CCRIF SPC
The Caribbean Catastrophe Risk Insurance Facility

Covered Area Rainfall Event (20/09/2022 to 22/09/2022)

Excess Rainfall

Event Briefing

Turks and Caicos

03 October 2022

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1 INTRODUCTION

This event briefing describes the impact of rainfall in the Turks and Caicos Islands, which was associated with a Covered Area Rainfall Event (CARE), starting on 20 September and ending on 22 September 2022. The Rainfall Index Loss (RIL) was below the attachment point of the Turks and Caicos Islands' excess rainfall policy and therefore no payout is due.

2 EVENT DESCRIPTION

On 17 September, Tropical Cyclone Fiona made landfall as a tropical storm on Guadeloupe, spreading tropical-storm conditions over the northern Leeward Islands. The next day, on 18 September, Fiona crossed the northeastern Caribbean Sea towards Puerto Rico. Over the Caribbean Sea, the warm sea surface temperature and the sufficient mid-level moisture favoured the intensification of the system and on 18 September at 1500UTC it became a hurricane, with its centre located near latitude 17.3°N, longitude 66.5°W, approximately 50 mi (80km) S of Puerto Rico.

On 19 September at 0730UTC, Fiona made landfall on the Dominican Republic as a category 1 hurricane. Hurricane conditions spread over the Dominican Republic and Puerto Rico. At 1800UTC, Hurricane Fiona left the northern coast of the Dominican Republic and moved into the northern Atlantic Ocean. At this time, the hurricane eye was sited near latitude 19.6° north, longitude 69.5° West, approximately 160 mi (270 km) SE of Grand Turk Island, Turks and Caicos Islands. The minimum central pressure was 975 mb and the maximum sustained winds were estimated at 90 mph (150 km/h). The system moved towards the northwest with an estimated forward velocity of 9 mph (15 km/h), proceeding along the southwest periphery of a subtropical high-pressure system.

The environmental conditions over the waters to the north of the island of Hispaniola (Haiti and the Dominican Republic)were particularly favourable for a further strengthening of the hurricane (due to a sea surface temperature greater than 20°C and the abundance of upper-level moisture), and on 20 September at 0600UTC Fiona strengthened, becoming a major hurricane (Figure 1). At this time, Fiona's centre was located near latitude 20.9° N, longitude 70.8° W, about 45 mi (70 km) SE of Grand Turk Island. Heavy rainfall and localized life-threatening flash flooding continued over portions of the Dominican Republic. Heavy precipitation from the inner rainband of Fiona impacted the Turks and Caicos Islands with continued life-threatening flooding.

During the next few hours, Fiona gradually turned toward the north with unchanged forward velocity, moving along the western periphery of the subtropical ridge. It presented unvaried intensity and other features. Its eye passed a few kilometers away from the Turks and Caicos Islands, where hurricane conditions persisted until 21 September at 0000UTC.

On 21 September at 0000 UTC, Fiona moved away from the waters surrounding the Turks and Caicos Islands and hurricane conditions gradually ceased over this country. Afterwards, Fiona continued to proceed over the North Atlantic Ocean as a major hurricane.

