CEDIM Forensic Disaster Analysis Group &
CATDAT and Earthquake-Report.com

Philippines (Bohol) Earthquake – Report #3

18.10.2013 – Situation Report No. 3 – 10.00am GMT

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Official Disaster Name	Date	UTC	Local	CATDAT_ID
Bohol EQ	**15-Oct-2013**	**12:12:31**	**+8**	**2013-285**

Preferred Hazard Information:

EQ_Latitude	EQ_Longitude	Magnitude	Hyp_Depth (km)	Fault Mech.	Source	Spectra
9.866	**124.011**	**7.1-7.2Mw**	**20**	**Thrust**	**USGS**	**None avail.**

Duration: 30 secs

Location Information:

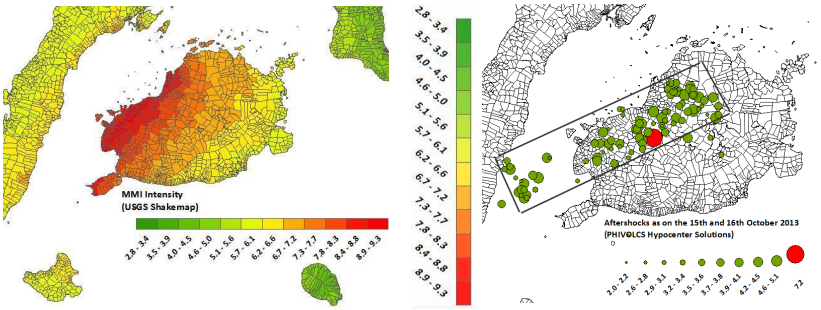
Country	ISO	Province	Most Impact	Building PF	HDI (2012)	Urbanity	Population
Philippines	**PH**	**Bohol**	**West Coast**	**Average**	**0.729**	**25%**	**1.3 million**
Philippines	**PH**	**Cebu**	**City**	**Good**	**0.761**	**66%**	**4 million**

Preferred Hazard Information:

MSK-64	MMI	PEIS	**Key Hazard Metrics**
IX	VIII-IX	VII-VIII	(VIII-IX) Epicenter, Loon, Clarin, (VII-VIII) Tagbilaran City, West Bohol, (VI-VII) Cebu City, East Coast Cebu, East Bohol

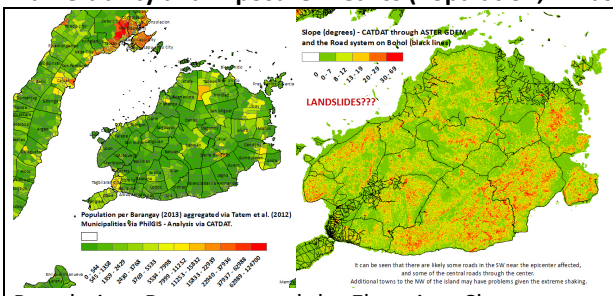
Hazard Description (Intensities and Ground Motion)

Intensities reached VII on the PEIS scale – very well built structures received slight damage. Older buildings suffered great damage. There was also limited liquefaction. The damage seen corresponds to VIII and perhaps very isolated VIII-IX locations on the MMI scale. Over 900 aftershocks have occurred, with magnitude 5 earthquakes continuing to pepper the region around Clarin, Loon and Tagbilaran on Bohol. The fault sense can start to be seen well from the PHIVOLCS data, with the fault break running at about WSW-ENE. At least 100 of these have been strong enough to be felt.



All absolute values for this earthquake should be treated with caution and are estimates!

Vulnerability and Exposure Metrics (Population, Infrastructure, Economic)



Population, Barangays and the Elevation, Slope

The island of Bohol has a capital stock around $5-6 billion USD with approximately 1.3 million inhabitants. It is mountainous in nature and has the chance for many landslide. Cebu is a key tourist area in the Philippines with 2 million arrivals per year as of 2013. Still, the average income and GDP per capita is about the same as that of the whole of the Philippines. Bohol has a lower GDP per capita in comparison. The main industries are dominated by agriculture which could be affected.

What have been the 2 largest comparable damaging events in the past? None in this region.

Date - Name	Impact Size	Damage %	Social % or Insured %	Economic Loss
1990 Bohol	Mw6-6.8, VII PEIS	7000 homeless	6 deaths, 200 injured	154m PHP ($7m US)
1996 Bohol	Mw5.6, VI PEIS	Poorly built structures	No deaths	Minor

Preferred Building Damage Information: (Damage states will be filled in later when more info available)

Description: Many government, churches and private (over 19000 so far) The counting of buildings destroyed has not been undertaken with only a few houses included in the current count of **2938 destroyed and 16371 damaged.** Based on families displaced, this value could be up to at least 10000 destroyed. Loon has been particularly hard hit as well as Clarin, Carmen, Tagbilaran and others. See the pictures for locations of current counting.	 Julie Jaramillo (all rights reserved)

Secondary Effect Information:

Type	Impact	Damage %	Social %	Economic %
Landslides	Many roads blocked, infrastructure damage	Minor	At least 10 deaths	1-5%

See below in the pictures for Barangays affected

Preferred Social Impact Information:

Type	Median	Accepted Range	Description	Source
Deaths	**191 (incl. 20 missing)**	May rise	The hypocenter has played a major role in fatality estimation: 20 to 400 =various models	Daniell, CATDAT, Earthquake Report.
	***NB: The lowest death toll is currently 171 as 20 are missing. The BQ mall may unfortunately have more victims according to eyewitnesses*			
Injuries	375	500+	188 Bohol, 182 Cebu	NDRRMC
Long term Homeless	31000	18000-63000	Using homeless trend model based on Visayas 2012, Luzon 1990 and other Philippines events.	Daniell, CATDAT
Short term homeless	250000?	163000+	**163000 currently displaced – see below**	NDRRMC
Affected	**3426000**	3m-7m (4.5m)	Cebu, West Bohol, Negros	NDRRMC

Preferred Current Economic Impact Information: $million int. event-day dollars

Type	Median	Accepted Range	Description	Source
Total Losses	$89.4m	$55m-100m	Total estimate (using rapid loss model combined with damage for range)	CATDAT/James Daniell
Insured Losses	<$2m	$1m-5m	Minor insurance takeout but Cebu some	CATDAT
Aid Impact	$2.2m		Put aside in disaster funds	NDRRMC

Direct Economic Damage (Total) - Summary

- There have been estimates of some components of the infrastructure damage being **563 million PHP** (around 12 million USD).
- The rapid loss estimation of CATDAT/James Daniell, gives a total damage value coming out to between 55-100 million USD (up to 4.5 billion PHP) with a median 89.4 million USD (3.9 billion PHP). This includes infrastructure and direct damage to buildings, industry and contents.
- This is a significant percentage of the gross capital stock of the location, with a MDR approaching 1.5%.

Weather

- The earthquake occurred in the middle of the typhoon season. Lots of isolated showers and thunderstorms during next 72-96 hours. >100mm expected in the next 5 days in Southern Bohol (usual for the season)
- They might be heavy in places, may trigger landslides in saturated and unstable slopes.
- Neither a typhoon nor any other organized tropical rain complex is expected next 144 hours.
- No widespread and heavy rain.

Source: Bernhard Mühr, CEDIM, http://www.wettergefahren-fruehwarnung.de/

Insured Loss Estimates:

Some public infrastructure damage occurred, and in addition there was minor damage to tourist facilities in various locations. It is still expected that the damage will be insignificant for the insurance industry. In addition no global impacts on supply chains.

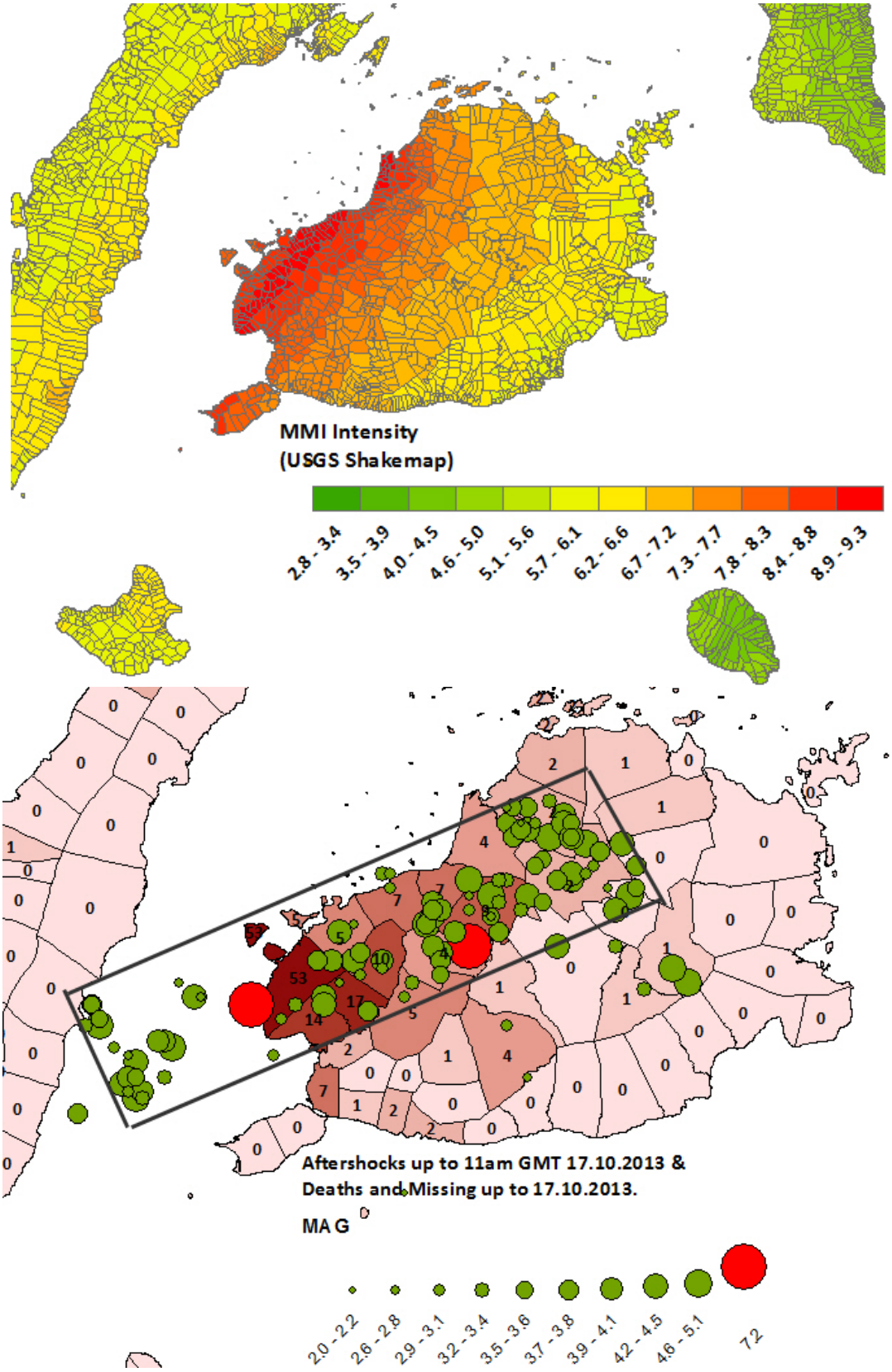
Abridged Summary Description from full CATDAT description sources:

A catastrophic earthquake hit the densely populated area of Cebu, and the less densely populated island of Bohol with catastrophic consequences.

CATDAT Economic Index Rank:	8: Very Damaging	**CATDAT Social Index Rank:**	8: Destructive

This report was produced in conjunction with the CATDAT database, earthquake-report.com, NDRRMC and USGS data. As shown below is full size documentation of the diagrams shown in the summary above. The data is current as of 18th October 11:00am European Standard Time. For the current data, go to www.earthquake-report.com.

Maps of the affected region signalling some of the destruction and photos of affected infrastructure.



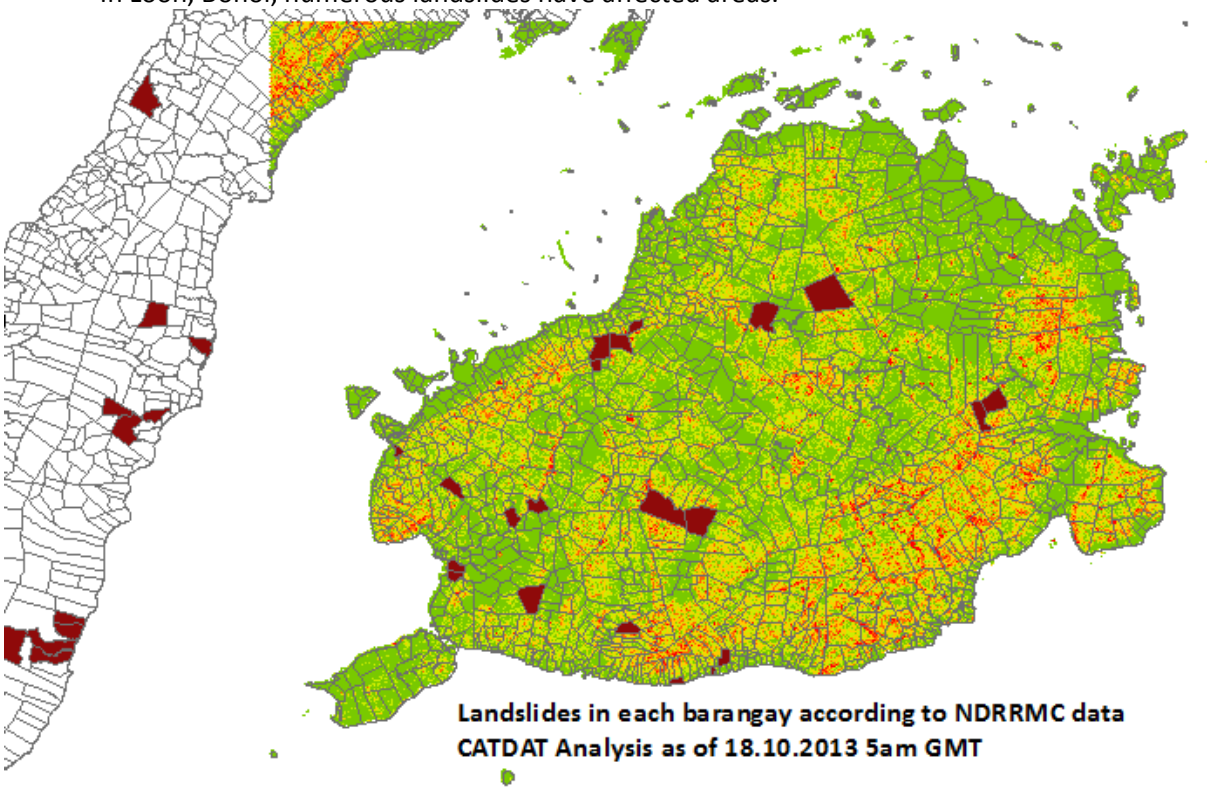
941 aftershocks have occurred so far, with the main ones shown here. Two aftershocks have caused minor additional damage (Earthquake Report). 29 main felt aftershocks have occurred. However, there is still potential for larger aftershocks up to M=6 which could cause additional damage. The intensity map will be reevaluated with the incoming damage and fault solution as there are 2 potential locations of the epicenter as shown in red on the diagram above.

Earthquake-induced Landslides

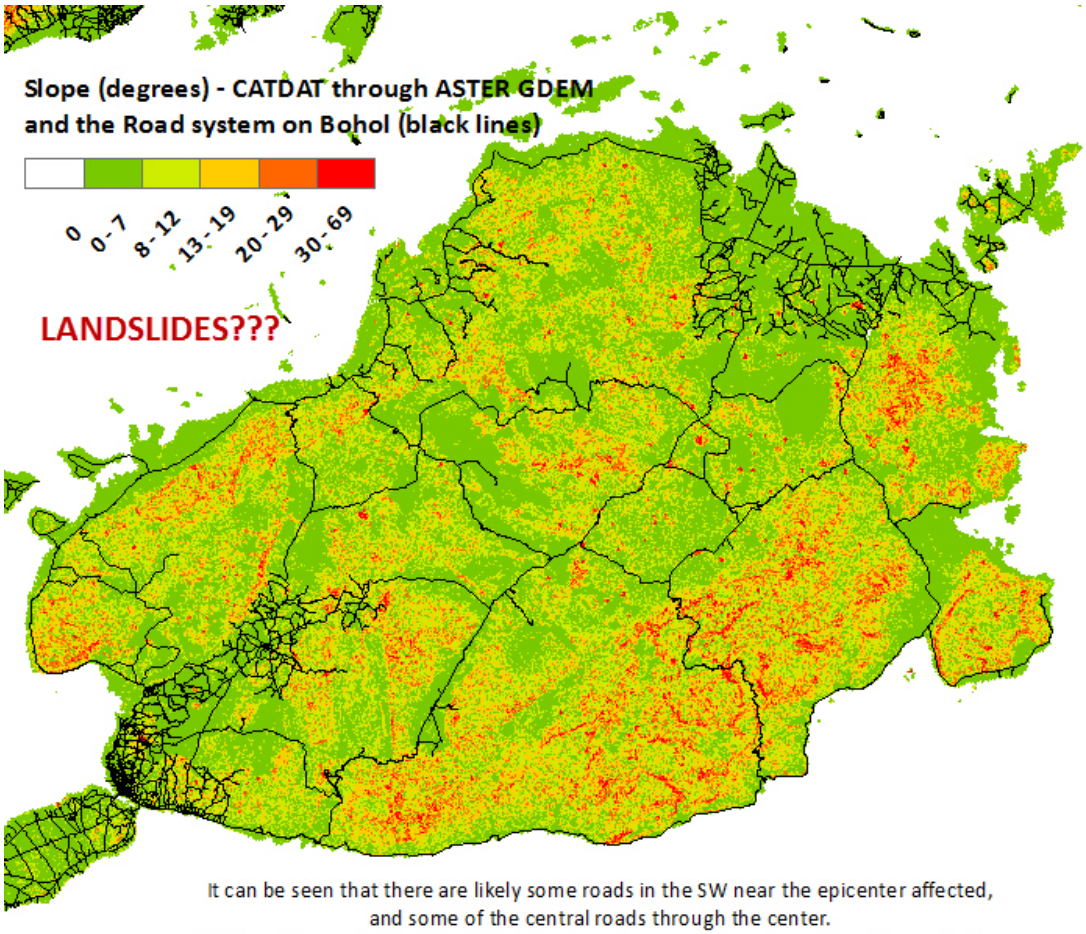
The magnitude 7.2 earthquake on 15 October 2013 main shock, triggered shallow landslides that can be observed on the steep natural slopes of the famous Chocolate Hills in Bohol. The shallow disaggregated landslides are typically not associated with particular geologic units and/or type of slopes. They are usually as deep as the root zone of the vegetative cover, anywhere from several decimeters to a meter deep, and consist of dry, highly disaggregated and fractured material that cascaded down-slope to flatter areas at or near the base of slopes.

