Philippines Catastrophe Risk Assessment and Modeling: Component 4

Developing a Post Event Loss Calculation Procedure

Concept Report Submitted to the World Bank

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1 Introduction

The Government of the Philippines (GoP) has begun taking a proactive approach to disaster risk management by approving the Disaster Risk Reduction and Management (DRRM) Act in May 2010 (Republic Act No. 10121). One of the priority areas identified by the DRRM Act is the establishment of appropriate risk finance policies and instruments that will help reduce the fiscal burden of the GoP to natural disaster impacts. Furthering the work on risk finance, the GoP is implementing a technical assistance program that would lead to the formulation of a risk finance strategy. Alongside, the GoP has requested a catastrophe risk assessment study that would provide the quantitative underpinnings for the design of an ensuing catastrophe liquidity facility, especially addressing the higher layers of risk.

The World Bank, which is assisting the GoP with its disaster risk management objectives, has retained AIR Worldwide Corporation (AIR) in partnership with the Asian Disaster Preparedness Center (ADPC) for conducting the catastrophe risk modeling and assessment study.

According to the project's Terms of Reference (ToR), the natural hazards to be considered in this study are earthquake ground shaking, typhoon wind and typhoon-induced precipitation, and flooding due to non-typhoon induced precipitation (i.e., monsoonal precipitation induced flooding). The study is built over five distinct but interconnected components, which are as follows:

- **Component 1:** Hazard Data and Loss Data Collection and Management
- **Component 2:** Exposure Data Collection and Vulnerability Function Development
- **Component 3:** Catastrophe Risk Assessment at the National and Local Levels
- **Component 4:** Design of Parametric Indices for Financial Transactions
- **Component 5:** Support for Placement of Parametric Risk Transfer Products (study can be extended to include this optional component depending on the GoP's decision regarding the use of the parametric risk transfer products towards the disaster risk financing strategy)

As part of Component 4, a conceptual post event loss calculation (PELC) procedure was developed which is summarized in this report. The primary objective for the development of the conceptual PELC procedure report is to outline the methods to obtain, process, and format event parameters for specific reported catastrophe events and to compute the property loss resulting from these events using the catastrophe risk models developed and enhanced for the Philippines under the project scope. This process lays the groundwork on what could be potentially used as part of a disaster risk transfer transaction. This document provides the basic procedures to enable any user to pre-process the data required to run the loss models for the earthquake (shake only) and tropical cyclone (tropical cyclone induced wind and precipitation only) perils. A user-guide of the model software and supplementary pre-processing software is not provided. Note that this document is a conceptual study and does not necessarily constitute a market ready product.

The primary proposed reporting agencies that are to be used to obtain the event parameters are outlined in Table 1.1. The proposed use of these agencies is based on several factors, including overall feasibility, industry experience with the agencies, real-time data availability, agency area of responsibility, and compatibility with the catastrophe loss models. Local agencies, such as the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and the Philippine Institute of Volcanology and Seismology (PHIVOLCS) are not used in part due to the reasons listed above. Note that the United States Geological Society (USGS), the Joint Typhoon Warning Center (JTWC), the Japan Meteorological Agency (JMA), and the Tropical Rainfall Measurement Mission (TRMM) have been used successfully by AIR in other disaster risk financing initiatives (e.g., the Pacific Disaster Risk Financing and Insurance (PDRFI) Program and Japan catastrophe bond modeling). Due to differences in observation methods and procedures between the different agencies, some variability in the reported parameters is to be expected.

Table 1.1. Summary of Proposed Reporting Agencies to be used for the PELC

Data Type	Primary Reporting Agency	Back-Up Reporting Agency
Earthquake	United States Geological Survey (USGS)	Global Centroid-Moment-Tensor (CMT) Project
Typhoon (Location and Intensity)	Japan Meteorological Agency (JMA)	Joint Typhoon Warning Center (JTWC)
Typhoon (Precipitation)	Tropical Rainfall Measurement Mission (TRMM)	Default Modeled Average

1.1 Limitations

The study, a part of which is summarized in this report is intended for use by the Government of the Philippines and the World Bank to assist them with quantifying the catastrophe risk associated with the population and built environment in the Philippines, and with the process of development and implementation of disaster risk finance strategies. Proper application of this study requires explicit recognition and understanding of the limitations of both the scope and methodology of the entire study.

The physical loss estimates that have been presented for the assets are neither facts nor confirmed predictions of loss that may occur either collectively or to any particular asset as a result of future events or any specific event; as such, the actual damage for a particular event may be materially different from that presented in this study. Furthermore, the assumptions adopted in determining the loss estimates do not constitute the exclusive set of reasonable assumptions, and the use of a different set of assumptions or methodology may produce materially different results. The results presented in this study simply represent our best assessment of the potential for physical losses, based on information and data available to us at the time of this study and that collected during the study.

The scope of services performed during this assessment may not adequately address the needs of other users, and any re-use of (or failure to use) this report or the findings, conclusions, or recommendations presented herein are at the sole risk of the user. Our conclusions with respect to the loss and hazard estimates are based on our professional opinion, engineering experience and judgment, analyses conducted in the course of the study, information and data available in the literature and that provided by the World Bank and various local agencies, and are derived in accordance with current standards of professional practice.

2 Post-Event Loss Calculation Procedure: Philippines Earthquake

2.1 Obtain Reported Event Parameters

The latest Earthquake Event Parameters for the event of interest are searched and retrieved from the Earthquake Reporting Agency (e.g., the United States Geological Survey "USGS": http://earthquake.usgs.gov/earthquakes/search/ or, if not available, the Global Centroid-Moment-Tensor "CMT" Project: http://www.globalcmt.org/CMTsearch.html).

For the USGS source, parameters can be found by clicking the "Scientific" tab and then the "Summary" tab on the webpage (e.g., see Section 2.4). The main data of interest is shown under the "Preferred Location Parameters" (e.g., see Section 2.4).

For the CMT source, parameters can be found under the "Results" section for the event of interest (e.g., see Section 2.4).

The latest Earthquake Event Parameters shall, at a minimum, include the following information:

1. **Date and Time of the Event**
2. **Magnitude**
3. **Location**
4. **Depth**

Note: Use the magnitude value reported, except when the magnitude unit is reported in "mb" or "Mb", use the following:

If "mb" is reported, use **Magnitude** = 0.85*(Magnitude value in "mb") + 1.03
If "Mb" is reported, use **Magnitude** = 0.85*[(Magnitude value in "Mb") + 2.2]/1.5 + 1.03

These relationships are derived from Scordilis (2006)[1]. Round value to the nearest 0.1 (use the round-up tie-breaking rule).

Additional event parameters, if provided by the Reporting Agencies, will be obtained as detailed below. For the USGS source, these additional events parameters can be found by clicking the "Moment Tensor" tab under the "Scientific" tab (e.g., see Section 2.4). In the subsequent webpage, the parameters listed at the top are to be used. For the CMT source, these additional parameters are listed in the "Results" section for the event of interest (e.g., see Section 2.4).

[1] Scordilis, E. M. (2006). Empirical global relations converting MS and mb to moment magnitude. Journal of seismology, 10(2), 225-236.

Note:	The "preferred" fault plane may be indicated by the Earthquake Reporting Agency and, in these cases, will be used for the PELC. If not, parameters corresponding to the two nodal planes will be considered as two possibilities for the same event for the loss calculation (e.g., see Section 2.4). The average loss value will be taken as the event loss.

