Introduction to Disaster Risk Financing and CCRIF Parametric Insurance

DAY 2

Prepared by: CCRIF SPC

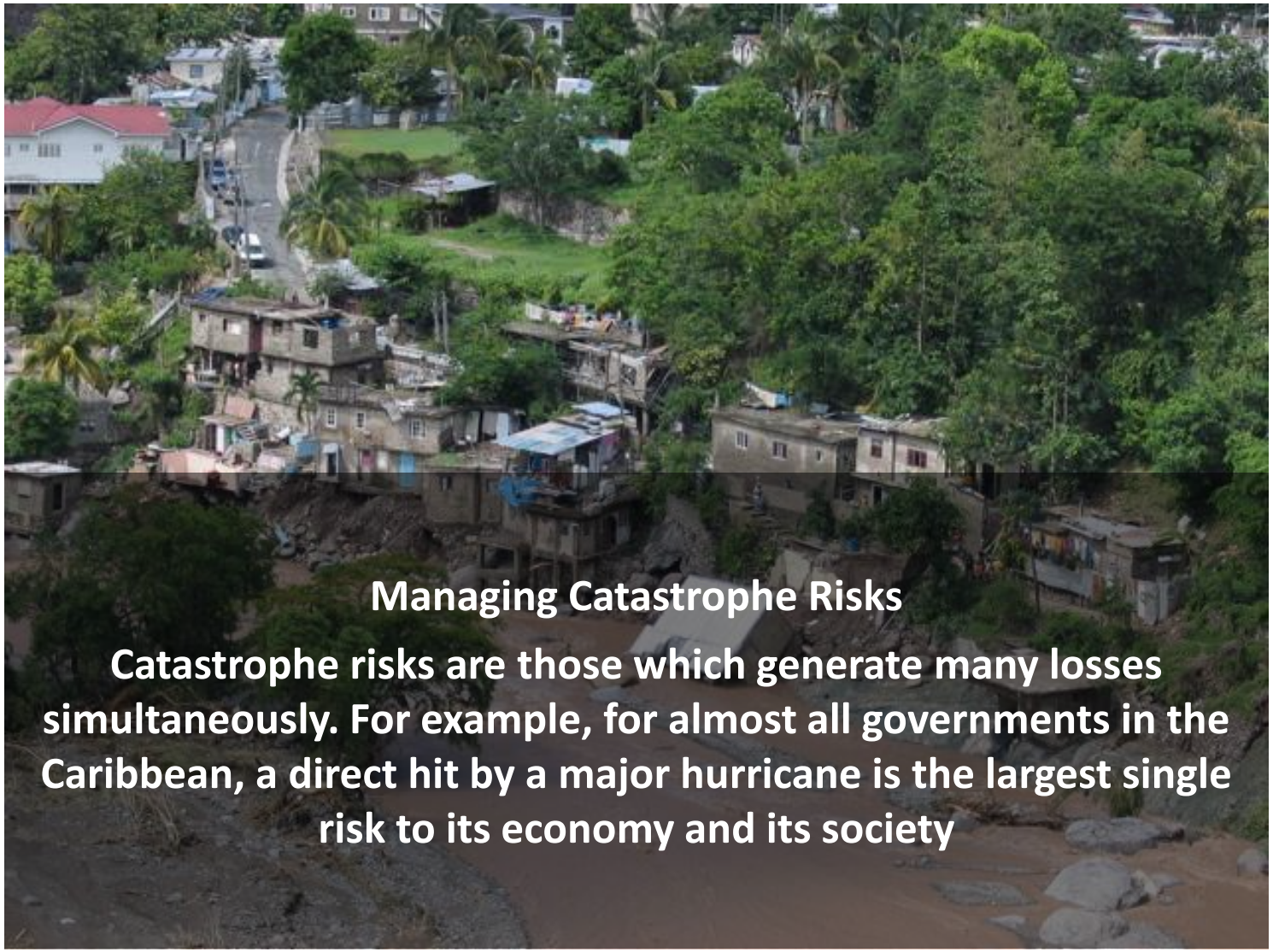
Group Exercise

Prepare a presentation on the impacts of a recent natural hazard event in your country.

Provide 4 factors, natural or man-made that could have contributed to the outcomes caused by the natural hazard. Provide 3 possible solutions that would mitigate against future similar hazards.

Some events:

- La Soufrière Volcanic Eruption
- Hurricane Eta
- Haiti earthquake 2021
- Hurricane Maria
- Heavy rainfall



Managing Catastrophe Risks

Catastrophe risks are those which generate many losses simultaneously. For example, for almost all governments in the Caribbean, a direct hit by a major hurricane is the largest single risk to its economy and its society

- **Climate Change and Disasters**
  - **Climate Change** changes the magnitude and frequency of extreme weather events
  - **Climate Change** changes average climatic conditions and climate variability, affecting underlying risk factors
  - **Climate Change** generates new threats, which a region may have no experience in dealing with

Comprehensive Disaster Risk Management (CDRM)

CDRM is an all hazards approach to disaster risk management that focuses on all phases of the DRM cycle (preparedness, response, risk reduction, recovery, and financial protection). CRDM emphasizes taking a holistic, integrated and participatory approach to addressing disaster risk, by the public and private sectors, all segments of civil society and the general population for the purpose of building resilient, safer societies.

International and Regional Frameworks

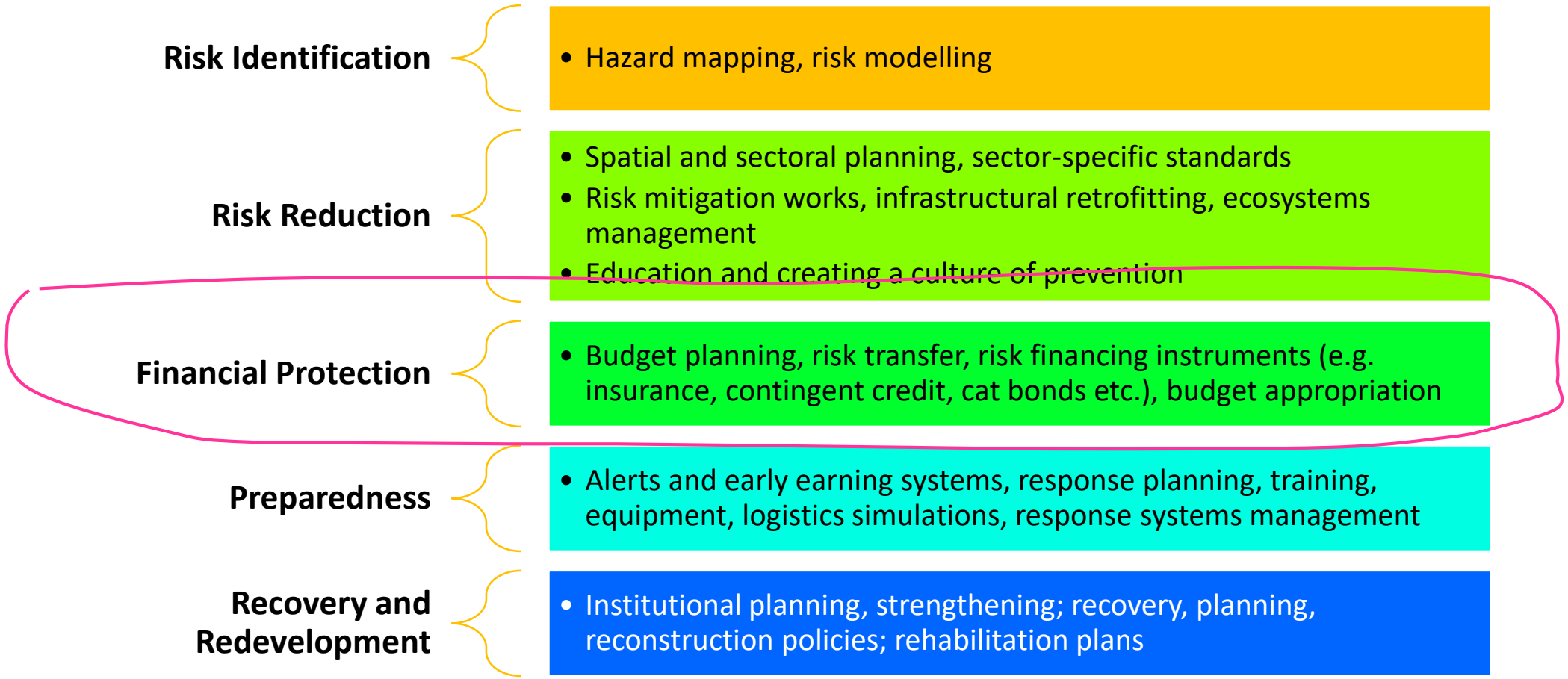
- 2030 Agenda for Sustainable Development and the Sustainable Development Goals
- Sendai Framework for Disaster Risk Reduction 2015 – 2030
- Hyogo Framework for Action 2005 – 2015
- Paris Agreement on Climate Change 2015
- Addis Ababa Action Agenda of the Third International Conference on Financing for Development (Addis Ababa Action Agenda)
- Caribbean Comprehensive Disaster Management Strategy and Programming Framework 2014-2024 (CDEMA)
- Regional Framework for Achieving Development Resilient to Climate Change (CCCCC)

Comprehensive Disaster Risk Management (CDRM)

Risk Identification	• Hazard mapping, risk modelling
Risk Reduction	• Spatial and sectoral planning, sector-specific standards • Risk mitigation works, infrastructural retrofitting, ecosystems management • Education and creating a culture of prevention
Financial Protection	• Budget planning, risk transfer, risk financing instruments (e.g. insurance, contingent credit, cat bonds etc.), budget appropriation
Preparedness	• Alerts and early earning systems, response planning, training, equipment, logistics simulations, response systems management
Recovery and Redevelopment	• Institutional planning, strengthening; recovery, planning, reconstruction policies; rehabilitation plans

Disaster Preparedness *= Disaster risk mitigation + ecosystem management + risk transfer and risk financing + social protection strategies*
(including addressing psychological impact of disasters)

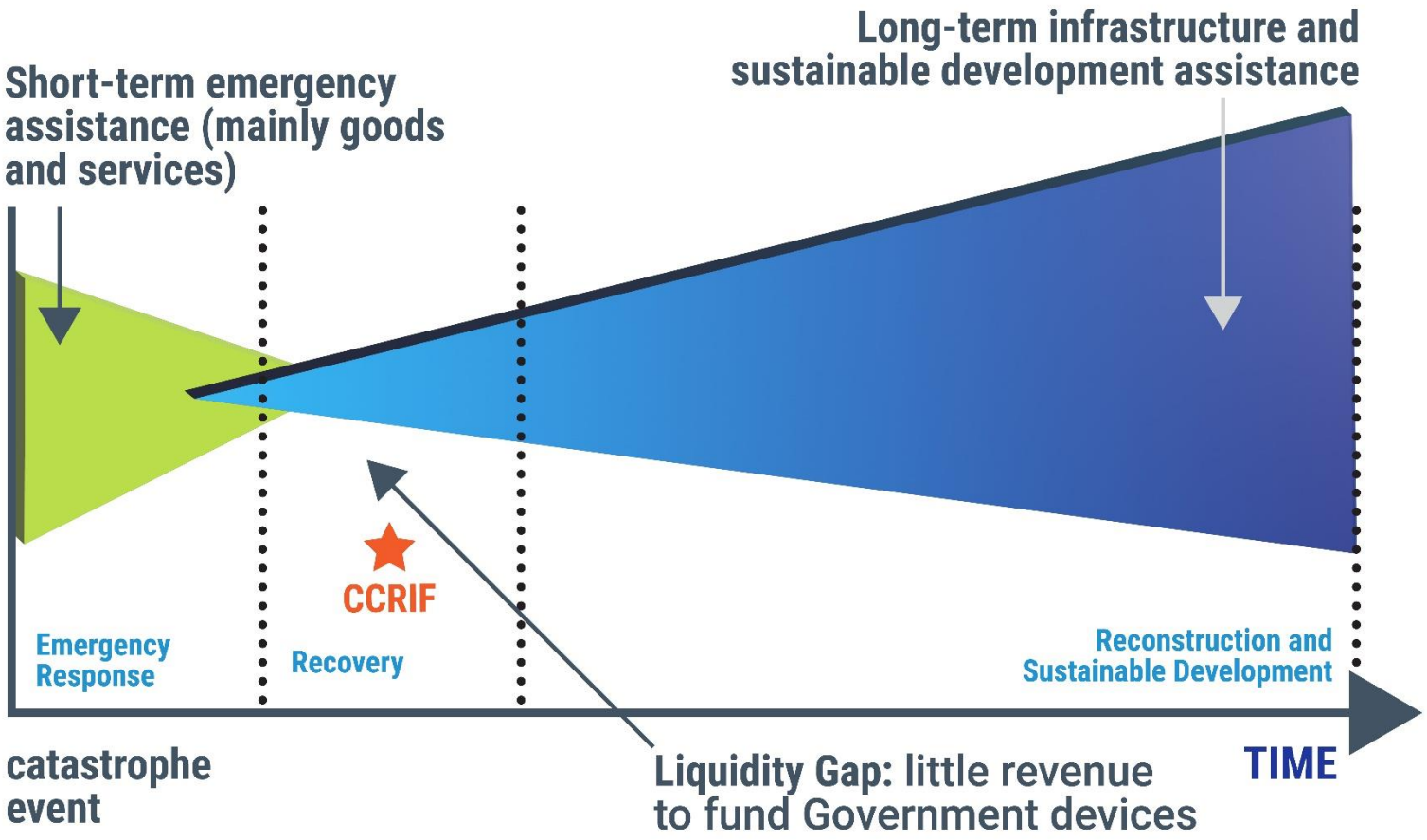
Comprehensive Disaster Risk Management (CDRM)



