



**16/11/2024 to 18/11/2024**

**Excess Rainfall  
Wind and Storm Surge**

**Final Event Briefing**

**Belize Water Services**

**25 November 2024**

## 1 SUMMARY

Tropical Cyclone Sara is the nineteenth named cyclone of the 2024 Atlantic Hurricane Season. From 14 to 17 November, tropical storm Sara crossed the Gulf of Honduras, making landfall near Belize City on 17 November at 1400UTC. The system presented initially a large convective structure, which became less organized during this period. During this time, Belize was affected intermittently by moderate to locally intense precipitation, due to the passage of convective rainbands. At the time of landfall, a burst of convection was located near the system centre. After landfall, the system spread moderate to intense rainfall over central Belize as TC Sara moved inland. On 17 November at 1800UTC, Sara weakened into a tropical depression and moved away from Belize. On the next day, it dissipated over the Yucatan Peninsula. Residual convection was active for three hours over northern Belize.

The runs of the CCRIF CWUIC model have produced losses for the Belize Water Services (BWS). The losses for BWS are below the Attachment Point of its CWUIC policy and therefore no payout under this policy is due.

This event briefing is designed to review the modelled losses due to wind, storm surge and excess rainfall calculated by CCRIF's CWUIC model for affected CCRIF member water utilities, to be analyzed with respect to members' CWUIC policies. BWS was the only CCRIF water utility member for which the CCRIF CWUIC loss model for wind, storm surge and excess rainfall produced losses due to Tropical Cyclone Sara.

