finally, the reconstruction phase involves a more complex process, mainly because the assessment of losses and damages, as well as the cost of total or partial reconstruction of the affected infrastructure, should have been completed by this phase. In addition, an investment project is implemented for this reconstruction, financed through the budget, but with the support of international partners, and resources are channeled through sectoral ministries, which, depending on the infrastructure of concern, involve subnational entities (provinces, districts, municipalities, and communes). Financial resources are allocated on a multi-annual basis, so that they are accrued as the reconstruction of the work proceeds. The recovery funding budget flow is shown in Figure 11, which reads from left to right. Note that the flow is composed of 4 phases: A, B, C and D.

- Phase A corresponds to the budget allocation made each year;
- Phase B of the budget flow occurs once the catastrophic natural phenomenon has occurred, usually lasting a few days to a few weeks;
- Phase C corresponds to the actual emergency management, which can take weeks or even months;
- Finally, Phase D, which considers the financing of reconstruction, particularly for works at the national level, usually takes years to execute.

Depending on the infrastructure, subnational entities may be involved in this last phase, either as beneficiaries of the infrastructure or as active entities in the execution of public works.

### Figure 11. Recovery financing from a budget perspective for Cambodia (considering national to sub-national level)



Source: Author's elaboration and elements taken from stakeholders' meetings

## **4.** Risk reduction and disaster risk financing: An analytical framework

The methodology for financial management of disaster risks and risk reduction, which has three components that are applied sequentially, is presented below. The first is related to risk analysis and considers knowing the assets exposed to risk, analyzing their characteristics in the face of hazards, and determining the potential losses that may occur in the face of a broad menu of catastrophic events' severities.

The second component of the methodology considers risk reduction in which, from the initial risk analysis, structural risk reduction measures are defined in the assets studied. These measures are selected for their viability and efficiency from a structural engineering perspective, and the unaffordability of the country's budgetary restrictions is considered.

Finally, the third component addresses how to use financial instruments for residual risk management, for which the distribution of probable losses is known, given the implementation of risk reduction measures. Based on the new risk scenario, the risk is managed through financial instruments that allow for financing of the probable losses in a cost-efficient manner.

The role of financial instruments is to enable the rapid mobilization of resources in the event of a disaster and to provide protection for the contractor's finances. Actors can combine various risk retention and risk transfer financial instruments to meet the costs of emergency care and post-disaster recovery.

#### Figure 12. Methodology for risk reduction and financial risk management

#### 3 **Risk Assessment Risk Reduction Risk Financing** Development of assets Assessment of vulnerability on Managing residual risk through inventory exposed, modeling strategic assets, proposing a portfolio of innovative catastrophe risk against natural structural reduction risk financial instruments hazards. measures through structural engineering techniques economically affordable

Source: Author's elaboration.

#### 4.1. Component 1: Risk analysis

International practices for catastrophic risk modeling were used, which suggest breaking down the analysis into three independents but closely interconnected modules.

Figure 12 indicates the three main modules that the risk analysis models consider: 1) Infrastructure Identification, 2) Natural Hazard Modelling, and 3) Risk Financing Modelling. The third module is based on 1 and 2 modules to assess the suitability of financial instruments according to the natural hazard occurrence and the probable losses given the vulnerability of each relevant assets type. In other words, considering the 1 and 2 modules outcomes, in terms of

assets inventory and the impact of natural hazards, the probabilistic losses, in terms of exceedance probability, are the base of the risk financing modeling.

In the third module, the analysis of modules 1 and 2 is considered. For example, in module 1, the risk analysis has been developed, the degree of exposure and vulnerability of the assets exposed to natural hazards is determined. The second module analyzes specific mitigation measures in order to determine whether they could reduce vulnerability by reducing exposure. In the third module, the results of the first module will be reviewed and possible financing options will be examined (prior to any mitigation measures being implemented), and with regard to module 2, module 3 will analyze the results of the mitigation measures that have been implemented. Therefore, module 3 can calculate a set of financial instruments before and after mitigation measures, in order to analyze how the mitigation measures affect the instruments.



#### Figure 13. Main modules of a catastrophic risk analysis

Source: Author's elaboration.

The first of the modules develops a detailed analysis of the exposed assets, for which a database is constructed that describes these assets, including occupancy type, GPS location and physical features, including building material. Figure 14 describes the sequence of activities to be carried out within this module. First, the variables that describe the information inherent to the assets are defined (for example, the location and physical characteristics, among other variables). Subsequently, a detailed analysis of these variables is performed, in order to assess the quality and level of data availability found. Once the information is collected, it is classified and analyzed. Finally, depending on the type of asset, a specific methodology is defined for those missing data variables and that by their nature are required for subsequent modules. For this purpose, a missing data treatment methodology was developed.

#### Figure 14. Development of inventory of relevant assets



Source: Author's elaboration.

Natural hazard modelling (see Figure 15) is usually divided into three components. The first is the selection of data that best describes the natural hazard, usually using information from both local and international agencies.

Subsequently, the collected data are modeled in terms of analytical framework that describe the behavior of a particular phenomenon.

Finally, once the phenomenon has been modeled, using probabilistic tools, its behavior is simulated in a few tens to hundreds of thousands of scenarios, which allows us to build a catalog of events and assign them a probability.

This modeling simulate potential future events that are likely to occur, in several sizes, severities and locations to be affected, as well as the frequency in a given location.

#### Figure 15. Modeling natural hazards



Source: Author's elaboration.

## 4.2. Component 2: Risk reduction as the spearhead of risk management

A first approach to understanding the dynamics of disaster risk financing and risk reduction is to consider two dimensions: time and the need for resources to act in the post-disaster phase (see Figure 16).

Regarding the timing of the need for resources, for example, post-disaster programs can take months and sometimes involve years of planning before they can be implemented. The removal of debris and reconstruction of lightly damaged rural roads can be accomplished within a few weeks to months of work, for example. On the other hand, when it comes to highly specialized infrastructure, such as high-specification roads, bridges, or dams, among others, the technical design and bidding process alone can take years and the construction and operation process can take a few more. The appropriate instrument must consider that not all resources are required immediately after the disaster has occurred. In this sense, resources are usually required for reconstruction over longer periods of time than for emergency relief.

#### Figure 16. Main phases of post-disaster funding needs



Source: Author elaboration with elements taken from Ghesquiere y Mahul (2010)

Risk management methodologies have a defining impact on the selection of what and how much of an instrument to use. To the extent that disaster risk lays ground for instrument selection, it will help define the magnitude of the instrument to be used.

