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

Philippines (Bohol) Earthquake – Report #4

19.10.2013 – Situation Report No. 4 – 6.00am GMT

Report Contributors: James Daniell (Earthquake Report & KIT); Armand Vervaeck, Carlos Robles, Jens Skapski (Earthquake Report); Bijan Khazai, Friedemann Wenzel, Bernhard Mühr, Chris Power (KIT); Pieter Nierop and Julie Jaramillo (Bohol, Philippines); Joachim Fohringer, Silke Eggert (GFZ)

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:

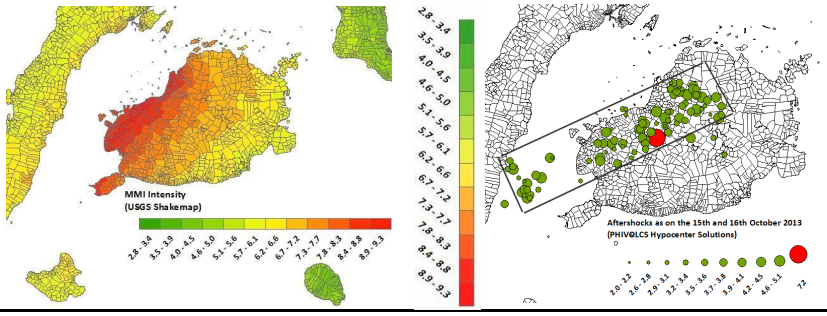
Country	ISO	Province	Most Impact	Building PF	HDI (2012)	Urbanity	Population
Philippines	**PH**	**Bohol**	**West Coast**	**Average**	**0.729**	**25%**	**1.3 million**
Philippines	**PH**	**Cebu**	**City**	**Good**	**0.761**	**66%**	**4 million**

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

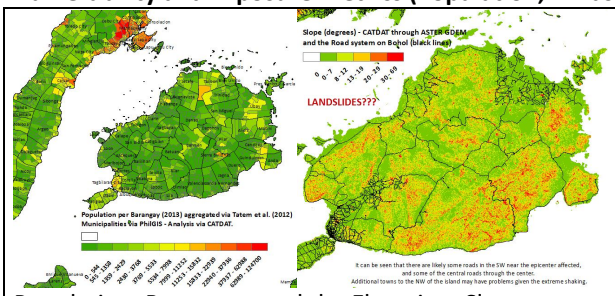
Hazard Description (Intensities and Ground Motion)

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 34500 so far) The counting of buildings destroyed has not been undertaken with only a few houses included in the current count of **8688 destroyed and 25910 damaged.** Based on families displaced, this value could be up to at least 15000 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	**192 (incl. 17 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 175 as 17 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	372595	372595+	**372595 currently displaced – see below**	NDRRMC
Affected	**3492496**	3m-7m (4.5m)	Cebu, West Bohol, Negros	NDRRMC

*predicted

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.

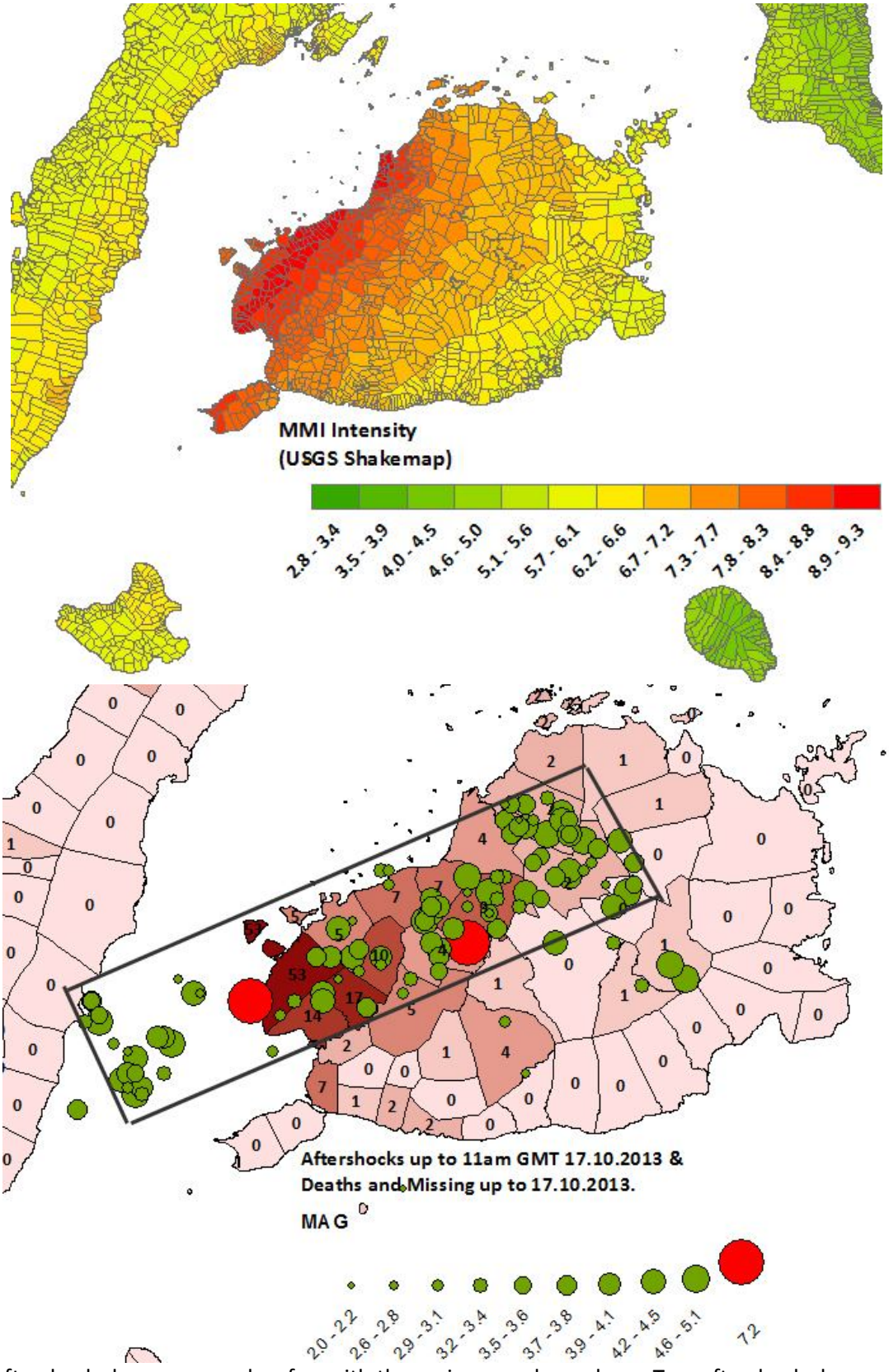
Abridged Summary Description from full CATDAT description sources:

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 19th October 6:00am 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.