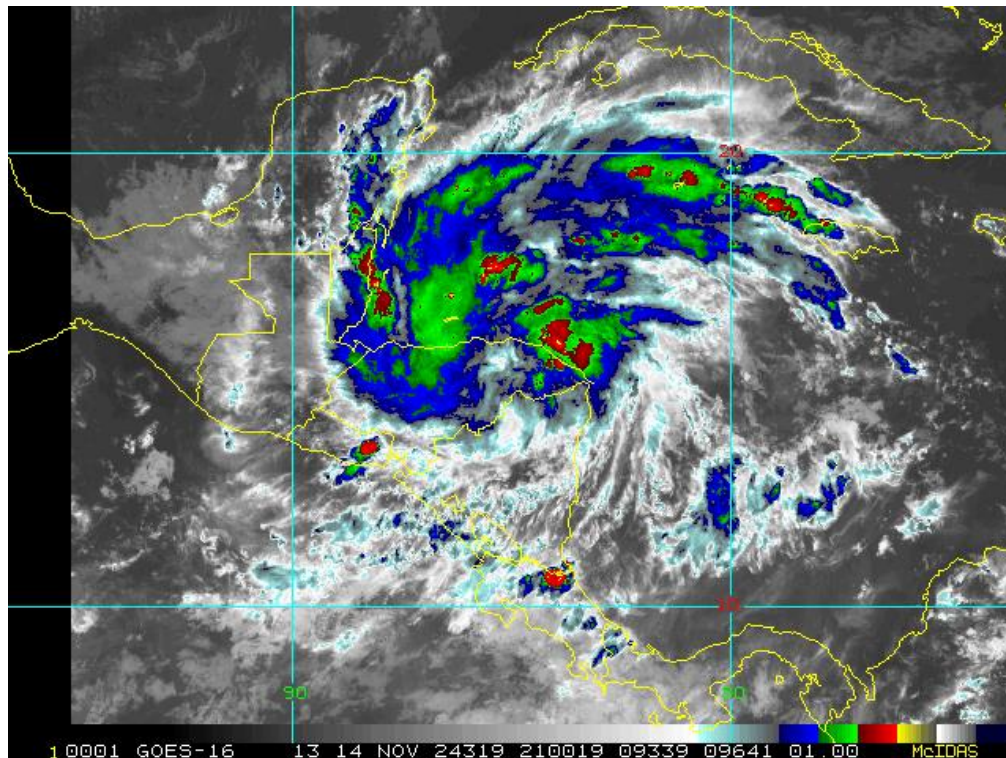
## 2 INTRODUCTION

On 14 November 2024 at 1800UTC, the National Hurricane Center (NHC) reported that a tropical storm formed just east of Honduras, and it was named Sara. The centre of the tropical cyclone was located near latitude 15.7° North and longitude 82.9° West, about 50 mi (85 km) NE of Cabo Gracias a Dios on the Nicaragua/Honduras border. Satellite images depicted a large convective band to the northwest of the centre of Sara, which reached Belize (Figure 1a). The associated moderate to locally intense precipitation affected the country mostly in the late hours of 14 November (Figure 1a)

The cyclone was initially steered by a mid-level ridge to the north, resulting in its progress westward at 12 mph (19 km/h) towards Central America. However, during the following two days, 15 and 16 November, Sara decreased its forward motion and turned west-northwest, passing almost parallel to the northern coast of Honduras, heading towards Belize City, Belize. During this period, Sara maintained almost unvaried intensity, and despite the convective structure it gradually lost organization. On 16 November at 1800UTC, Tropical Storm Sara was located, near latitude 16.3° North, longitude 86.8° West, about 125 mi (200 km) SE of Belize City, Belize. It presented maximum sustained winds of 45 mph (72 km/h) and a minimum central pressure of 1002 mb (Figure 2). The satellite imagery revealed a disorganized convective structure, with a broken curved band on the northwest side, located over Belize, and low convection near the centre of circulation (Figure 1b). The convective rainband spread moderate to locally intense rainfall over most of Belize, particularly over the coastal regions, mainly during the late hours of the day.

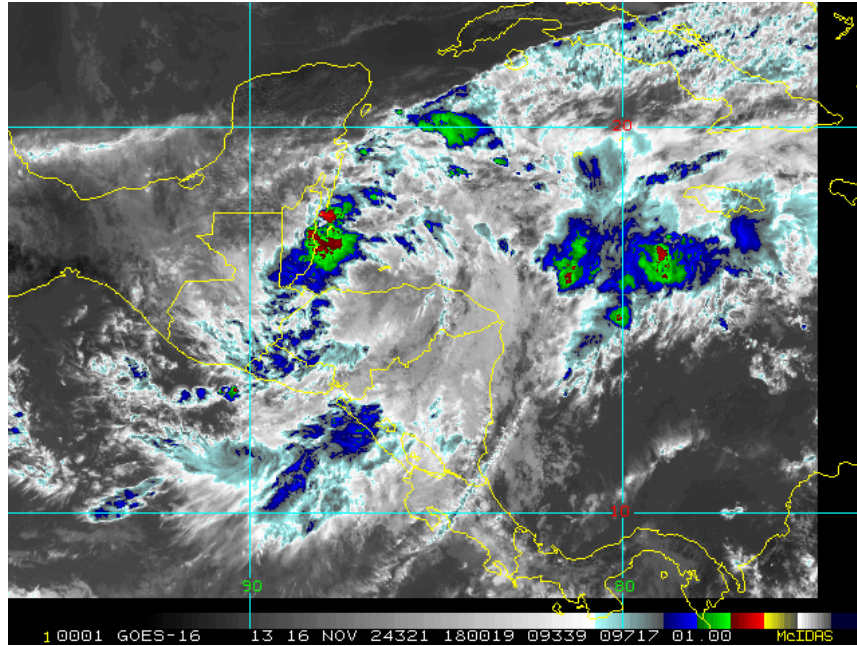
During the first 12 hours of 17 November, Sara remained a poorly organized tropical storm, with the most significant banding features in the northern semicircle well away from the low-level centre. The system maintained a slow forward motion of 5 mph (7 km/h) towards the west-northwest, heading towards Belize. Despite the close proximity to Belize, the strongest winds (less intense than tropical-storm-force) and the most active convection remained generally confined offshore, affecting marginally the coastal area of northern Belize. At 1400UTC, Tropical Storm Sara made landfall near Belize City, with maximum sustained winds of 40 mph (65 km/h) and a minimum central pressure of 1003 mb. The satellite imagery showed a burst of convection near the low-level centre, which moved inland and crossed central Belize from east to west, leaving the country at 1800UTC(Figure 1c). At the same time, Sara weakened into a tropical depression.