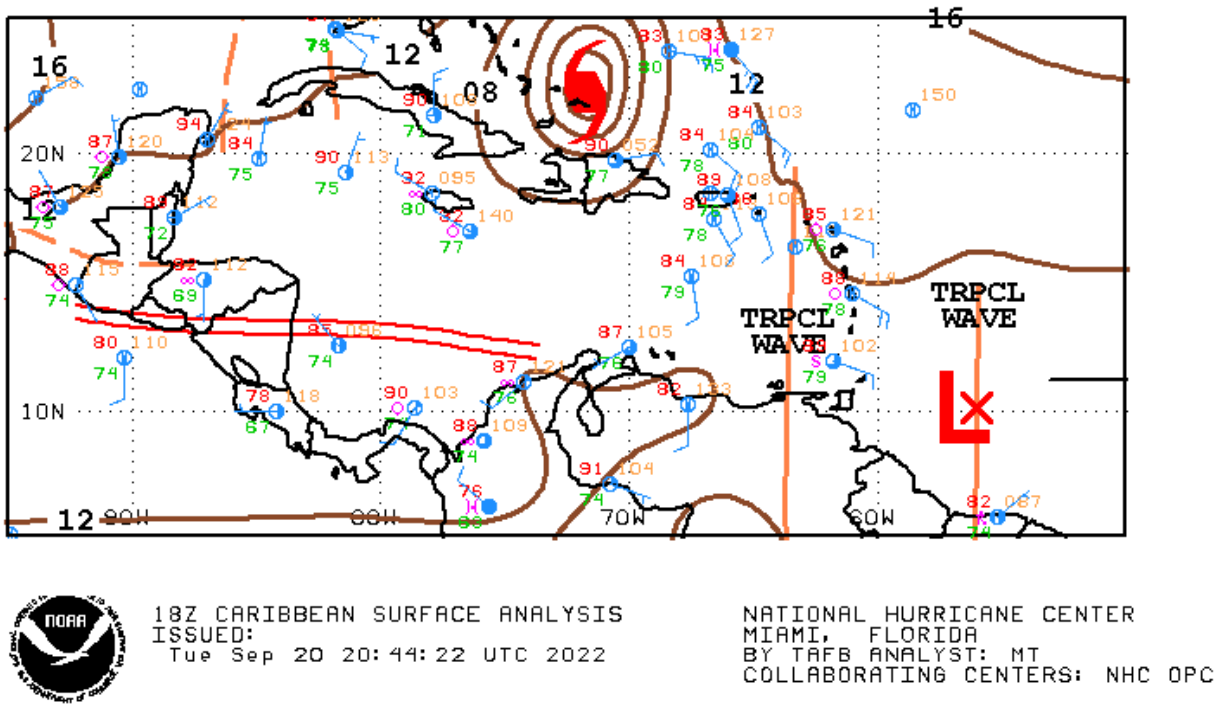
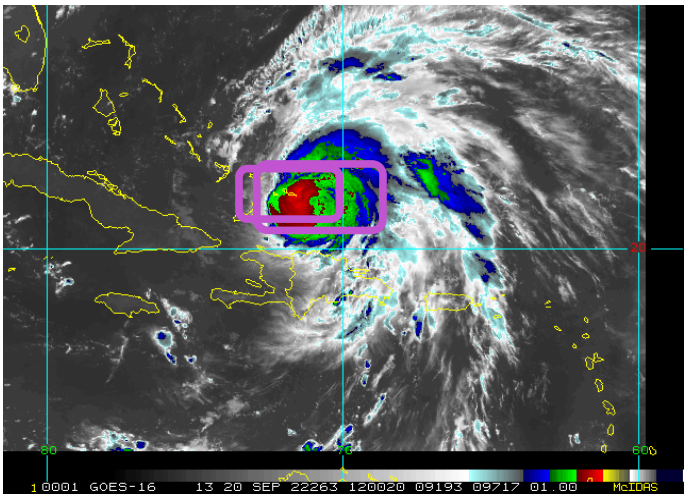
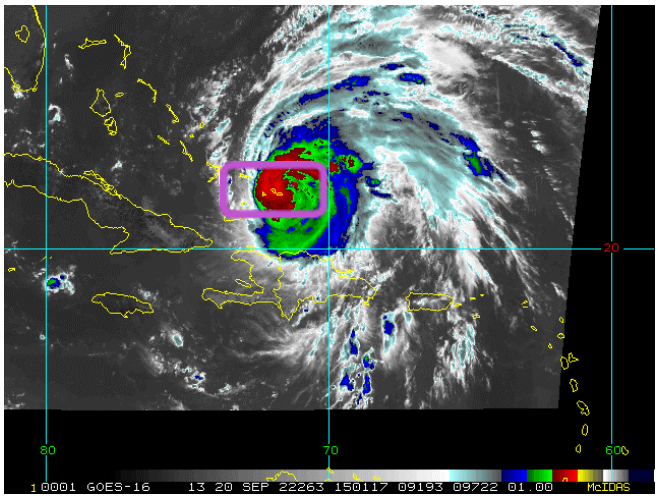


Figure 1 Surface analysis over the Caribbean area on 20 September at 1800UTC. Tropical Cyclone Fiona was located over Turks and Caicos Islands. Source: US National Hurricane Center[1]