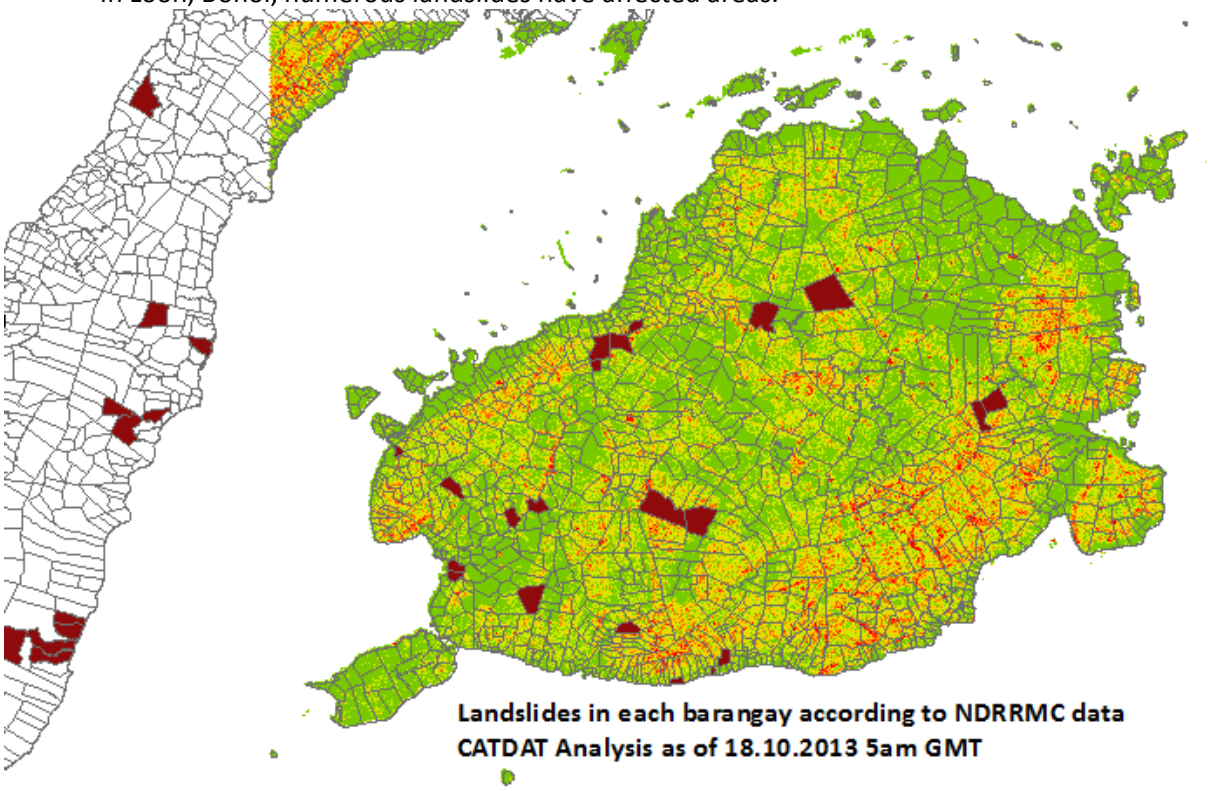
941 aftershocks have occurred so far, with the main ones shown here. Two aftershocks have caused minor additional damage (Earthquake Report). 29 main felt aftershocks have occurred. However, there is still potential for larger aftershocks up to M=6 which could cause additional damage. The intensity map 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.

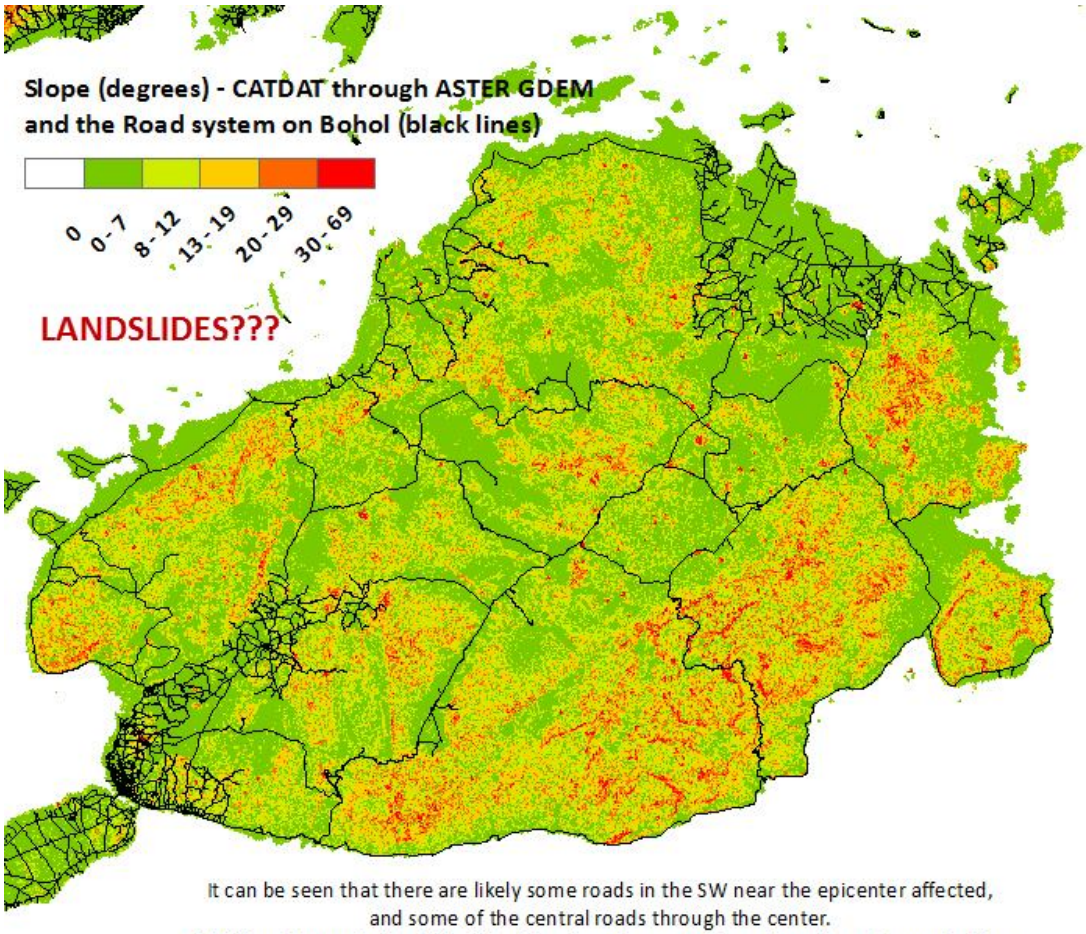
Shallow disaggregated landslides account form most the failure types after earthquakes. However, some of the landslides shown on the Chocolate Hills (when looked at more closely are more deep-seated rock and earth slumps that involve relatively large volumes of material (see Figure at the end of the 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.