During the late hours of 17 November and the first hours of 18 November, the depression moved inland, crossing Guatemala and eventually degenerated into a trough of low pressure over the Yucatán Peninsula on 18 November at 0900 UTC. Although the system weakened, a burst of convection developed over northern Belize and affected the area with moderate to intense precipitation between 0300UTC and 0600UTC of 18 November.

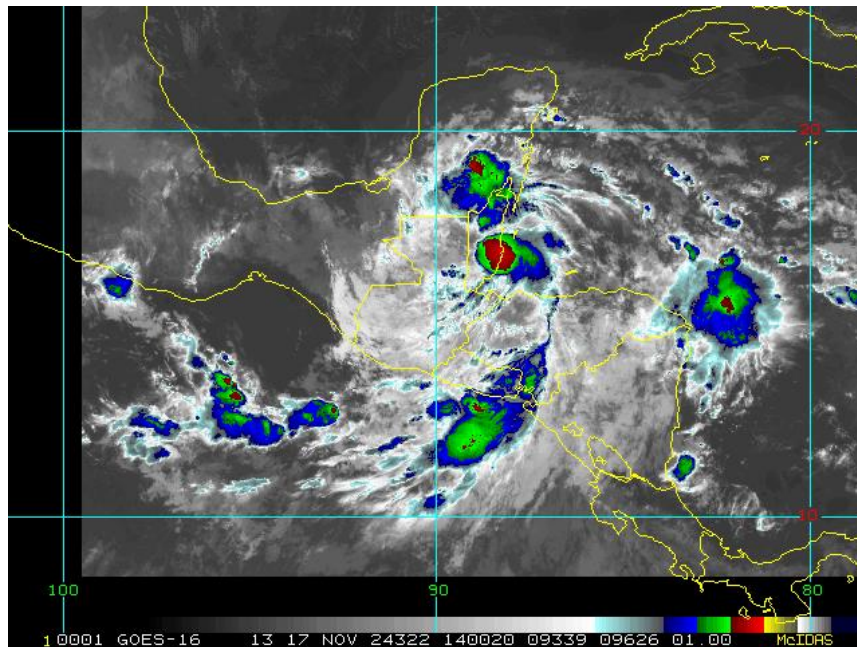


a) 14 November at 2100UTC





b) 16 November at 1800UTC



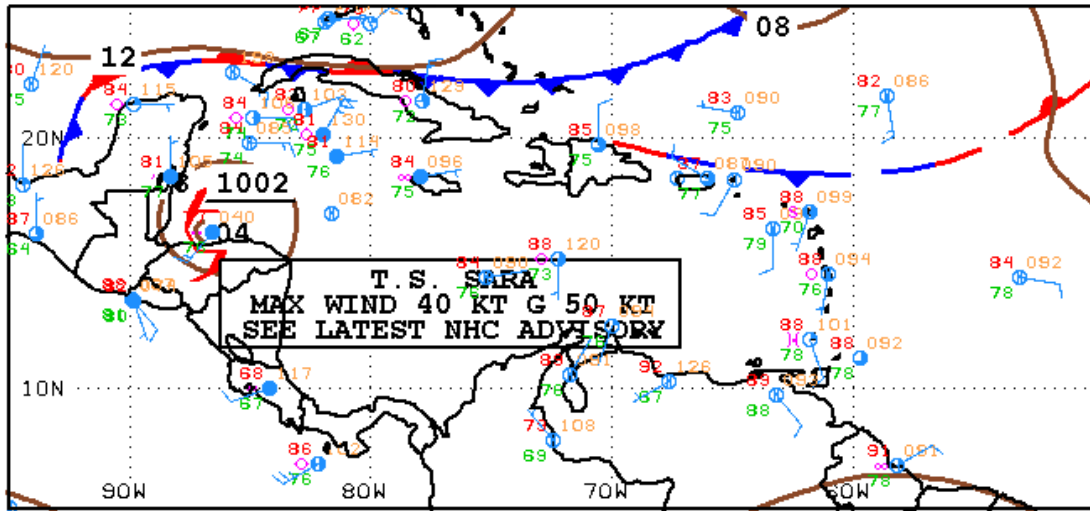
c) 17 November at 1400UTC

Figure 1 Satellite imagery on 14, 16 and 17 November, 2024, at different times as indicated in the labels from the thermal infrared channel enhanced with colour. Blue/green colours represent high altitude clouds (top cloud temperature between  $-50^{\circ}\text{C}$  and  $-70^{\circ}\text{C}$ ), while the red/yellow colours represent very high altitude clouds (top cloud lower than  $-70^{\circ}\text{C}$ ). High altitude clouds indicate strong convection associated with intense precipitation. Source: NOAA, National Environmental Satellite, Data and Information Service <sup>1</sup>.

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<sup>1</sup> RAMSDIS Online Archive, NOAA Satellite and Information Service, available [here](#)

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18Z CARIBBEAN SURFACE ANALYSIS  
ISSUED:  
Sat Nov 16 20:28:24 UTC 2024

NATIONAL HURRICANE CENTER  
MIAMI, FLORIDA  
BY TAFB ANALYST: MAHONEY  
COLLABORATING CENTERS: NHC OPC

Figure 2 Surface analysis over the Caribbean area on 16 November 2024 at 1800 UTC. Source: US National Hurricane Center<sup>2</sup>

### 3 CCRIF SPC MODEL OUTPUTS

The CWUIC model is made up of two components: the tropical cyclone (TC) component, accounting for the losses produced by wind and storm surge, and the excess rainfall (XSR) component, accounting for the losses associated with excess rainfall. Each of the two model components estimates a loss value specifically related to the hazard for which it is designed. When both a tropical cyclone and a Covered Area Rainfall Event (CARE) happen at the same time, the outputs of the two model components are added together. When only one model component, TC or XSR, reports losses associated with a specific event, only the losses produced for that component are counted. In the following description, the model output for each component is described separately.