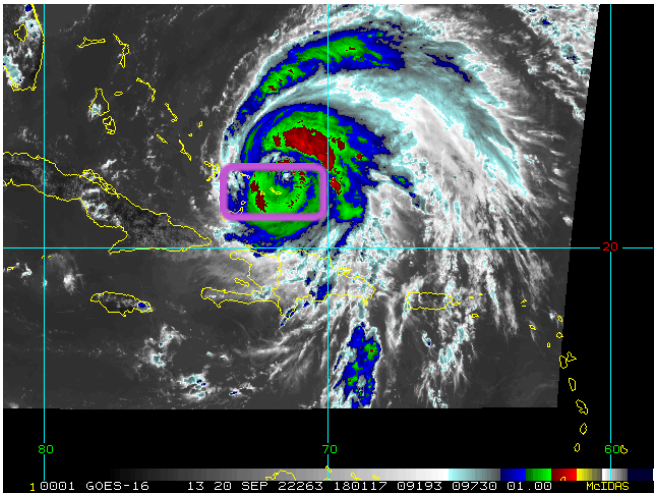


a) 20 September at 1200 UTC

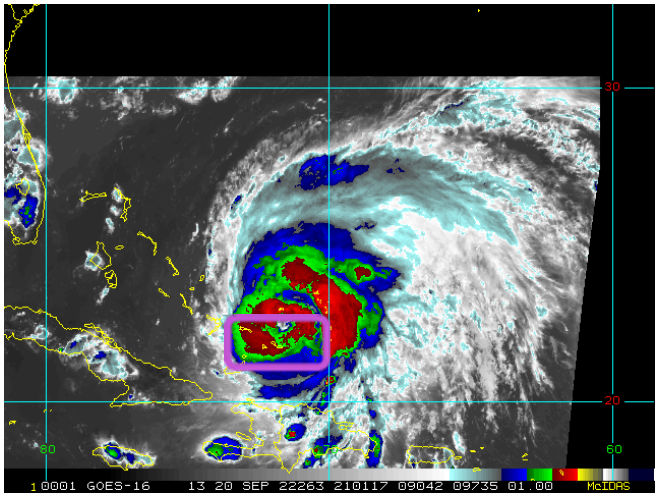


b) 20 September at 1500 UTC

1 National Oceanic and Atmospheric Administration - FTP, National Hurricane Center, review date: 20 September 2022, available at: *https://www.nhc.noaa.gov/tafb/CAR_18Z.gif*



c) 20 September at 1800 UTC



d) 20 September at 2100 UTC

Figure 2 Satellite imageries on 20 September at different times as indicated by the labels, from thermal infrared channel enhanced with colour. Blue/green colours represent high altitude clouds (top cloud temperature between -50°C and -70°C), while the red/yellow colours represent very high altitude clouds (top cloud lower than -70°C). High altitude clouds indicate strong convection associated with intense precipitation. Turks and Caicos Islands are surrounded by a violet square. Source: NOAA, National Environmental Satellite, Data and Information Service[2].

3 IMPACTS

The storm caused damage on the islands of Grand Turk and Salt Cay, where flooding and winds affected critical infrastructure. Also, the storm resulted in many islanders being without electricity and drinking water[3].

4 RAINFALL MODEL OUTPUTS

All three data sources used by the XSR 2.5 model, CMORPH[4], WRF5 and WRF7[5], detected the occurrence of precipitation over the Turks and Caicos Islands and the surrounding waters during the period 18-22 September 2022. However, each data source reported a specific distribution and accumulation of rainfall, as discussed below. The CARE for the Turks and Caicos Islands was activated on 20 September and lasted for the period 20-22 September. The CARE was

2 RAMSDIS Online Archive, NOAA Satellite and Information Service, available at: https://rammb-data.cira.colostate.edu/tc_realtime/storm.asp?storm_identifier=al072022

3 Local news, damages in Turks and Caicos. Royal Navy Responds to Hurricane Damage in Turks and Caicos (maritime-executive.com)

4 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*. Further details in the Definitions section of this report.