For example, in Figure 17, two parts are shown. On the left side is the exceedance probability curve of a hypothetical country. This curve shows us, on the horizontal axis, the amount of loss, and on the vertical axis (see Figure 17 left side), the exceedance probability.

Note that on the left side of Figure 17, the curve described is ascending and asymptotic to zero, i.e., as the values of the vertical axis (exceedance probability), the probabilistic losses tend to infinity and are capped by the exposed assets value.

Hence, the question arises as to whether any combination of instruments is suitable for funding these probabilistic losses. To answer this question properly, it is necessary to have an understanding of the specific structure of the exceedance probability curve, as well as the parameters associated with each instrument of financing that needs to be assessed.

Figure 17, on the right-hand side, shows another type of exceedance probability (EP) curve, on the horizontal axis, the estimated return of period, and on the vertical axis (see Figure 17 right side), the loss amount.

This chart indicates another method of expressing EP probability is terms of return period, which describes the expected likelihood of a loss of a given size occurring within a given timescale. As an example, a 50-year return period states that, on average, an event/scenario will repeat itself once every 50 years when repeated samples are taken.

Then, Figure 17, on the right-hand side, shows the same information of EP Curve (left-hand side), but in terms of the return of period. To switch between these two metrics, follow these metrics: Loss Return Period = 1/(Exceedance Probability) and then, Exceedance Probability = 1/(Loss Return Period).



#### Figure 17. Exceedance probabilistic curve and post-disaster financial needs

Source: Author elaboration

Figure 18 considers the investment in risk reduction. The dotted line, below the solid line, shows the fact that risk reduction has a structural effect on the analytical understanding of risk, that is, investing in such a project or projects decreases the risk. Therefore, for the same probability of exceedance, the probabilistic loss decreases. The magnitude of this decrease will depend on the amount of investment and in particular on the structural engineering factors that will be carried out as a risk reduction measure.

#### Figure 18. Investment risk reduction effect in risk financing strategy



Source: Czajkowski, Jeffrey & Russo, Elisabetta & Brandenburg, Aaron & Groshong, Lisa & Young, Michael & Nielsen, Matt & Cope, Anne & Giammanco, Ian. (2020). Application of Wildfire Mitigation to Insured Property Exposure. 10.13140/RG.2.2.13898.39366.

Figure 18 condenses not only the risk and financing gap reduction due to mitigation measures, which has structural effects on the description of risk in the long term.

Therefore, in terms of a risk financing strategy, the ex-ante risk financing instruments should reflect these, i.e., risk mitigation and the dispersion of financing at each stage of the disaster in accordance with the risk described by the exceedance probability curve.

#### 4.3. Component 3: Risk financing

Finally, the third module is based on the interaction of modules 1 and 2, which generates loss scenarios, typically by generating exceedance probability curves. These curves are the starting point for the financial analysis. The first element is the identification of the instruments available in the country, to later model the behavior of the instrument for the generated exceedance probability curve. In the last stage, by means of statistical analysis of simulation, the behavior of the instruments are studied in terms of economic efficiency, that is to say, for what type of losses (low recurrence and high severity, to high recurrence and low severity) the instrument has a better yield.

#### Figure 19. Modeling risk financing



Source: Author's elaboration.

Once the distribution of probable disaster losses is known, the next step is the financial management of residual risk through financial instruments for disaster risk management that allow the financing of such losses in a timely and costeffective manner. The following sections present the characteristics of financial instruments for risk management that the government can use.

#### 4.3.1 Instruments for financing risk retention: for lower and highest frequency events

Risk retention financing instruments make it possible to manage disaster losses using government's own resources, assume a first part of the loss in exchange for a reduction in the cost of risk transfer, and are generally used when transferring risk.

- It could be economically efficient for low severity events that generate minor losses but have a high probability of occurrence.
- For some low-frequency events, i.e., low probability of occurrence, but high severity, generate large losses, risk retention could be not enough to finance it.

Depending on the type of risk, it must be determined whether a risk retention instrument for risk management is efficient.

An advantage of risk retention instruments is the flexibility in deciding how and when they would have to be disbursed. However, in order to use them, the restrictions in the applicable regulatory framework for setting up reserves should be reviewed<sup>78</sup>, as well as the minimum average balance that they should have in a year to face the average losses that could occur, and that they do not represent idle resources. Finally, these instruments require the definition of clear and transparent rules for their financing and use.

The instruments for financing risk retention are divided into two types, depending on when they are implemented:

- Ex-post, after a disaster, which does not require prior planning, e.g., budget reallocations and sovereign issuance debt.
- Ex-ante, prior to an event, planning should be done in advance and proactively, e.g., disaster funds and contingent lines of credit<sup>79</sup>, and

The following subsections describe the characteristics of the main instruments for financing risk retention (ex-ante and ex-post).

#### 4.3.1.1 Budget reallocations

Budget reallocations provide resources in a short period of time, making it the first instrument that is commonly available to meet needs in the event of high-frequency disasters; However, they depend on the availability of resources at the time of the disaster, internal decisions, and the time required to execute the administrative procedures to make the resources available.

Budget reallocation seen as an ex-post financial instrument is not economically efficient, due to the opportunity cost of modifying the plans of the programmed budget exercise by taking money from projects to which resources had originally been allocated and that will no longer generate the investment returns or the expected social benefit. Therefore, budgetary resources that are allocated ex-ante to an event through budgetary planning of potential losses allow for a reduction in the use of instruments such as budget reallocations.

Budget reallocations could also be used as an option after a disaster, considering that it is one of the most onerous ex-post financial instruments. It reduces the resources allocated to priority projects that contribute to the development of the economy.

Fiscal rules, institutional frameworks, and guidelines that allow for a timely response, as well as internal approval processes that allow for the transparent flow of resources, must be defined in order to make budget reallocations for disaster response.

<sup>78</sup> Cardona, O. D., 2009, Financial Management of Disaster Risk - Retention and Transfer Financial Instruments for the Andean Community.

<sup>79</sup> Clarke, D. J. and Dercon, S., 2016, Dull Disasters: How Planning Ahead Will Make a Difference, Oxford University Press.

#### 4.3.1.2 Sovereign issuance debt

Frequently, sovereign debt is utilized to finance disaster-related damages. Governments impacted by disasters issue debt on global markets or binational debt; however, depending on the type of disaster and its severity, the postdisaster macroeconomic conditions exacerbate the conditions under which they issue debt, making financing through this source frequently scarce and costly.