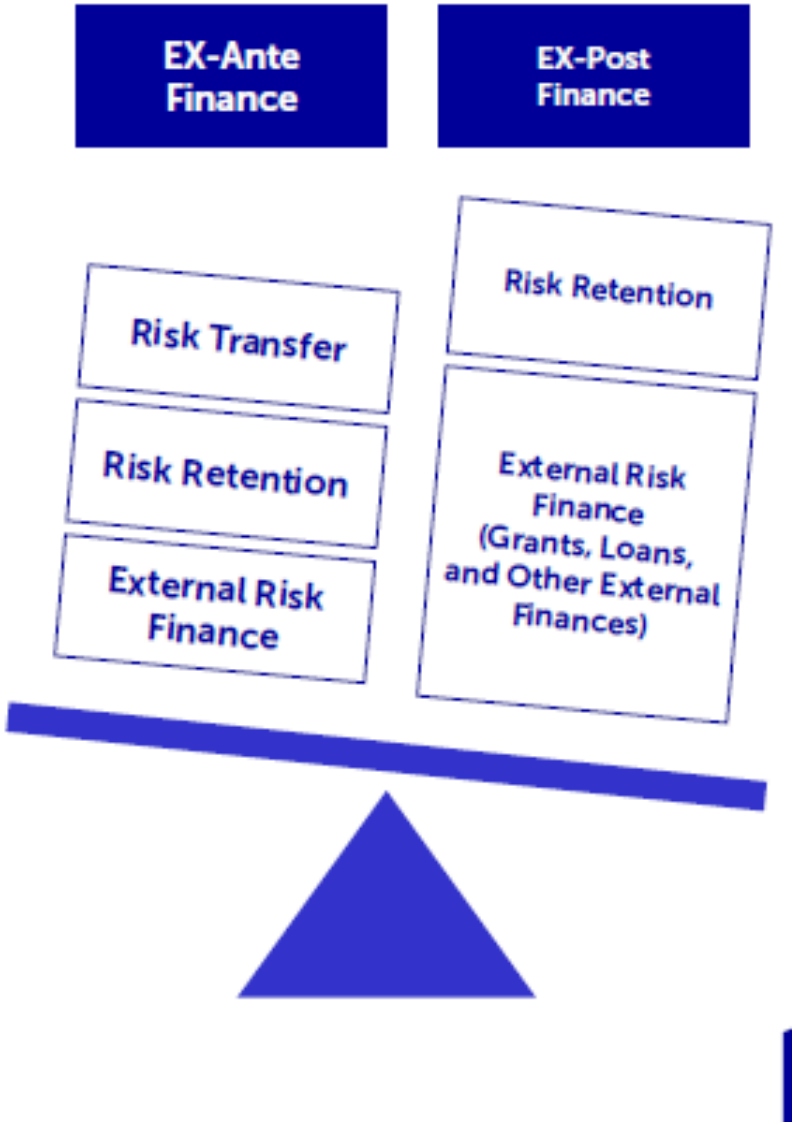
Disaster Preparedness *= Disaster risk mitigation + ecosystem management + risk transfer and risk financing + social protection strategies*
(including addressing psychological impact of disasters)

- The increasing frequency and severity of climate extremes has forced governments to consider new ways of meeting the financial consequences of natural disasters, and there is a growing interest in implementing sovereign Disaster Risk Financing and Insurance (DRFI) programmes in an attempt by

Sovereign Liquidity Gap



Meeting Disaster Risk Related Needs – Disaster Risk Financing



Ex-Ante and Ex-Post Finance

Ex-Ante and Ex-Post Finance

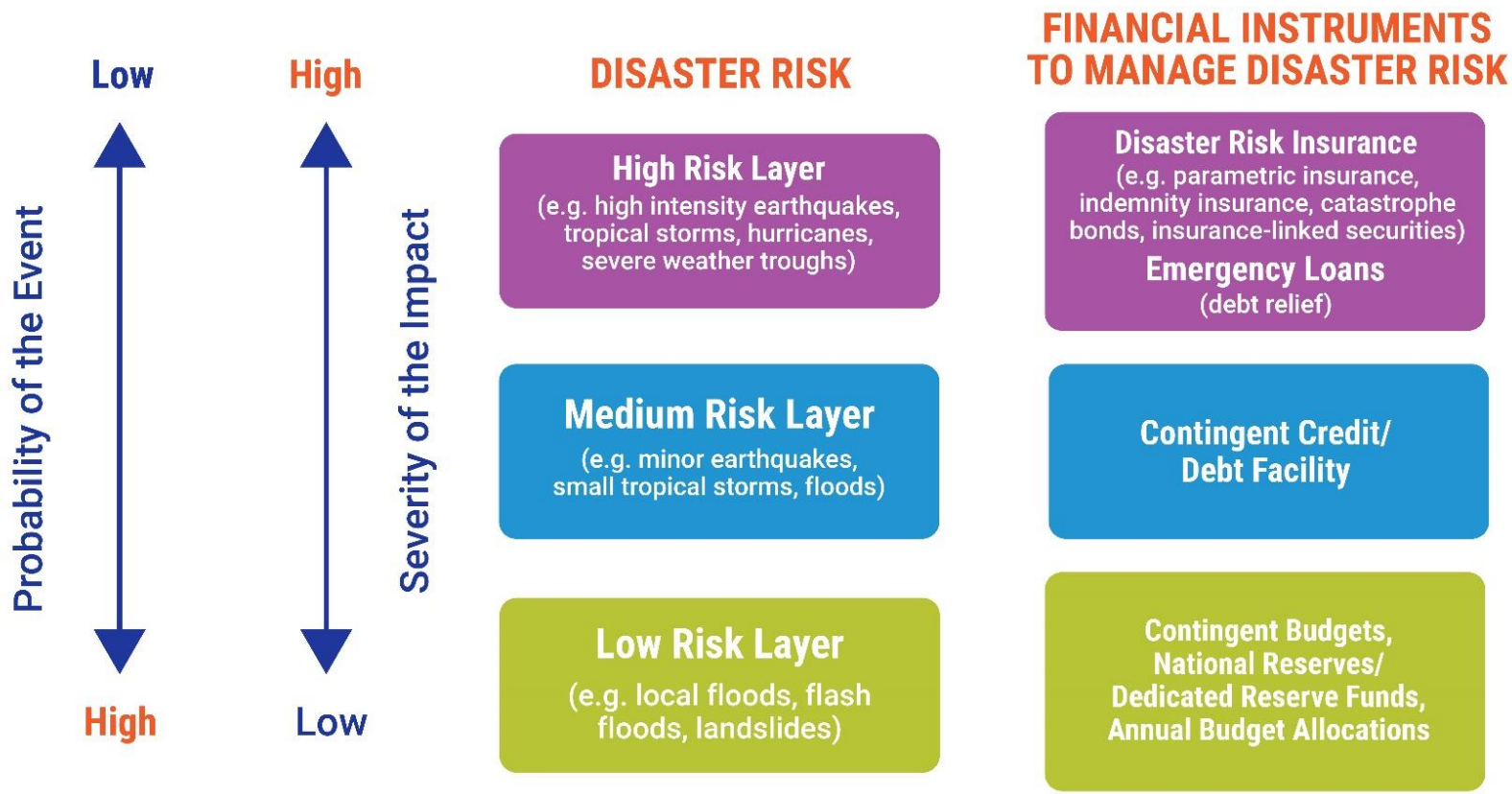
Ex-Ante

- Risk transfer such as insurance and regional risk pools such as CCRIF and ARC, Insurance for Public Assets, Natural Resource Insurance, Meso and Microinsurance, Catastrophe Bonds
- Risk Retention such as Government revenue and budget allocation, contingency and dedicated reserve funds, taxation (to increase resources for DRR)
- External risk finance such as contingent credit facilities which can be arranged ex-ante

Ex-Post

- Risk Retention such as budget reallocation and realignment, taxation (to raise resources for recovery)
- External Risk Finance such as loans and grants

Which Instruments should a government choose?



Risk Layers and Corresponding Disaster Risk Management Instruments

CCRIF SPC – A Disaster Risk Financing Tool

- Who is familiar with it?
- What is it?
- When was it established?
- What does it provide to the Caribbean?
- Is your country a member?

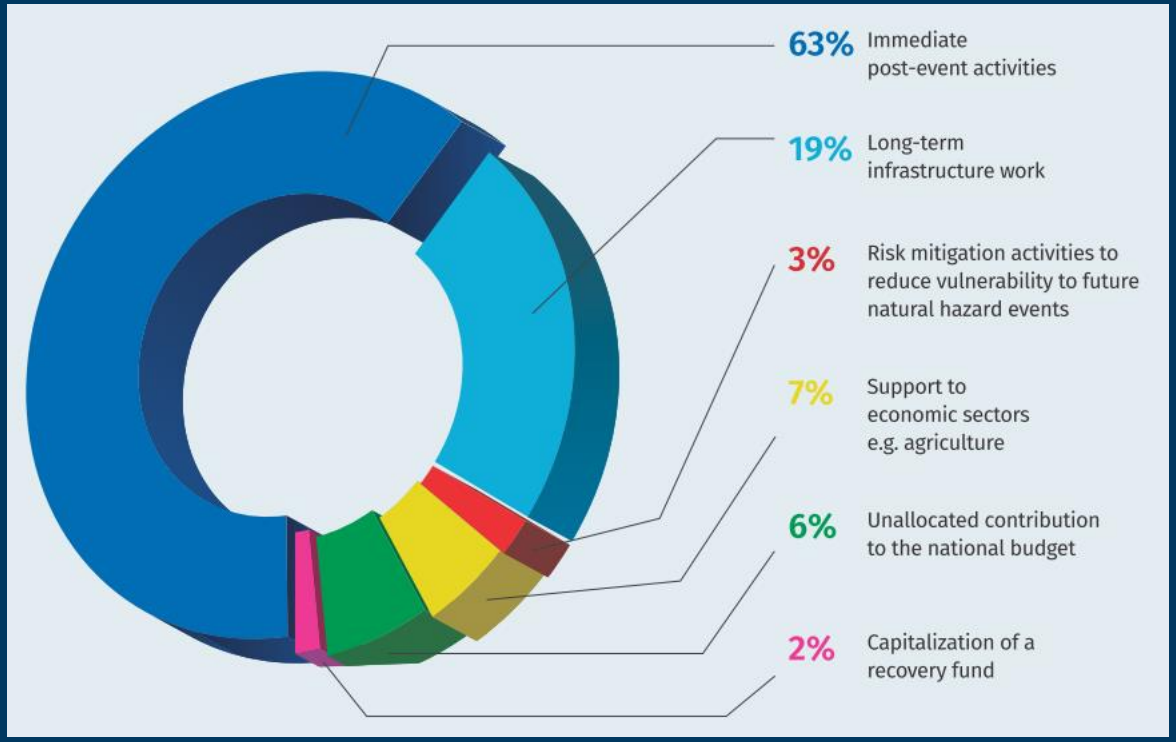
CCRIF SPC – The Caribbean's Parametric Insurance Programme

- Prompted by Hurricane Ivan and request for assistance by Caribbean governments made to the World Bank
- CCRIF is the world's first multi-country multi-peril risk pool based on parametric insurance and provides parametric catastrophe insurance for Caribbean and Central American governments.
- CCRIF operates as a not-for-profit organization and currently provides its products and services to 19 Caribbean governments and 3 Central American governments – and one electric utility company.
- CCRIF represents a cost-effective way to pre-finance short-term liquidity to begin recovery efforts for an individual government after a catastrophic event, thereby filling the gap between immediate response aid and long-term redevelopment

CCRIF Parametric Insurance Products, Payouts and Use of Payouts

54 payouts totalling US$245 million made to 16 member governments… within 14 days of the event

Approximately 3.5 million persons have benefitted from CCRIF payouts since 2007.



Other Perils and Economic Sectors

Go to www.menti.com and use the code 3949 0339

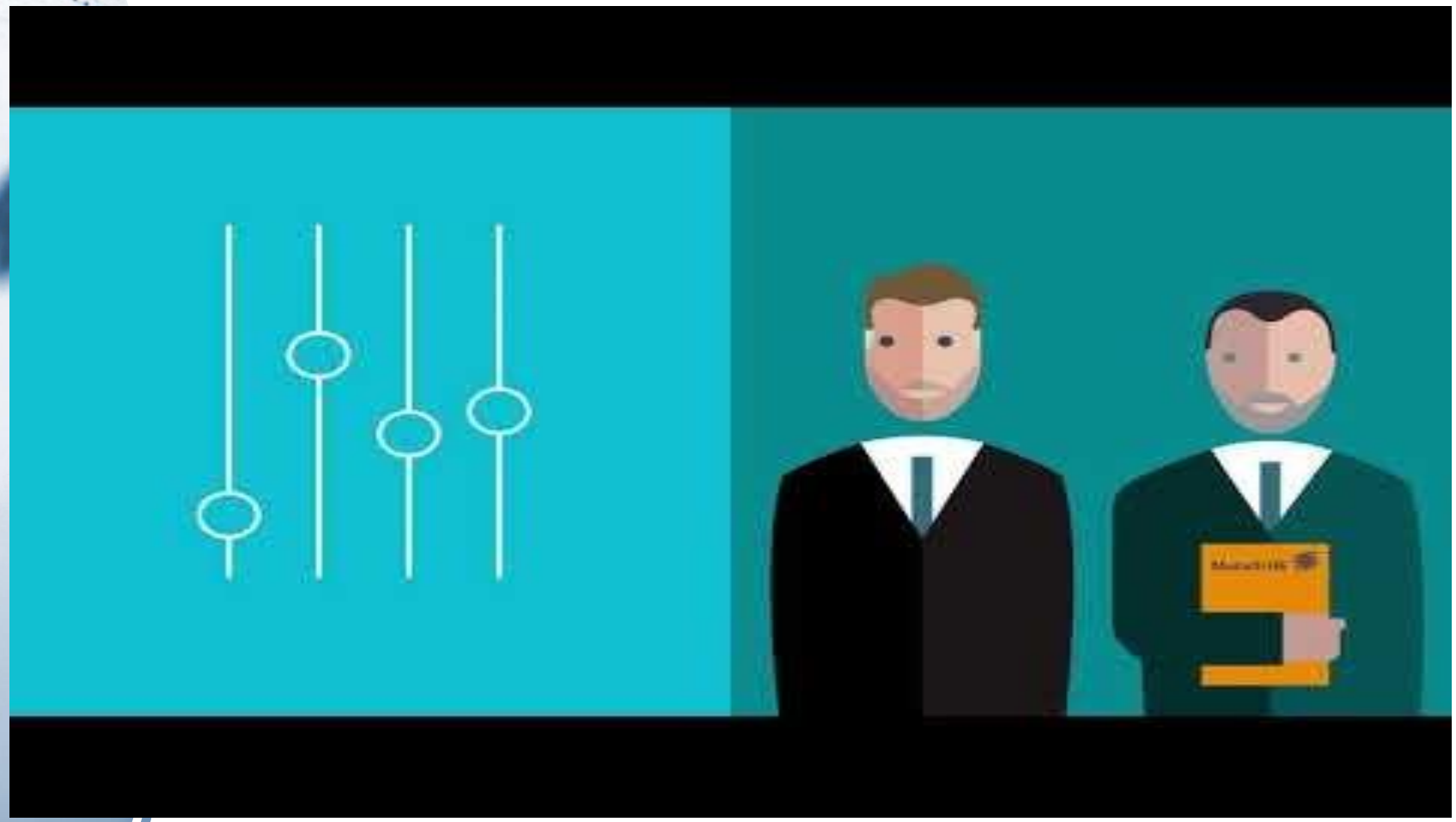
Which insurance products would you like to see offerred? Pick your top 3.