The additional event parameters obtained from the moment tensor solution are as follows:

1. **Strike** (also known as rupture azimuth)
2. **Dip**
3. **Rake** (also known as slip)

If the reported moment tensor data is not available, default parameters will be used.

Note:	If available, use the "Finite Fault Model" to identify the preferred Nodal Plane. The values of "**strike**", "**dip**", and "**rake**" are to be taken from closest corresponding Nodal Plane solution from the "Moment Tensor" data (rather than the values listed in the "Finite Fault Model"). If the Nodal Plane has not been clearly identified, use the procedures from above.

See Section 2.4 for a sample report from the Earthquake Reporting Agency.

2.2 Calculate Additional Earthquake Event Parameters

In addition to the Earthquake Event Parameters explicitly reported by the Earthquake Reporting Agency, other parameters needed for the loss model are to be determined as per the steps described below:

Dip Azimuth

The dip azimuth equals the "**strike**" (also known as rupture azimuth) plus 90°. If the result is larger than 360°, subtract 360° from the result.

Attenuation Flag

The attenuation flag, which defines the tectonic regionalization, is generally based on the location of the event. A software program will determine the appropriate attenuation flag via a closest search algorithm based on the stochastic catalog. The possible attenuation flags are "**S**" = subduction, "**D**" = deep, or "**C**" = crustal.

Fault Type

The possible fault types are "**R**" = reverse, "**N**" = normal, or "**S**" = strike-slip. The fault type is determined from the **"rake"** angle (also known as slip) using the following conditions:

1. If 45° ≤ "**rake**" ≤ 135°, then fault type = **R**
2. If -135° ≤ "**rake**" ≤ -45°, then fault type = **N**
3. For all the other "**rake**" angle values, then fault type = **S**

Rupture Length and Width

The rupture length and width is determined empirically, and is generally based on well-known relationships (e.g., Wells and Coppersmith, 1994)[2].

For subduction events (i.e., attenuation flag = "**S**"), the rupture length and width (in km) is determined as follows:

Rupture Area = 10^(0.83***M**-2.61)

Rupture Length = 10^(0.52***M**-2.05)

Rupture Width = (Rupture Area) / (**Rupture Length**)

Where **M** = magnitude as obtained from Section 2.1. After each calculation step, round the value to the nearest digit (use the round-up tie-breaking rule).

For all other events (i.e., attenuation flag = "**D**" or "**C**"), the rupture length and width (in km) is determined as follows:

Rupture Area = 10^(0.91***M**-3.49)

1. For Rupture Area < 33 km^2
    a. **Rupture Length** = sqrt(Rupture Area)
    b. **Rupture Width** = sqrt(Rupture Area)
2. For 33 km^2 ≤ Rupture Area ≤ 6180 km^2
    a. **Rupture Length** = 0.6*(Rupture Area)^0.65
    b. **Rupture Width** = (Rupture Area) / (**Rupture Length**)
3. For Rupture Area > 6180 km^2
    a. **Rupture Width** = 35 km
    b. **Rupture Length** = (Rupture Area) / (**Rupture Width**)

Where **M** = magnitude from Section 1. For each calculation step, round the value to the nearest digit (use the round-up tie-breaking rule).

2.3 Format Earthquake Event Parameters

A comma-separated values (CSV) file format is needed to store the event input data for loss calculation. The format and values of the fields for input file used in the loss calculation is as follows:

1. **Year** (given – see Section 2.1)
2. **Day of the Year** (given – see Section 2.1)

[2] Wells, D.L., and Coppersmith K.J. (1994). New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement" Bull. Seismol. Soc. Am., 84, 974–1002

3. **Hour** (given – see Section 2.1)
4. **Nodal Plane Number** (use "1" or "2"; depending if one or two nodal planes are used – see note below)
5. **Source Zone Number** (use "1")
6. **Event Identification Number** (use "1")
7. **Magnitude** (given – see Section 2.1)
8. **Latitude** (in decimal degrees – given – see Section 2.1)
9. **Longitude** (in decimal degrees – given – see Section 2.1)
10. **Strike** (angle in degrees – given – see Section 2.1)
11. **Km per Degree** (calculated as cos(|latitude in radians|)*111)
12. **Depth** (in kilometers – given – see Section 2.1)
13. **Rupture Length** (in kilometers – calculated – see Section 2.2)
14. **Rupture Width** (in kilometers – calculated – see Section 2.2)
15. **Dip** (angle in degrees – given – see Section 2.1))
16. **Dip Azimuth** (angle in degrees – calculated – see Section 2.2)
17. **Fault Type Flag** (calculated – see Section 2.2)
18. **Attenuation Flag** (calculated – see Section 2.2)
19. **Catalog Flag** (use "X")
20. **Number of Rupture Segments** (use "-1")

Note: If a "preferred" fault plane is not indicated by the Earthquake Reporting Agency, the data for each of the two nodal planes (NP1 and NP2) are computed and stored as two separate events in the input file. The first record (line) will have "**Nodal Plane Number**" = 1 and the second record (line) will have "**Nodal Plane Number**" = 2.

Note: Round all values to three digits after the decimal point (use the round-up tie-breaking rule).

2.4 Example of Procedure to Collect and Process Parameters from the Earthquake Reporting Agency

This section provides an example of how to collect and process parameters for the M7.1 earthquake that occurred 4km SE of Sagbayan, Philippines on 2013-10-15 00:12:32 UTC.

The USGS website (http://earthquake.usgs.gov/earthquakes/search/) is searched to access the earthquake event page for the event of interest (e.g., see Figure 1 – in this case the event page is http://comcat.cr.usgs.gov/earthquakes/eventpage/usb000kdb4#summary). The relevant earthquake parameters can be found by clicking the "Scientific" tab and then the "Summary" tab on the webpage (e.g., see Figure 2). Additional parameters are obtained from the moment tensor (which indicates the strike, dip, and rake) by clicking the "Scientific" and then "Moment Tensor" tab (if available – e.g., see Figure 3 and Figure 4). Additional information on the preferred nodal plane can be found by clicking the "Scientific" tab and then the "Finite Fault" tab (if available – e.g., see Figure 5). In this example, both the "Moment Tensor" and "Finite Fault" information is available.

The **Event Date and Time** (Year = 2013, Day of Year = 288, Hour = 0), **Magnitude** (7.1), **Location** (Latitude = 9.880; Longitude = 124.117), **Depth** (19.0 km) are indicated in the "Scientific - Summary" page (e.g., see Figure 2). The **strike**, **dip**, and **rake** for the two nodal plane solutions (NP1: **strike** = 238°, **dip** = 46°, **rake =** 103° and NP2: **strike** = 39°, **dip** = 46°, **rake** = 77°) are indicated in the "Moment Tensor" page (e.g., see Figure 3 and Figure 4). The "Finite Fault" information, although available, does not clearly indicate the preferred fault plane, as provided under the "Result" section; thus, both nodal plane solutions are used.