#### TC Component

There is no tropical cyclone component related to this CARE. No tropical cyclone occurs during this CARE (16 - 18 November 2024). Thus, there are no CWUIC TC losses.

#### XSR Component

<sup>2</sup> National Oceanic and Atmospheric Administration - FTP, National Hurricane Center, review date: 16 November 2024, available at: [https://www.nhc.noaa.gov/tafb/CAR\\_18\\_Z.gif](https://www.nhc.noaa.gov/tafb/CAR_18_Z.gif)

All data sources used by the XSR 3.0 model, CMORPH, IMERG, WRF5, WRF7, WRF11 and WRF15<sup>3</sup>, detected the occurrence of precipitation over Belize and the surrounding waters during the period 14 to 18 November 2024. Each data source reported a specific distribution and accumulation of rainfall, as discussed below and shown in Figure 5. A CARE for Belize was activated on 16 November and lasted until 18 November. The CARE was activated due to the use of the 12-hour and the 48-hour aggregation intervals for precipitation<sup>4</sup> and thus the period considered by the XSR 3.0 model for the loss estimate based on the accumulated precipitation in Belize was 14 to 18 November 2024.

CMORPH	CMORPH reported total accumulated values of precipitation higher than 150 mm over the central area among the districts of Cayo, Belize and Stann Creek. Lower values were reported for the rest of the country.
IMERG	IMERG reported total accumulated values of precipitation higher than 200 mm over the districts of Cayo, Belize, Stann Creek and Corozal. Lower values were reported for the rest of the country.
WRF5	WRF5 showed total accumulated values of precipitation higher than 150 mm for the northern part of Belize, while lower values than 90 mm were reported over southern Belize.
WRF7	WRF7 reported total accumulated values of precipitation higher than 150 mm over the district of Cayo, while some isolated areas on the northern part of Belize reported values between 120 mm and 150 mm. Lower values were reported over the rest of the country.
WRF11	WRF11 reported accumulated values of precipitation higher than 240 mm over isolated areas over the central and northern parts of Belize, while values between 150 mm and 240 mm were reported over most of the country.