Damage to the sovereign debt risk profile is the primary cause for the scarcity and difficulty of this sort of funding. In other instances, the disaster undermines credit quality by degrading the economy's infrastructure, production and consumption capacities. When the damage is structural and the likelihood of a recovery is doubtful, risk rating agencies lower the sovereign rating of a country's debt, which decreases sources of financing and increases the cost of financing via this source.

#### 4.3.1.3 Disaster funds

Disaster funds generally accumulate their own resources, in case they are not used during the year, to meet emergency response needs in the event of a disaster caused by frequent, low-severity events. Once the holding fund is sufficiently capitalized, its resources may be used for reconstruction activities.

The constitution and administration of retention funds involves costs, since the fees of the public or private institution that administers the fund's resources must be covered, as well as the time required to define the rules for the efficient and transparent use of the resources. International experience in financial risk managing has identified the following actions for setting up a retention fund:

- A. Analyze the regulatory framework to identify that the creation and management of the retention fund is permitted, i.e., the fund must comply with applicable regulations.
- B. To carry out a legal act, where they are detailed:
  - a. Sources of funding;
  - b. Legal form, i.e., through a bank account or trust;
  - c. Type of account where the resources will be deposited. This could be a commercial bank, central bank, or development bank;
  - d. Corporate governance;
  - e. Objectives of the fund.
- C. Development and publication of manuals and/or rules of operation that detail the framework of action of the fund for disaster response and encourage transparency in decision-making and the use of resources:
  - a. Trigger mechanism to make resources available;
  - b. Procurement of goods and services regulations;
  - c. Financial management, accounting records, and audits.

In addition to its own resources, the holding fund could receive contributions from donors and sovereign debt facilities.

#### 4.3.1.4 Contingent debt facilities

In the event of a catastrophic event, a contingent debt facility is an instrument that provides the borrower with contingent financing. Designed to provide rapid access to funds after a disaster, the facility enables borrowers to respond quickly to emergencies and recover quickly.

These facilities typically take the form of loans that are triggered by pre-defined events, such as disasters. Following the trigger event, the borrower can draw funds from the facility to address immediate needs, such as emergency response and recovery.

Contingent debt facilities are particularly issued by multilateral organizations that provide immediate liquidity in the event of a disaster and can be used for financing:

- Average losses;
- Emergency needs due to disasters when there is no financial instrument for risk transfer;
- Losses that exceed the coverage of insurance, reinsurance, or other financial instruments, such as bridge financing, since the resources are freely available.

These facilities are commonly granted to the national government through the Ministry of Finance by multilateral institutions, such as the World Bank, the Asian Development Bank (ADB), and the Japan International Cooperation Agency (JICA), among others. The agreement between the government and the multilateral must define the indexes, triggers, or circumstances for the availability of resources.

Table 9 shows the main characteristics and conditions for contracting contingent lines of credit for disaster relief offered by the multilateral institutions mentioned above.

## Table 9. Features of contingent credit facilities for disaster response, offered by multilateralinstitutions.

Multilateral Institution	World Bank	Asian Development Bank (ADB)	Japan International Cooperation Agency (JICA)
Name	Catastrophe Deferred Drawdown (CAT- DDO)	Precautionary Financing Option (PFO) under its Countercyclical Support Facility (CSF) or (CSF-PFO)	Stand-by Emergency Credit for Urgent Recovery (SECURE)
Approval Criteria	<ul> <li>Appropriate macroeconomic policy framework;</li> <li>Disaster risk management programme.</li> </ul>	<ul> <li>Existence of an adequate macroeconomic policy framework and debt sustainability, including an IMF assessment letter.</li> <li>Satisfactory completion of a set of substantive legal, institutional, and policy reforms to disaster risk management (captured in a policy matrix, based on prior actions).</li> <li>A DPL outlining the government's commitment to development expenditure program to enhance resilience to natural hazards.</li> </ul>	Macroeconomic and public financial management Plan for implementing JICA's technical cooperation for disaster prevention.
Limit	US \$ 500 million or 0.25% of GDP, whichever is less.	<ul> <li>Each DMC can mobilize an amount equal to 0.50% of GDP, up to a maximum of \$500 million if financed by regular OCR or a maximum of \$250 million if financed by COL/ADF. Small DMCs whose 0.50% of GDP is less than \$20 million may avail of up to \$20 million, subject to their available resources.</li> </ul>	¥10 billion (US \$92 million) or 0.25% of GDP, whichever is less.

Multilateral Institution	World Bank	Asian Development Bank (ADB)	Japan International Cooperation Agency (JICA)
Trigger Mechanism	- Predetermined trigger, such as the declaration of the country's state of emergency.	- Disbursement is available only if pre-specified condition(s) linked to a disaster caused by natural hazard— typically the DMC's declaration of a state of emergency, or its equivalent— have been met.	- Formal request from the country.
Validity (available) <sup>80</sup>	- For three years.	- Up to the full allocated amount is available for disbursement at any time within 3 years of signing the legal agreement(s).	- For three years.
Conditions of Execution	Flexibility of the country to decide when and how much to disburse. Country-specific regulations for the exercise of spending. - Disbursement within 48 hours of request, and for various types of disasters.	<ul> <li>There is a policy matrix which include a set of substantive legal, institutional, and policy reforms to disaster risk management aimed at enhancing the DMC's resilience to natural hazards. ADB should demonstrate its value addition in supporting the reforms.</li> </ul>	Regulatory framework for the procurement of services or goods applied by JICA. Disbursement within 15 business days of request.
Operational Requirements	- Satisfactory DRM program at the time of disbursement.	<ul> <li>The policy matrix should include a detailed PPPF, itemizing future reforms as well as ADB policy and technical support priorities.</li> </ul>	- Adjust the operation of the credit to JICA's cooperation.
Cost of Financing	Fixed price: projected by the WB, and if applicable, plus a market risk premium. - Variable prices: 6-month LIBOR + / - BM financing margin.	- 6-month LIBOR +/ - ADB's financing margin for CSF resources specifically	- Fixed for all types of SECURE credit, with a rate of 0.01%.
Renewal Availability	- Once, for a maximum of six years in total.	- The initial availability period of the CDF for regular OCR, COL, and ADF is 3 years. Regular OCR-financed CDF can be renewed up to four times for a maximum of 15 years, while COL and ADF-financed CDF can be renewed once for a maximum of 6 years. Each renewal is for a period of up to 3 years.	Up to a maximum of 15 years with extension procedures every 3 years.