The remaining parameters are calculated as follows:

Dip Azimuth = NP1: "strike = 238°" + 90° and NP2: "strike = 39°" + 90°
= NP1: 328° and NP2: 129°
Attenuation Flag = "C" (determined with supplementary software)
Fault Type = NP1: 45° ≤ "rake = 103°" ≤ 135° and NP2: 45° ≤ "rake = 77°" ≤ 135°
= NP1: "R" and NP2: "R"
Rupture Length and Width

Rupture Area = 10^(0.91* "M = 7.1" - 3.49) = 935 km^2
33 km^2 ≤ "Rupture Area = 935 km^2" ≤ 6180 km^2
Rupture Length = 0.6*("Rupture Area = 935")^0.65 = 51 km
Rupture Width = ("Rupture Area = 935 km^2") / ("Rupture Length = 51 km") = 18 km

Had the USGS data not been available, the CMT data would have been used (e.g., see Figure 6). The **Event Date and Time** (Year = 2013, Day of Year = 288, Hour = 0), **Magnitude** (7.1), **Location** (Latitude = 9.84; Longitude = 123.96), **Depth** (12.0 km), **strike**, **dip**, and **rake** (rake is also known as slip) for the two nodal plane solutions (NP1: **strike** = 42°, **dip** = 40°, **rake** = 80° and NP2: **strike** = 235°, **dip** = 50°, **rake** = 98°) are all shown in the "Results" section for the event of interest. The remaining parameters are to be calculated accordingly as detailed in the previous sections.