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<sup>3</sup> CMORPH Model: the satellite-based rainfall precipitation estimates provided by the NOAA Climate Prediction Center (CPC) using the so-called Morphing Technique [http://www.cpc.ncep.noaa.gov/products/janowiak/cmorph\\_description.html](http://www.cpc.ncep.noaa.gov/products/janowiak/cmorph_description.html). Further details are provided in the Definitions section of this report

IMERG Model: The satellite-based rainfall estimation model developed by NASA, expressed in mm, derived by aggregating the IMERG 30-minute Rainfall Data at 10km spatial resolution and available at <https://jsimpsonhttps.pps.eosdis.nasa.gov/imerg/late>. Further details are provided in the Definitions section of this report. WRF5, WRF7, WRF11 and WRF15 Models: the Weather Research and Forecasting Model weather model 2 data <https://www.mmm.ucar.edu/weather-research-and-forecasting-model>. These data are initialized by the NCEP FNL dataset. (NCEP FNL Operational Model Global Tropospheric Analyses [<http://rda.ucar.edu/datasets/ds083.2/>]). Further details are provided in the Definitions section of this report.

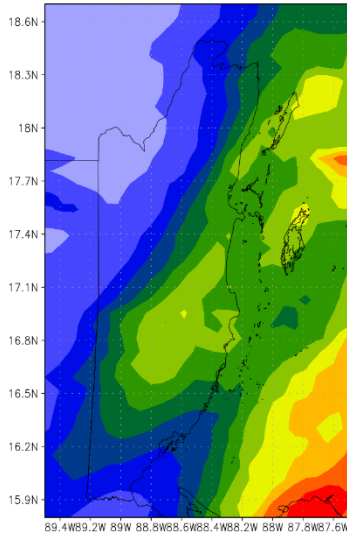
<sup>4</sup> The two aggregation periods correspond to the Rainfall Aggregation Period #1 and Rainfall Aggregation Period #2, as indicated in the Schedule. Further details are provided in the Definitions section of this report.

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**WRF15**

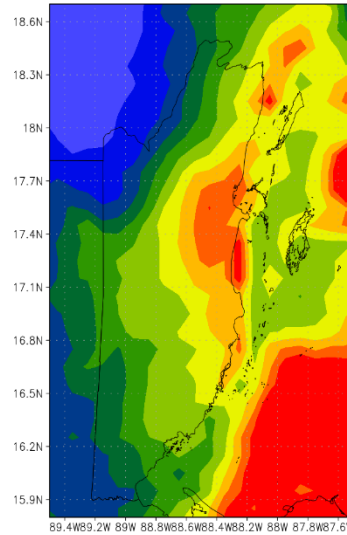
WRF15 reported accumulated values of precipitation higher than 240 mm over isolated areas on the Cayo, Belize and Corozal districts, while values between 150 mm and 240 mm were reported over most of central and northern Belize. Values lower than 90 mm were reported over southern Belize

CARE Event: 14–18NOV2024 – CMORPH [mm]



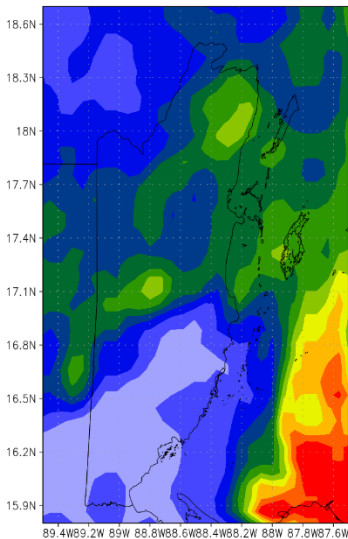
**a) CMORPH**

CARE Event: 14–18NOV2024 – IMERG [mm]