Mentimeter

CCRIF Products, Current and in Development and the Perils Covered

CCRIF Products	Perils											Add. Info
	GS	Wind	Rain	Flood	Drought	Heat Wave	Land-slide	Vol Er	Tsunami wave	Storm surge	Wave Height	
Earthquake	◆											
Tropical cyclone		◆								◆		
Excess Rainfall			◆									
Products under Development												
Drought					◆							
Run-Off				◆								
Eco Sectors Covered												
Electric Utilities		◆								◆		
Fisheries		◆	◆							◆	◆	
LPP (microins)		◆	◆									Adaptive Social Protection
Eco Sectors under Consideration												
Agriculture		◆	◆	◆	◆					◆		Including Livestock
Tourism	◆	◆	◆							◆		
Gov. Buildings and other Infra	◆	◆	◆	◆						◆		Schools, hospitals, offices, PS, houses
Housing Stock	◆	◆	◆	◆			◆			◆		

What is Parametric Insurance?



https://www.youtube.com/watch?v=RhMwqMzaBMs

How CCRIF Parametric Insurance Policies Work

Parametric insurance disburses funds based on the occurrence of a pre-defined level of hazard and impact	Policy triggered on the basis of exceeding a pre-established trigger event loss
	Estimated based on wind speed and storm surge (tropical cyclones) or ground shaking (earthquakes) or volume of rainfall (excess rainfall)
	Hazard levels applied to pre-defined government exposure to produce a loss estimate
	Payout amounts increase with the level of modelled loss, up to a pre-defined coverage limit

CCRIF makes payouts within 14 days after an event.

Characteristics of Parametric Insurance

- Generally less expensive than an equivalent indemnity insurance product
- Payouts can be calculated and made very quickly because loss adjusters do not have to be relied on to estimate damage after a catastrophe event, which can take months or years
- Governments do not have to provide detailed asset values and other information prior to the insurance programme commencing
- Calculation of payouts is totally objective
- The risk, which drives policy pricing, is uniformly defined
- Subject to basis risk which means that events can occur which produce modelled losses that are different from losses on the ground

Cat Modelling

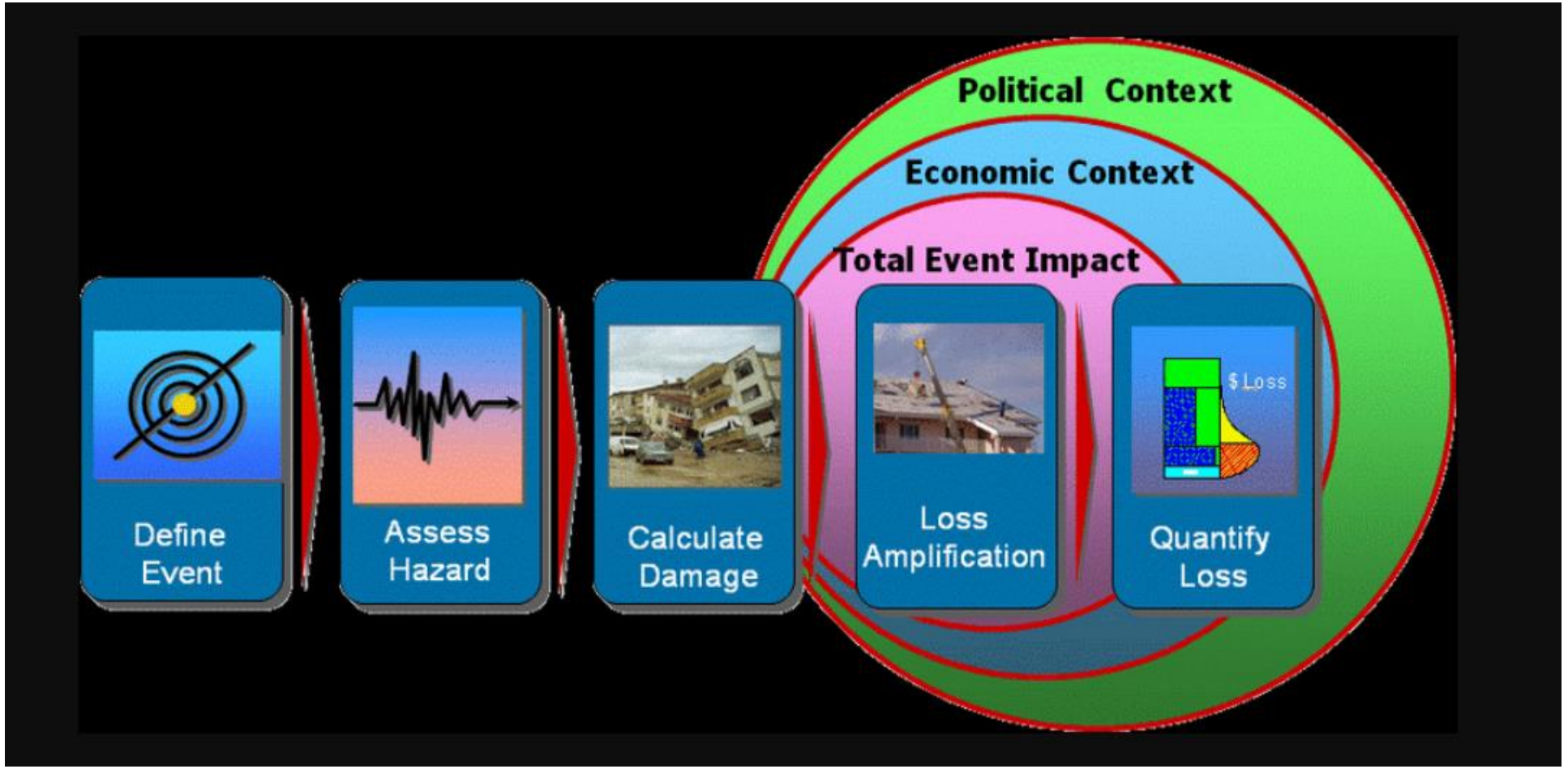
Catastrophe (Cat) Modelling

Catastrophe (Cat) modelling uses computer-assisted calculations to estimate the losses that could be sustained due to a catastrophic event

Catastrophe modeling allows insurers and reinsurers, financial institutions, corporations, and public agencies to evaluate and manage natural catastrophe risk.

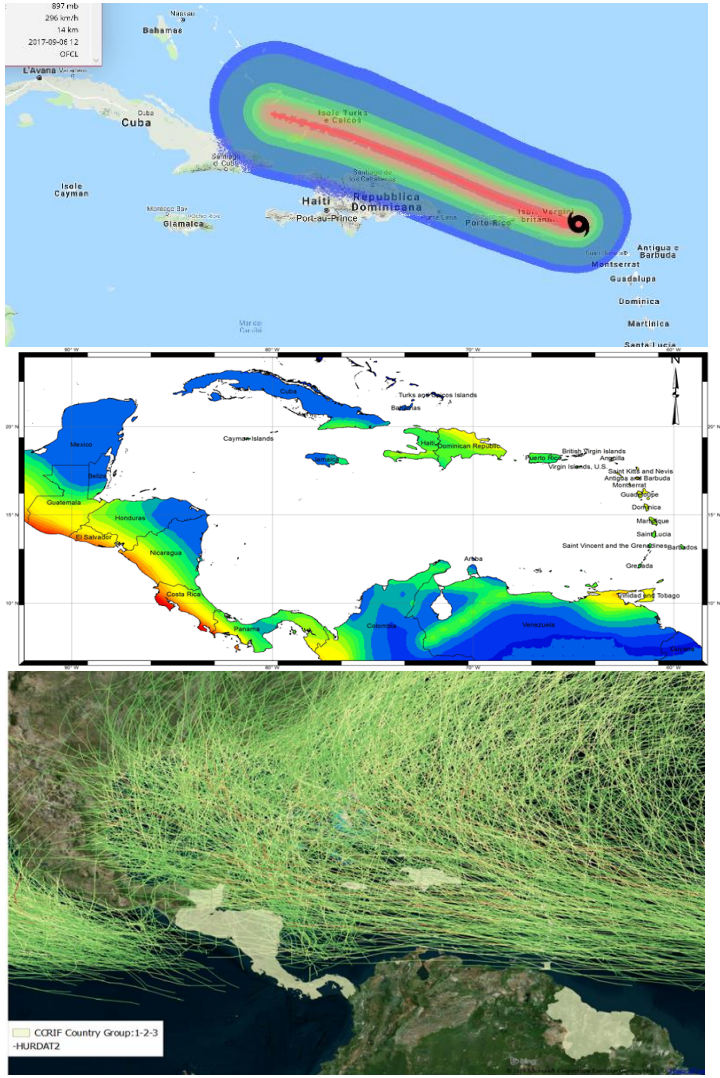
A combination of science, technology, engineering knowledge, and statistical data is used to simulate the impacts of natural and man-made perils in terms of damage and loss.

Catastrophe (Cat) Modelling



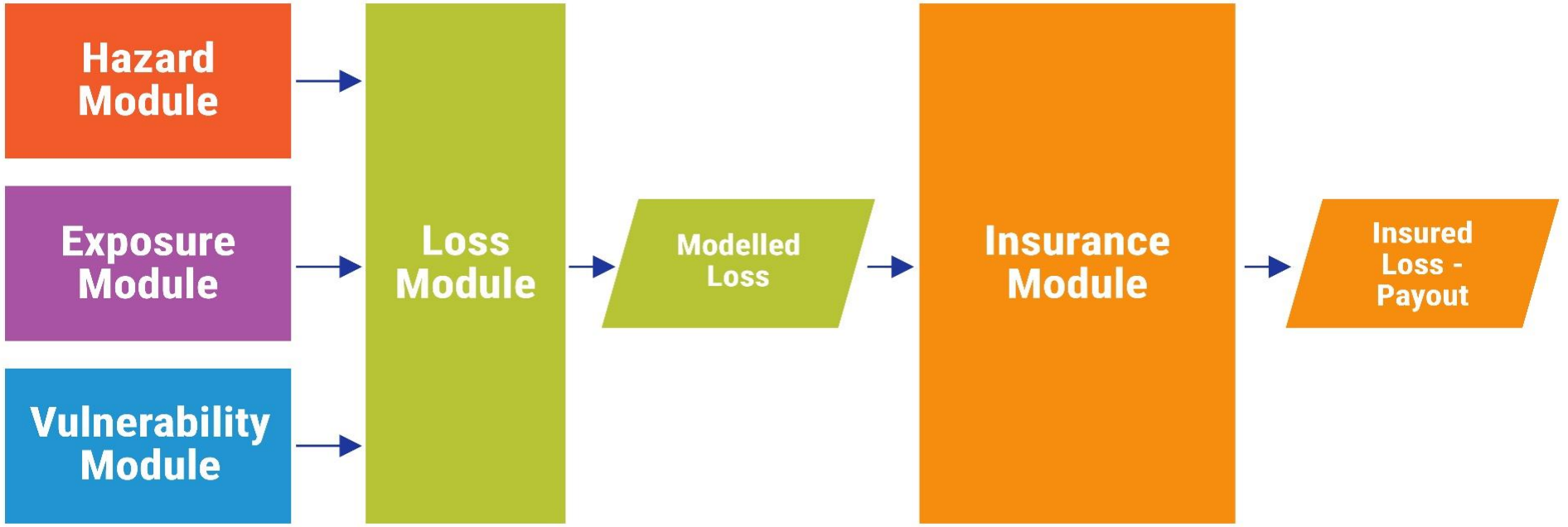
The Role of Loss Estimation and Cat Modelling

- **Before an event-** What might happen if…? What will we need? Where can we request resources? What areas will be impacted?
- **During an event-** Where is this hurricane going? Who should be evacuated? What should we deploy to the region?
- **After an event-** What just happened? Should we request international help? Where is the most damage? Where are people without food and shelter?
- **On average-** Where should we build stronger, higher, or farther away? Where should we retrofit, acquire property, or replace facilities? What should be insured? (insurers- how much should that cost?)