Figure 1 – Main Earthquake Event Page from the USGS

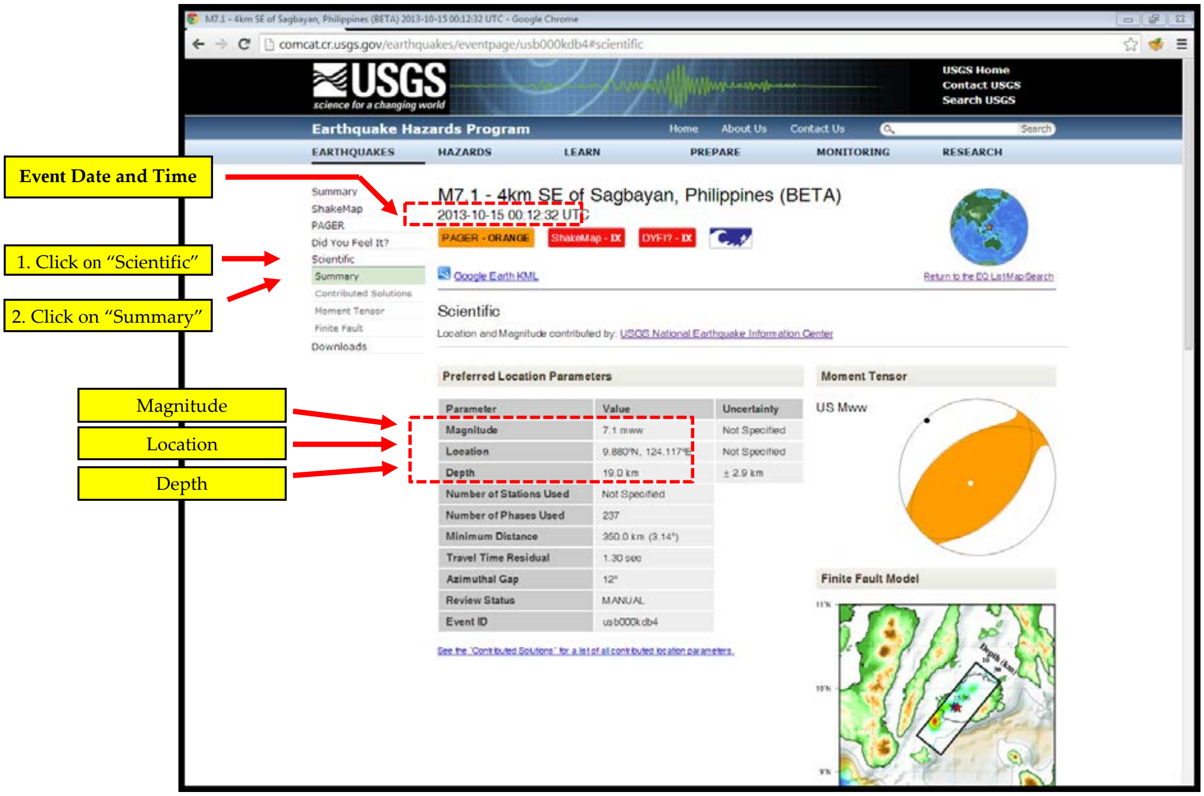

Figure 2 – Event Summary Page from the USGS

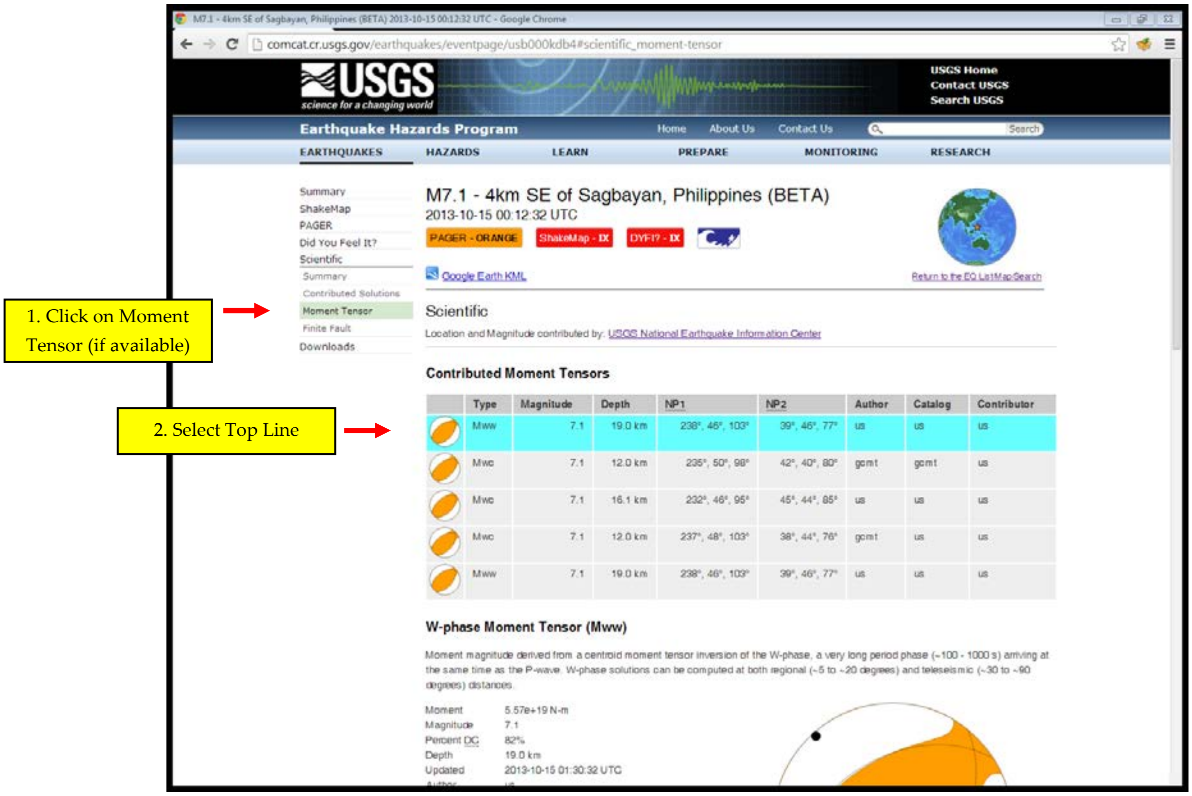

Figure 3 – Moment Tensor Page from the USGS

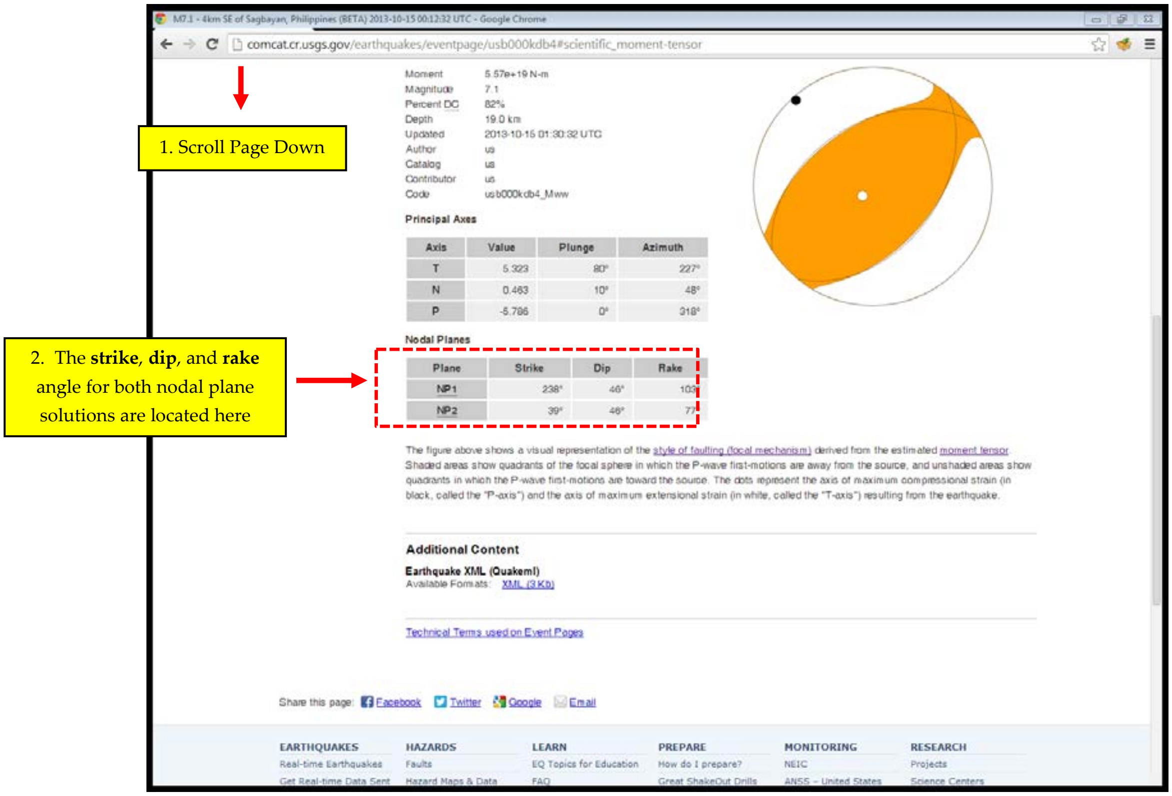

Figure 4 – Bottom of Moment Tensor Page from the USGS

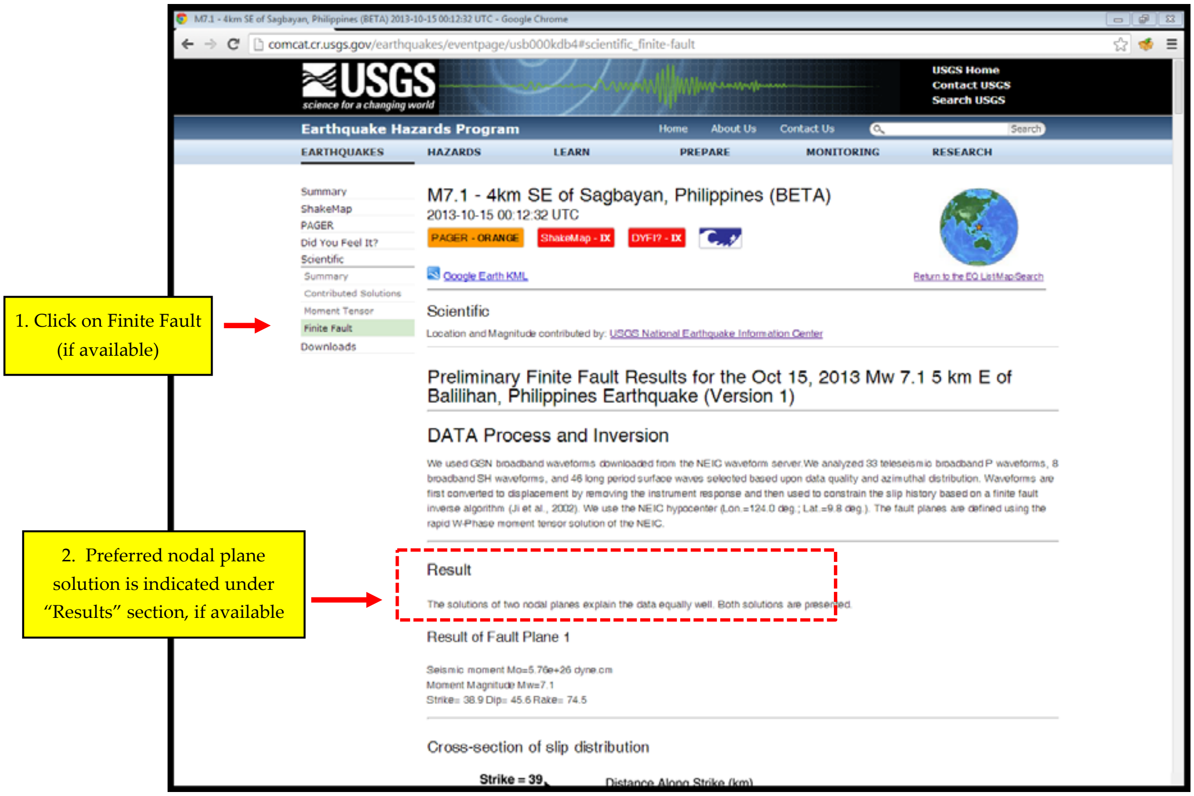

Figure 5 – Finite Fault Page from the USGS

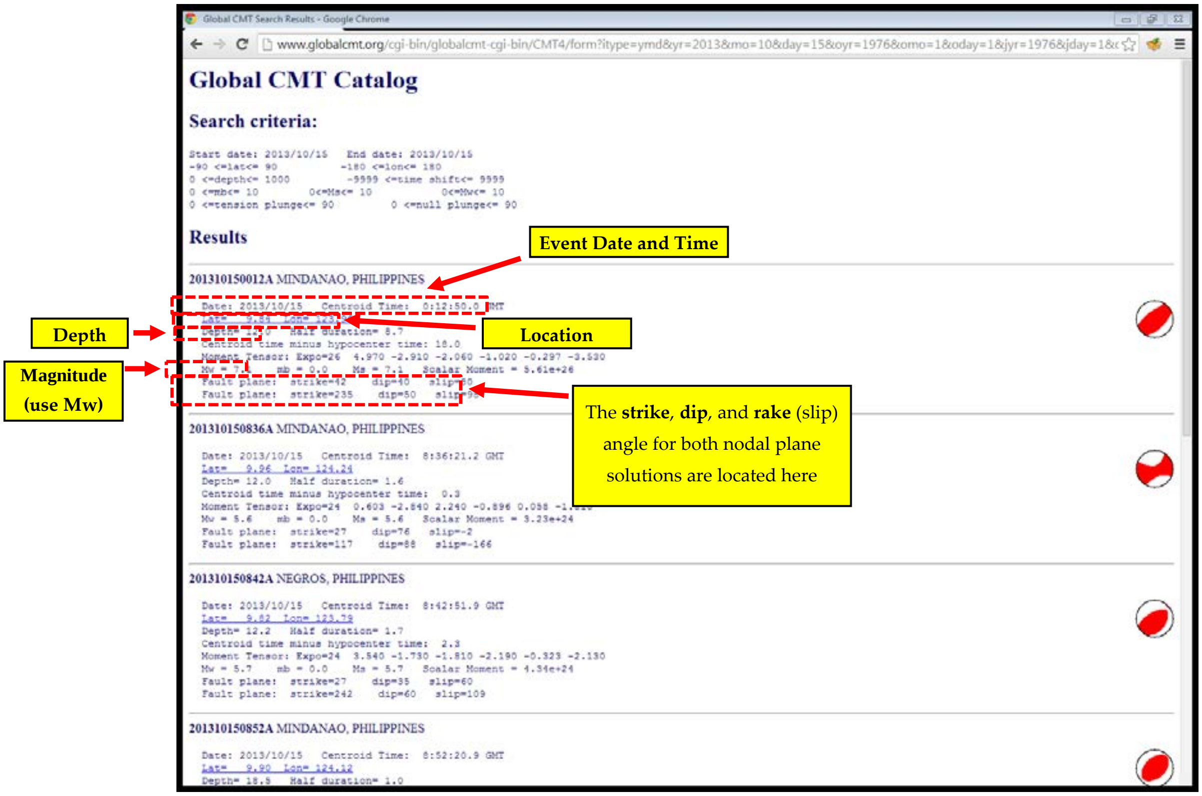

Figure 6 – Results Page from the CMT Source

3 Post-Event Loss Calculation Procedure: Philippines Typhoon

3.1 Reported Event Parameter Sources

The latest Typhoon Event Parameters for the event of interest are searched and retrieved from the following sources:

Parameter	Data Collection Time Interval	Primary Source	Back-Up Source
Location & Central Pressure	6-hourly storm track or higher	JMA(1)	JTWC(2)
Environmental Pressure	Once at 1st landfall	JMA(3)	Default
Storm Wind Radii	6-hourly storm track or higher	JMA(1)	No Adjustment
Radius of Maximum Wind	6-hourly storm track or higher	Willoughby Algorithm(4)	AIR Model
Maximum Precipitation Rate	Once at 1st landfall	TRMM (QA'd or near-real-time)(5)	Default
Precipitation Radius	Once at 1st landfall	TRMM (QA'd or near-real-time)(5)	Default

(1) Japan Meteorological Agency (JMA) Track Data
(2) Joint Typhoon Warning Center (JTWC) Track Data
(3) Japan Meteorological Agency (JMA) Surface Analysis
(4) Radius of Maximum Wind (Rmax) is generated by the model as a function that relates Rmax to central pressure and latitude.
- If storm wind radii are collected from the primary source, Rmax will be adjusted according to the Willoughby Algorithm.
- If storm wind radii are not collected from the primary source, no adjustment will be made to the Rmax generated by the model.

(5) Tropical Rainfall Measuring Mission (TRMM) QA'd data will be used if available. If not, TRMM near-real-time data will be used.

The following sections will provide detailed information on how to obtain the event information from the sources identified in the table above.

Note: If published data cannot be found at the links provided in this section, make a reasonable effort to search other publicly-accessible locations for the appropriate information.

While some event parameters – such as storm location and central pressure – require data along each reported point along the cyclone's track, the other event parameters in the table above require data as reported at landfall.

Determining Landfall Hour for Cyclones with a Single Landfall, Multiple Landfalls, or By-Passers

The landfall hour is defined to be the time when the tropical cyclone first makes landfall across the coastline of mainland Philippines. The landfall hour is identified by plotting the tropical cyclone event's track (latitude and longitude) on a map and taking the time associated with the track point that is nearest to the coastline **prior** to landfall.