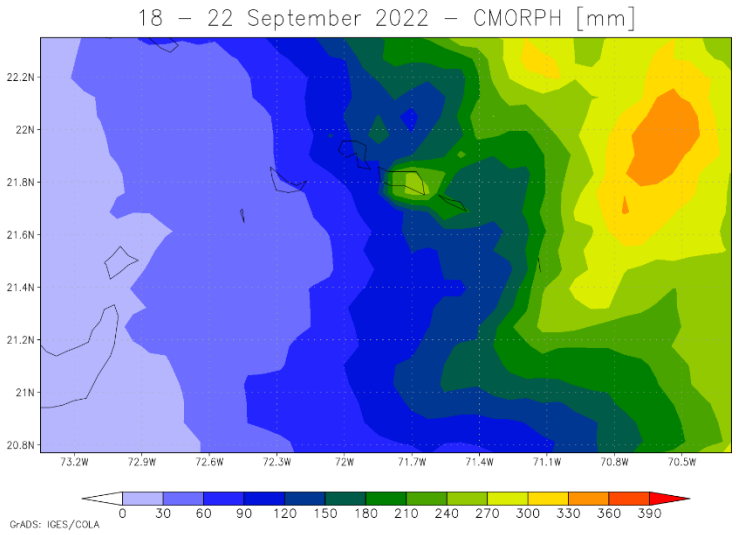
5 WRF5 and WRF7 Models: the Weather Research and Forecasting Model weather model-based Configuration #1 and #2 data *https://www.mmm.ucar.edu/weather-research-and-forecasting-model*. These data are initialised by the NCEP FNL dataset. (NCEP FNL Operational Model Global Tropospheric Analyses [*http://rda.ucar.edu/datasets/ds083.2/*]). Further details in the Definitions section of this report.

activated due to the use of the 12-hour and the 48-hour aggregation intervals for precipitation[6], thus the period considered by the XSR 2.5 model for the loss estimate based on the accumulated precipitation in the Turks and Caicos Islands was 18-22 September.

CMORPH reported total accumulated amounts of precipitation between 30 mm and 270 mm over the Turks and Caicos Islands. The maximum amounts, ranging between 240 mm and 270 mm, were shown over Middle Caicos.

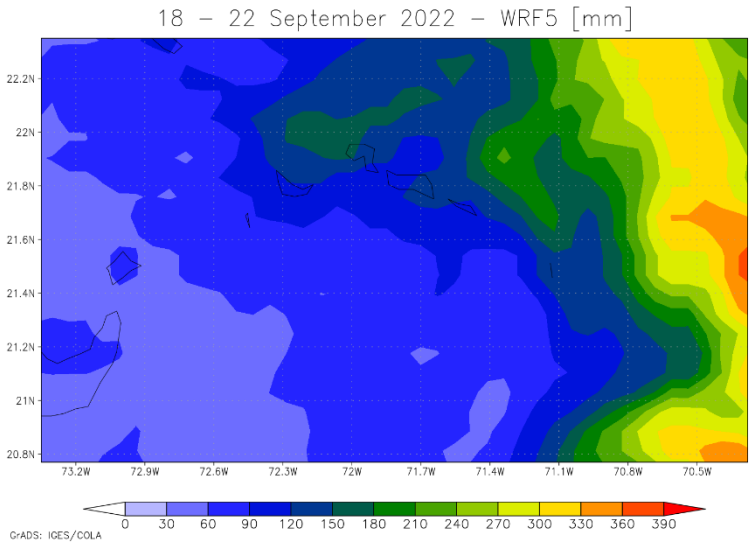
WRF5 showed total accumulated values of precipitation higher than 90 mm over the Turks and Caicos Islands, with the maximum amounts, between 150 mm and 180 mm over the northern region of North Caicos.

WRF7 simulated total accumulated values of rainfall between 30 mm and 150 mm over the Turks and Caicos Islands. The maximum amounts, between 120 mm and 150 mm, were reported over Providenciales, in the western part of the country.