Shallow disaggregated landslides account form most the failure types after earthquakes. However, some of the landslides shown on the Chocolate Hills (when looked at more closely are more deep-seated rock and earth slumps that involve relatively large volumes of material (see Figure at the end of the report from Julie Jaramillo). Earthquake triggered landslides contributed to the following noted disruptions as shown and more than 32 barangays have reported landslides :

- The highway in Cortes particularly in Lilo-and was rendered impassable due to a landslide. A part of Cortes' highway was also damaged.
- In Balilihan, the Bohol Mayor, Dominisio Chatto has confirmed that 5 people died from a landslide due to the earthquake.
- In Loon, Bohol, numerous landslides have affected areas.

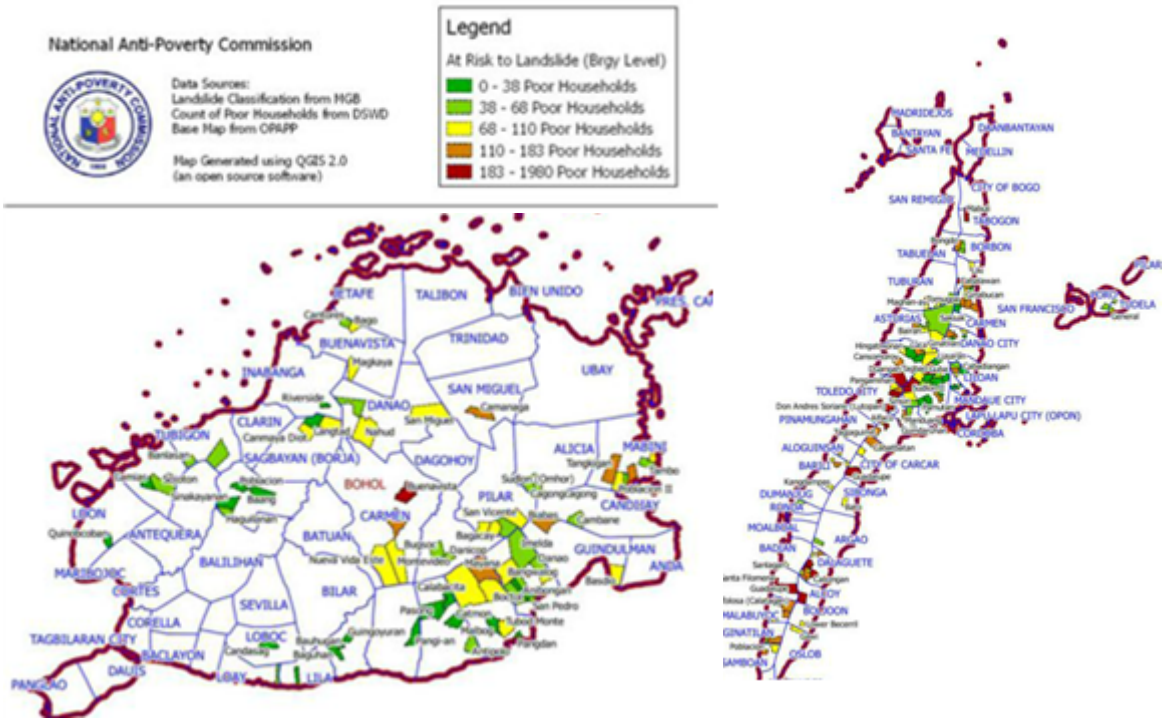


Left: Chocolate Hills Landslides (courtesy: @docjolt); Right: Julie Jaramillo on site at Choc Hills.



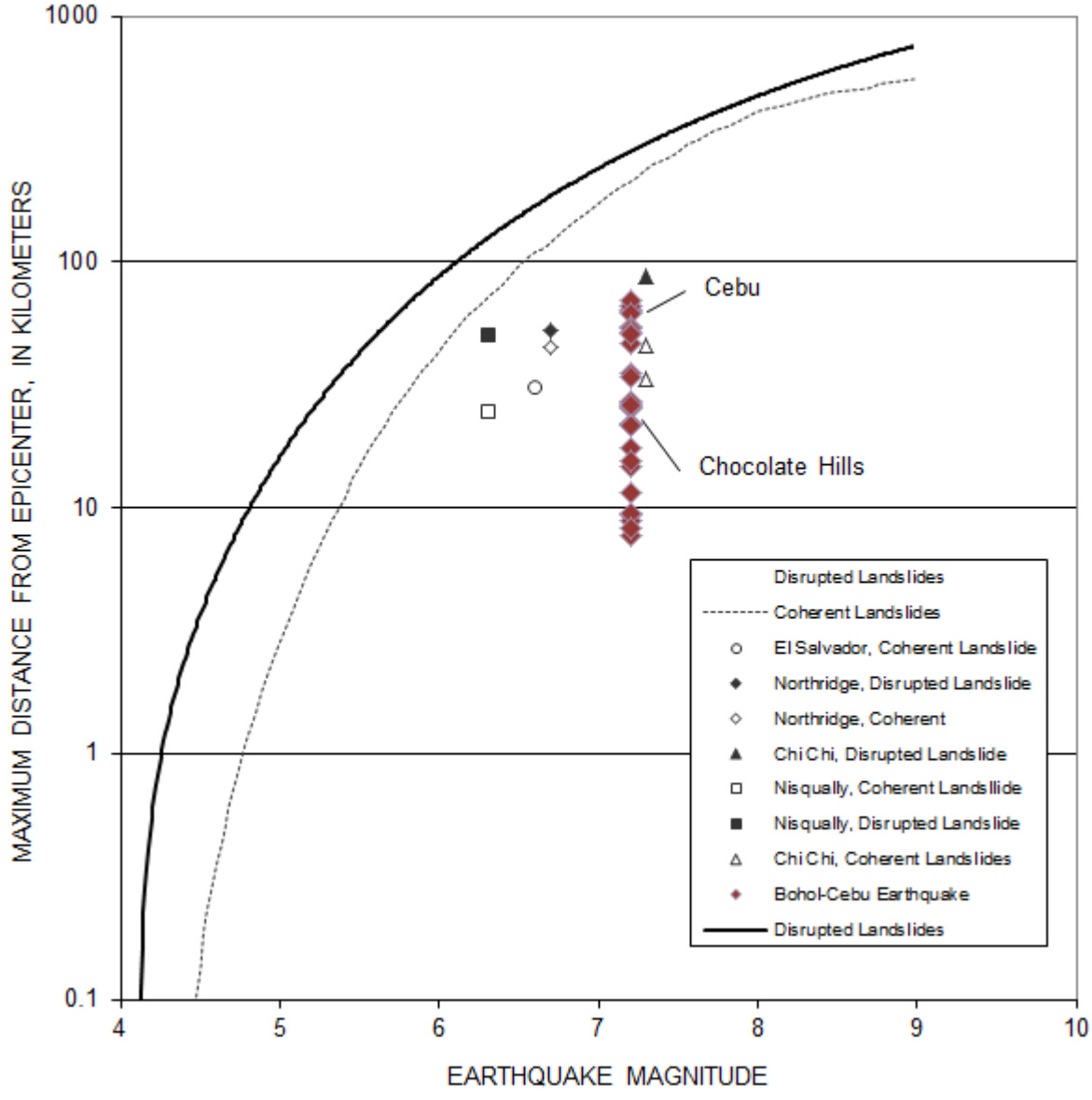
It can be seen that there are likely some roads in the SW near the epicenter affected,
and some of the central roads through the center.
Additional towns to the NW of the island may have problems given the extreme shaking.

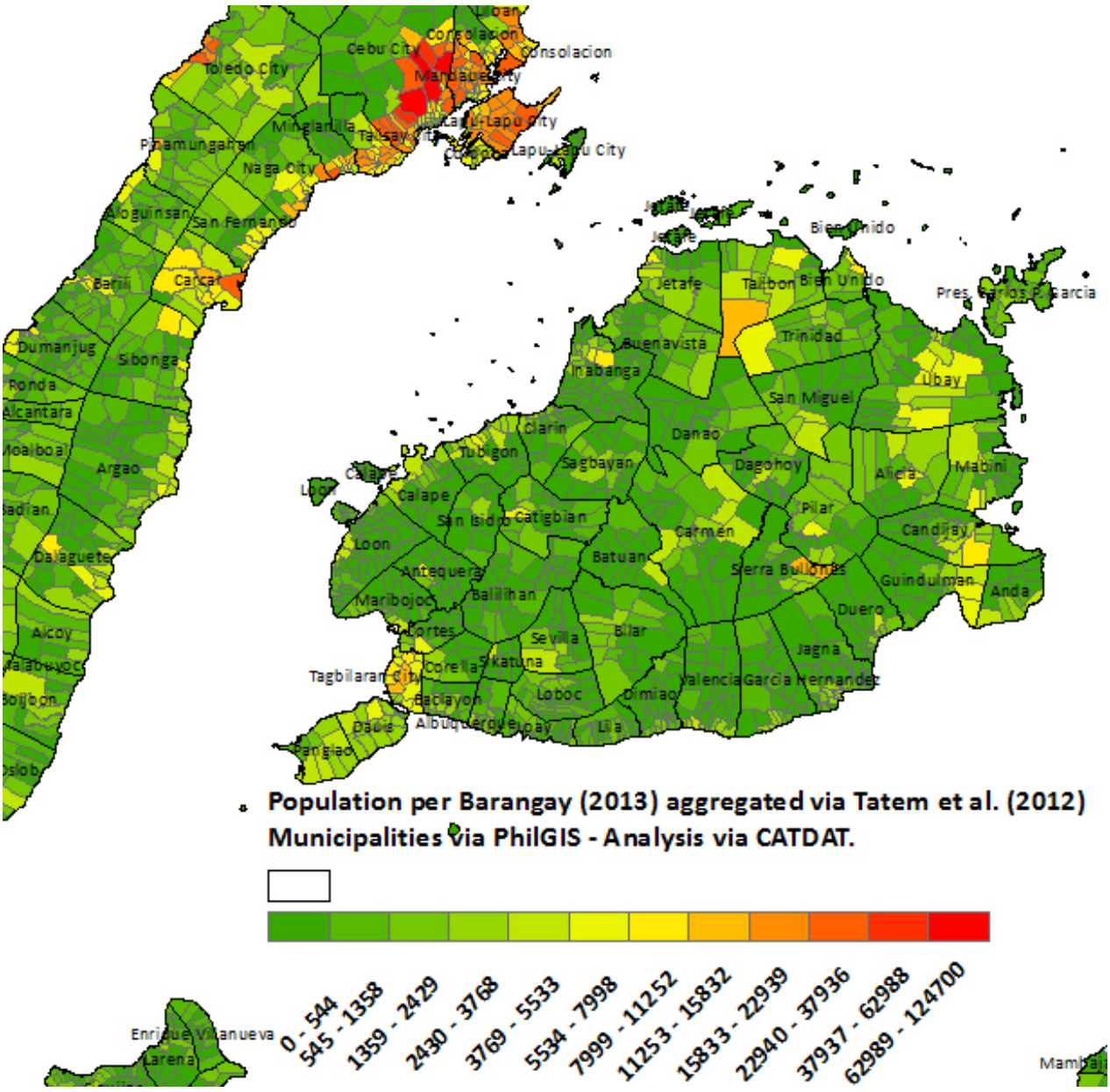
To aid in the rescue and relief as well as resettlement operations, the National Anti-Poverty Commission (NAPC) on Wednesday released the maps of Cebu, Negros Oriental, and Siquijor indicating location of poor households in barangays that are exposed to high risks of landslides.