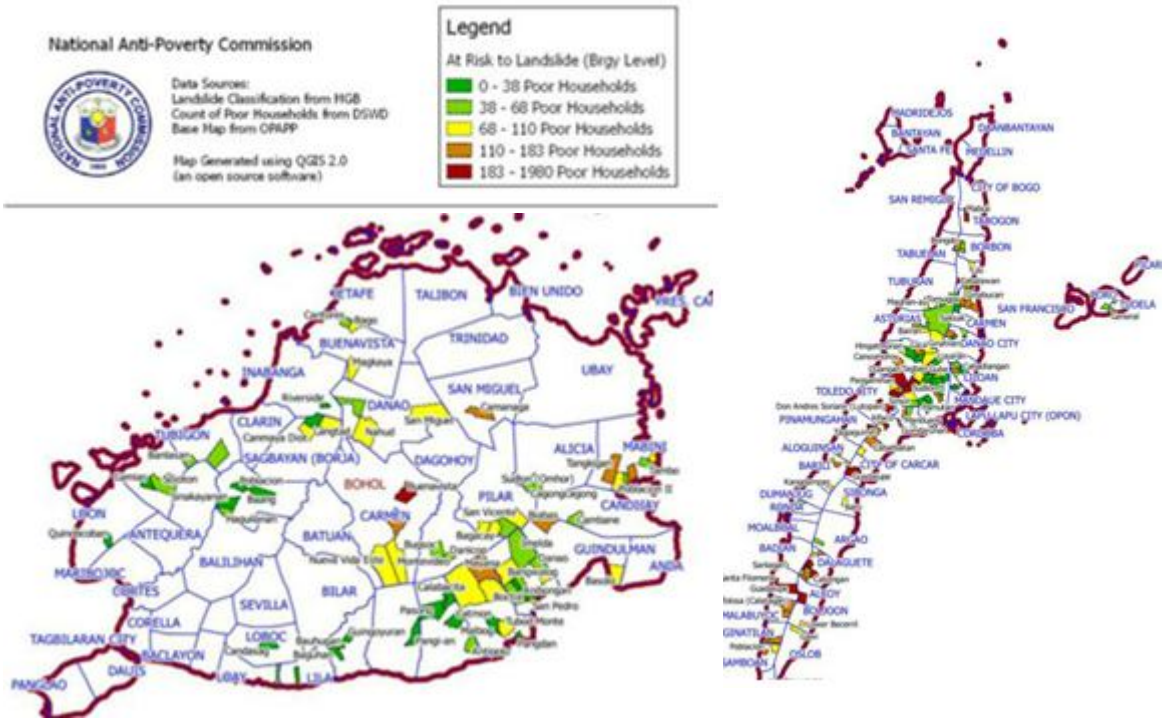
Landslides in each barangay according to NDRRMC data
CATDAT Analysis as of 18.10.2013 5am GMT

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



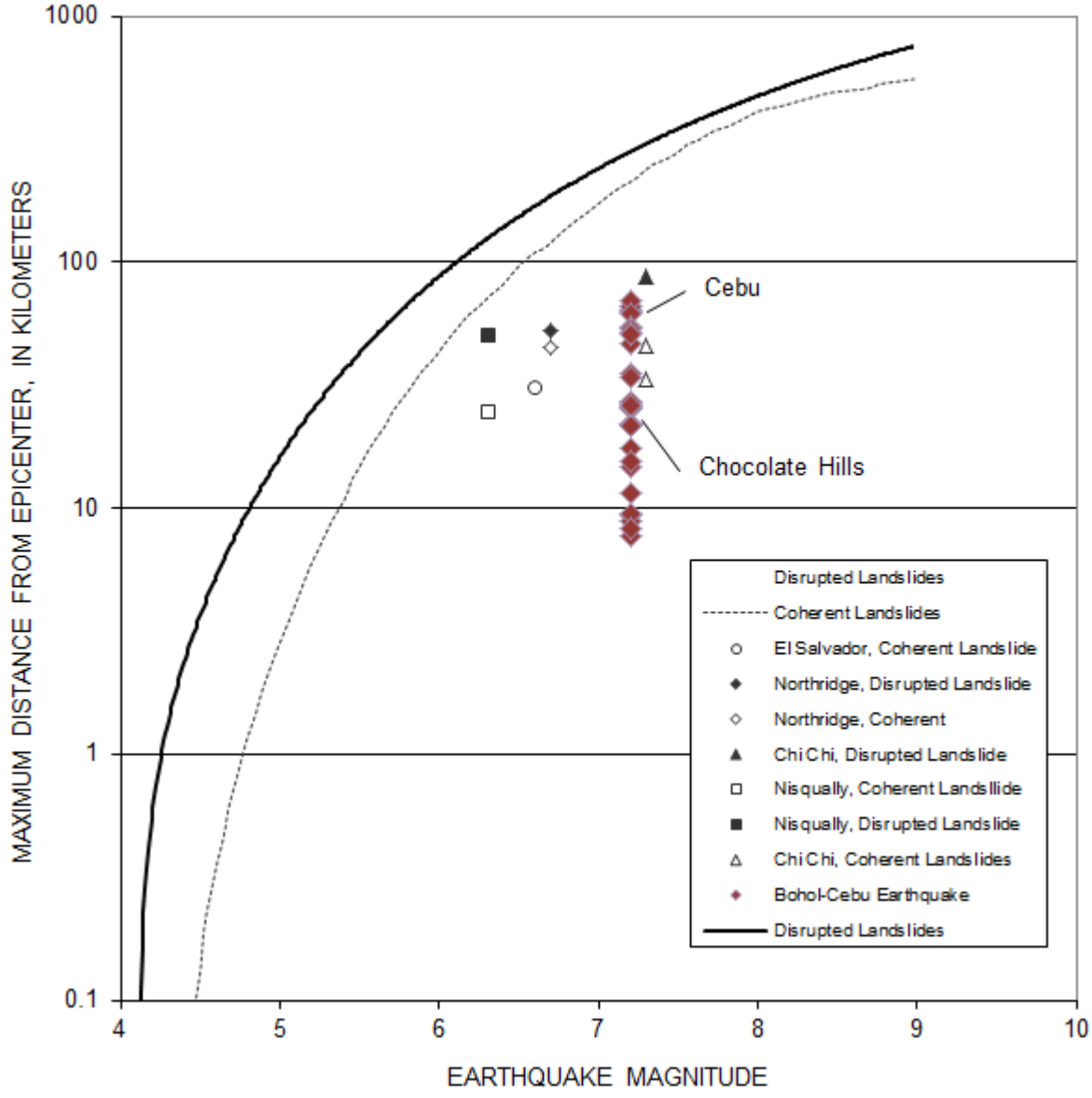
It can be seen that there are likely some roads in the SW near the epicenter affected,
and some of the central roads through the center.
Additional towns to the NW of the island may have problems given the extreme shaking.