If there are multiple landfalls, one should still use the first landfall.

If the storm is a by-passer, the landfall hour should be assigned based on the time of closest geographic approach to the Philippines coastline.

3.2 Storm Location and Central Pressure

Primary Source

Retrieve the detailed track information for the Typhoon Event from the Japan Meteorological Agency (JMA). The easiest way to obtain JMA track information is through the Digital Typhoon website ("yyyy" will be the current year):

http://agora.ex.nii.ac.jp/digital-typhoon/year/wnp/yyyy.html.en

Click on the appropriate storm name (number) and then click on "Detailed Track Information" near the top of the page.

If Digital Typhoon does not publish the detailed track information from the JMA at the above location, but does publish it at another publicly-accessible location, make a reasonable effort to identify such location and obtain such detailed track information. If no location can be identified, detailed track information should be obtained directly from the JMA website ("yyyy" will be the current year).

http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/Besttracks/bstyyyy.txt

Note:	The information from Digital Typhoon is the same information collected by the JMA – and should not be considered a secondary source.

An example of the track plot and detailed track information for Typhoon Haiyan in 2013 (extracted from http://agora.ex.nii.ac.jp/digital-typhoon/summary/wnp/l/201330.html.en) is shown in Figure 7. The data shown must be formatted accordingly to be used with the catastrophe loss modeling software.

Year	Month	Day	Hour	Lat.	Long.	Pressure (hPa)	Wind (kt)	Class	Image
2013	11	3	06	5.8	157.2	1004	0	2	Image
2013	11	3	12	6.1	155.5	1008	0	2	Image
2013	11	3	18	6.1	153.3	1004	0	2	Image
2013	11	4	00	6.1	152.2	1002	35	3	Image
2013	11	4	06	6.2	150.4	1000	35	3	Image
2013	11	4	12	6.3	148.8	998	40	3	Image
2013	11	4	18	6.5	147.2	992	45	3	Image
2013	11	5	00	6.5	145.9	985	55	4	Image
2013	11	5	06	6.5	144.6	980	60	4	Image
2013	11	5	12	6.9	142.9	975	65	5	Image
2013	11	5	18	7.1	141.3	965	75	5	Image
2013	11	6	00	7.3	139.7	950	85	5	Image
2013	11	6	06	7.6	138.0	930	95	5	Image
2013	11	6	12	7.9	136.2	920	105	5	Image
2013	11	6	18	8.2	134.4	905	115	5	Image
2013	11	7	00	8.7	132.8	905	115	5	Image
2013	11	7	06	9.3	131.1	905	115	5	Image
2013	11	7	12	10.2	129.1	895	125	5	Image
2013	11	7	18	10.6	126.9	895	125	5	Image
2013	11	8	00	11.0	124.8	910	110	5	Image
2013	11	8	06	11.4	122.5	940	90	5	Image
2013	11	8	12	11.9	120.5	940	90	5	Image
2013	11	8	18	12.2	118.0	940	90	5	Image
2013	11	9	00	12.3	116.6	940	90	5	Image
2013	11	9	06	13.5	114.8	940	90	5	Image
2013	11	9	12	14.4	113.1	945	85	5	Image
2013	11	9	18	15.4	111.4	950	80	5	Image
2013	11	10	00	16.5	110.3	955	75	5	Image
2013	11	10	06	17.9	109.0	960	70	5	Image
2013	11	10	12	19.4	108.0	965	65	5	Image
2013	11	10	18	20.4	107.5	975	60	4	Image
2013	11	11	00	21.5	107.1	990	40	3	Image
2013	11	11	06	22.4	107.7	1004	0	2	Image