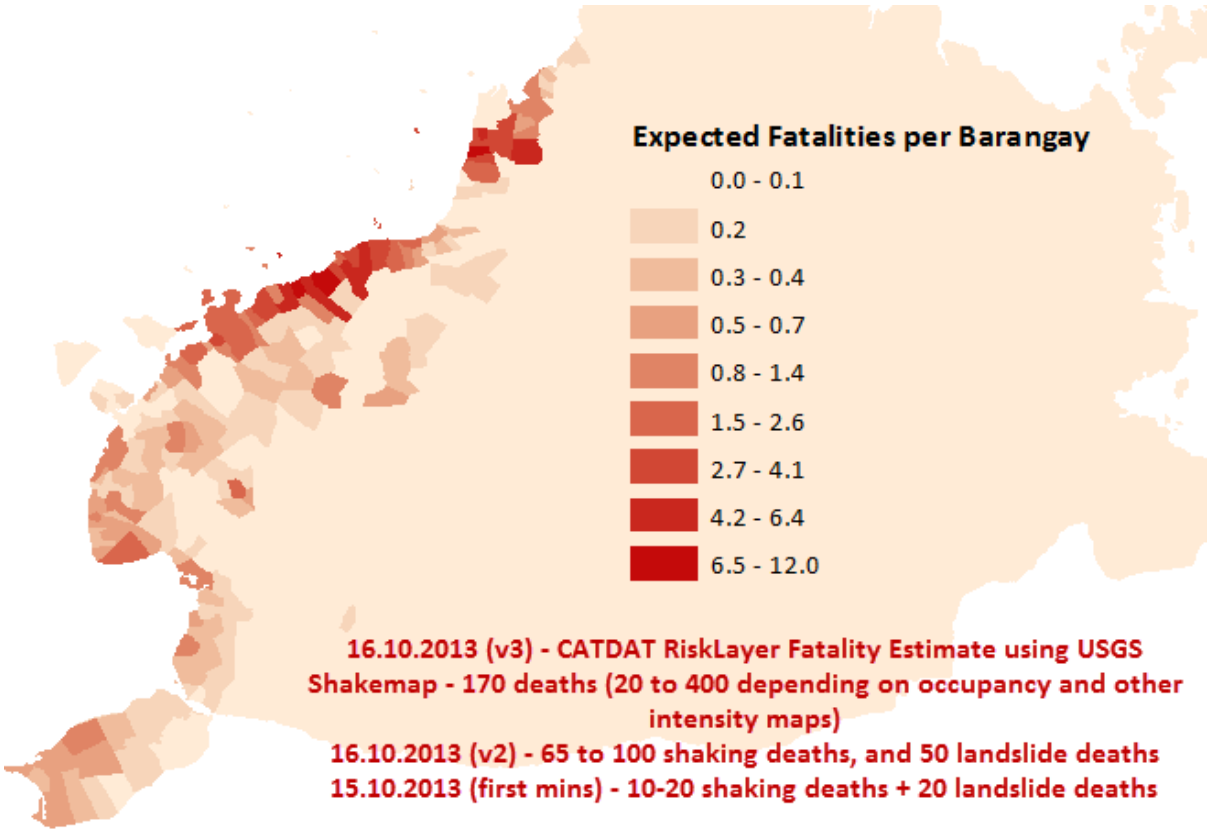
The landslide distances are within the bounds seen in historical earthquakes as tested by Bijan Khazai for ChiChi, Northridge, Seattle (Nisqually) and El Salvador earthquakes, and James Daniell for Cebu-Bohol (after Keefer, 1999; Khazai, 2004).

Keefer (1984a) presents magnitude-distance relationships using two distance definitions (epicentral and fault projection) for three different landslide categories: coherent, disrupted slides and falls, and lateral spreads and flows. The figure above shows the earthquake magnitude and the maximum distance from the epicenter limit curves obtained by Keefer (1984a) for both coherent and disrupted slides. Superimposed on these curves is a suite of more recent events that plots well within this envelope, indicating that for the most part the types of landslides that occurred were quite typical of what can be expected in major earthquakes.





This region holds 10.75 % of the Total Elderly Population, as a percent of the Population of the Region VII the elderly make up 4.75 % of the total population which is higher than the national average (3.77 %).



16.10.2013 (v3) - CATDAT RiskLayer Fatality Estimate using USGS Shakemap - 170 deaths (20 to 400 depending on occupancy and other intensity maps)