80 From the start of the contract with the multilateral institution.

Multilateral Institution	World Bank	Asian Development Bank (ADB)	Japan International Cooperation Agency (JICA)
Payment Period	35 years	15 years	40 years
Grace Period	3 years	NA	10 years
Renewal Cost	0.25%	0.25%	0.00%
Initial commission	0.50%	0.25%	0.50%
Standby fee	0.00%	NA	0.00%
Commitment Committee	0.00%	0.15%	0.00%

Source: Author's elaboration with information from the World Bank (WB), the Asian Development Bank (ADB) and the Japan International Cooperation Agency (JICA).

#### 4.3.1.5 Donors and international assistance

Resources from donations and international assistance are usually provided in the case of catastrophic events that are not recurrent and where the number of losses is uncertain. Such resources are therefore mainly used for immediate response actions, such as humanitarian assistance.

However, resources donated are inherently uncertain, so planning resources can be difficult. It should be noted that this is the primary disadvantage of using this source of funding in order to support as part of a financing strategy.

Donations for disaster relief are a source of resources of low costs for the governments affected, since many donors have humanitarian programs to support relief activities, among other actions. However, some of the limitations of this mechanism are that:

- Resources are limited, representing a portion of the total need for emergency response and recovery, and rarely support reconstruction programs;
- Donations may be motivated by the visibility of the disaster in the media, so attendance and recurrence cannot be predicted;
- Internal and international arrangements must be made to schedule and receive resources, which can be a complex and time-consuming process involving uncertainty;
- The allocation of resources is not very flexible, as they are generally earmarked for previously identified expenditures.

As a summary of the section, Table 10 presents the main characteristics of the instruments for financing risk retention that were described in this section.

Instruments	Budget reallocation	Disaster Relief Holding Funds	Contingent lines of credit: - of Multilaterals	Donations and international assistance
Amount	Medium	Limited	High, maximum of US \$500 million	Limited
Flexibility in the amount	- Agreed, according to need	- Defined annually	- Agreed, according to need	- Agreed, according to need
Financial cost	- Opportunity cost of resources.	<ul> <li>Account or Trust</li> <li>Administration</li> <li>Opportunity cost of resources.</li> </ul>	Institutional interest rates + commissions	- Opportunity cost of resources.
Reference to calculate the cost	- Social Discount Rate and Benchmark Rate of Return	- Social Discount Rate and Benchmark Rate of Return	- LIBOR plus Rate and Fee Adjustments	- Social Discount Rate and Reference Rate of Return.
Flexibility in the use of resources	- According to the needs	- Distribution of resources according to needs	It is defined when the agreement is made, they can be: - Free destination, - With predetermined destinations.	In accordance with the donor's objectives and mission.
Disbursement time	- Days to weeks	- Days to weeks	- Weeks	- Weeks to months
Logistics	- Negotiations with government and legislative body - Fulfillment of the requirements and procedures.	- Design and implementation of the fund.	-Negotiations with the institution and government and comply with the requirements and procedures.	- Approach donors and comply with the requirements and procedures.

Source: Author's elaboration

#### 4.3.2 Instruments for financing risk transfer

Instruments for financing the transfer of risk make it possible to eliminate the contracting parties' uncertainty about the materialization of the risk by transferring it to a financial institution. Traditional insurance is the most common instrument used to transfer disaster risks from the insured to the insurer<sup>81</sup>. However, there are currently several alternatives, such as parametric insurance and catastrophe bonds.

#### 4.3.2.1 Insurance

It is a contract in which the insurer is obliged to compensate the contracting party, in exchange for the payment of a premium, in the event of a loss covered by said contract and which is agreed by both parties<sup>82</sup>.

<sup>81</sup> Clarke, D. J. and Dercon, S., 2016, Dull Disasters: How Planning Ahead Will Make a Difference, Oxford University Press.

<sup>82</sup> Cardona, O. D., 2009, Financial Management of Disaster Risk - Retention and Transfer Financial Instruments for the Andean Community.

#### 4.3.2.1.1 Traditional Insurance

The insurer, through a contract, assumes the risk of a disaster and undertakes to indemnify the insured for the losses caused by the disaster in exchange for the payment of a premium. Traditional insurance contracts may include the figure of the deductible, which is an amount or percentage of the loss payable by the insured and which sets the amount above which the insurer will be liable for losses in excess of that amount or percentage. Additionally, a maximum amount of coverage to be paid by the insurer is established. Losses exceeding this amount will not be covered.

In order to make the claim of a traditional insurance coverage, a loss adjustment process must be carried out, in which an adjuster verifies and quantifies the magnitude of the insured's losses, so that the insurer, based on this information, makes the indemnity to the insured.





Source: Author's elaboration

#### 4.3.2.1.2 Parametric insurance

Parametric insurance is a contract whereby the insurer undertakes to compensate the contracting party when the previously agreed parameters or triggers of an event—generally quantitative, such as the intensity of the event or the amount of the loss—are met. This insurance is measured and/or calculated by a third party using a predetermined methodology of variables independent of the insured and the insurer.

Parametric insurance is based on the probability of occurrence of an event and not the loss it could cause, so no adjustments are made to these. Instead, once compliance with the parameter is corroborated, the insurer must compensate the insured in an almost expeditious manner, in accordance with the provisions of the contract. The indemnity may be staggered, associated with the value of the parameter -.

While for traditional insurance schemes some catastrophic risk are not usually considered insurable, through parametric ones can be covered, and international experience shows that they are used for catastrophic events, such as tropical cyclones, earthquakes, and extreme rainfall, in order to limit the financial impact of the losses they could cause.

The reason why parametric insurance is attractive compared to indemnity insurance is the speed of payment, the loss verification process is substantially faster and it is common that the premium can be lower as there is no administrative cost (adjusters) inherent to the policy.

#### Figure 21. Parametric insurance Operation



Source: Author's elaboration

Through an insurance or reinsurance contract, or by issuing a catastrophic bond, parametric insurance coverage is granted. The difference between these mechanisms is the entity with whom the contract is made—considering its risk retention capacity—which could be an insurance company, a reinsurer, or the capital market.

Insureds and insurers can both have deductibles and retentions in a structure such as that in Figure 21. Thus, the insured may define a level of risk from which to transfer the risk, and below that level, the insured maintains a level of retention, furthermore, the insurer may impose a further level of retention. Depending on the complexity of the scheme, different levels of retention may be allowed by insured and insurer at the same time.

#### 4.3.2.2 Capital market: catastrophe bonds

The capital market is an alternative for financing and transferring disaster risks, where financial mechanisms have emerged that allow risk to be assumed. Although it does not replace insurance and reinsurance markets, it complements them by transferring part of the risk.

When Insurance markets (traditional and parametric) experiment a high pricing season, catastrophe bonds could be an affordable alternative.