CCRIF's Parametric Model Construct

CCRIF's parametric policies are based on a loss modelling approach. The objective of the loss modelling approach is to equip CCRIF with the capacity to estimate loss probabilities for individual countries, price contracts for specific countries, and estimate site-specific hazard levels and losses for specific events during the contract period.



CCRIF's Parametric Models – The Modules

Hazard

- Defines the expected frequency and severity of a hazard event at a specific location / computes real-time hazard parameters
- Based on a database of historical and simulated events
- EQ: 1520-2017
  TC: 1850-2017
  XSR: 1998-2018

Exposure

- Provides a comprehensive and spatially-distributed list of vulnerable assets e.g. buildings, airports/ports, power facilities, road networks, crops

Vulnerability

- Assesses the vulnerability of the assets in the exposure module to the hazards defined in the hazard module

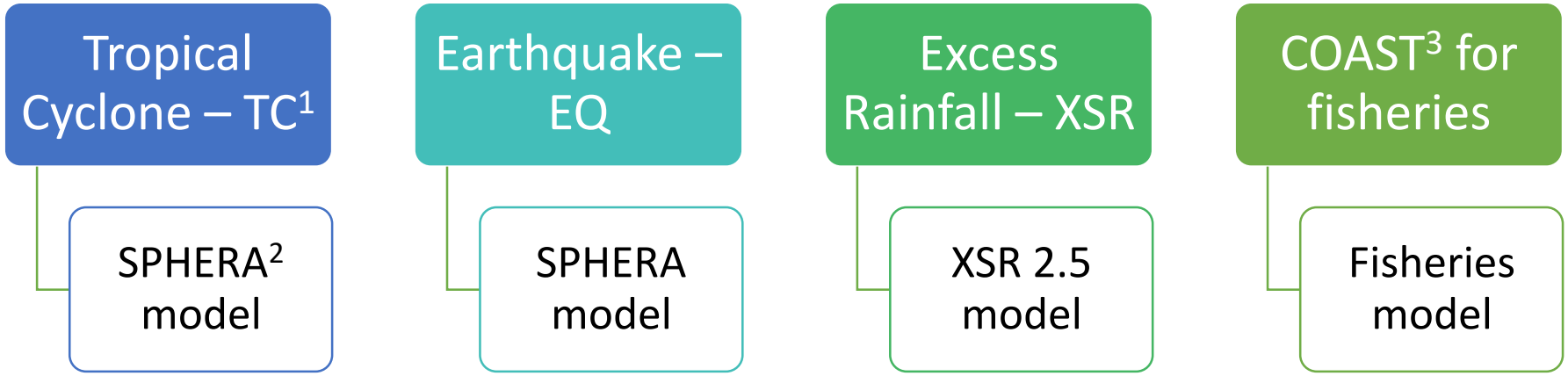
Loss

- Uses the Hazard, Exposure and Vulnerability modules to calculate a modelled loss for a current hazard event

Insurance

- Applies the modelled losses to the conditions of the country's CCRIF policy to determine if the policy is triggered and computes the payout to the country.

CCRIF's Parametric Products and Models



1. Used in Electric Utilities product also
2. System for Probabilistic Hazard Evaluation and Risk Assessment
3. Caribbean Oceans and Aquaculture Sustainability Facility

CCRIF Models – Definitions: TC

A **Tropical Cyclone event:**

A tropical cyclone in the geographical domain which affects at least one CCRIF member country with wind speed > 39 mph (62.7 km/h): a tropical storm or a hurricane – not tropical depression

This applies to the following policies:

- Tropical Cyclone
- COAST
- Electric Utilities

Geographical Domain:
Caribbean and Central America

CCRIF Models – Definitions: EQ

An **Earthquake event**:

An earthquake with a magnitude greater than or equal to 5.0 that occurs inside the geographical domain, which generates a peak ground acceleration of at least 0.01g in at least one CCRIF member country

Peak ground acceleration measures the intensity of the earthquake and is defined as the maximum ground acceleration that occurred during an earthquake

Geographical Domain:
Caribbean and Central America

CCRIF Models – Definitions: XSR

An **Excess Rainfall event – a Covered Area Rainfall Event (CARE):**

A CARE is any rainfall event in which the amount of daily average rainfall, which fell during an accumulation period (12 or 48 hours in Caribbean countries; 24 or 72 hours in Central American countries) is greater than a specified rainfall threshold over at least a specified percentage of the area of a CCRIF member country.

A CARE is composed of a number of consecutive days that meet the conditions listed above, which may include a tolerance period (1 day for Caribbean, 2 days for Central America) in which the rainfall may fall below the thresholds.

The values of the accumulation period's rainfall threshold and covered area percentage are country-specific and were optimized to increase the likelihood that severe XSR events are captured by the model and moderate events are not falsely detected.

A CARE may occur during a tropical cyclone or a non-cyclonic system at any time of year.

CCRIF Models – Definitions: COAST

The fisheries model for COAST policies covers events that fall within the Adverse Weather Component and/or the Tropical Cyclone component.

Adverse Weather Component – a qualifying event:

The occurrence of maximum daily rainfall measured in a 24-hour moving window over any of the exposed assets in a CCRIF member country above a pre-defined threshold, or of a maximum daily significant wave height close to any of the exposed assets above a pre-defined threshold

These conditions must occur for at least three consecutive days to be a COAST adverse weather event.

Tropical Cyclone Component – a qualifying event:

Any tropical cyclone affecting at least one member country with winds greater than 39 mph (62.7 km/h) (same as TC policy)

CCRIF Models and Event Reports

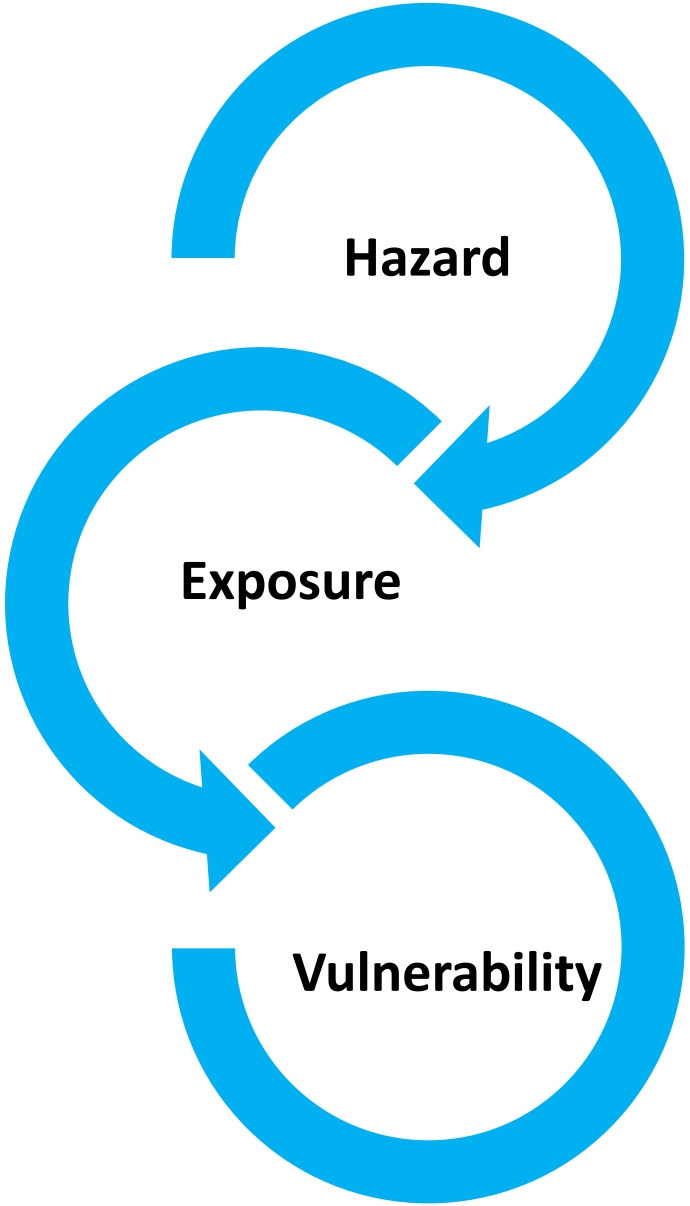
- CCRIF monitors and reports on tropical cyclone (TC), earthquake (EQ), Excess Rainfall (XSR)events as well as “COAST events” and “electric utilities events” in the Caribbean Basin that have the potential to affect one or more of its member countries that have the corresponding policies.

- CCRIF reports on all hazard events that meet the definition of a qualifying event (for TC, EQ, XSR, COAST or Electric Utilities) as defined in the previous slides. These events are publicly available on the CCRIF website at: https://www.ccrif.org/content/publications/reports/others

- Note that one tropical cyclone event can generate, a tropical cyclone excess rainfall, COAST and/or Electric Utilities report for the same affected country/ies if the relevant definition is met.

SPHERA Model

TC
EQ



- **Tropical Cyclone:** Tropical cyclone data from NOAA within geographic region (wind and storm surge)
- **Earthquake:** Earthquake data from USGS (peak ground acceleration)

Buildings, airports/ports, power facilities, road network, crops

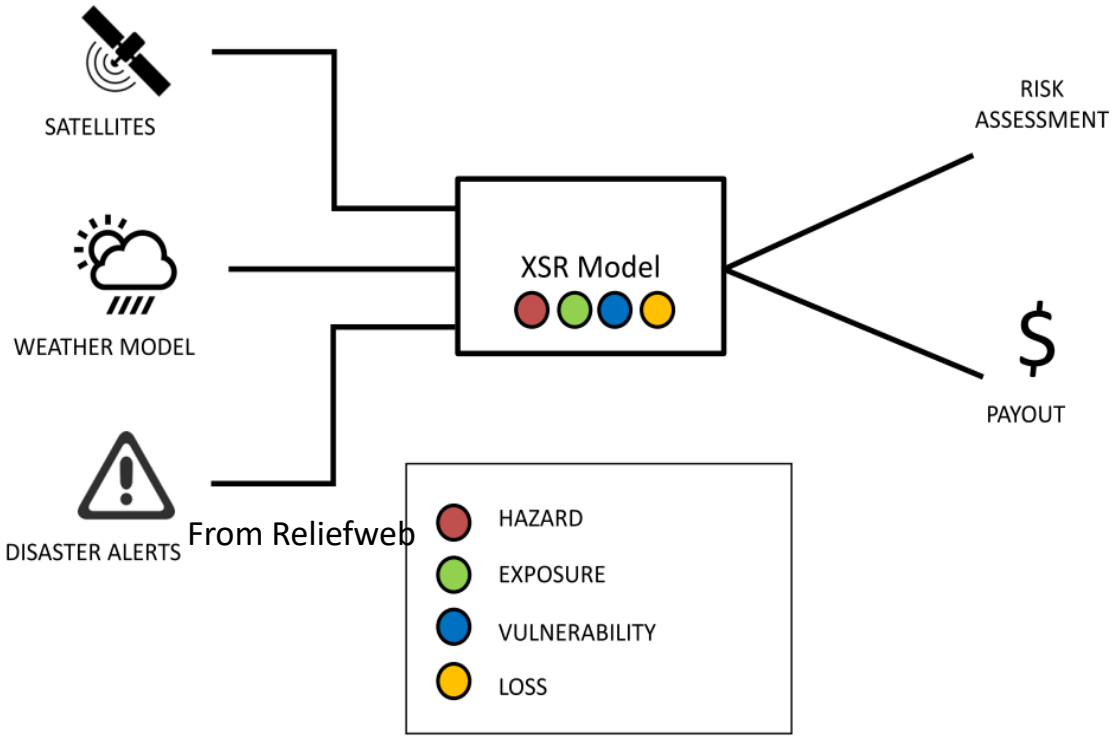
- Location
- Economic value (replacement cost/estimated income)
- Physical attributes (materials, dimensions)

- **Tropical Cyclone:** Relates wind/storm surge intensities to infrastructure damage ratios
- **Earthquake**: Relates ground shaking values to infrastructure damage ratios