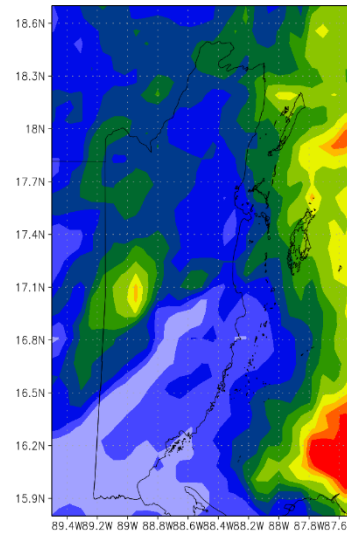
**b) IMERG**

CARE Event: 14–18NOV2024 – WRF5 [mm]



**c) WRF5**

CARE Event: 14–18NOV2024 – WRF7 [mm]



**d) WRF7**



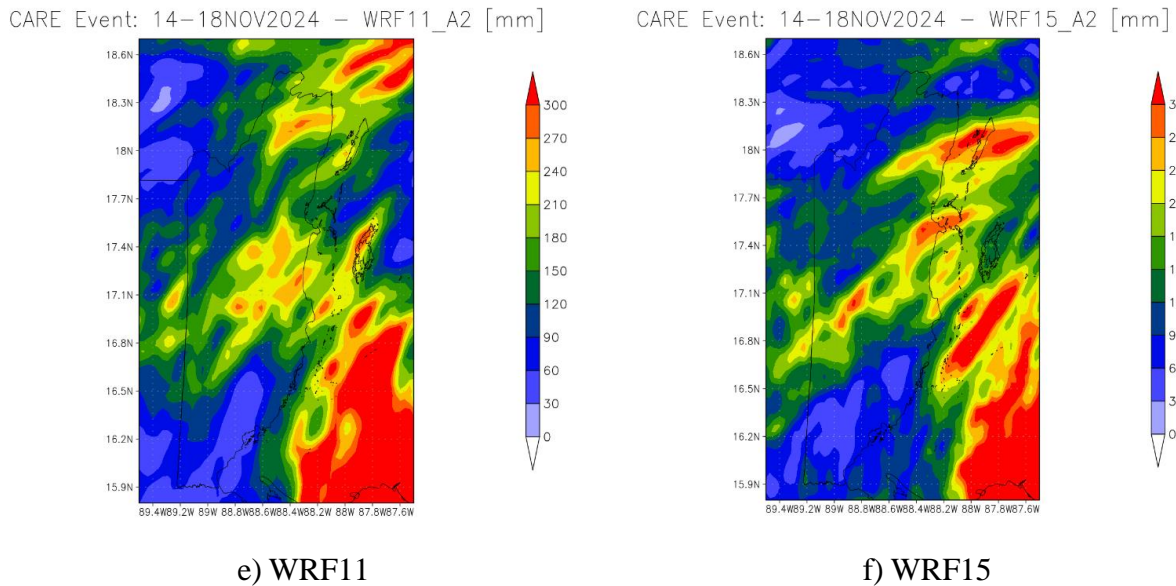


Figure 7 Total accumulated precipitation during the period 14 - 18 November, 2024 estimated by CMORPH (a), IMERG (b), WRF5 (c), WRF7 (d), WRF11 (e), WRF15 (f). Source: CCRIF SPC

Daily rainfall maps by CMORPH, IMERG, WRF5, WRF7, WRF11 and WRF15 over the exposure map of XSR 3.0 are not included here and they can be downloaded at the following links for 12-hour aggregation and 48-hour aggregation respectively:

[https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/BLZ/CARE\\_4\\_2024/daily\\_prec\\_short.mp4](https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/BLZ/CARE_4_2024/daily_prec_short.mp4)

[https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/BLZ/CARE\\_4\\_2024/daily\\_prec\\_long.mp4](https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/BLZ/CARE_4_2024/daily_prec_long.mp4)