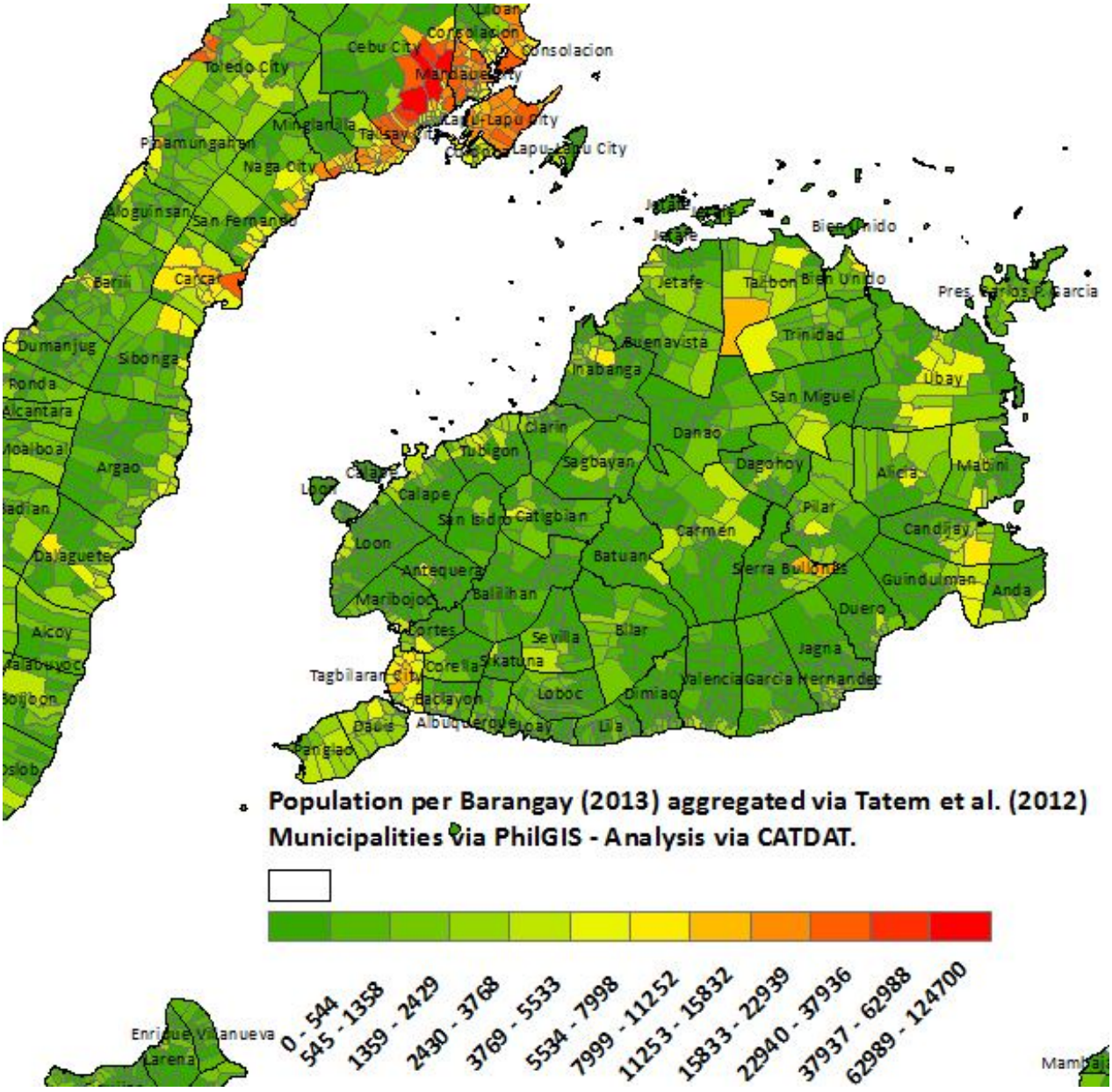
To aid in the rescue and relief as well as resettlement operations, the National Anti-Poverty Commission (NAPC) on Wednesday released the maps of Cebu, Negros Oriental, and Siquijor indicating location of poor households in barangays that are exposed to high risks of landslides.



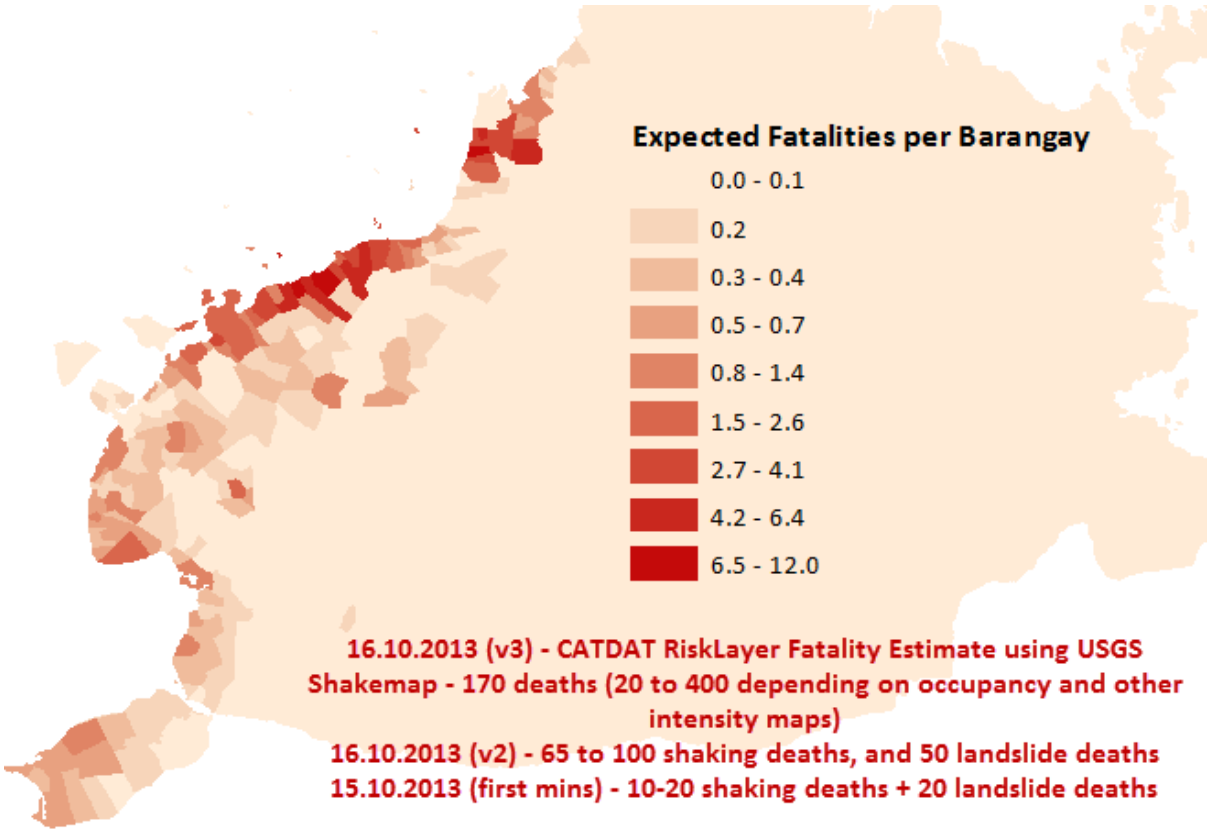
The landslide distances are within the bounds seen in historical earthquakes as tested by Bijan Khazai for ChiChi, Northridge, Seattle (Nisqually) and El Salvador earthquakes, and James Daniell for Cebu-Bohol (after Keefer, 1999; Khazai, 2004).