Japan Meteorological Agency Best Track Data | Correction Date : 2013-12-18

Figure 7 – Track Information from the Japan Meteorological Agency for Typhoon Haiyan (201330) Obtained from "Detailed Track Information" from "Digital Typhoon"

Note: When the storm first reaches maximum wind speeds of 35 knots or greater (i.e., it strengthens to tropical storm strength), the storm becomes an eligible event. Disregard any parameters before this wind value threshold.

Secondary Source

The secondary source for track data is the Joint Typhoon Warning Center data via the United States Naval Research Laboratory (NRL) webpage (e.g., located within the "trackfile.txt" under http://www.nrlmry.navy.mil/tcdat/). For example, the "trackfile.txt" for Typhoon Haiyan 2013 can be found at http://www.nrlmry.navy.mil/tcdat/tc13/WPAC/31W.HAIYAN/trackfile.txt. The data shown must be formatted accordingly.

Note: When the storm first reaches maximum wind speeds of 35 knots or greater (i.e., it strengthens to tropical storm strength), the storm becomes an eligible event. Disregard any parameters before this wind value threshold.

3.3 Environmental Pressure

Primary Source

Retrieve information for environmental pressure for the typhoon event from the JMA. This information can be obtained from surface analysis data issued by the JMA (e.g., http://www.jma.go.jp/en/g3/images/asia/yymmddhh.png,where yy = last two digits of the year, mm = month, dd = day, hh = 03, 09, 15, or 21).

Determine the value of the environmental pressure, via the outermost closed isobar associated to such storm as demonstrated for Tropical Cyclone Yasi in Figure 8. Although the image shown is from the Australia BoM, the same approach is applied for the JMA information.

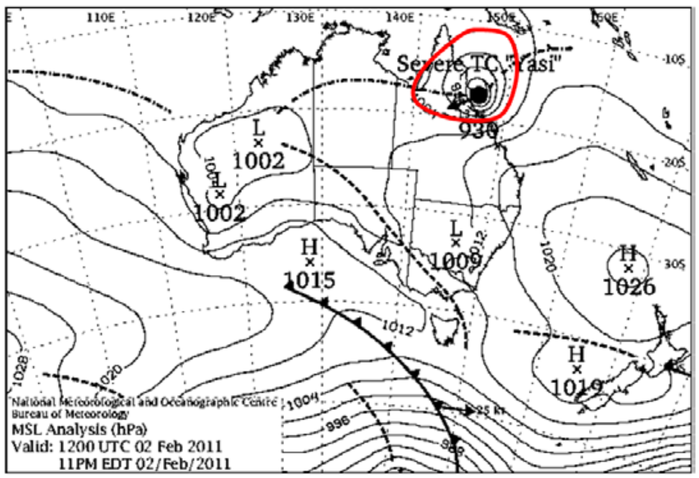

Figure 8 – Example of How to Determine the Environmental Pressure, Via the Outermost Closed Isobar (Highlighted in Red), of a Tropical Cyclone – In this Example of Yasi (2011), the Environmental Pressure is Reported as 1004 mb

The outermost closed isobar must reflect the storm circulation, whose radius in any direction from the center does not exceed 10°. This ensures that the outermost closed isobar is nearly circular or elliptical and thereby represents the actual storm circulation. If 10° is exceeded, select the outermost closed isobar that is one contour closer to the storm center, until the 10° criteria, in all directions, is satisfied. Note that 10° is the distance between the latitude/longitude lines as seen in Figure 8.

This value will be entered into the pre-processing software. To account for any potential error in the 4 mb contour interval, 2 mb is added to the environmental pressure when the user enters the environmental pressure directly into the script. This adjustment is made within this script and the user should insert the value directly obtained from the map and not manually increase by 2 mb.

Secondary Source

The environmental pressure default is based on historical data and assumes a mean value.

3.4 Storm Wind Radii

Note that the storm wind radii are not parameters directly used by the model. They are only used in an auxiliary function to determine the radius of maximum wind used in the model (for more information refer to the radius of maximum wind section which directly follows this section).

Primary Source

Retrieve information for storm wind radii for the Typhoon Event from the Japan Meteorological Agency (JMA). The easiest way to obtain this information is through the Digital Typhoon website ("yyyy" will be the current year):

http://agora.ex.nii.ac.jp/digital-typhoon/year/wnp/yyyy.html.en

Click on the appropriate storm name (number) and then click on "Detailed Wind Information" near the top of the page (e.g., see Figure 9).

The radii of gale-force and storm-force winds (e.g., "radius of major/minor storm/gale axis") are calculated as the averages of the major and minor radii for each respective wind parameter. If no value is given, assume a value of zero.

Year	Month	Day	Hour	Lat.	Long.	Wind (kt)	Gust (kt)	Direc. of Major Storm Axis	Radius of Major Storm Axis (nm)	Radius of Minor Storm Axis (nm)	Direc. of Major Gale Axis	Radius of Major Gale Axis (nm)	Radius of Minor Gale Axis (nm)	Image
2013	11	3	06	5.8	157.2	0	0	-	-	-	-	-	-	Image
2013	11	3	12	6.1	155.5	0	0	-	-	-	-	-	-	Image
2013	11	3	18	6.1	153.3	0	0	-	-	-	-	-	-	Image
2013	11	4	00	6.1	152.2	35	0	-	-	-	symmetric	60	60	Image
2013	11	4	06	6.2	150.4	35	0	-	-	-	symmetric	60	60	Image
2013	11	4	12	6.3	148.8	40	0	-	-	-	symmetric	100	100	Image
2013	11	4	18	6.5	147.2	45	0	-	-	-	symmetric	120	120	Image
2013	11	5	00	6.5	145.9	55	0	symmetric	30	30	symmetric	120	120	Image
2013	11	5	06	6.5	144.6	60	0	symmetric	40	40	symmetric	120	120	Image
2013	11	5	12	6.9	142.9	65	0	symmetric	50	50	symmetric	150	150	Image
2013	11	5	18	7.1	141.3	75	0	symmetric	60	60	symmetric	150	150	Image
2013	11	6	00	7.3	139.7	85	0	symmetric	60	60	NE	180	150	Image
2013	11	6	06	7.6	138.0	95	0	symmetric	60	60	NE	180	150	Image
2013	11	6	12	7.9	136.2	105	0	symmetric	70	70	NE	200	150	Image
2013	11	6	18	8.2	134.4	115	0	symmetric	70	70	NE	200	150	Image
2013	11	7	00	8.7	132.8	115	0	symmetric	70	70	NE	200	150	Image
2013	11	7	06	9.3	131.1	115	0	symmetric	70	70	NE	230	150	Image
2013	11	7	12	10.2	129.1	125	0	symmetric	80	80	N	250	180	Image
2013	11	7	18	10.6	126.9	125	0	symmetric	80	80	N	250	180	Image
2013	11	8	00	11.0	124.8	110	0	symmetric	70	70	N	250	180	Image
2013	11	8	06	11.4	122.5	90	0	symmetric	70	70	N	270	180	Image
2013	11	8	12	11.9	120.5	90	0	symmetric	70	70	NE	270	180	Image
2013	11	8	18	12.2	118.0	90	0	symmetric	80	80	NE	270	180	Image
2013	11	9	00	12.3	116.6	90	0	symmetric	80	80	NE	240	180	Image
2013	11	9	06	13.5	114.8	90	0	symmetric	80	80	NE	240	180	Image
2013	11	9	12	14.4	113.1	85	0	symmetric	80	80	NE	240	180	Image
2013	11	9	18	15.4	111.4	80	0	symmetric	80	80	NE	240	180	Image
2013	11	10	00	16.5	110.3	75	0	symmetric	80	80	NE	240	180	Image
2013	11	10	06	17.9	109.0	70	0	symmetric	80	80	NE	240	180	Image
2013	11	10	12	19.4	108.0	65	0	symmetric	80	80	NE	200	150	Image
2013	11	10	18	20.4	107.5	60	0	symmetric	50	50	symmetric	150	150	Image
2013	11	11	00	21.5	107.1	40	0	-	-	-	symmetric	120	120	Image
2013	11	11	06	22.4	107.7	0	0	-	-	-	-	-	-	Image