16.10.2013 (v2) - 65 to 100 shaking deaths, and 50 landslide deaths

15.10.2013 (first mins) - 10-20 shaking deaths + 20 landslide deaths

NDRRMC Update on Infrastructure damaged (www.ndrrmc.gov.ph) – Situation Report 7

Effects of Magnitude 7.2 Sagbayan, Bohol Earthquake

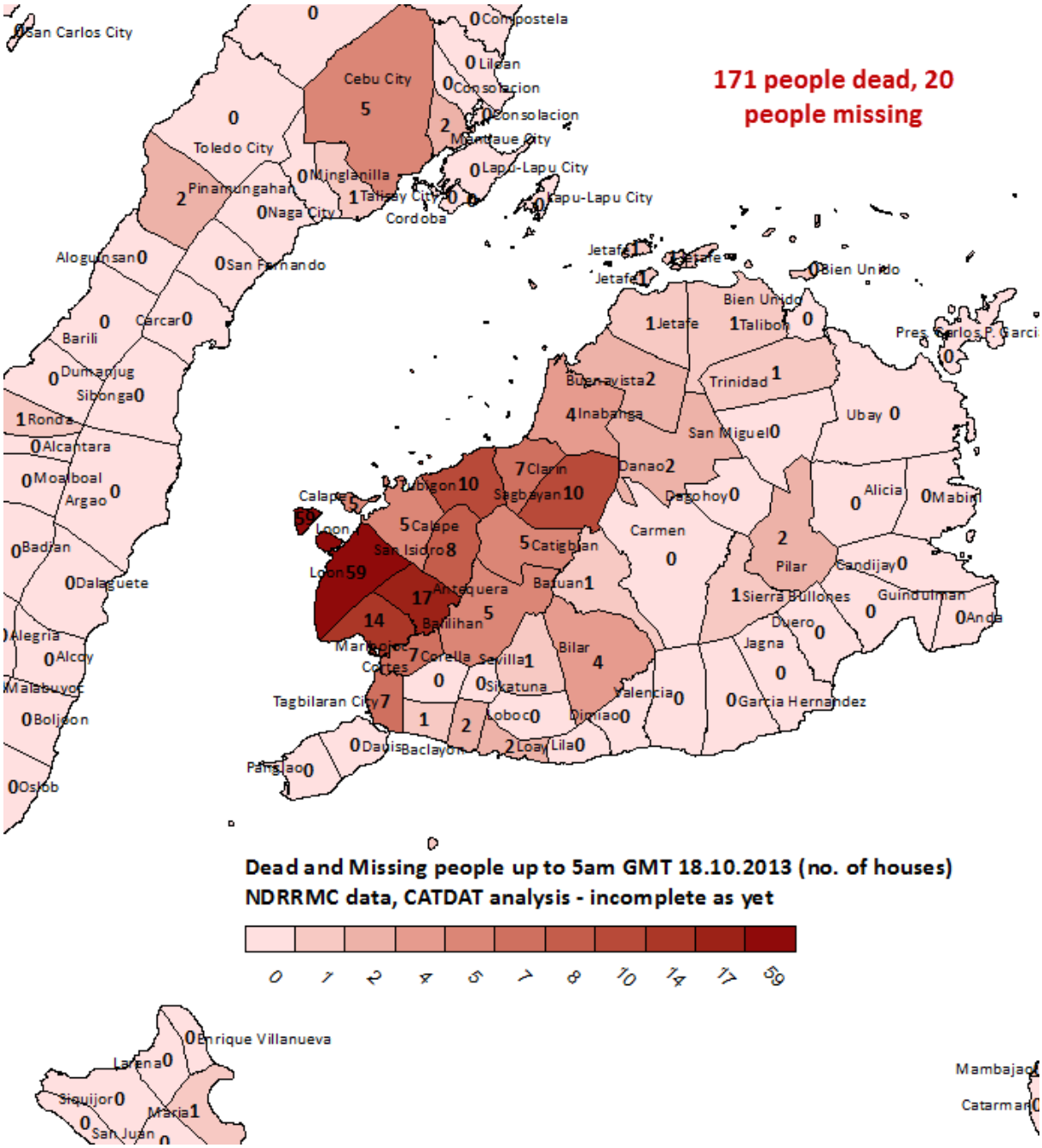
DAMAGED ROADS AND BRIDGES

18 October 2013, 6:00 AM

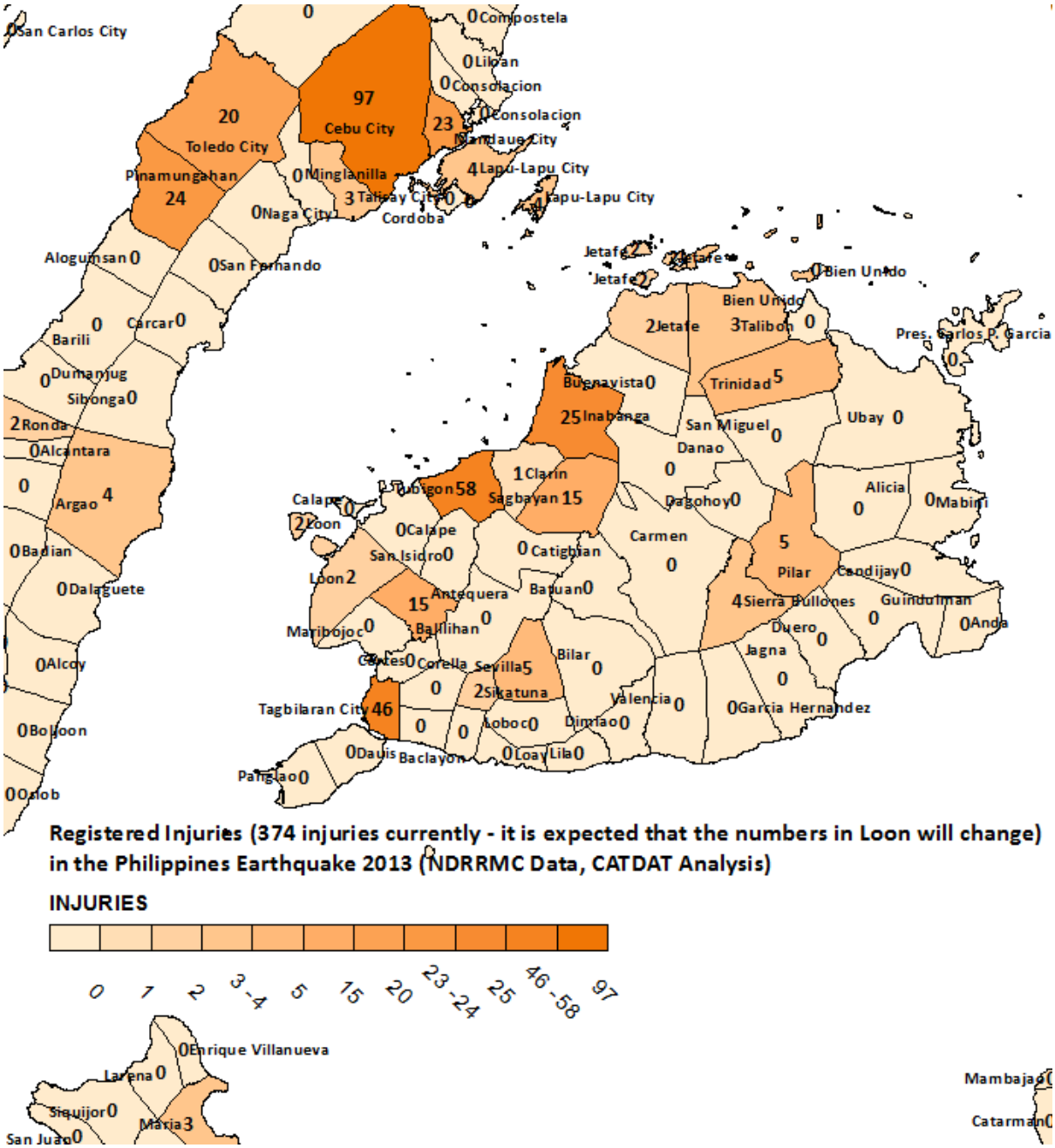
REGION	Province/Municipality	DAMAGED ROADS AND BRIDGES	
		NATURE OF DAMAGE	STATUS
VII	**BOHOL**		
	BRIDGES		*28*
	Bayog Bridge	Settlement of abutment	Hardly Passable
	Can eway Bridge	Settlement of abutment	Hardly Passable
	Moawa Bridge	Settlement of abutment	Hardly Passable
	Abatan Bridge Maribojoc	Bridge collapsed	Not passable
	Agape Bridge	Settlement of bridge approach	Not passable
	Bacong Bridge	Damaged	Not passable
	Balbalan Bridge	Settlement of bridge approach	Not passable
	Banban Bridge	Settlement of bridge approach	Not passable
	Bongkokan Bridge	Settlement of bridge approach	Not passable
	Clarin Bridge, Clarin	Settlement of bridge approach	Not passable
	Camayaan Bridge	Damaged bridged approach	Not passable
	Daet Bridge	Settlement of bridge approach	Not passable
	Dimiao Bridge	Settlement of bridge approach	Not passable
	Hinawanan Bridge	Settlement of bridge approach	Not passable
	Loay Bridge	Damaged	Not passable
	Moalong Bridge	Bridged collapsed	Not passable
	Palo Bridge	Settlement of bridge approach	Not passable
	Panangatan Bridge	Settlement of bridge approach	Not passable
	Punan Bridge	Settlement of bridge approach	Not passable
	Sen. Clarin Bridge, Loay	Settlement of bridge approach	Not passable
	Hunan Bridge	Settlement of bridge approach	Not passable
	Tagbawane Bridge	Bridge collapsed	Not passable
	Tagimtim Bridge	Settlement of bridge approach	Not passable
	Tultogan Bridge	Collapsed bridge approach	Not passable
	Anislag Bridge	**Damaged bridge approach**	**Not passable**
	Mactan Bridge - Expansion Joint	Damaged	Passable
	Salog Bridge	Damaged bridge approach	Passable
	Suarez Bridge	Damaged bridge approach	Passable
	ROADS		*6*
	National Highway at Laya Section	Damaged, remedial works on going	Not passable
	Cortes-Balilihan-Macaas Road	Massive landslide	Not Passable
	Jagna-Sierra Bullones Road	Road settlement	Hardly Passable
	Tagbilaran-East Road	Settlement	Not Passable
	Tagbilaran-North Road	Road slip and settlement of pavement	Not Passable
	Loay Interior Road	Damaged	Not Passable
	CEBU		
	BRIDGES		*6*
	Casanga Bay Bridge	Pavement settlement	Passable
	Mandaue-Mactan Bridge	Cracks	Passable
	Marcelo-Fernan Bridge	Cracks	Passable
	Maguikay Flyover	Cracks	Passable
	Pilipog Bridge 1	Cracks	Passable
	Batuanon Bridge	Cracks on revetment/slope protection	Passable
	ROADS		*4*
	Natalio Bacalso Ave	Rockslip/landslide	Passable
	Carcar-Barili Road	Asphalt pavement cracks	Passable
	Sibunga-Dumanjug	Concrete pavement cracks	Passable
	Cebu-Toledo-Wharf	Lanslides	Passable
VI	**NEGROS OCCIDENTAL**		
	BRIDGE		*1*
	Malabong Bridge	Partially Damaged	Passable