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

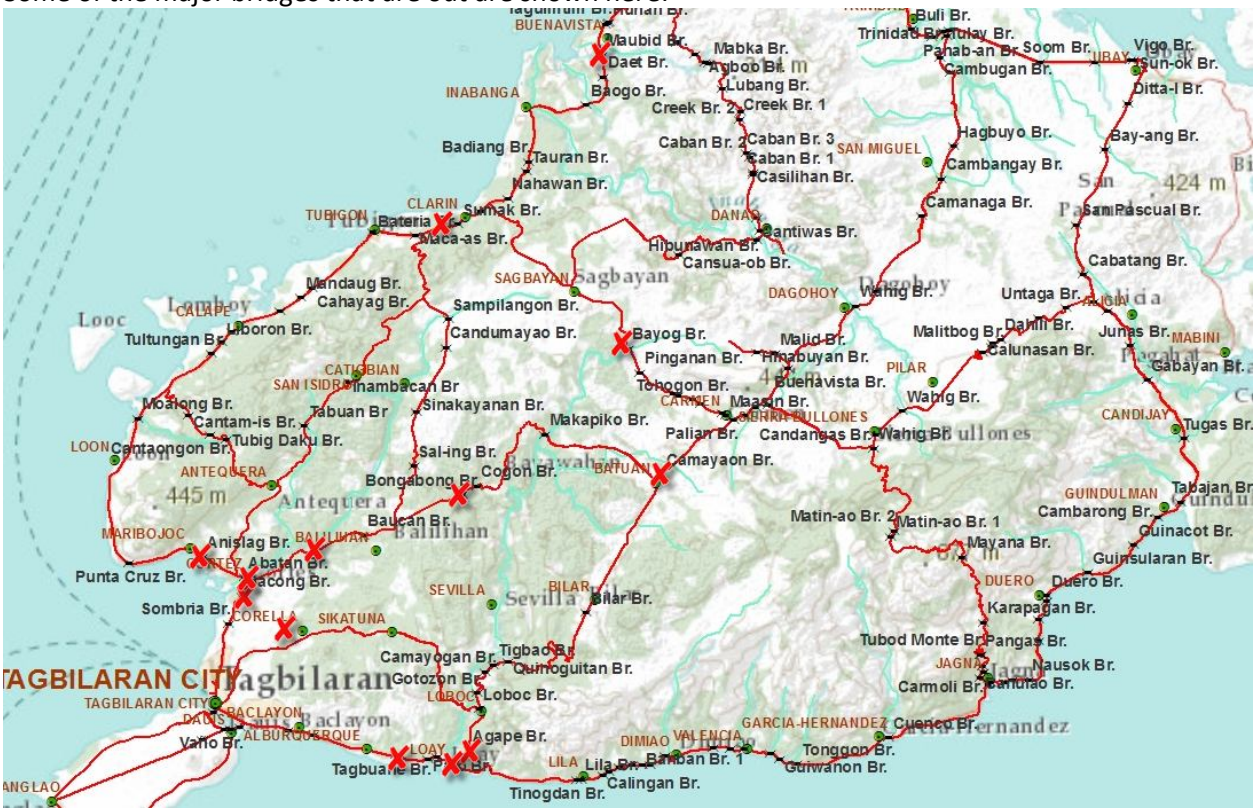
NDRRMC Update on Infrastructure damaged (www.ndrrmc.gov.ph) – Situation Report 9

DAMAGED ROADS AND BRIDGES
19 October 2013, 6:00 AM

REGION	Province/Municipality	DAMAGED ROADS AND BRIDGES	
		NATURE OF DAMAGE	STATUS
VII	**BOHOL**		
	BRIDGES		*30*
	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
	Liboron Bridge	Intermittent shattered pavements	Not passable
	Maubid Bridge	Depression on bridge approach and cracking, loosened slope protection material	Not passable
	Mactan Bridge - Expansion Joint	Damaged	Passable
	Salog Bridge	Damaged bridge approach	Passable
	Suarez Bridge	Damaged bridge approach	Passable
	ROADS		*13*
	Jagna-Sierra Bullones Road	Road settlement	Hardly Passable
	National Highway at Laya Section	Damaged, remedial works on going	Not passable
	Cortes-Balilihan-Macaas Road	Massive landslide	Not Passable
	Tagbilaran-East Road	Settlement	Not Passable
	Tagbilaran-North Road	Road slip and settlement of pavement	Not Passable
	Loay Interior Road	Damaged	Not Passable
	Maribojoc-Antequera, Catagbacan Road	Lanslide	Not Passable
	Antequera-San Isidro, Libertad Road	Lanslide	Not Passable
	Danao-Getafe Road, TNR	Cracked roadway	Not Passable
	Carmen-Sagbayan-Bacani Road	Cracked roadway	Not Passable
	Sagbayan-Danao Road	Cracked roadway	Not Passable
	Tagilaran East Road	Cracked concrete pavement	Not Passable
	Valencia-Loay, Tagilaran East Road	Cracked concrete pavement	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		*5*
	Carcar Bypass Road	Collapsed road side protection (both sides) including bridge approach	Not Passable
	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

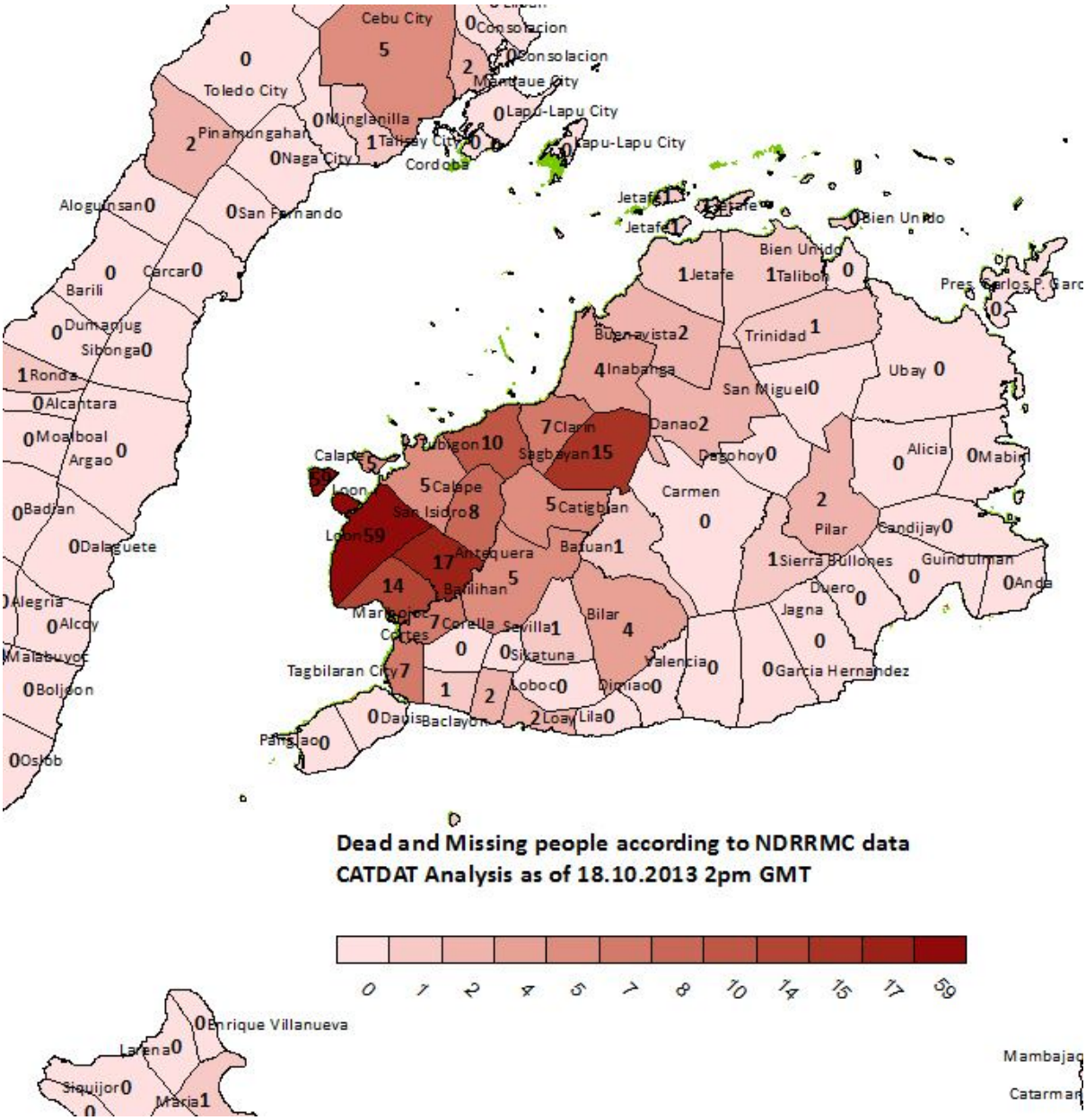
It can be seen that most bridges on Bohol are not passable due to settlement of the bridge approaches. As stated by people on Bohol, the only method of transport in most cases is by motorcycle, as public transport has not been running.