Although a Disaster Alert for TC Sara in Belize was issued by ReliefWeb for this rainfall event in Belize; the final RIL ( $RIL_{FINAL}$ ) was calculated as the average of the RILs for CMORPH, IMERG, WRF5, WRF7 and WRF15 ( $RIL_{CMORPH}$ ,  $RIL_{IMERG}$ ,  $RIL_{WRF5}$ ,  $RIL_{WRF7}$  and  $RIL_{WRF15}$ ). The  $RIL_{FINAL}$  was below the attachment point of the Excess Rainfall component of BWS' CWUIC policy and therefore the policy was not triggered, thus a payout is not due to the BWS under its CWUIC policy.

#### 4 REPORTED IMPACTS

On November 17 BWS advised the customers to take proactive measures to ensure the safety of their drinking water in areas affected by flooding. On November 18 BWS announced an unplanned water interruption due to a broken water main on San Pedro Town and Orange Walk districts.

#### 5 CCRIF LOSS MODEL

The final run of the CCRIF's CWUIC tropical cyclone and excess rainfall loss model for the Belize Water Services, produced losses below the Attachment Point of its CWUIC policy and therefore no payout under this policy is due.

For additional information, please contact CCRIF SPC at: [pr@ccrif.org](mailto:pr@ccrif.org)



## DEFINITIONS

<b><i>Active Exposure Cell Percentage Threshold</i></b>	The percentage of the total number of XSR Exposure Grid Cells within the Covered Area of the Insured, that must be exceeded to trigger a Covered Area Rainfall Event.
<b><i>Active Exposure Grid Cells</i></b>	The XSR Exposure Grid Cells for which in the same single day the Aggregate Rainfall #1 value computed using the CMORPH-based Rainfall Estimate equals or exceeds the Rainfall Event Threshold #1 or the Aggregate Rainfall #2 value computed using the CMORPH-based Rainfall Estimate equals or exceeds the Rainfall Event Threshold #2.
<b><i>Aggregate Rainfall #1</i></b>	The rainfall amount accumulated over the Rainfall Aggregation Period #1 (as defined in the Schedule) measured in millimeters(mm) in any of the XSR Exposure Grid Cells in the Covered Area of the Insured. For a given day and a Rainfall Aggregation Period #1 of n hours, the Aggregate Rainfall #1 is the maximum amount of rainfall accumulated over any of the n-hour windows that intersect the day itself considering a time interval of 3 hours.
<b><i>Aggregate Rainfall #2</i></b>	The rainfall amount accumulated over the Rainfall Aggregation Period #2 (as defined in the Schedule) measured in millimeters(mm) in any of the XSR Exposure Grid Cells in the Covered Area of the Insured. For a given day and a Rainfall Aggregation Period #2 of n hours, the Aggregate Rainfall #2 is the maximum amount of rainfall accumulated over any of the n-hour windows that intersect the day itself considering a time interval of 3 hours.
<b><i>Calculation Agent</i></b>	Entity charged with undertaking the primary calculation of the Rainfall Index Loss.
<b><i>CMORPH-based Maximum Aggregate Rainfall #1</i></b>	The maximum value during the Covered Area Rainfall Event of the Aggregate Rainfall #1 computed using the CMORPH-based Rainfall Estimates in any given XSR Exposure Grid Cell over the Covered Area of the Insured.
<b><i>CMORPH-based Maximum Aggregate Rainfall #2</i></b>	The maximum value during the Covered Area Rainfall Event of the Aggregate Rainfall #2 computed using the CMORPH-based Rainfall Estimates in any given XSR Exposure Grid Cell over the Covered Area of the Insured.