On the other hand, there are conditions that can make the risk attractive to the catbond market, which can mean a better premium. This happens when a risk is new, for example, Mexico in 2006 issued an earthquake catbond, although there were other earthquake bonds, none for the specific risk of Mexico, this meant that by placing the risk, the bond could be placed in the markets with better conditions for the insured. Thus, other countries may bring a risk that is new to the market and may find favorable conditions in the catastrophe bond markets.

The catastrophe bond is a fixed income financial asset in which the investor buys a security for a value that will be repaid at the end of a period, and during which they receive cash flows based on the interest granted by the bond.

For the issuance of catastrophe bond securities, the issuer and the investor use a special purpose vehicle (SPV) as an intermediary, which is created for that purpose, through one or more collateral assets of the issuance, the insurance premiums of the policyholders. The SPV is a separate legal entity that enters into an insurance contract with an insurance company to issue the catastrophe bond securities in exchange for payment from investors who purchase the security. The company that transfers the risk of the bond receives a premium, which is used by the SPV to pay investors coupons. The SPV manages the bond proceeds and put into a collateralized account, invested in high quality credit risk securities, beside the investment in this securities, the structured of the SPV agrees a swap contract with a high quality contrapart to fix the return of the investment.

In this instrument, a trigger must be established, such that when the circumstances are met under which all or part of the principal and/or coupons (interest on the principal) must be used, compensation is made to finance a disaster. This compensation may be based on actual losses, according to the sum insured agreed with the insurer issuing the bonds, or through payments based on indexes that cannot be influenced by the insured and that are related to the coverage of the disaster risk that the bond is covering.

Figure 22 shows the operation of the catastrophe bond, from the interaction of the insured with the insurer, and of the latter with the capital market through the SPV.

#### Figure 22. Operation of the catastrophic bond



Source: Author's elaboration.

Finally, as a summary of this section, Table 11 presents the main characteristics of the risk transfer financing instruments discussed above.

<b>Table 11. Characteristics</b>	of risk	transfer	financing	instruments
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Instruments		Advantages	Limitation	Cost of anchoring	Flexibility in the use of resources	Disbursement time	Logistics	Financial Cost
Insurance	Traditional	<ul> <li>Agreed sum insured</li> <li>Clarity of coverage</li> </ul>	- Ensure appropriate costs	- Risk premiums	- Free destination	- Tardiness	<ul> <li>Established</li> <li>processes (e.g.,</li> <li>transparency)</li> <li>Inspection and</li> <li>adjustment periods</li> </ul>	- Pure Risk Premium + Commissions
	Parametric	<ul> <li>Agreed sum insured</li> <li>Clarity of coverage</li> </ul>	- Ensure appropriate costs	- Risk premiums - Basis risk*	- Free destination	- Expedited	<ul> <li>Established</li> <li>processes (e.g.,</li> <li>transparency)</li> <li>Corroboration of</li> <li>the detonator</li> </ul>	- Pure Risk Premium + Commissions
Capital markets	Catastrophic bonus	<ul> <li>Agreed sum insured</li> <li>Clarity of coverage</li> </ul>	- Ensure appropriate costs	- Risk premiums - Basis risk	- Free destination	- Expedited	<ul> <li>Established</li> <li>processes (e.g.,</li> <li>transparency)</li> <li>Corroboration of</li> <li>the detonator</li> </ul>	- Pure Risk Premium + Commissions

Note: Basis risk in insurance refers to the possibility that someone has purchased insurance, but the money they receive in a claim does not equal the full cost of that particular claim event.

Source: Author's elaboration

## **4.4.** Opportunities and constraints on existing financial infrastructure in Cambodia for risk financing instruments

This sub-section explores the current state of financial markets, local availability of financial instruments, and feasibility to implement the risk financing instruments mentioned above.

#### 4.4.1 Risk retention instruments

Based on consultation meetings with the GoC, the analysis identified the current status on the risk retentions instruments at Cambodia.

Budget reallocations

The GoC strongly relies on budget allocations and reallocations. Each key ministry and agency involved in disaster management is assigned an annual budget for maintenance and improvement of infrastructure. Specifically, for the MTPW, MRD, and MWRAM, there is no specific budgetary line for emergency and disaster. In the case of disaster, the first source of funding is the budgetary line assigned to maintenance and improvement of infrastructure (see section 3.2 and figure 11 for further details).

During the last 5 fiscal years, the budget available for the budget line mentioned in each ministry was approximately USD\$ 99 million, with the exception of the current fiscal year (2022) which was roughly double the average of the 2018-2021 period. According to our analysis, the annual average loss in the transport sector is nearly USD \$45 million. Given that there is no budget line allocated for disasters and emergency, it seems as though the budget available for maintenance would be insufficient for both activities (maintenance and improvement & emergency and disaster), which imply the budget reallocation as a common practice in the budget management.

#### Table 12. Annual allocation by ministry for maintenance and improvement of infrastructure

		20	18	20	19	202	20	20	21	202	22
Ministry	Name of Program	Budget (KHR), Millon Riels	Million USD								
MPWT	Program 1: Develop, repair, maintain, and manage public work building transport infrastructure and inventory	285,441	70	286,088	71	286,474	71	286,307	70	540,706	133
MRD	Program 1: Continue rehabilitation, maintenance, and improve rural infrastructure.	99,177	24	109,065	27	117,749	29	117,583	29	267,307	66

		20	18	20	19	202	20	20	21	202	22
Ministry	Name of Program	Budget (KHR), Millon Riels	Million USD								
MWRAM	Program 2: Flood and drought management	5,932	1	5,848	1	5,734	1	4,234	1	3,564	1
	Total	390,550	95	401,001	99	409,957	101	408,124	100	811,577	200

Source: Budget in Brief Fiscal Year, MEF, 2018 -2022

• Disaster funds

We could not identify an explicit fund within the budget or off the budget that was specifically developed for emergency and disasters. However, the regulatory framework, in particular the Law on Disaster Management, which was enacted by the Cambodian National Assembly in 2015, mandates that the government "shall have the appropriate reserve budget and resource to be ensured for the disaster management" (Section 7, Article 39). Based on this regulation, there is a window of opportunity to ponder the possibility of creating a disaster fund as feasible public policy in financial disaster management.

• Contingent credit lines

According to our assessment, there are two alternative contingent debt sources for Cambodia, the World Bank, and the Asian Development Bank. However, at the moment to be drafting this report, this type of contingent debt facility is not being used by the GoC.