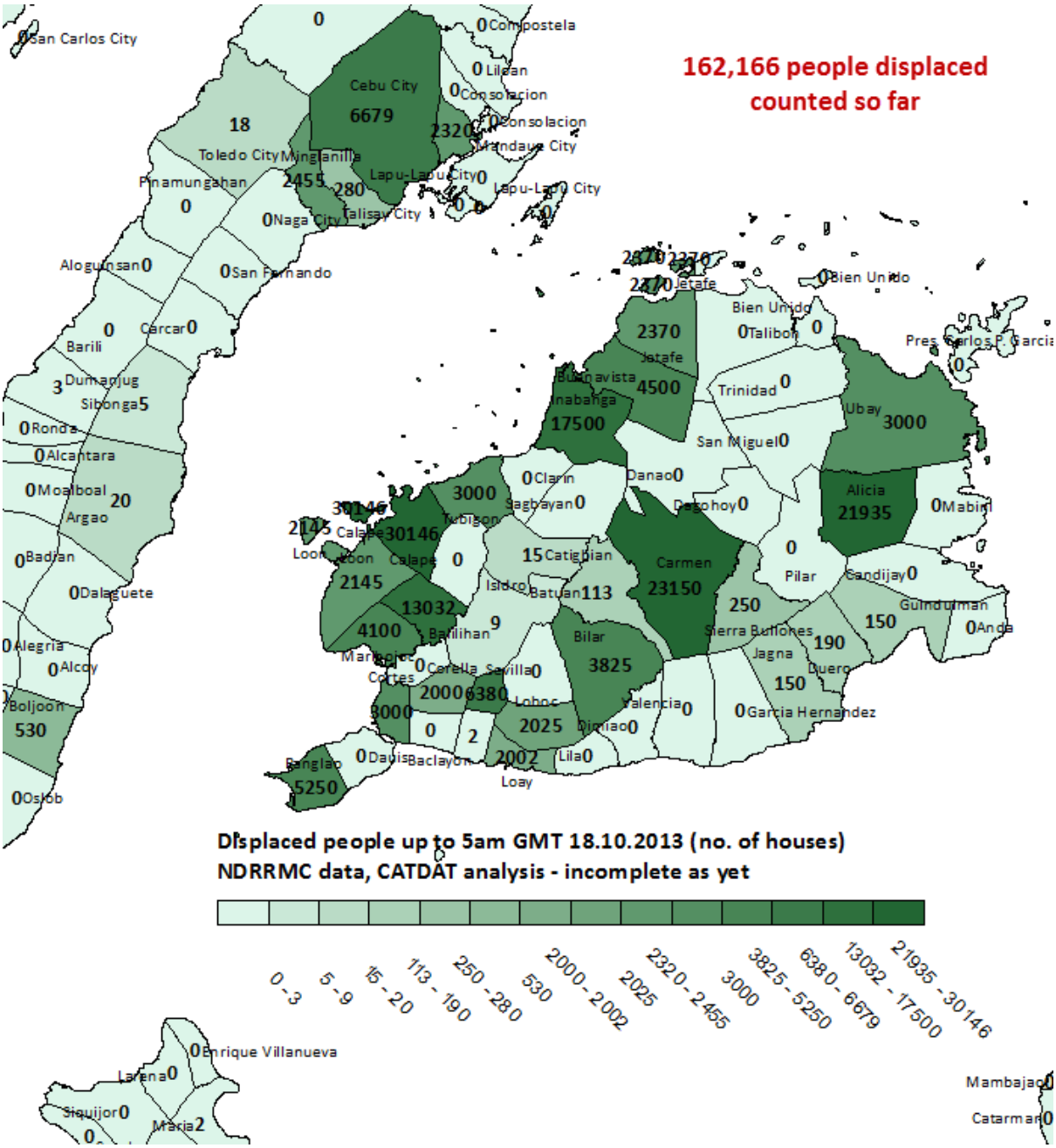
ROADS	10
BRIDGES	35

It can be seen that most bridges on Bohol are not passable due to settlement of the bridge approaches. As stated by people on Bohol, the only method of transport in most cases is by motorcycle, as public transport has not been running.



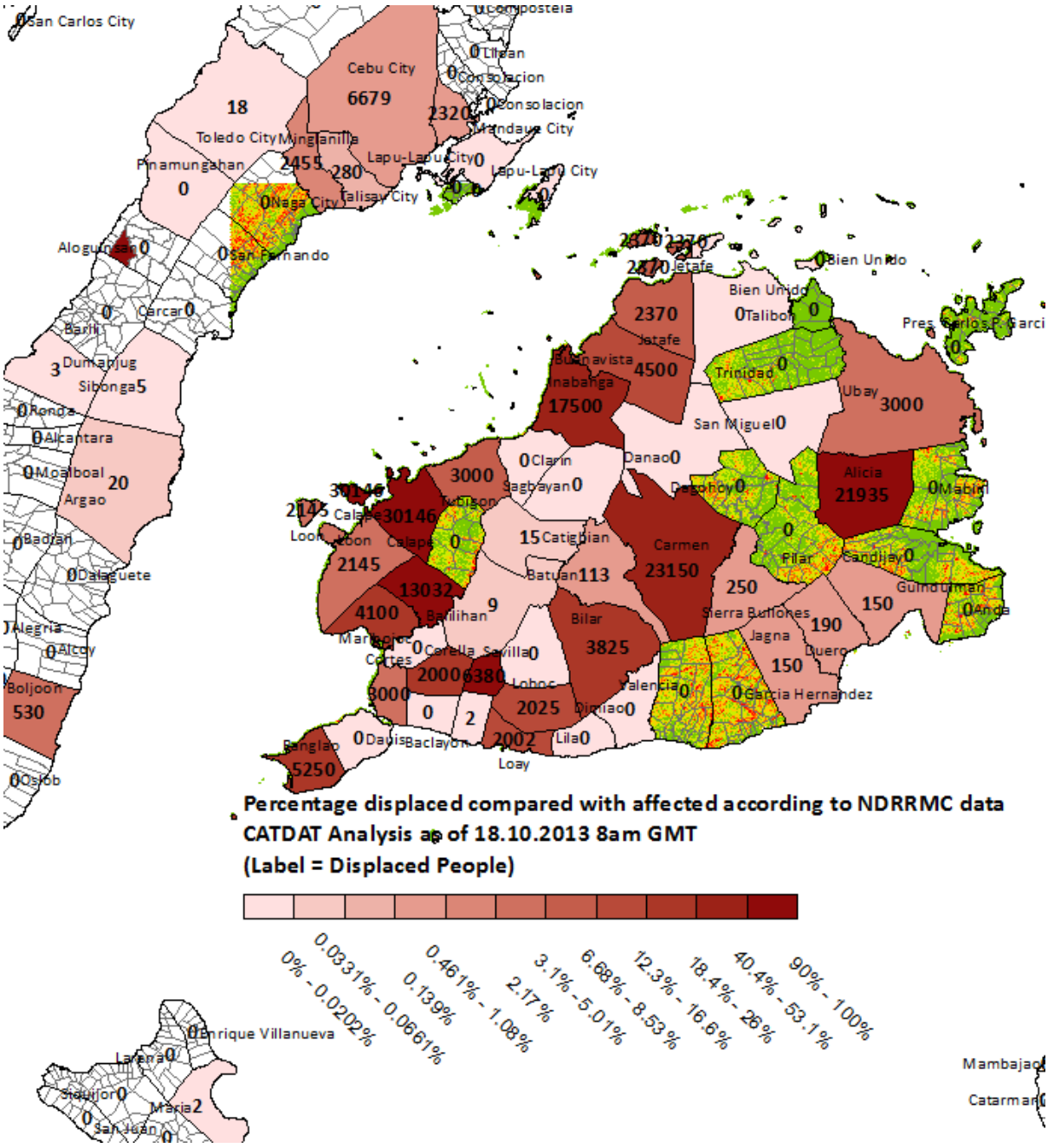
Most of the dead and missing are in Loon (59), Antequera, Tubigon, Clarin, Sagbayan and are primarily located on the western side of Bohol island.


0 San Carlos City
0 Compostela
0 Liloan
0 Consolacion
97 Cebu City
23
0 Consolacion
Mandaue City
20 Toledo City
4 Lapu-Lapu City
Pinamungahan 24
0 Minglanilla
3 Talisay City
0 Lapu-Lapu City
Cordoba
0 Naga City
Aloguinsan 0
0 San Fernando
Jetafe
Jetafe
Jetafe
0 Bien Unido
Bien Unido
2 Jetafe
3 Talibon
0
Pres. Carlos P. Garcia
0
Barili 0
Carcar 0
0 Dumanjug
Sibonga 0
Buenavista 0
Trinidad 5
2 Ronda
25 Inabanga
San Miguel 0
Ubay 0
0 Alcantara
Danao
0
1 Clarin
Tubigon 58
Sagbayan 15
Alicia
0 Mabini
0
Argao 4
Calape 0
2 Loon
Dagohoy 0
0 Calape
Carmen
0 Badian
San Isidro 0
0 Catigbian
5
Pilar
Candijay 0
0 Dalaguete
Loon 2
Antequera
Batuan 0
4 Sierra Bullones
Guindulman
15
Maribojoc 0
Bailihan 0
0
0 Anda
Duero
0 Alcoy
Cortes 0
Corella
Sevilla 5
Bilar
0
Jagna
0
0
2 Sikatuna
Valencia 0
Tagbilaran City 46
0 Garcia Hernandez
0 Boljoon
0
0
Loboc 0
Dimiao 0
0 Dauis
Baclayon
0 Loay
Lila 0
Panglao 0
0 Anlob
Registered Injuries (374 injuries currently - it is expected that the numbers in Loon will change) in the Philippines Earthquake 2013 (NDRRMC Data, CATDAT Analysis)
INJURIES
0
1
2
3-4
5
15
20
23-24
25
46-58
97
0 Enrique Villanueva
Larena 0
Siquijor 0
Maria 3
San Juan 0
Mambajao 0
Catarman 0



Emergency Situation according to NDRRMC site report 7 (18. Oct 2013 – 06:00) for displaced families and persons who are in or outside evacuation centers.

Province	No. of evacuation centers	Displaced families/persons	Families/persons inside centers	Families/persons outside centers
Cebu	25	2387/12325	1009/5439	1378/6886
Bohol	60	31132/150235	19025/92179	12107/58060
Total	85	33520/162566	20034/97618	13486/64948



It is still thought that many affected in Loon, have gone to shelters in Calape or Balilihan. In addition, many have gone to Alicia and Ubay. We must wait for more information as the data is likely incomplete.