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Figure 9 – Wind Information from the Japan Meteorological Agency for Typhoon Haiyan (201330) Obtained from "Detailed Wind Information" from "Digital Typhoon"

Secondary Source

The secondary source for wind radii data is to use the AIR model whereby no adjustment will be made to the radius of maximum wind for storm size.

3.5 Radius of Maximum Wind

Primary Source

The radius of maximum wind (Rmax) is the distance from the storm center to the strongest wind speeds. The primary source is to use the observed wind radii data (gale-force and storm-force wind radii) from the JMA to calculate the Rmax using AIR's radial wind profile model which utilizes the Willoughby Algorithm[3]. This ensures that the storm wind speed footprint is consistent with what was observed.

Secondary Source

[3] Willoughby et al (2007), "Parametric Representation of the Primary Hurricane Vortex. Part II: A New Family of Sectionally Continuous Profiles"(http://journals.ametsoc.org/doi/pdf/10.1175/MWR3106.1)

The secondary source for Rmax is determined from the AIR model. The Rmax is generated internally for each hour of the path file using an event-independent empirical function that relates Rmax to the central pressure and latitude.

3.6 Maximum Precipitation Rate

Primary Source

The primary source for maximum precipitation rate (Pmax) is obtained from the Tropical Rainfall Measurement Mission (TRMM). The easiest way to obtain this information is through the TRMM website:

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=TRMM_3-Hourly&selectedMap=Blue Marble&

Using the graphical-user interface (GUI), create the appropriate precipitation map.

One must set the parameters so that a 6-hour window of average precipitation rate is plotted for a time period most closely centered on landfall. A 6-hour window is used in order to immunize from any short-lived or small-scale precipitation features. The latitude and longitude values should be set by adding 10 degrees of latitude and longitude to the landfall latitude and longitude. To do this, create a window around the area you want to focus on (the yellow box as seen in Figure 10 below). Set visualization dropdown to "Lat-Lon map, Time-averaged". An example is shown in Figure 10 for Cyclone Larry (2006). This approach can also be used for any eligible cyclone that affects the Philippines.

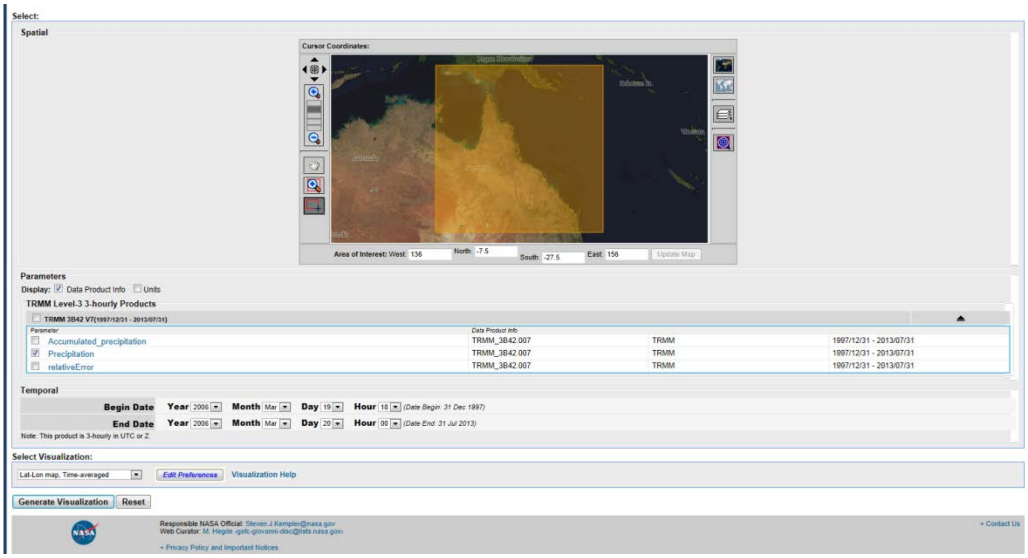

Figure 10 – Example of How to Set the Plot Parameters to Obtain a TRMM-Based Precipitation Rate for Cyclone Larry (2006) at Landfall

Clicking the Download Data button will allow the user to download an ASCII file containing precipitation rates for the area identified in the previous step. Under "Two Dimensional Map Plot", check the box next to ASC and click "Download in Batch" (Figure 11). On the resultant webpage, click on the file name (Figure 12) and save the file.