Some of the major bridges that are out are shown here:-

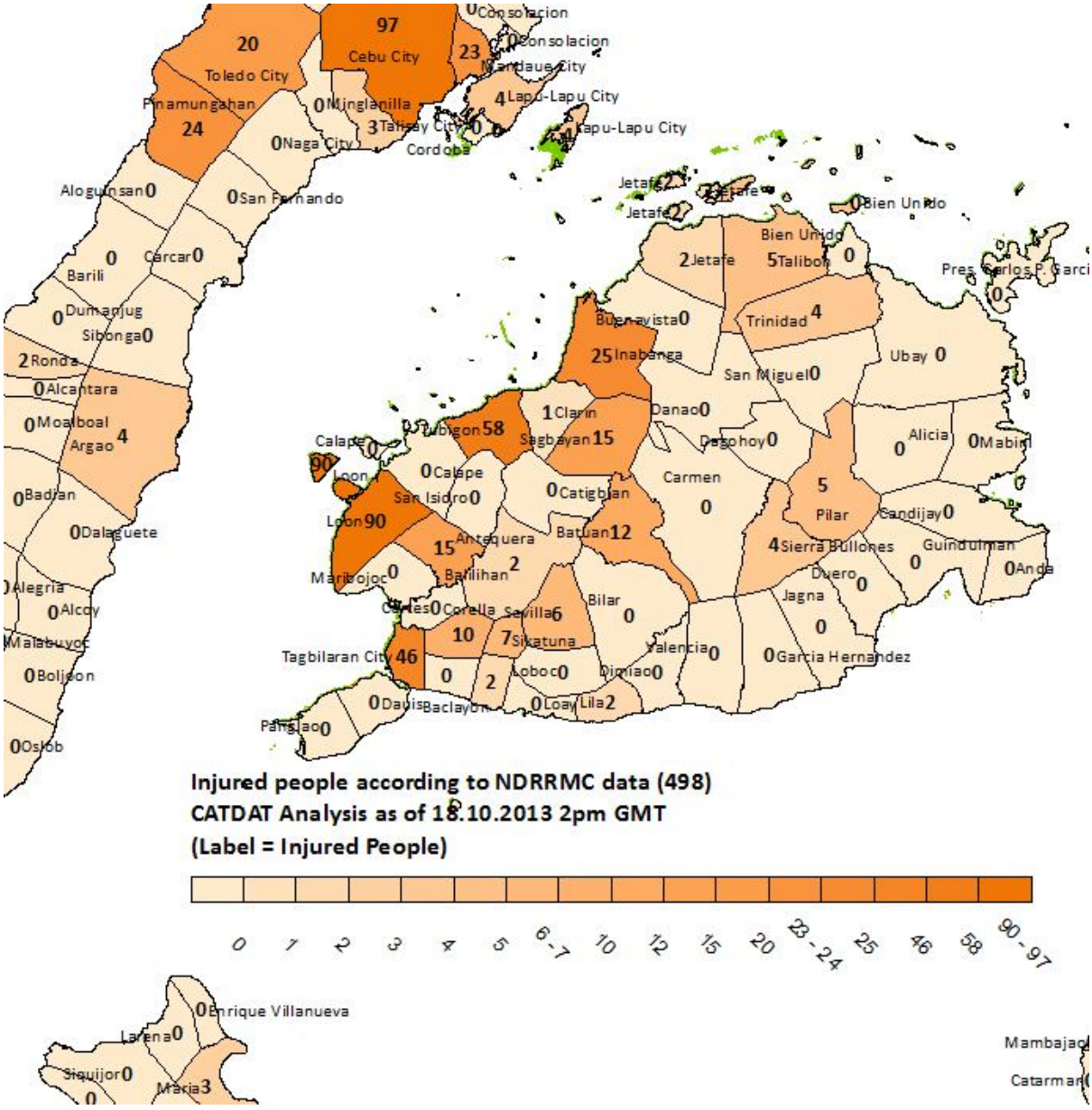


For a current update, users should go to the transportation department for an in-depth analysis. (http://www.dpwh.gov.ph/) where the last update on the website was the following:

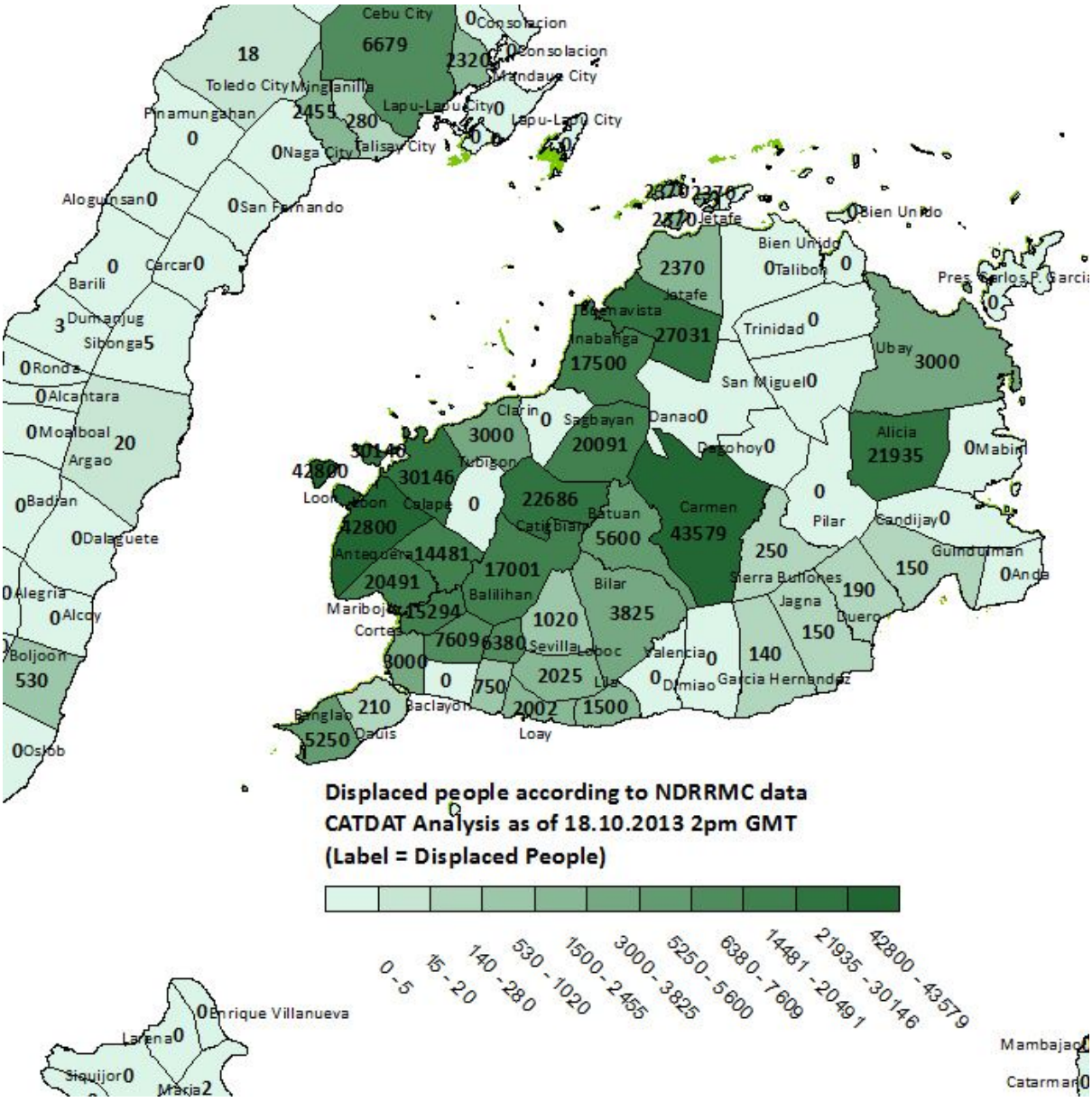
„Eleven national bridges in Bohol damaged by the October 15, 2013 earthquake are now passable. In his report to Department of Public Works and Highways (DPWH) Secretary Rogelio L. Singson, DPWH Region 7 Director Ador Canlas reported that restoration works on damaged bridge approach due to settlements were completed. The following bridges are now passable: Camayaan Bridge, K0015+744 (Cortes, Bohol); Tultogan Bridge, K0038+837 (Calapi, Bohol); Bacong Bridge, K008+613; Anislag Bridge, K0013+666; and Daet Bridge, K0078+784 – all located along Tagbilaran North Road. Five (5) bridges along Tagbilaran East Road which earlier assessed to have cracks and settlement on bridge approaches are now open to light vehicle namely, Bonkokan Bridge, K0228+035; Banban Bridge, K0227+263; Balbalan Bridge, K0225+300; Agape Bridge, K0019+050; and Panangatan Bridge, K0219+024. The Camayaan Bridge along Loboc LIR Road in Loon, Bohol is also now passable. Still closed as of reporting are the following bridges along Tagbilaran North Road: Abatan Bridge, K0010+187; Moalong Bridge, K0031+428, Loon, Bohol; Disamparados Bridge; Liboron Bridge; Hunan Bridge; Taguimtim Bridge, K0083+110; Masiped Bridge; and Damiao Bridge, K0082+811 Damaged unpassable bridges along Tagbilaran East Road includes Tagbauane Bridge, K0246+655, Albur, Bohol; Palo Bridge, K00244+286; Hinawanan Bridge, K0243+624; and Clarin Bridge, K0242+517. Meanwhile, DPWH has opened to at least one (1) lane the Cortes-Balilihan-Catigbian Road Macaas Road and Tagbilaran East Road Baclayon Section which were affected by massive landslide and crack/settlement of pavement, respectively. Appropriate warning signs on the affected roads/bridges to warn the motoring public were earlier installed by concerned DPWH District Engineering Offices in Bohol.“



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. There are currently **175 dead and 17 missing reported. This is the same as 19.10.2013, with 2 missing now reported dead in Clarin, Bohol.**



Since the last update, consolidation has occurred with the numbers – with only 89 people injured in Cebu compared with 393 in Bohol. 3 people have been injured in Siquijor, 1 in Negros Oriental and 1 in Ilolio. Once the numbers have consolidated, a new picture will be released, with the 97 in Cebu city, redistributed to Bohol. 487 are now counted to be injured instead of 498.



Emergency Situation according to NDRRMC site report 9 (19. 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	2388/12327	1009/5439	1379/6886
Bohol	65	76620/360236	20995/103478	55625/256758
Total	90	79009/372565	22004/108917	57005/263648

The numbers are still being counted and we must wait for more information.

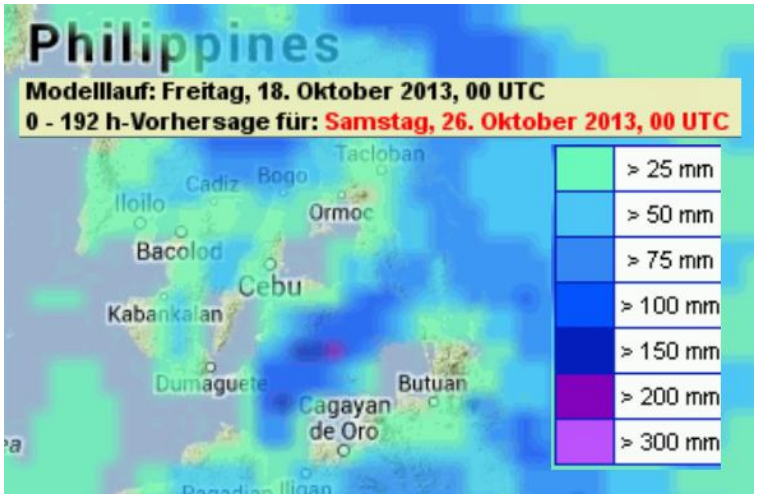
Weather Impacts

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 below 100000.

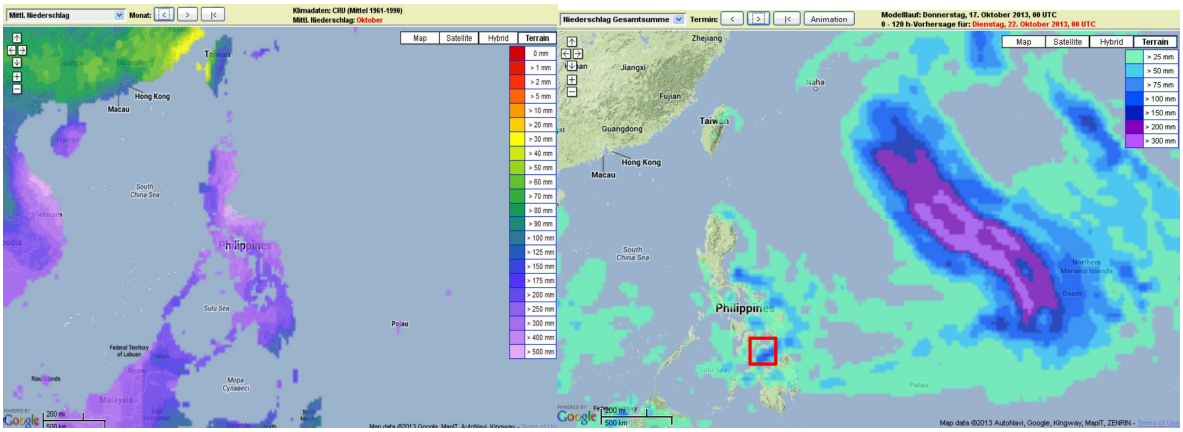
The attached GFS rain forecast for the next 120 hours is shown below.
No organized tropical systems will affect the Cebu/Bohol area within next 5-7 days. Most rain expected over the Mindanao-Sea and the southern half of Bohol, especially in mountainous areas.
All other areas have to take into account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