On the other hand, based on the International Monetary Fund (IMF)<sup>83</sup> review on Cambodia economy, the risk of external and overall debt distress is low. According to Article IVs Consultation for Cambodia: "Cambodia's external public debt stood at around US\$8.8 billion (35 percent of GDP) in 2020. The external debt-to-GDP ratio has remained stable around 30 percent of GDP since 2012 but increased by 7 percent of GDP in 2020." The majority of that debt (69%) is bilateral, with more than half being provided by China. Therefore, the IMF review found that the current risk of distress is low, but the sustainability of the debt could be easily committed in the case of a major shock to exports and economic growth.

Therefore, incurring in additional debt should be considered cautiously. However, Developing an ex-ante risk financing strategy for highly vulnerable sectors could mitigate volatility in economic growth. In that sense, a contingent debt facility could be part of that mitigation strategy.

• Donors and international assistance

Donor support is a recurrent source of funding in the event of major disasters. Up to USD 1 billion has been donated for relief, such as during the flooding of 2008; roughly the same amount was donated in 2009<sup>84</sup>. However, by its nature, this funding is not guaranteed. Thus, it is unwise for the GoC to rely on it as a funding source as part of its risk financing strategy.

<sup>83</sup> IMF (2021). "Staff report for the 2021 Article IV Consultation (debt sustainability analysis)". November 2021.

<sup>84</sup> PDNA (2010). "Cambodia Post-Ketsana Disaster Needs Assessment". Royal Government of Cambodia, World Bank, GFDRR, UN System, ADB and ADPC.

#### 4.4.2 Risk transferring instruments

This sub-section explores the current state of local risk markets at Cambodia, as well as the availability of risk financing instruments locally and feasibility to implement them.

• Traditional insurance

According the Insurance Regulator of Cambodia (IRC), Cambodia's insurance industry reported a total premium of USD \$293.4m in 2021 and it continues to increase by 9.5% every year, despite the economic fallout from the COVID-19 pandemic.

In 2020, the Ministry of Economy and Finance (MEF) introduced a new regulation on the reinsurance business, Prakas No. 329 on Granting Licences for Reinsurance Business (Reinsurance Prakas), which brought regulatory clarity to the reinsurance business<sup>85</sup>.

As of 2019, the last years' figures were made available. There are approximately 73 insurers and other insurance operators registered with the MEF, including: 13 general insurers, one reinsurer, 11 life insurers, 7 micro insurers, 16 insurance brokers, 22 insurance agents, and 3 insurance loss adjusters. The most prevalent type of insurance is general insurance, which covers health, automobiles, fire, and personal injury. Typically, garment factories, warehouses, and hotels are the purchasers of fire insurance. Given that Cambodia is a less developed nation and that the concept of insurance was only introduced in the last ten years, microinsurance (that is, insurance for the protection of low-income people against specific perils) also plays a role in the country's insurance market.

Cambodia's insurance market is still in its infancy. For example, the property and casualty (P&C) or non-life sector is still below its emerging Asia-Pacific peers (2.3% for non-life premiums as % GDP in 2021)<sup>86</sup>. Since 1997, Cambodia reported consistently below 0.3%<sup>87</sup> (non-life premiums as % GDP).



#### Figure 23. Non-life insurance premiums as % of GDP

Source: ASEAN.

 $85 \qquad https://uk.practicallaw.thomsonreuters.com/w-012-6781?transitionType=Default&contextData=(sc.Default)&firstPage=true and the state of the sta$ 

86 Swiss Re (2021). "Swiss Re Sigma". 2021.

87 Federal Reserve Bank of St. Luis, with data from the World Bank, taken from Association of Southeast Asian Nations (ASEAN).

#### Regulatory framework

In 2007, three regulations (prakas) amended the Insurance Law of 2000 to update licensing, corporate governance, and solvency requirements, resulting in significant changes to insurance infrastructure. In addition, the minimum solvency requirements were raised and a 20% mandatory cession of each risk to state-owned Cambodia Reinsurance Company (also called Cambodia Re) was implemented. In 2011, the Ministry of Economy established new licensing and capital requirements for micro-insurance activities. Currently, foreign insurers can own 100% of locally incorporated subsidiaries. A locally incorporated and capitalized subsidiary is required for the establishment of commercial presence. Lastly, for non-admitted reinsurers – with the previously mentioned ceding obligation to Cambodia Re – and marine cargo risks. Fronting is permitted if compliance with mandatory cession to Cambodia Re is maintained.

#### Opportunities

Despite the insurance industry being in its early development stages, we identified various opportunities, particularly in the non-life insurance sector, for disaster funding. Based on our desk review and consultation meetings, a window of opportunity may exist through the state-owned reinsurer to build a mechanism of risk management for public finances. This institution could become a linchpin in the financial risk management strategy for disaster preparedness. Finally, the GoC is part of the developing regional initiative "Southeast Asia Disaster Risk Insurance Facility (SEADRIF)<sup>88</sup>", which aims is to provide access to disaster risk financing solutions to SEADRIF country members, and to increase financial resilience to climate and disaster risks. SEADRIF provides ASEAN countries with advisory and financial services for post disaster rapid financing to reduce the negative impact on people and their livelihoods.

• Parametric insurance

According to our review, there are no specific regulations focused on parametric insurance, but based on consultation meetings, there are projects currently under review of authorities for implementing parametric schemes.

• Catastrophic bonds

Catbonds are not currently considered among the potential risk-financing instruments for the GoC. Nevertheless, based on our analysis, this type of financial instrument could be an appropriate source of funding, but not at the current level of development of Cambodia.

<sup>88</sup> https://www.worldbank.org/en/news/feature/2019/01/17/southeast-asia-disaster-risk-insurance-facility-seadrif-technical-briefing -for-japanese-insurance-industry-drmhubtokyo

## 5. Fiscal vulnerability assessment for Cambodia's transport sector

To determine fiscal vulnerability of the transport sector, a statistical analysis of historical losses was carried out, based on the information available in CamDi<sup>89</sup>, PDNA reports available for transport sector assessment, and the Desinventar<sup>90</sup> database for Cambodia.

The methodology<sup>91</sup> implemented is composed of the following steps:

- a. Set a database of kilometers of the road network that have been historically damaged.
- b. Set a database of cost by kilometer damaged.
- c. Based on historical data, estimate, by simulation, scenarios of damages to the road network.
- d. Given the potential scenarios, estimate the fiscal financing gap.
- e. Propose alternatives, through risk financing instruments, for funding the fiscal financing gap.

The methodology implemented is fed by the following inputs:

- a. Time series of road network damaged.
- b. Frequency of disasters in Cambodia.
- c. Definition of the replacement cost by kilometer of road network based on historical data.
- d. Estimation of the severity of damages by kilometer and in USD and simulation scenarios of kilometers damaged and potential losses.