***CMORPH-based  
Covered Area Rainfall  
Parameters***

The CMORPH Model information provided on a continuous basis by the XSR Model Data Reporting Agency used by the Calculation Agent to obtain the CMORPH-based Rainfall Estimates using the XSR Rainfall Model. Parameters are drawn from XSR Exposure Grid Cells within the Covered Area of the Insured, by their respective latitude and longitude. Measurement units and precision of data ingested by the XSR Rainfall Model are identical to those provided by the XSR Model Data Reporting Agency and are further elaborated in the Attachment entitled ‘Calculation of Rainfall Index Loss and Policy Payment

***CMORPH Model***

The satellite-based rainfall estimation model provided by NOAA CPC as described in the Rainfall Estimation Models section of the Policy.

***Covered Area***

The territory of the Insured as represented in the XSR Rainfall Model.

***Covered Area Rainfall  
Event***

Any period of days, with an interruption less than or equals to the Event Tolerance Period, during which the number of Active Exposure Grid Cells is greater than or equal to the product of (a) Active Exposure Cell Percentage Threshold multiplied by (b) the total number of XSR Exposure Grid Cells within the Covered Area.

***Country Disaster Alert***

An official disaster alert issued by Relief Web (<http://reliefweb.int/>) for the country in question for one of the following types of events: tropical cyclone, flood, flash flood and severe local storm. Any disaster alert issued later than seven

(7) days after the completion of the Covered Area Rainfall Event (CARE) event will not be considered. The Disaster Alert description issued by Relief Web and/or its attached documentation must include specific reference to the CARE dates with a tolerance period of 2 calendar days.

***Maximum Aggregate  
Rainfall #1***

The highest value during a Covered Area Rainfall Event of the Aggregate Rainfall #1 amount in any of the XSR Exposure Grid Cells in the Covered Area of the Insured computed.

<b><i>Maximum Aggregate Rainfall #2</i></b>	The highest value during a Covered Area Rainfall Event of the Aggregate Rainfall #2 amount in any of the XSR Exposure Grid Cells in the Covered Area of the Insured computed.
<b><i>Rainfall Event Threshold #1</i></b>	Aggregate Rainfall #1 level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.
<b><i>Rainfall Event Threshold #2</i></b>	Aggregate Rainfall #2 level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.
<b><i>Rainfall Aggregation Period #1</i></b>	The number of hours over which the Aggregate Rainfall #1 is computed for all XSR Exposure Grid Cells during a Covered Area Rainfall Event.
<b><i>Rainfall Aggregation Period #2</i></b>	The number of hours over which the Aggregate Rainfall #2 is computed for all XSR Exposure Grid Cells during a Covered Area Rainfall Event.
<b><i>Rainfall Index Loss</i></b>	For any Covered Area Rainfall Event affecting the Insured, the US Dollar loss calculated by the Calculation Agent using the XSR Rainfall Model, as described in the Attachment entitled ‘Calculation of Rainfall Index Loss and Policy Payment’. The Rainfall Index Loss can only be calculated once the Covered Area Rainfall Event is completed.
<b><i>WRF5 Model</i></b>	The weather research and forecasting rainfall model by NOAA with Configuration #5 data initialized with and assimilating the data provided by the National Center for Environmental Prediction as described in the Rainfall Estimation Models and in the Input Data to the Rainfall Estimation Models sections of this Attachment.
<b><i>WRF7 Model</i></b>	The weather research and forecasting rainfall model by NOAA with Configuration #7 data initialized with and assimilating the data provided by the National Center for Environmental Prediction as described in the Rainfall Estimation Models and in the Input Data to the Rainfall Estimation Models sections of this Attachment.

<b><i>XSR Rainfall Model</i></b>	The computer model used to calculate the Rainfall Index Loss, as described in the Attachment entitled ‘Calculation of Rainfall Index Loss and Policy Payment’.
<b><i>XSR Exposure Grid Cells</i></b>	The 30 arc-second by 30 arc-second grid of cells each of which is attributed with an XSR Grid Cell Exposure Value greater than zero.
<b><i>XSR Grid Cell Exposure Value</i></b>	The value, used to calculate the CMORPH-based Exposure Grid Cell Loss, the WRF5-based Exposure Grid Cell Loss, and the WRF7-based Exposure Grid Cell Loss.