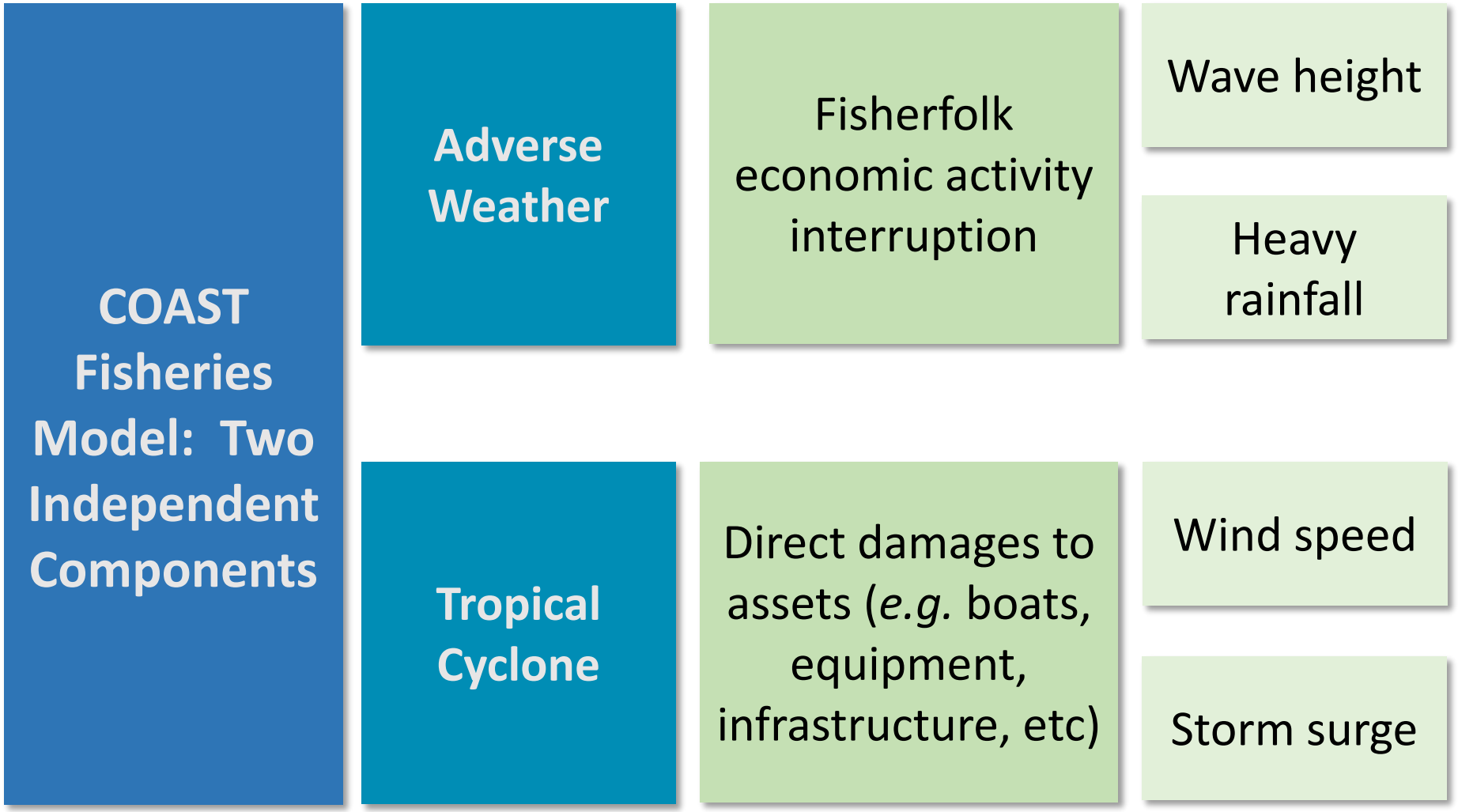
XSR 2.5 Model

CMORPH: developed by NOAA Climate Prediction Center. It is low-orbiter satellite-based precipitation model which captures more precisely the ***spatial and temporal location*** of the rainfall caused by the event.

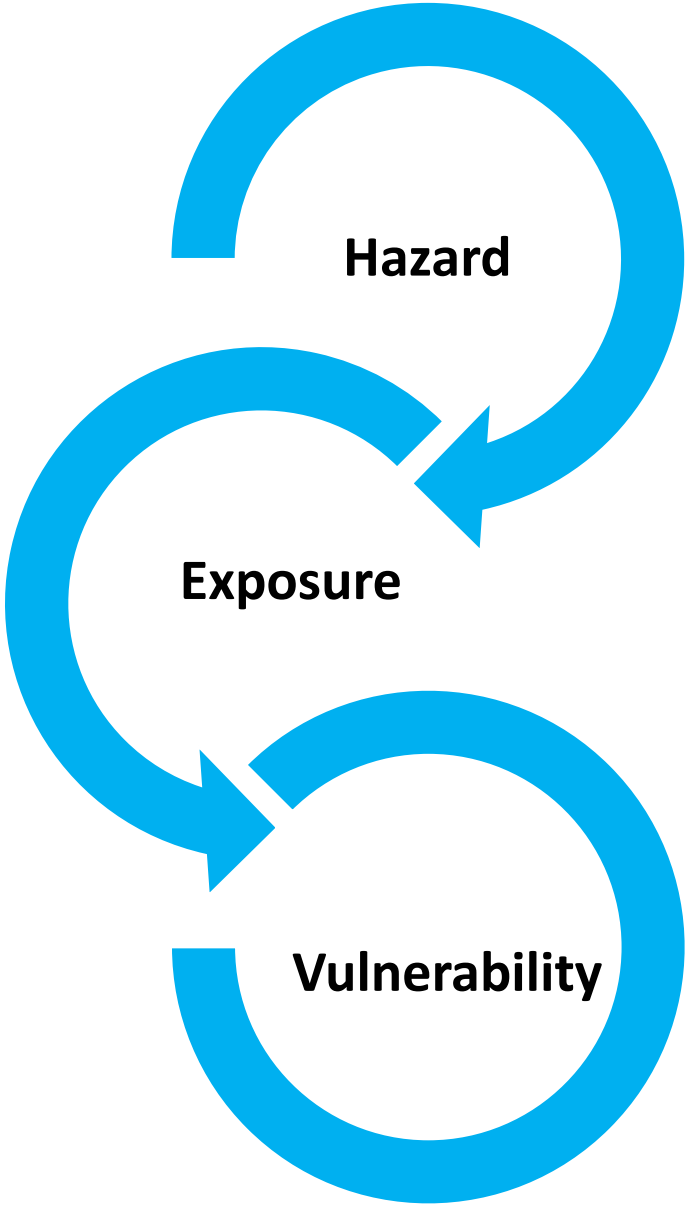
WRF: Weather forecasting models developed by the US National and Oceanic and Atmospheric Administration (NOAA), which computes the amount of rainfall based on climate conditions. This weather forecast model reproduces the ***intensity*** of the rainfall event.



Fisheries Model for COAST



COAST Fisheries Model



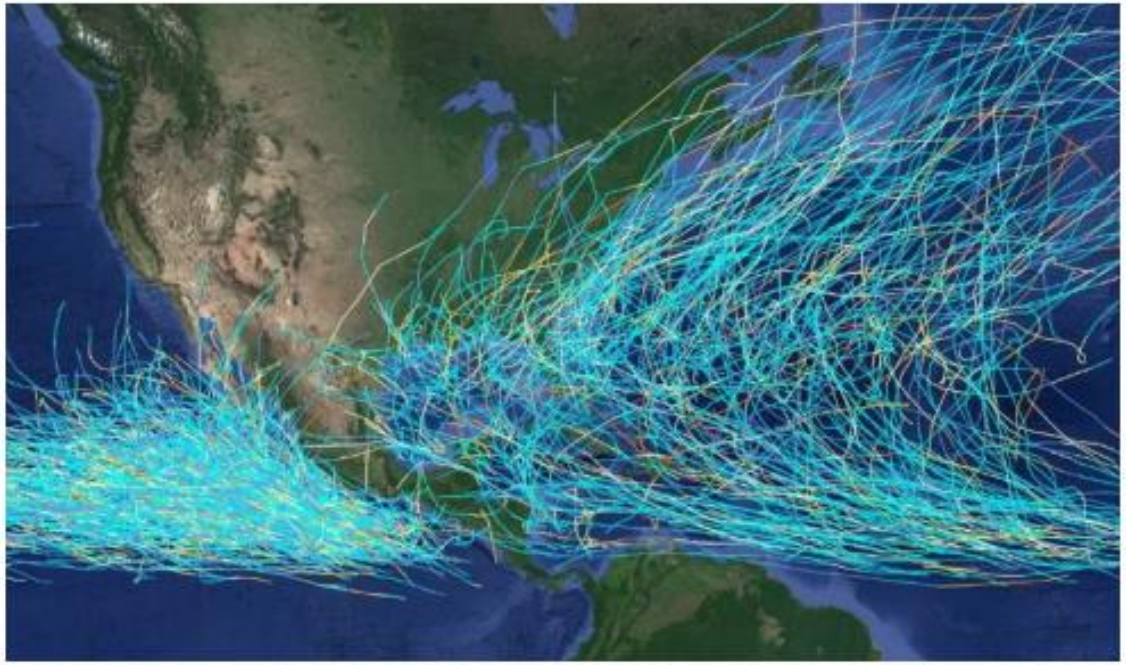
- **Adverse Weather Component:** Wave height and strong rainfall (for at least 3 consecutive days)
- **Tropical Cyclone Component:** Wind speed and storm surge

Comprises infrastructure, boats and fisherfolk characteristics such as:

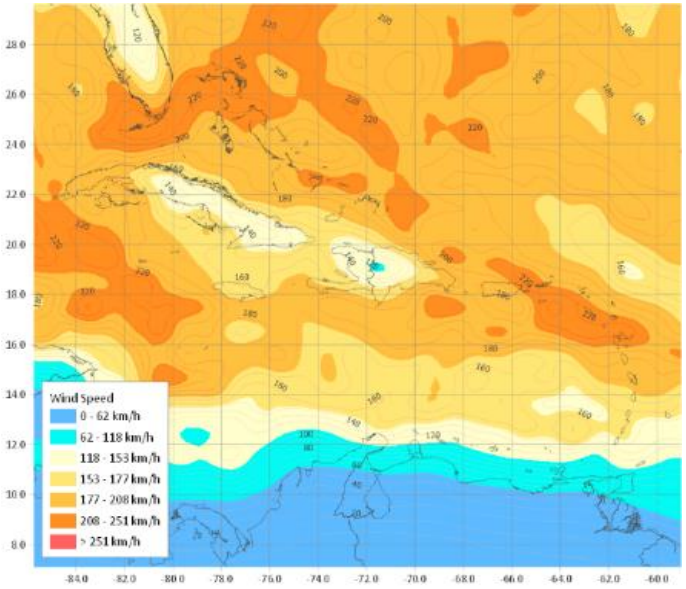
- Location
- Economic value (replacement cost/estimated income)
- Physical attributes (materials, dimensions)

- **Adverse Weather Component:** relates rainfall depth or wave height levels to daily lost revenues
- **Tropical Cyclone Component:** Relates wind/storm surge intensities to infrastructure damage ratios (%)

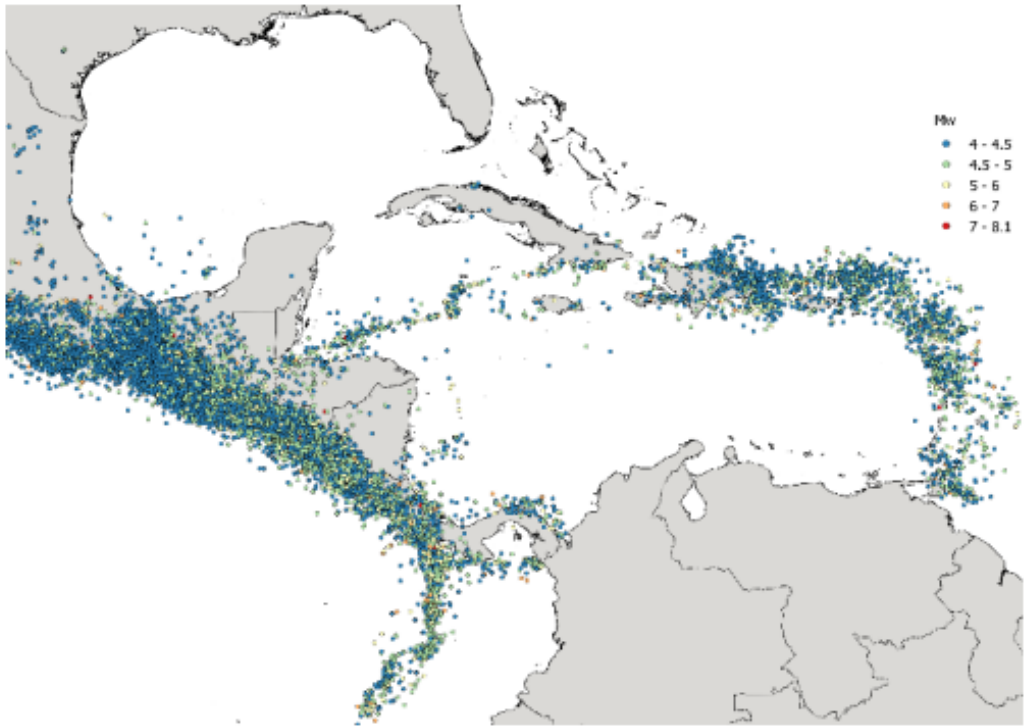
Hazard Module - TC



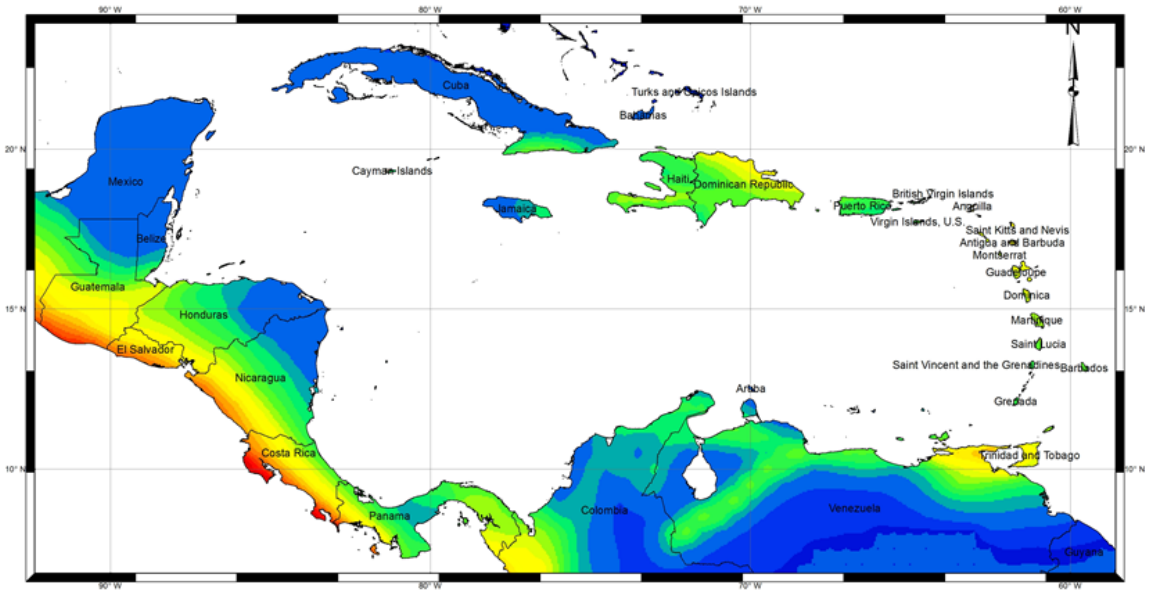
Track of tropical cyclones for the Caribbean Sea and Eastern North Pacific from 1998 to 2017, information from the HURDAT2 database