Using the current data:- About 60% of the displaced persons are accommodated in evacuation centers; 40% are not. Supply with food and health services focuses on the evacuation centers. In some of the municipalities most people have no evacuation centers available are in special need of support. In some municipalities the situation seems to be much worse than in the average:

Municipality	Intensity experienced in main shock	Total Pop. (2012)	Number of displaced persons	Number of persons in evacuation centers
Alicia	ca. 6	24834	21935	1375
Calope	> 8	31308	30146	5750
Loon	> 8	41561	2145	2145
Maribojoc	> 8	19762	4100	4100
Sikatuna	ca. 7.5	6172	6380	6380

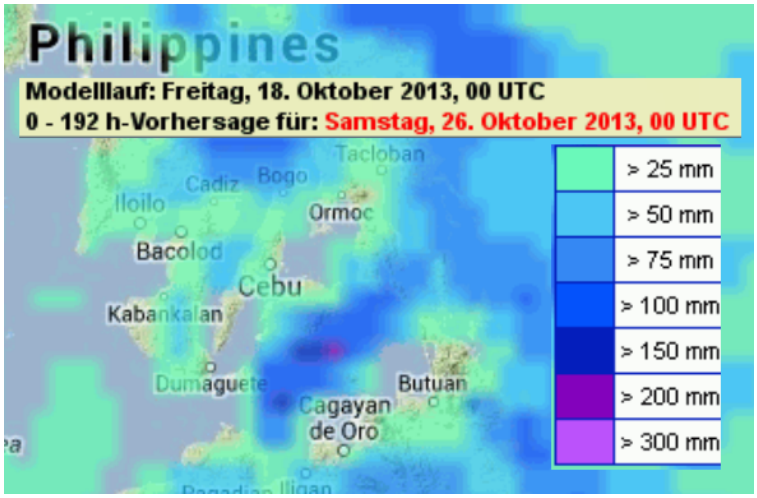
Weather Impacts

It is not yet clear which requirement for shelters will emerge from this situation. There are no obvious natural aggravating factors to seek shelter. The weather conditions are fair (day temperatures of about 30 centigrade, night temperatures of 24 degrees; little rain announced); the aftershock activity is (currently) moderate. As most affected areas are rural people likely have social mechanisms to avoid shelters. The total number of shelter seeking persons should be clearly below 100000.

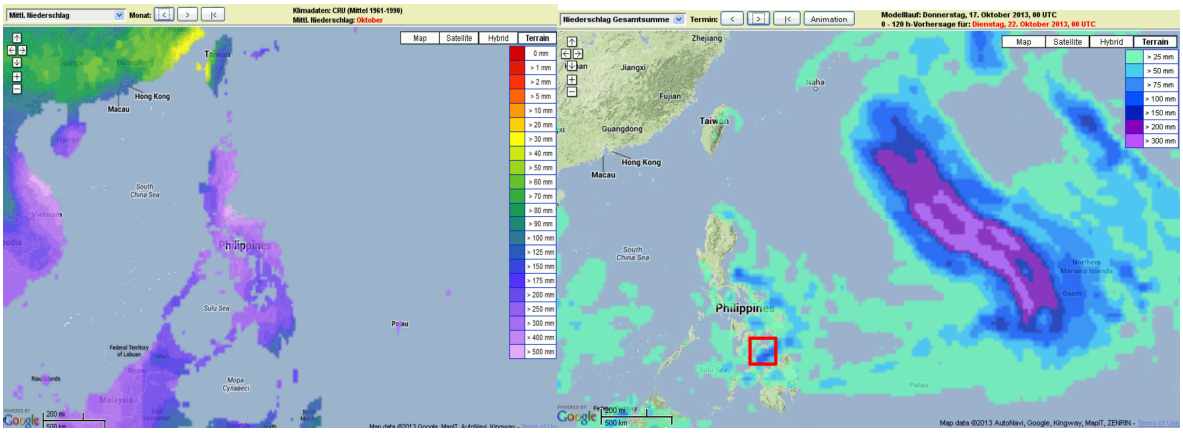
The attached GFS rain forecast for the next 120 hours is shown below.
No organized tropical systems will affect the Cebu/Bohol area within next 5-7 days. Most rain expected over the Mindanao-Sea and the southern half of Bohol, especially in mountainous areas.
All other areas have to take into account some thunderstorms, only isolated, however may be heavy for a short while.

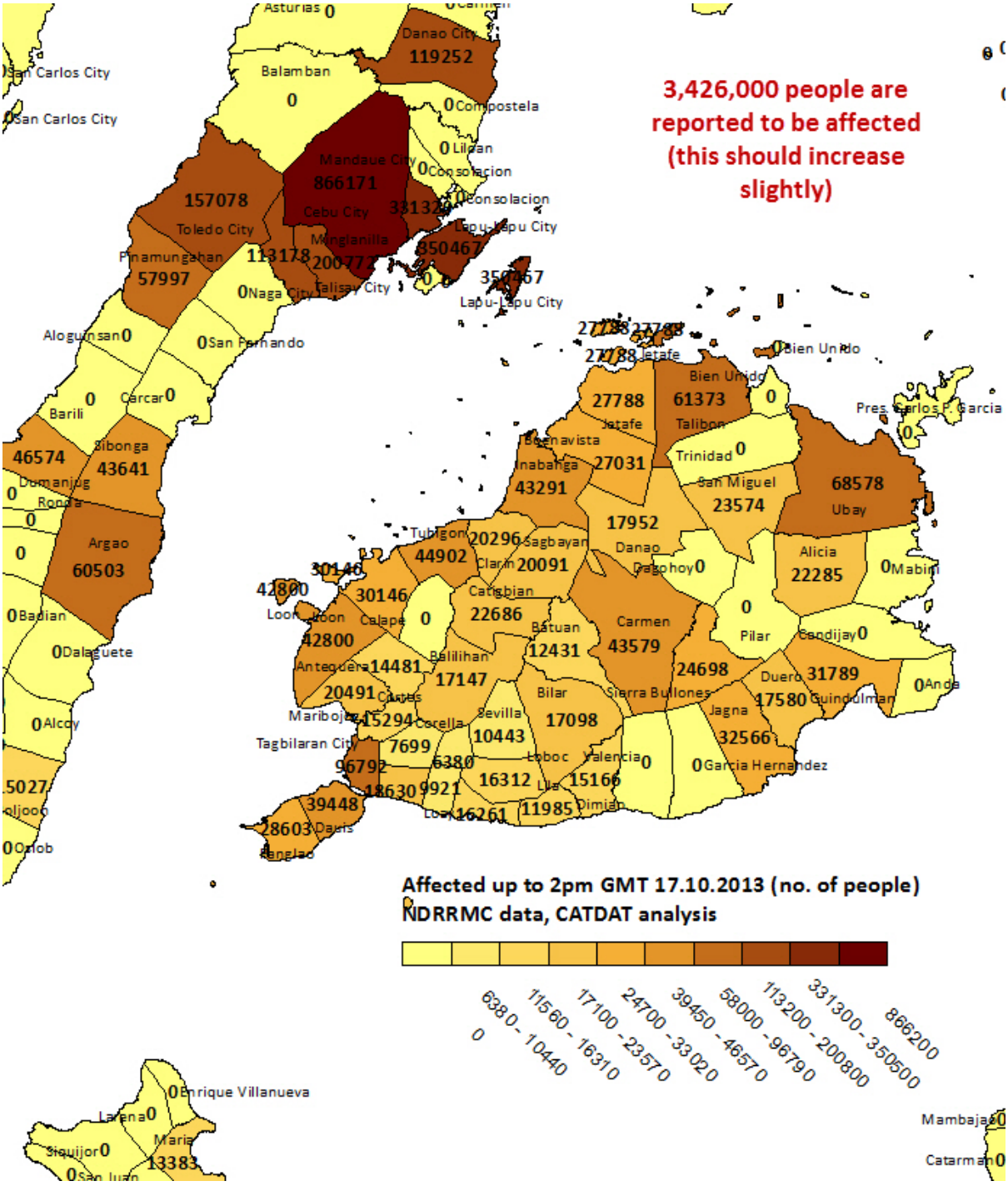
October is still monsoon (and typhoon) season. A tropical cyclone must taken into account within next weeks. 3 and 6 hourly rain forecast (updated every 6 hours) can be found here: http://www.wettergefahren-fruehwarnung.de/GM/precip_01.html

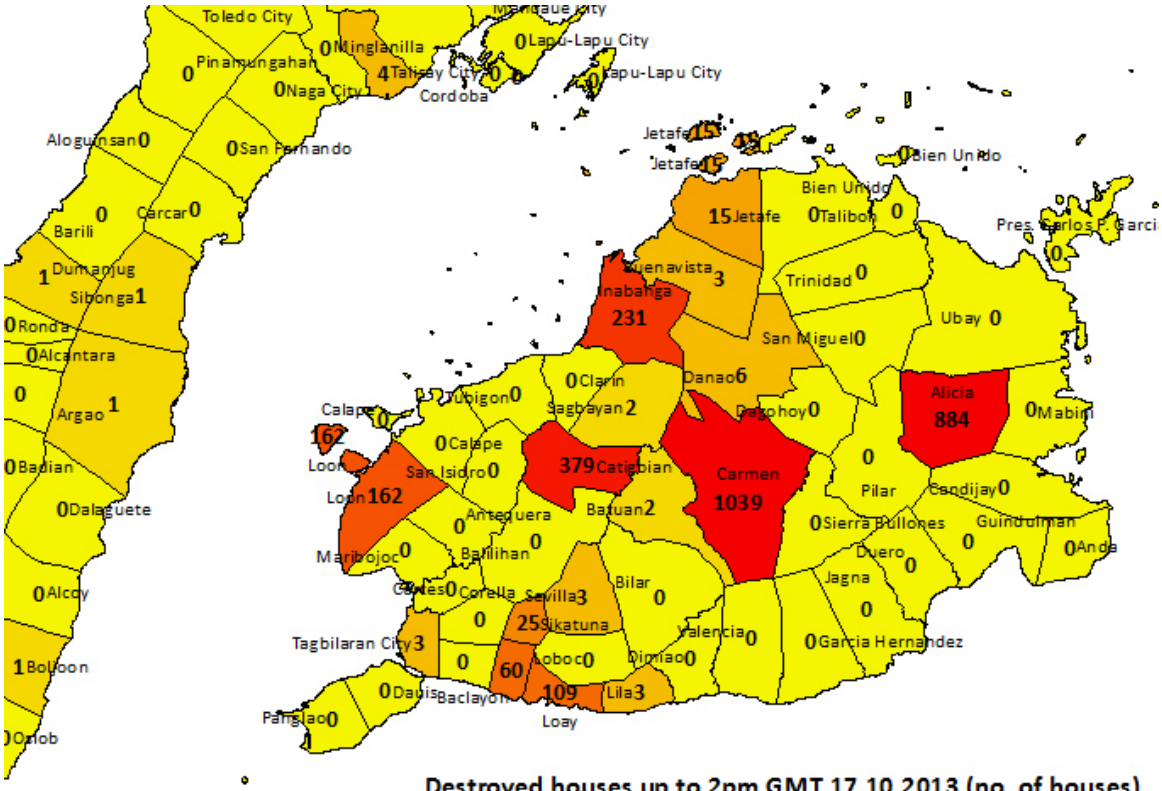
The vast rain area to the east is related to the track of "Francisco" another typhoon heading for Japan, but not affecting Philippines.