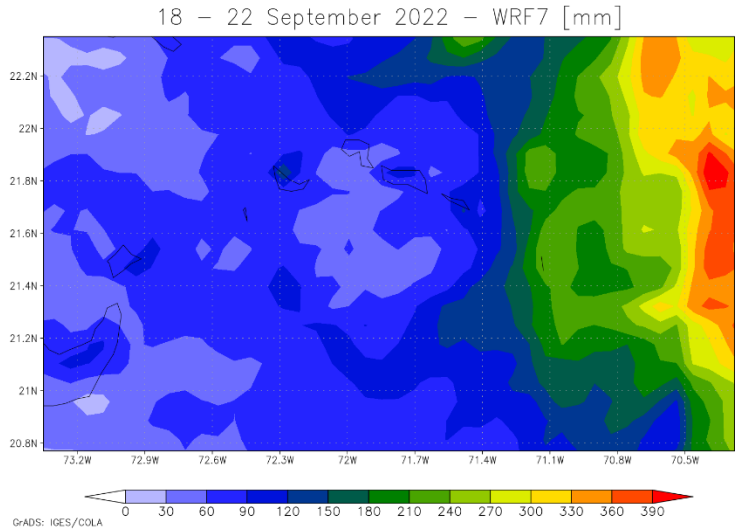


a) CMORPH

6 The two aggregation periods correspond to the Rainfall Aggregation Period #1 and Rainfall Aggregation Period #2, as indicated in the Schedule. Further details in the Definitions section of this report.



b) WRF5



c) WRF7

Figure 5 Total accumulated precipitation during the period 18-22 September, 2022 estimated by CMORPH (a), WRF5 (b) and WRF7 (c). Source: CCRIF SPC

Daily rainfall maps by CMORPH, WRF5 and WRF7 over the exposure map of XSR 2.5 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/TCA/CARE_1_2022/daily_prec_short.mp4
https://wemap.ccrif.org/OUTPUT/CCRIF/XSR/Events/TCA/CARE_1_2022/daily_prec_long.mp4

The Rainfall Index Loss (RIL) was above the loss threshold for Turks and Caicos Islands for the three data sources used by XSR2.5. The RIL was the highest for WRF7, due to the larger amount of accumulated precipitation presented over Providenciales Island, one of the areas characterized by the highest exposure for the Turks and Caicos Islands.

The final RIL (RIL_{FINAL}) was calculated as the average of the three RILs from CMORPH, WRF5 and WRF7. The RIL_{FINAL} was greater than zero and therefore this CARE qualified as a loss event. However, the RIL_{FINAL} was below the attachment point of Turks and Caicos Islands' excess rainfall policy and therefore it did not trigger a policy payout.

5 TRIGGER POTENTIAL

The Rainfall Index Loss calculated for this Covered Area Rainfall Event (CARE) for Turks and Caicos was below the attachment point of the Excess Rainfall policy and therefore no payout is due.

For additional information, please contact CCRIF SPC at: pr@ccrif.org

DEFINITIONS

Active Exposure Cell Percentage Threshold	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.
Active Exposure Grid Cells	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.
Aggregate Rainfall #1	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.
Aggregate Rainfall #2	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.
Calculation Agent	Entity charged with undertaking the primary calculation of the Rainfall Index Loss.
CMORPH-based Maximum Aggregate Rainfall #1	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.
CMORPH-based Maximum Aggregate Rainfall #2	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 ReliefWeb (*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 ReliefWeb 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.
Maximum Aggregate Rainfall #2	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.
Rainfall Event Threshold #1	Aggregate Rainfall #1 level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.
Rainfall Event Threshold #2	Aggregate Rainfall #2 level as defined in the Schedule which should be exceeded to trigger an Active Exposure Cell.

Rainfall Aggregation Period #1	The number of hours over which the Aggregate Rainfall #1 is computed for all XSR Exposure Grid Cells during a Covered Area Rainfall Event.
Rainfall Aggregation Period #2	The number of hours over which the Aggregate Rainfall #2 is computed for all XSR Exposure Grid Cells during a Covered Area Rainfall Event.
Rainfall Index Loss	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.
WRF5 Model	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.
WRF7 Model	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.
XSR Rainfall Model	The computer model used to calculate the Rainfall Index Loss, as described in the Attachment entitled 'Calculation of Rainfall Index Loss and Policy Payment'.
XSR Exposure Grid Cells	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.
XSR Grid Cell Exposure Value	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.