Regarding element A of the methodology, figure 24 illustrates the data collected from the Desinventar dataset for Cambodia and CamDi.

#### Figure 24. Damaged meters at national level by year



Source: UNDRR- Desinventar-Sendai, and CamDi.

- 89 Compound D-4, "Sendai Framework Monitoring Institutional Role Matrix for Target and Indicator based Reporting".
- 90 UNDRR-Desinvetar-Sendai, taken from: https://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=khm& continue=y
- 91 This methodology is based on historical events according to statistical modeling techniques, it does not consider factors such as climate change or changes in the exposed assets that have occurred after the historical events, so the results may vary, however, given the data restrictions in the country this effort represents an analysis with all the available information.

Concerning the frequency of catastrophe events, i.e., number of events in the window of time assessed (2000 to 2021), this data was taken from EMDAT (see table 1).

It is important to highlight that the national data collected of damages by meter to the road network is aggregated; therefore, there is no breakdown by type of road (rural, 1 digit, 2 digit, etc.). As such, the result of the assessment will be consolidated as well.

For the process of scenario simulations, based on the datasets mentioned, several probabilistic functions were considered that fit the data collected. In order to improve the approximation of the parameters for each distribution selected, an optimization process was implemented, which focused on minimizing the distance from the data and the predicted data by each distribution. In order to select the best results, several goodness-of-fit tests were conducted, specifically the Anderson-Darling test. This optimization was carried out for 4 distributions: Log-normal, Gamma, Weibull, and Logistics. From this group, we selected the one with lower log-likelihood, which was the Weibull distribution.

Taking the adjusted parameters for the mentioned distributions, 3 goodness-of-fit tests were carried out: Anderson-Darling test, the Kolmogorov-Smirnov, and the Cramer von Mises. However, based on the lower log-likelihood, the Weibull distribution was selected (see figure 25).



#### Figure 25. Weibull – Severity

Source: Author's estimations

Regarding the historical replacement cost by kilometer, this variable was taken from PDNA reports and data provided by the GoC. For the average cost by kilometer was taken the following sample of cost: USD\$ 103,000, USD\$ 268,000, and USD\$ 362,863.88. Which provides a range and half point.

## **5.1. Estimation of fiscal financing gap for Cambodia's transport** sector

Based on the replacement costs compiled for each type of road, a scenario analysis was developed. In scenario A, the road is predominantly rural. Concrete roads are assumed in scenario C, while concrete and rural parts are assumed in scenario B. Considering the fact that the material type is not counted kilometer by kilometer during the analysis, an approximate interval can be calculated by using this type of scenario, where all affected roads would be rural (A), concrete or asphalt (C), while scenario B would provide an intermediate point.

Based on the three above scenarios, and the frequency and severity of past events, it was estimated a exceedance probability curve. Considering the scenario range, the analysis outcome will provide an estimation of the financing gap, as indicative of damage frequency.

#### Table 13. Replacement average cost by scenario

	Replacement average cost by kilometer (USD)
Scenario A	103,000.0
Scenario B	268,000.0
Scenario C	362,863.9

Based on section 4, there were estimated the exceedance probability curve (see Figure 26) considering the three scenarios, the curve expresses in terms of exceedance probability and amount of loss, all combinations for each replacement cost considered.



#### Figure 26. Exceedance probability curve by scenario

#### Source: Author's elaboration

The Table 14 below provides the Annual Average Loss (AAL) estimated by scenario. In this case, for each scenario of replacement cost, allows to estimate the AAL, considering the historical frequency and severity, through simulation methods, it is possible to reproduce historical events for each scenario, and then, estimate AAL as the average losses of each simulated losses per type of replacement cost.

#### Table 14. AAL by scenario

	AAL (USD\$ million)
Scenario A	76.6
Scenario B	199.3
Scenario C	269.8

Table 15 shows the probabilistic losses of the transport sector in Cambodia by return period type (inverse of the exceedance probability) and scenario. Assuming that the transport sector is primarily explained by the value of the road network, then Table 14 is a proxy for the losses of the road sector and the potential funding needs of the Cambodian government.

The three scenarios, based on historical data, provide an estimation of potential damages in the transport sector. The Table highlights that the annual average loss (AAL) for scenario A, as a measure of recurrency of damages, is US \$76.6 million. It has the potential to reach scenario C, with an AAL of US\$ 269.8. Roughly in the middle, scenario B is close to US \$199.3. This probabilistic analysis provides elements to assess the relevance of the current budget annually allocated to the MPWT, MRD, and MWRAM. The last fiscal year (2022) reached a total budget of USD\$200 m, which is close to scenario B.

Regarding the severity of damages, Table 14 provides some key points extracted from the exceedance probability curve. The probabilistic damages are provided in terms of return period (years) for the three scenarios. The analysis provided damages for 5, 10, 25, 50 and 100 years of return. The three scenarios provide a wide range of probabilistic damages, and level of catastrophic risk faced by the GoC's public finance in the transport sector.

Based on historical information, it is estimated that these damages per return of period are the financing needs that the transport sector in Cambodia could have. Given that the government's participation in this sector is dominant, it is estimated that these losses would be from the public sector and therefore a contingent liability of the government of Cambodia in the event of a disaster in this sector, particularly in those of extreme severity. For example, the middle point between scenarios (B), the severity for events of high frequency, 5 years of return of period, report USD\$ 103.4m, in the extreme case of events of 100 years of return of period reach damages close to US\$3,509.6.

Return of Period (years)	Scenario A	Scenario B	Scenario C			
	Probabilistic losses (US \$ million)					
1 in 5 Year	39.8	103.4	140.0			
1 in 10 Year	136.5	355.2	481.0			
1 in 25 Year	427.6	1,112.7	1,506.5			
1 in 50 Year	806.0	2,097.1	2,839.4			
1 in 100 Year	1,348.8	3,509.6	4,751.9			
AAL	76.6	199.3	269.8			
Severe (1-in-5 Year)	39.8	103.4	140.0			
Extreme (1-in-100 Year)	1,348.8	3,509.6	4,751.9			

#### Table 15. Transport sector Financing Gap: probabilistic damages by return of period and scenario

Source: Author's estimation.

Figures 27 to 32 show, by return period, the size of probabilistic losses and selected losses in the transport sector for each scenario assessed, which allows for estimation of the financing needs or gap that the government may have.