It can be seen that around 100-200mm of rain may fall in the next 5 days in Bohol, increasing the chances of major landslides, if large aftershocks occur. 200mm-300mm is the average for October on Bohol using data from 1961-1990.



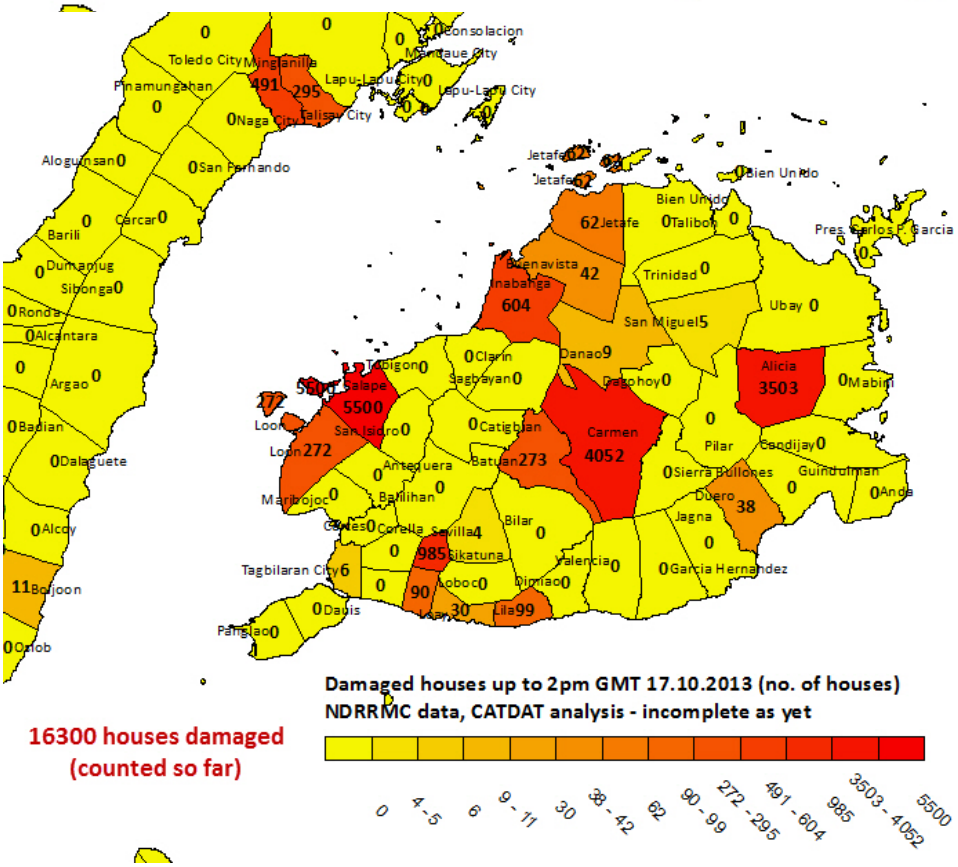

3,426,000 people are reported to be affected (this should increase slightly)
Affected up to 2pm GMT 17.10.2013 (no. of people)
NDRRMC data, CATDAT analysis
0
6380 - 10440
11560 - 16310
17100 - 23570
24700 - 33020
39450 - 46570
58000 - 96790
113200 - 200800
331300 - 350500
866200
Asturias 0
Danao City 119252
San Carlos City
Balamban 0
0 Compostela
San Carlos City
0 Liloan
Mandaue City 866171
0 Consolacion
157078
Cebu City 331320
0 Consolacion
Toledo City
Lapu-Lapu City
Minglanilla 350467
Pinamungahan 113178
57997
Talisay City 200772
350467
0 Naga City
Lapu-Lapu City
Aloguinsan 0
0 San Fernando
27788 27788
27788 Jetafe
0 Bien Unido
Bien Unido 61373
0
Pres. Carlos P. Garcia
0
Barili 0
Cercar 0
27788
Jetafe
Talibon
Bcenavista
Trinidad 0
46574
Sibonga 43641
Inabanga 27031
43291
San Miguel 23574
68578
Ubay
Dumanjug
0
Ronda
0
17952
Tubigon 20296
Sagbayan
Danao
Argao 60503
0
44902
Clarin 20091
Pagohoy 0
Alicia 22285
0 Mabini
30140
42800
30146
Catigbian 22686
0
Carmen 43579
0
Badian
Look
Ubon
Calape
Batuan 12431
Pilar
Candijay 0
42800
0 Dalaguete
Antequera 14481
Balilihan 17147
24698
Duero 31789
0 Anda
20491
Cortes
Bilar
Sierra Bullones
17580 Guindulman
0 Alcoy
Maribojoc 15294
Corella
Sevilla 17098
Jagna
Tagbilaran City
7699
10443
32566
96792
6380
Loboc
Valencia
0
0 Garcia Hernandez
16312
15166
18630 9921
Lila
39448
11985
Dimiao
16261
28603 Davis
Panglao
0 Onlob
0 Enrique Villanueva
Larena 0
Siquijor 0
Maria
13383
Mambajao 0
Catarman 0



Destroyed houses up to 2pm GMT 17.10.2013 (no. of houses)
NDRRMC data, CATDAT analysis - incomplete as yet

0 | 1 - 2 | 3 - 6 | 15 | 25 | 60 - 109 | 162 | 231 | 379 | 884 - 1039

2938 houses destroyed (counted so far)

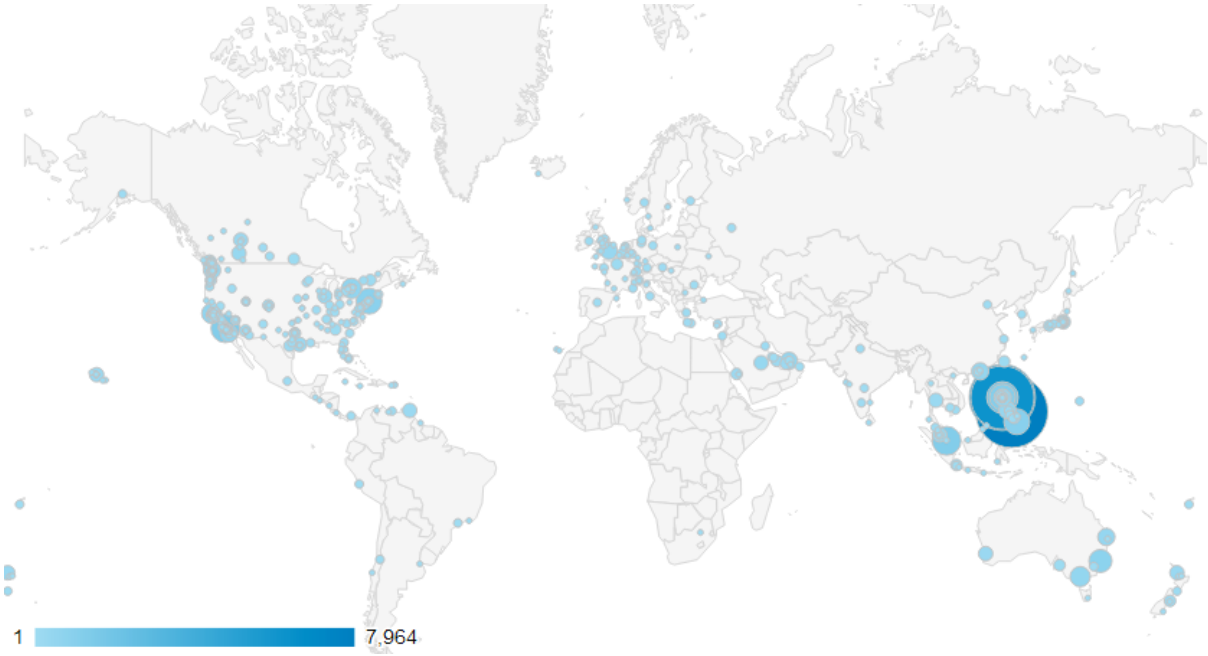


Damaged houses up to 2pm GMT 17.10.2013 (no. of houses)
NDRRMC data, CATDAT analysis - incomplete as yet

0 | 4 - 5 | 6 | 9 - 11 | 30 | 38 - 42 | 62 | 90 - 99 | 272 - 295 | 491 - 604 | 985 | 3503 - 4052 | 5500

16300 houses damaged (counted so far)

Over 40% of people logging into the Earthquake Report website in the first 10 mins were from Cebu City, 12% of people logging into the website in the first 6 hours were from Cebu City, and around 30% from Philippines. The following diagram shows visitors in the first 6 hours from each city. The darker circle in Cebu City, and the other blue circle is Manila. Individual peaks were seen with each major aftershock and the initial alert after 1 minute was from IP address increases.



The social sensoring project of CEDIM at GFZ and KIT (Joachim Fohringer) has also been active with characterising photos from Twitter responses. Here is the link to these photos and the location of the twitter response.

http://ig1-dmz.gfz-potsdam.de/cedim/philippines/images.html

Photos by Julie Jaramillo (All rights reserved)


islands
souvenirs

A Chocolate Hill landslide - Deep-seated rock slump