Hazard Module - EQ



Geographic distribution of earthquakes that occurred in Central America and the Caribbean since 1520



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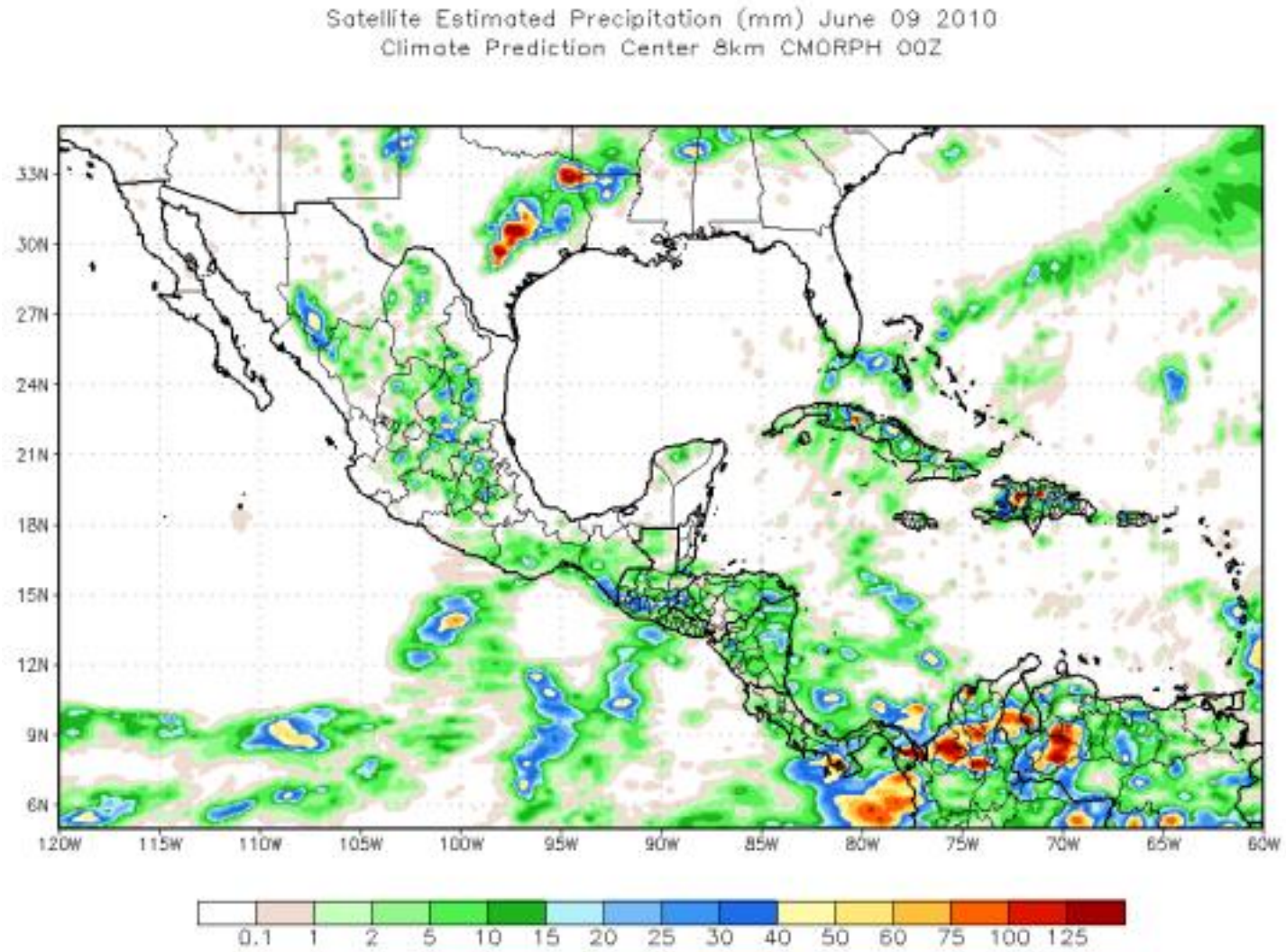
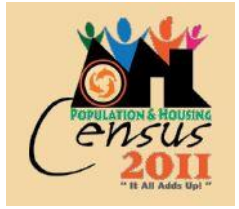
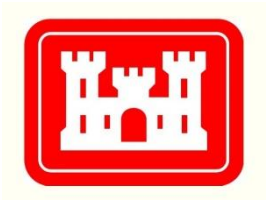
Hazard Module - XSR

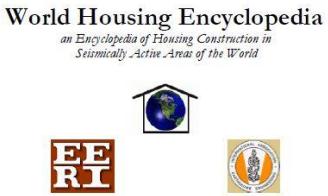


Exposure Database

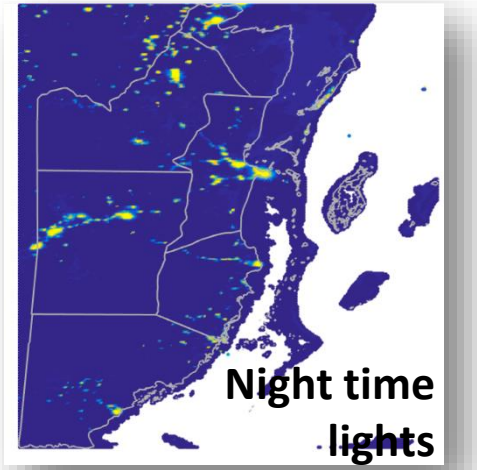
- The SPHERA IED is built and validated on country level census data, technical documentation, international peer-reviewed literature, publicly available reports and databases, and satellite images

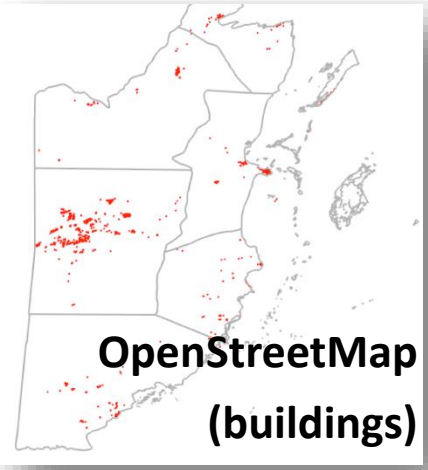


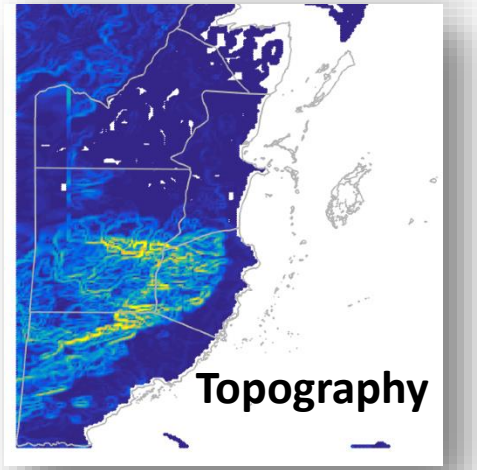


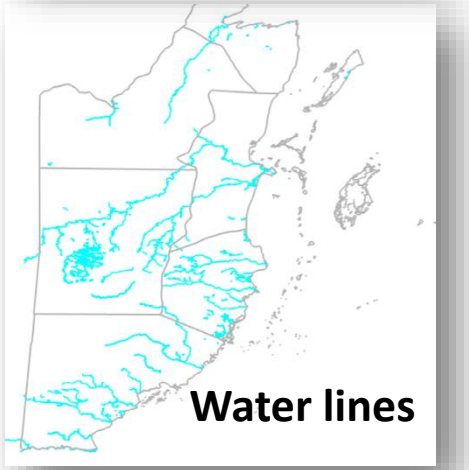


Exposure Database







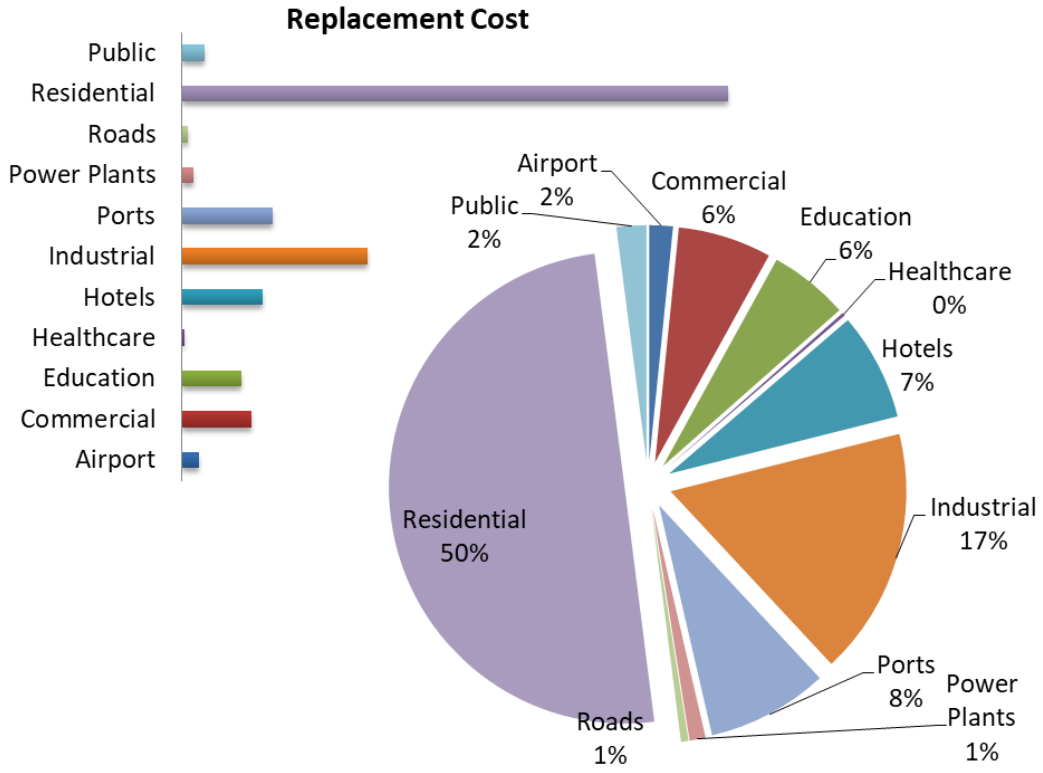


Exposure Module

Using remotely sensed data and economic statistics from various sources, valuation estimates of the country's exposure are determined.

Categories included:

- Residential buildings
- Commercial buildings
- Public Buildings
- Industrial facilities
- Hotels and restaurants
- Healthcare infrastructure
- Energy Facilities
- Education infrastructure
- Airports and ports
- Transportation (roads) network
- Crops (TC, EQ)

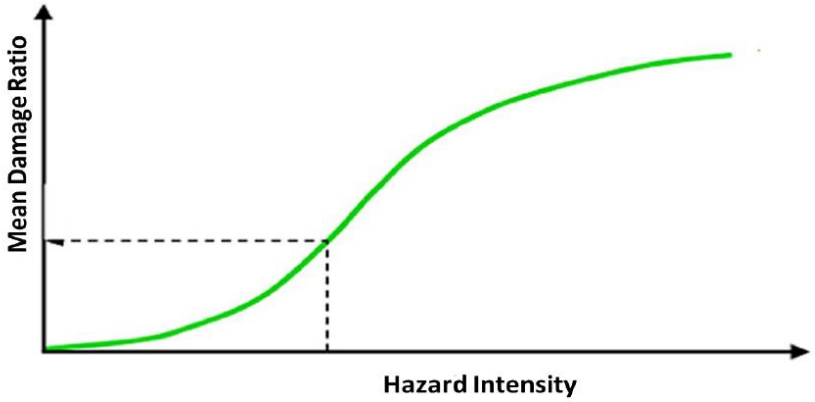


Crops:

• 6 different crops (banana, maize, coffee, rice, sugar cane, and generic)

Vulnerability Module

- Susceptibility of an asset (building, infrastructure, crop) to be damaged by a hazard
- Usually expressed through damage curves



- Mean damage ratio (MDR): repair cost divided by replacement cost of the structure

Damage functions assess the structural behaviour and fragility of the assets in the exposure

TC: Two damage mechanisms, hence two sets of damage functions:

- Wind damage functions
- Storm surge damage functions

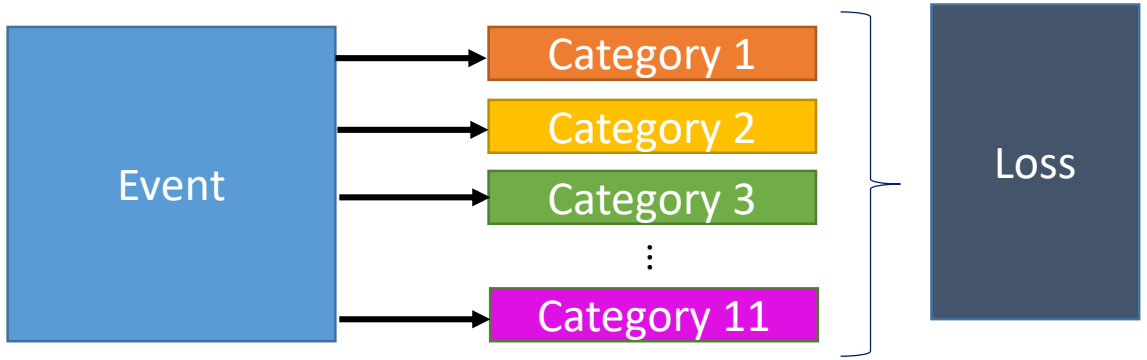
EQ: damage based on ground shaking

XSR: rainfall amount

Based on literature review of existing fragility and vulnerability functions

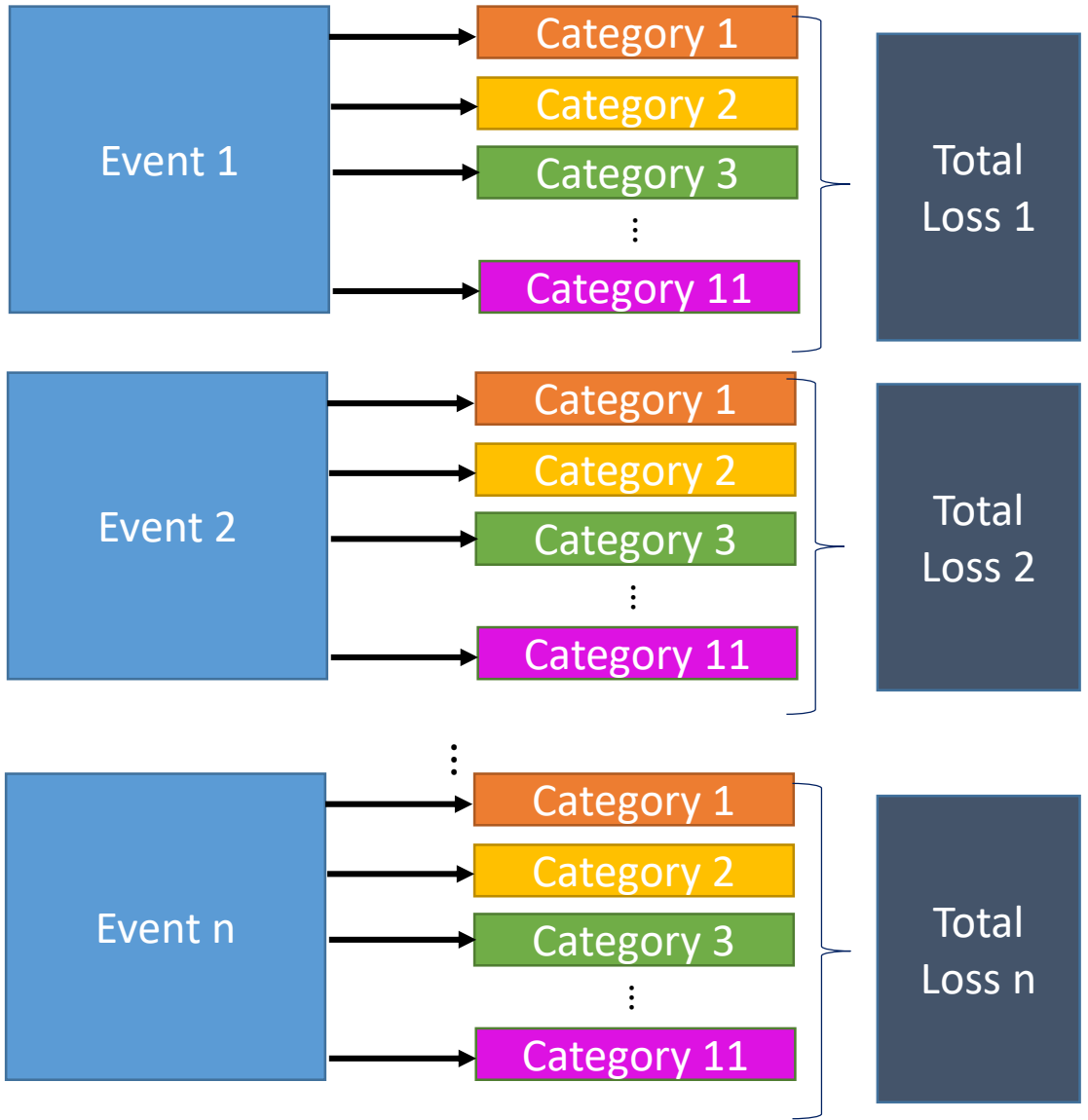
Loss Module

$$L_i = V_i(H_i) \times E_i$$



The loss module translates the damage ratio derived in the vulnerability module into a dollar loss by multiplying it by the value at risk for each asset class across the country.

Loss Module



$$L_i = V_i(H_i) \times E_i$$

The loss module translates the damage ratio derived in the vulnerability module into a dollar loss by multiplying it by the value at risk for each asset class across the country.

Losses are then aggregated at the level governed by the policy (national or sub-national).

Loss assessment

Event	Loss
1	Loss $_1$
2	Loss $_2$
3	Loss $_3$
⋮	⋮
n	Loss $_n$

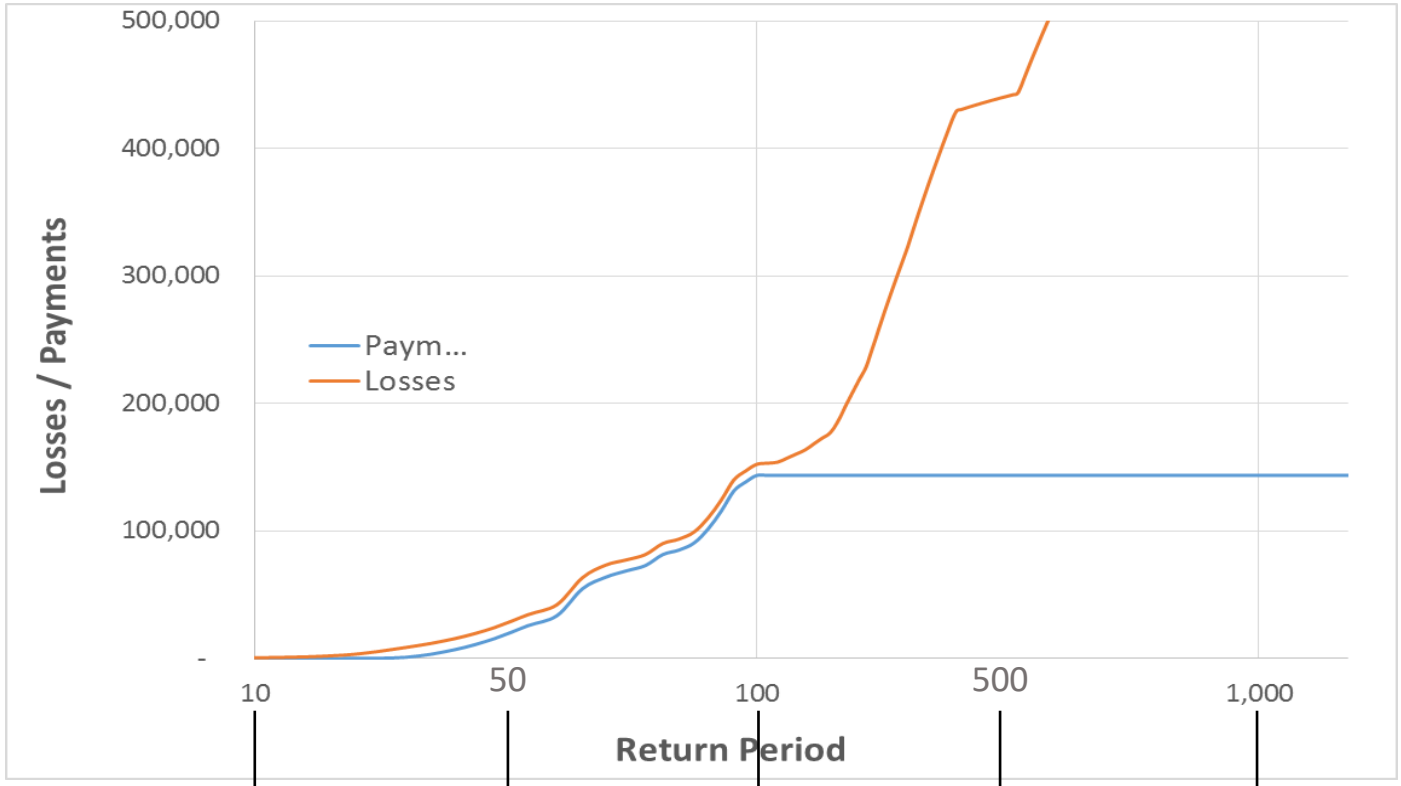
$$\textbf{Annual Probability of Exceedance of "Loss A"} = \frac{Number\ of\ times\ Loss\ A\ has\ been\ exceeded}{Number\ of\ Years}$$

$$\textbf{Return period of "Loss A"} = \frac{Number\ of\ Years}{Number\ of\ times\ Loss\ A\ has\ been\ exceeded}$$

Loss probability curves are generated from the results in the long-term loss event set.

Loss assessment

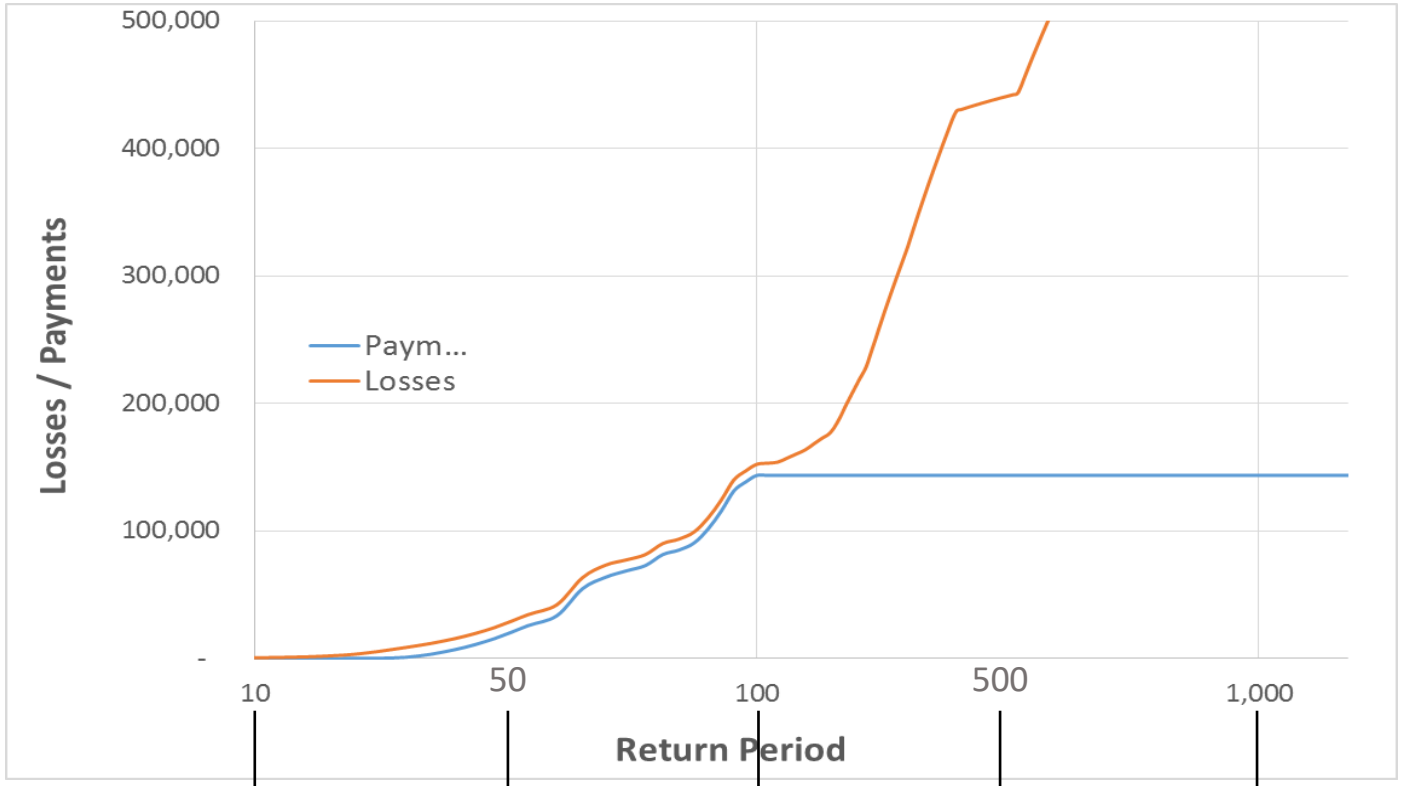
Loss probability curve for a sample country



$$\text{Annual Probability of exceedance} = \frac{1}{\text{Return Period}}$$

Loss assessment

Loss probability curve for a sample country



$$\text{Annual Probability of exceedance} = \frac{1}{\text{Return Period}}$$

10%	2%	1%	0.2%	0.1%

Insurance Module

The insurance module compares the modelled losses from the event to the conditions of the country's policy to determine if the policy is triggered and calculates the value of the payout.

A CCRIF policy is triggered when the modelled loss for an event in a member country equals or exceeds the attachment point specified in the policy contract.

The payout increases as the level of losses increases, up to the policy coverage limit.

The claims verification, administration and payout process

- CCRIF uses **automated systems** which allows us to monitor every possible event that may trigger a payout under the terms and conditions of a country's policy. The system detects **earthquakes, tropical cyclones and rainfall** events.
- For XSR, there is a **minimum number of days** required to compute the accumulation of rain. Also, a rainfall event is not considered complete until the rainfall has fallen below a given threshold for **two consecutive days**.
- CCRIF issues an **event briefing** after an event has been completed if there has been a loss above a certain value across most of the country.
- If a country's policy is triggered by an event **CCRIF will automatically contact the Ministry of Finance** about the next steps required to receive payment.