#### Figure 27. Modeled losses for scenario A

#### Figure 28. Loss comparison for scenario A



Source: Author's estimation

Source: Author's estimation



#### Figure 30. Loss comparison for scenario B



Source: Author's estimation

#### Figure 31. Modeled losses for scenario C



Source: Author's estimation

Figure 32. Loss comparison for scenario C



#### 5.2. Risk Financing strategy proposed

Based on the probabilistic analysis of damages conducted in the previous subsection, the financing gap has been estimated for three scenarios. In this section, the financial instruments described in section 4 will be used as part of the residual financing instruments.

For this analysis, there are four instruments: First, a budgetary line available in the three ministries (MPWT, MRD, MWRAM) for maintenance, even though this budget line is not specifically labeled for disasters, for the purpose of this report, it will assume that the GoC is able to allocate a budgetary line specifically allocated for disasters, and it will be the same size as the current maintenance budgetary line; second, the creation and implementation of a reserve fund; Third, a contingent credit facility hired by the GoC with a multilateral institution; and fourth, a parametric insurance policy.

In the analysis, four risk financing strategies were proposed. The base strategy is the current situation, i.e., there are no other instruments. The risk financing strategies 1, 2, and 3 represent several amounts of protection through each instrument (see Table 15). The size of coverage of each instrument was defined considering the market availability to finance through each instrument considering the current condition and risk profile of the GoC. In all these strategies, it was assumed that the instrument starts to pay once the annual budget allocations are exhausted; therefore, they pay in excess of the budget allocation.

Source: Author's estimation

Source: Author's estimation





#### Source: Author's elaboration

For this analysis, the scenarios of damages developed in the previous section are used as based for the strategy design. Strategy 1 considers the damages estimated in scenario A, strategy 2 for scenario B, and strategy 3 for scenario C. In the case of the base strategy, scenario A was used.

The last segment of Table 16 represents how the funding provided by the financial instruments absorbs the probabilistic damages. In other words, each row of the Table corresponds to each section indicated in the Table left side, damages of scenarios section, less strategies funding provides funding gap impact. It worth to highlight that, scenarios for larger damages corresponding to larger amounts of financial coverage.

		Scenario A	Scenario A	Scenario B	Scenario C
		Base Strategy	Strategy 1	Strategy 2	Strategy 3
Strategies	Annual Budget Ilocation	120.0	120.0	160.0	200.0
	Reserve Fund	0.0	5.0	6.0	8.0
	Contingent Credit	0.0	40.0	50.0	80.0
	Insurance	0.0	60.0	80.0	120.0
Scenarios	1-in-5 event	39.8	39.8	103.4	140.0
	1-in-10 event	136.5	136.5	355.2	481.0
	1-in-25 event	427.6	427.6	1112.7	1506.5
	1-in-50 event	806.0	806.0	2097.1	2839.4

#### Table 16. Risk financing strategies by type of damage scenarios (USD\$ million)

		Scenario A	Scenario A	Scenario B	Scenario C
		Base Strategy	Strategy 1	Strategy 2	Strategy 3
unding gap impact	Funding Gap (1-in-5 event)	0.0	0.0	0.0	0.0
	Funding Gap (1-in-10 event)	16.5	0.0	59.2	73.0
	Funding Gap (1-in-25 event)	307.6	202.6	816.7	1098.5
LL.	Funding Gap (1-in-50 event)	686.0	581.0	1801.1	2431.4

Source: Author's estimation with EM-DAT data.

First able, all these strategies are framed in the context of damage estimates. The financing gap in red/negative is still a gap that could be financed with ex-post sovereign loans, for instance. These strategies are examples of how an ex-ante strategy could mitigate the financing uncertainty experienced by the government in the event of a disaster, as well as how it could reduce the costs inherent to financing, since ex-post costs are usually higher than ex-ante costs. It should be noted that when these strategies are designed, their activation mechanism contemplates at least covering the return period indicated in the strategy; however, if a higher return period occurs, the instrument is also activated.

Strategies 1 to 3 differ from the base strategy because they mitigate the financing risk, define in advance which strategy to follow financially, and allow an orderly and efficient pattern to be established so that public services and the population using the road network experience the least possible interruption of service due to lack of financing.

It must be emphasized that the analysis developed in this sub-section does not include the hazard modelling and exposure modelling described in section 4, given the lack of data. For the development of this document, no strategic and national risk reduction measures have been identified that could structurally reduce risk in Cambodia at national level. The probabilistic methodologies for damages estimation provide rough estimations, given the data available.

#### 5.3. Limitations of the analysis

The analysis presented, based on statistical analysis developed thanks to historical data, is consistent with international methodologies and practices for estimating probabilistic losses. Therefore, its conclusions, in terms of existing data and the time window analyzed, are sufficiently robust to explain future scenarios based on such data and time frameworks.

However, as indicated in section 4, the first step of the methodology presented here suggests a risk analysis of the road sector, in which losses are identified, modelled, and then estimated according to the vulnerability of each road section. An analysis of these characteristics allows higher resolution conclusions to be reached, because it makes it possible to derive probabilistic losses based on vulnerability and not exclusively on historical losses.

It is worth mentioning that the loss estimates discussed in section 4 should also be calibrated with historical information so that the vulnerability model is consistent with historical losses.

Therefore, given the limited data, a statistical analysis allows for a better approximation of the damage potential. This approximation can be improved in its resolution if an analysis as described in section 4 is developed.

# 6. Recommendations for DRR & DRF strategies for Cambodia's road sector

This report has provided an assessment of the catastrophic losses that Cambodia has experienced in its recent past. From this starting point, the need for disaster risk management strategies, especially risk reduction as well as residual risk management, are relevant.

For this purpose, the current risk financing strategy has been evaluated, which currently relies on retention instruments, especially on budget reallocation when extreme events occur, as well as on international aid. In this context, there is an important window of opportunity to implement ex-ante financial management strategies and to assess risk reduction measures.

This document presents a methodological framework for addressing risk reduction and financial management, its prerequisites, and the constituent elements of the methodological framework.

A historical analysis of losses is also presented. Through a probabilistic study, a funding gap was found for a set of losses between a 5- and 100-year return period.

The road sector was studied in particular. For this assessment, historical losses were considered, and the physical losses that the sector has experienced in recent years was modelled. Estimating a financing gap that could reach up to between US \$800 million to US\$ 2,800, focused up to the 50 years of the return period. These estimations, among other provided, could help to the GoC to foresee the strengthening of public financing through ex ante risk financing instruments.

As an alternative to the current financing strategy, 3 strategies integrated by ex-ante financing instruments were presented. The government of Cambodia could explore financing alternatives, different from the base strategy studied, to mitigate the financing risk and the uncertainty inherent in financing for the road sector in particular.

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