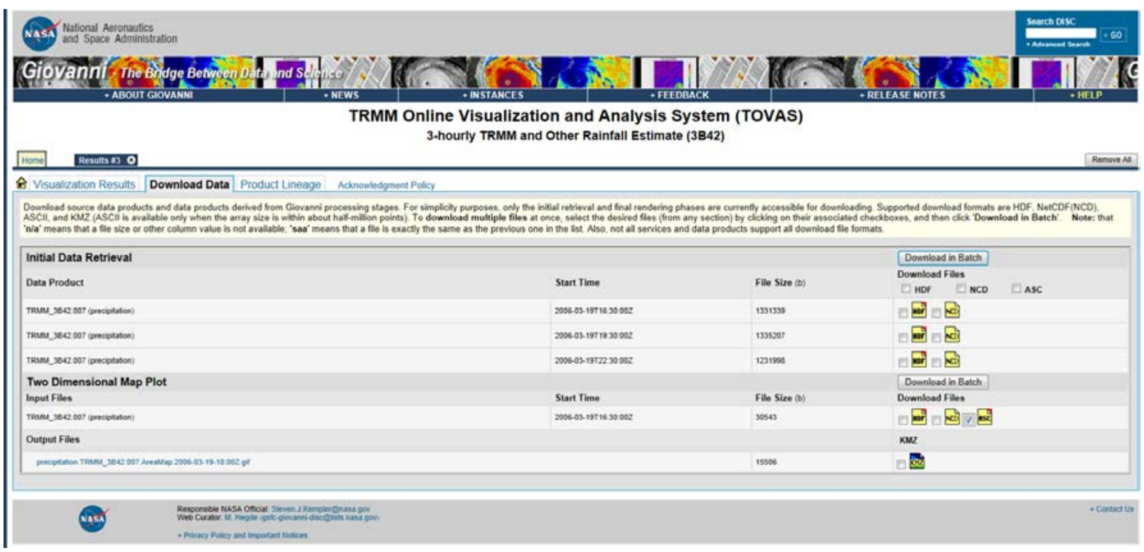

Figure 11 – Example of How to Download TRMM Data

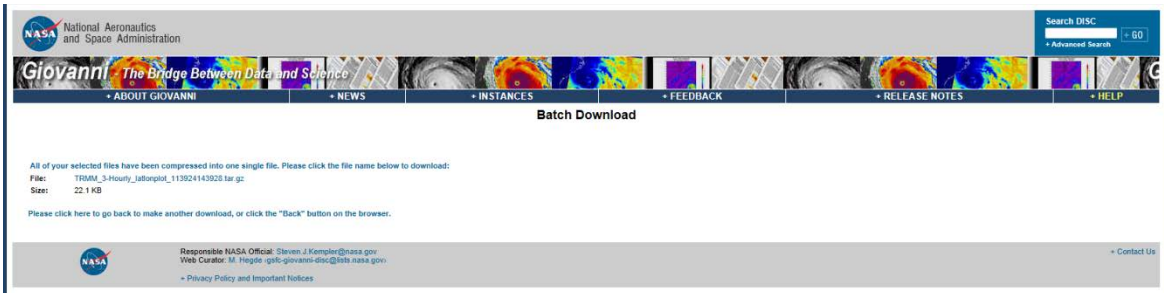

Figure 12 – Example of How to Save the TRMM File

The Pmax value is chosen in an automated way and calculated as the maximum TRMM precipitation rate within 2.5° (latitude and longitude) of the landfall location. For Larry, the rate is 33.04 mm/hr while for Yasi it is 16.53 mm/hr.

If Pmax cannot be obtained from the QA'd site as indicated above, Pmax should be determined using the real-time TRMM site at:

http://disc2.nascom.nasa.gov/Giovanni/tovas/realtime.3B42RT.2.shtml

The site is set up in a similar way as the QA'd site. The user will need to specify the latitude and longitude bounds and time in the same way but simply clicks the ASCII Output button instead of going through the other steps from the QA site.

Secondary Source

The Pmax default is based on historical data and assumes a modeled mean rate.

3.7 Precipitation Radius

Primary Source

Retrieve information for precipitation radius for the tropical cyclone event from the TRMM visualization used to estimate the precipitation rate. Precipitation radius is calculated in an automated way as the average north, south, east, and west radius (planar distance) to where the precipitation rate is first 1 mm/hr and evaluated from the landfall latitude and longitude (detailed in Figure 13 and Figure 14 – this approach can also be used for any eligible cyclone that affects the Philippines).

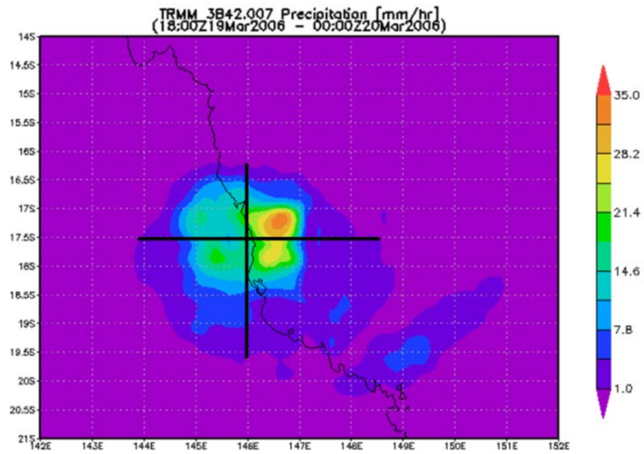

Figure 13 – TRMM-Based Estimate of Six-Hourly Average Rainfall Rate (mm/hr) for Cyclone Larry (2006) for Time Shown at Landfall – Black Lines Denote the East-West and North-South Distances for the Outer Precipitation Radius

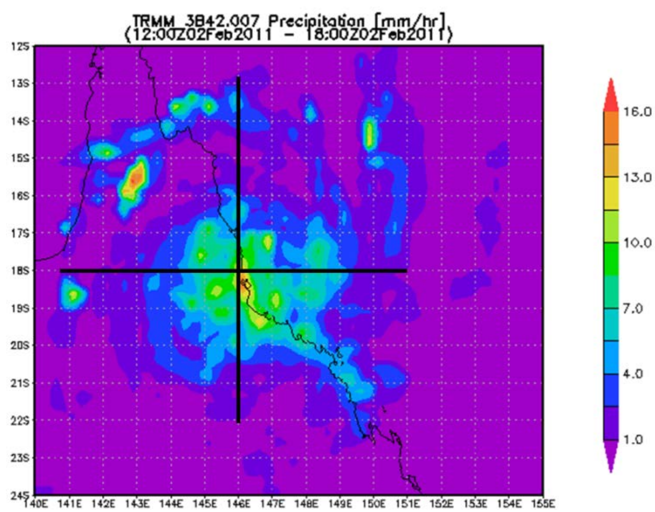

Figure 14 – TRMM-Based Estimate of Six-Hourly Average Rainfall Rate (mm/hr) for Cyclone Yasi (2011) for Time Shown at Landfall – Black Lines Denote the East-West and North-South Distances for the Outer Precipitation Radius

For Larry, the precipitation radius is 210.22 km while for Yasi it is 455.30 km.

Secondary Source

The precipitation radius default is based on historical data and assumes a model mean radius.

4 Generating Loss Results

Once the parameters have been downloaded from the Reporting Agencies and processed as described in the previous sections, they are formatted and input into the appropriate AIR catastrophe loss model software (earthquake or typhoon) to derive the modeled loss estimates. The loss model software will automatically return a value of the modeled loss.

About AIR Worldwide Corporation

AIR Worldwide Corporation (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 50 countries. More than 400 insurance, reinsurance, financial, corporate and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, agricultural risk management, and property replacement cost valuation. AIR is a member of the ISO family of companies and is headquartered in Boston with additional offices in North America, Europe and Asia. For more information, please visit www.air-worldwide.com.

About Asian Disaster Preparedness Center (ADPC)

As a leading regional resource center, Asian Disaster Preparedness Center (ADPC) works towards the realization of disaster reduction for safer communities and sustainable development in Asia and the Pacific. Since its inception in 1986, ADPC has been recognized as the major independent center in the region for promoting disaster awareness and the development of local capabilities to foster institutionalized disaster management and mitigation policies. ADPC was originally established as an outreach center of the Asian Institute of Technology after a feasibility study conducted jointly by two agencies of the United Nations, the Office of the United Nations Disaster Relief Coordinator (current the UN Office for the Coordination of Humanitarian Affairs) and the World Meteorological Organization in January 1986. Funding for the study was provided by the United Nations Development Program in response to requests from countries in the region for international assistance to strengthen their national disaster management systems. Thus, the initial role conceived for the center was mandated by an expressed need to assist countries of the Asia and the Pacific region in formulating their policies and developing their capabilities in all aspects of disaster management.