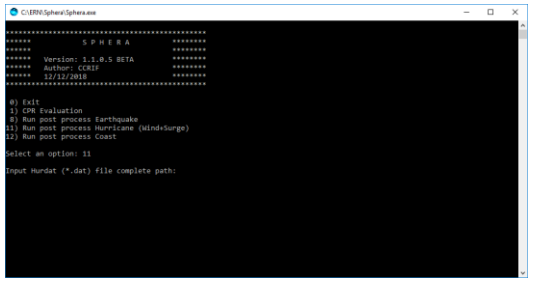
TC: Real-time operation

1 - NOAA activates a tropical cyclone alert

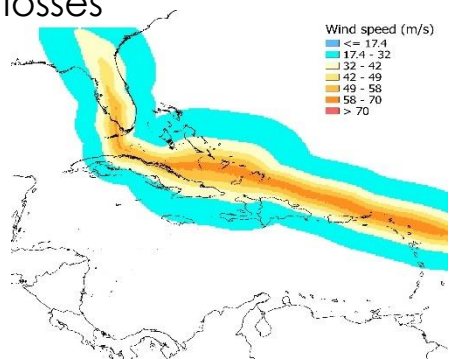
2 - NOAA produces a best track file

```
AL, 11, 2017082806, 01, CARQ, -24, 117N,  174W,  25,    0, DB,  34,
AL, 11, 2017082806, 01, CARQ, -18, 118N,  179W,  25,    0, DB,  34,
AL, 11, 2017082806, 01, CARQ, -12, 119N,  184W,  25,    0, DB,  34,
AL, 11, 2017082806, 01, CARQ,  -6, 120N,  190W,  25,    0, DB,  34,
AL, 11, 2017082806, 01, CARQ,   0, 120N,  195W,  25, 1009, DB,  34,
AL, 11, 2017082806, 01, CARQ,   0, 120N,  195W,  25, 1009, DB,  50,
AL, 11, 2017082806, 01, CARQ,   0, 120N,  195W,  25, 1009, DB,  64,
AL, 11, 2017082806, 03, CLP5,  12, 123N,  209W,   0,    0,   ,   0,
AL, 11, 2017082806, 03, CLP5,  24, 128N,  224W,   0,    0,   ,   0,
AL, 11, 2017082806, 03, CLP5,  36, 134N,  242W,   0,    0,   ,   0,
AL, 11, 2017082806, 03, CLP5,  48, 141N,  263W,   0,    0,   ,   0,
AL, 11, 2017082806, 03, CLP5,  60, 147N,  286W,   0,    0,   ,   0,
```

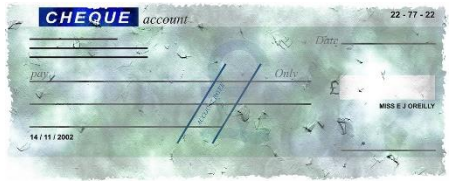
3 – CCRIF's calculation agent runs SPHERA using the best track file as input



4 - SPHERA produces estimates of wind speed, storm surge and economic losses



5 – Given the country's policy parameters, if the losses are above the attachment point, a payout is computed

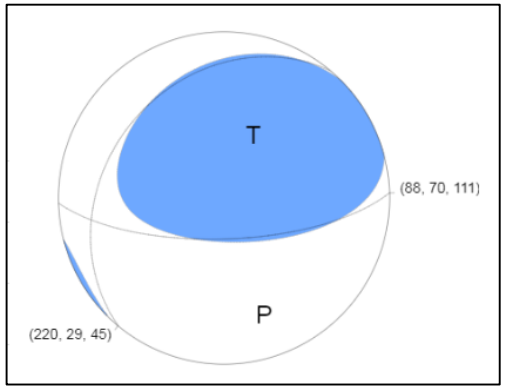


EQ: Real-time operation

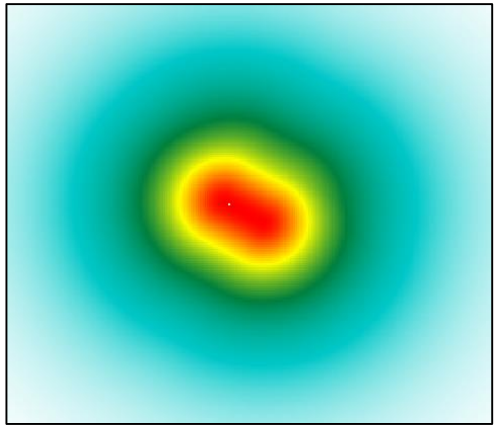
1 - USGS reports an EQ

2 – USGS reports magnitude, depth and moment tensor solution

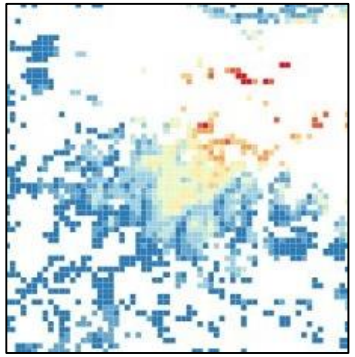
M=7.3
10.773° N
62.902° W
Depth=146.8km



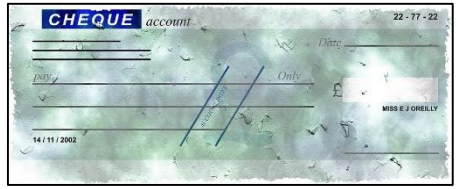
3 – CCRIF's calculation agent runs SPHERA using the USGS parameters as input



4 - SPHERA produces estimates of ground motion intensities and economic losses

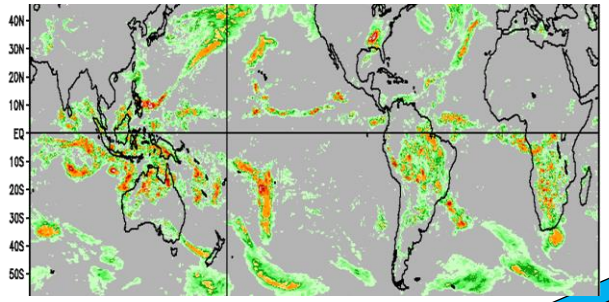


5 – Given the country's policy parameters, if the losses are above the attachment point, a payout is computed



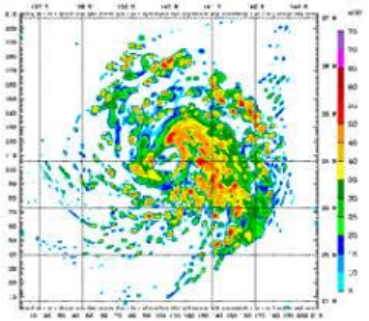
XSR 2.5 Real Time Operation

1 - NOAA provides global data of CMORPH, GFS FNL and ADP

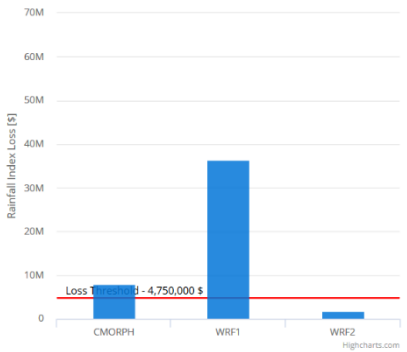


2 – The data are downloaded and cut over the geographical domain

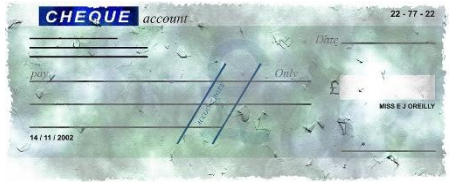
3 – CCRIF's calculation agent runs the WRF model



4 – XSR produces estimates of economic losses



5 – Given the country's policy parameters, if the losses are above the attachment point, a payout is computed



Identification of a CARE

The definition of a Covered Area Rainfall Event is based only on rainfall estimates from CMORPH. A CARE occurs for a given country if threshold values of these 3 parameters are jointly exceeded:

- Aggregation Period (e.g., 12/48 hours for Caribbean countries and 24/72 hours for Central American countries)
- Rainfall intensity (e.g., 50mm/day for a number of days equal to the aggregation period)
- Minimum Cell Fraction (e.g., 10% of all the 1km x 1km exposure cells in a country with rainfall intensity above threshold for the aggregation period)

Two aggregation periods are used, i.e., the CARE can be activated either by a short (12 hours in the Caribbean, 24 hours in Central America) and very intense precipitation or by a longer and less intense event (24 hours in the Caribbean, 72 hours in Central America). The period which produces the greater amount of rainfall is selected.

These are CARE criteria. Once the CARE criteria are met the CARE starts. The CARE ends when the CARE criteria are no longer met. Note that the CARE is not interrupted if the CARE criteria are not met for a country-specific tolerance period (TP) (e.g., 1 day for Caribbean countries and 2 days for Central American countries) after the CARE start date.

Covered Area Rainfall Event(CARE)

A CARE is any rainfall event in which the amount of average rainfall is greater than a specified threshold over a specified accumulation period over at least a specified percentage of the area of a country.

In order to have a reportable event, the following procedure must be followed:

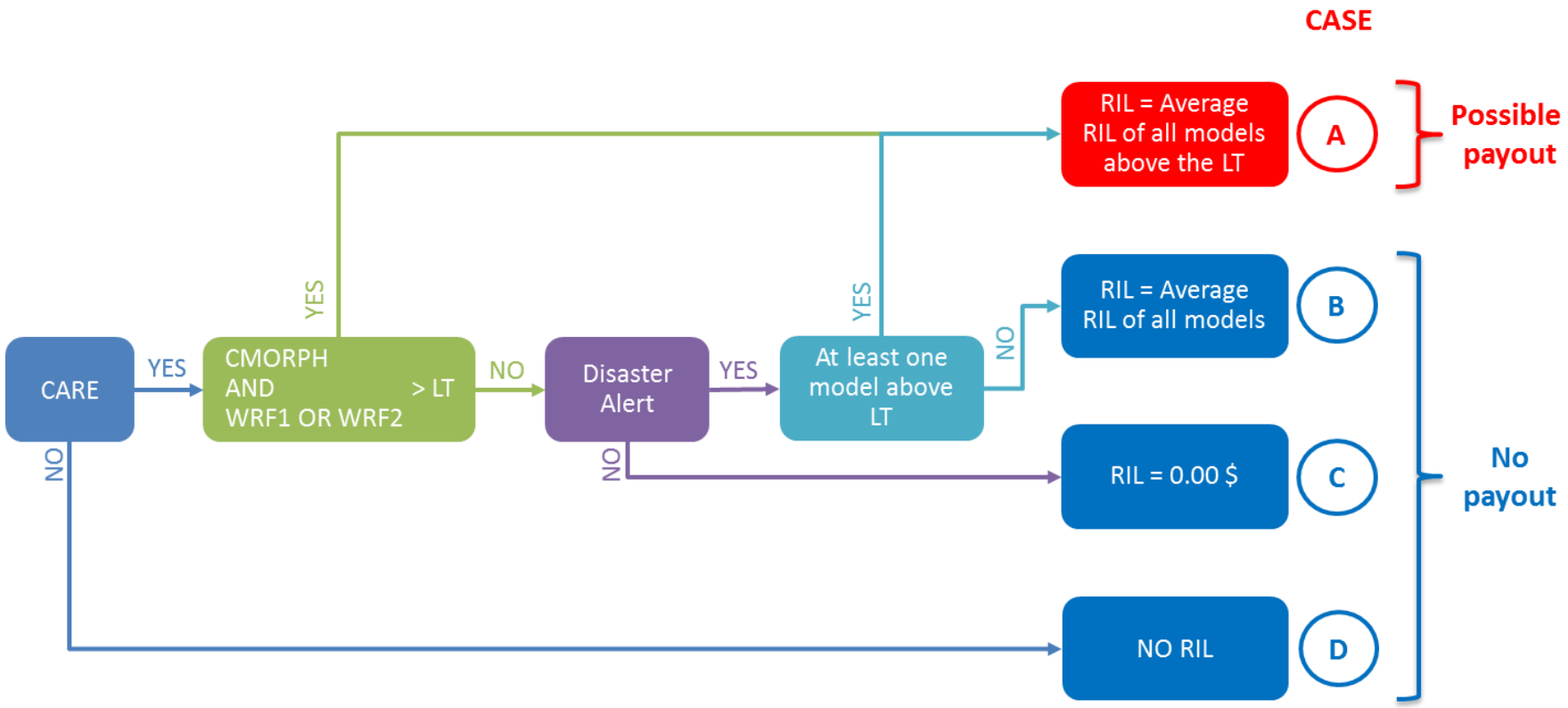
1. Compute the rainfall index as the maximum rainfall intensity over the aggregation period **(Caribbean: 12/48 hours)**
2. Compute the number of active cells as the number of cells that, at each day, have a rainfall index greater than the rainfall index threshold **(eg: 50 mm/88 mm)**

Individual Cell Thresholds

3. Compute the start date of the event as the first day in which the number of active cells is above the active cells threshold **(eg: 10% of total cells)**
4. Compute the end date of the event as the last day in which the number of active cells is above the threshold with a period of tolerance **(Caribbean: 1 day)**

Country Thresholds

XSR 2.5 – which events count?



Loss calculation – examples

Laura – Haiti

RIL above the loss threshold for Haiti for all three data sources: CMORPH, WRF5 and WRF7. The RIL was highest for CMORPH due to the higher amounts of accumulated precipitation presented over the capital Port-au-Prince and surroundings, an area characterized by high exposure.

RIL-final was calculated as the average of the RILs for the CMORPH, WRF5 and WRF7 data sources. The RIL-final was higher than the attachment point of the Excess Rainfall policy for Haiti, and therefore this event was classified as a triggering event thus resulting in a payout.

Rainfall Sept/Oct 2020 – Dominica

RIL above the loss threshold for Dominica for two of the data sources: CMORPH and WRF5. RIL-final was calculated as the average of the RILs for the CMORPH and WRF5 data sources.

RIL-final was greater than zero and therefore this CARE qualified as a loss event. However, RIL-final was below the attachment point of Dominica's Excess Rainfall policy and thus did not trigger a policy payout.