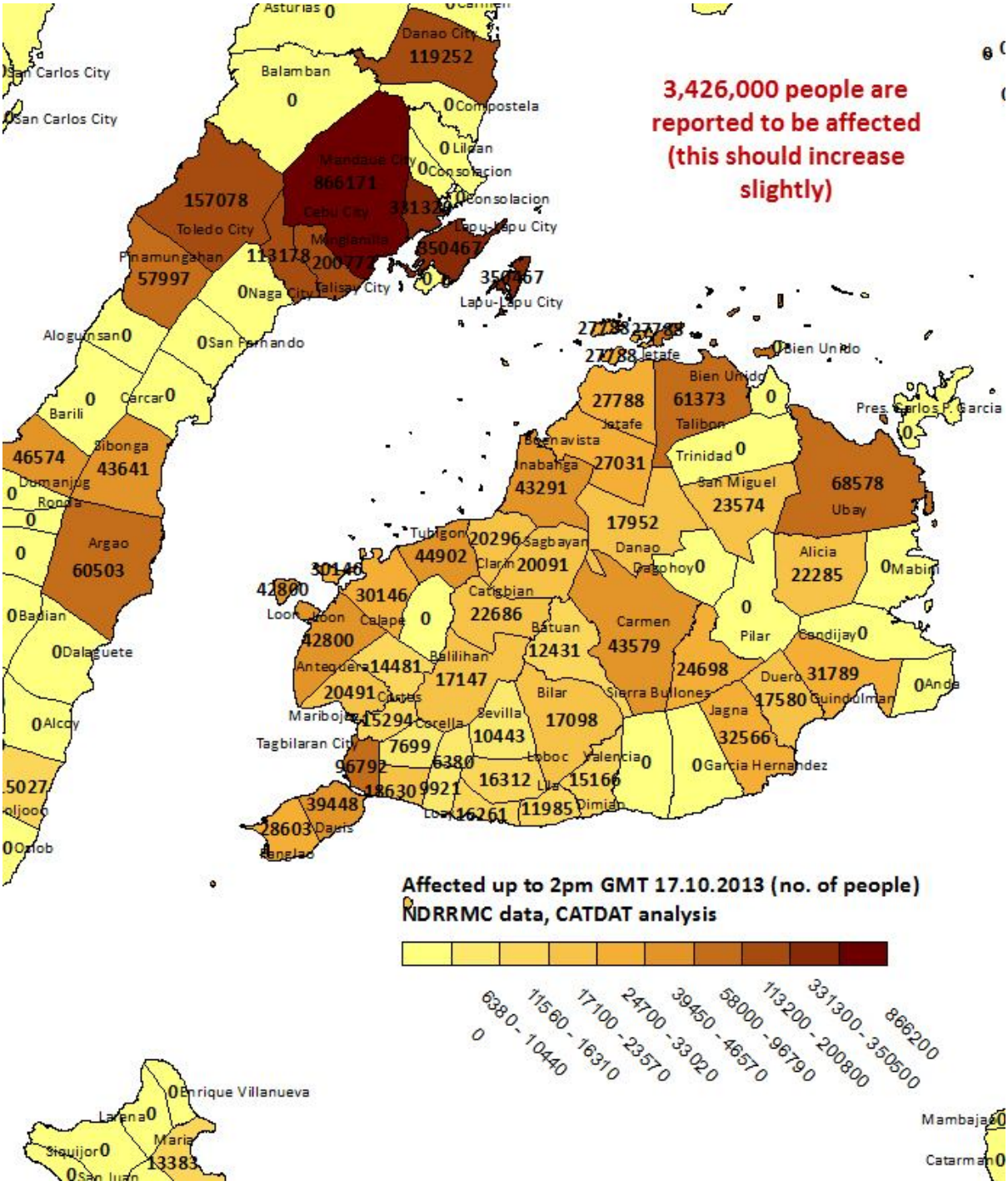
October is still monsoon (and typhoon) season. A tropical cyclone must taken into account within next weeks. 3 and 6 hourly rain forecast (updated every 6 hours) can be found here: http://www.wettergefahren-fruehwarnung.de/GM/precip_01.html

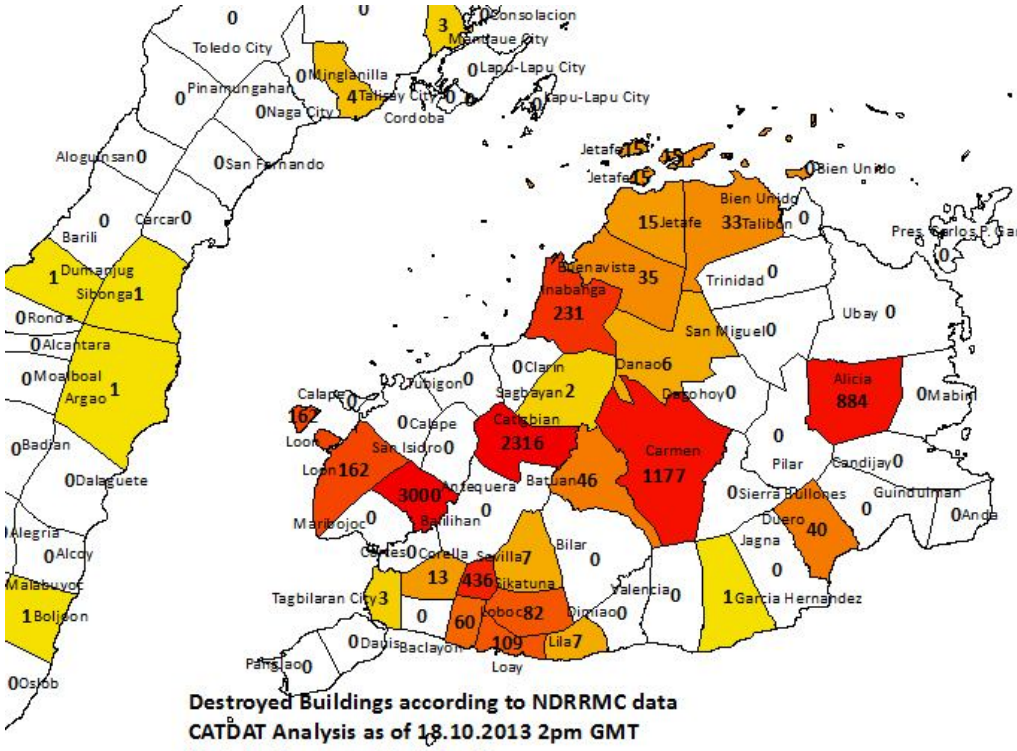
The vast rain area to the east is related to the track of "Francisco" another typhoon heading for Japan, but not affecting Philippines.

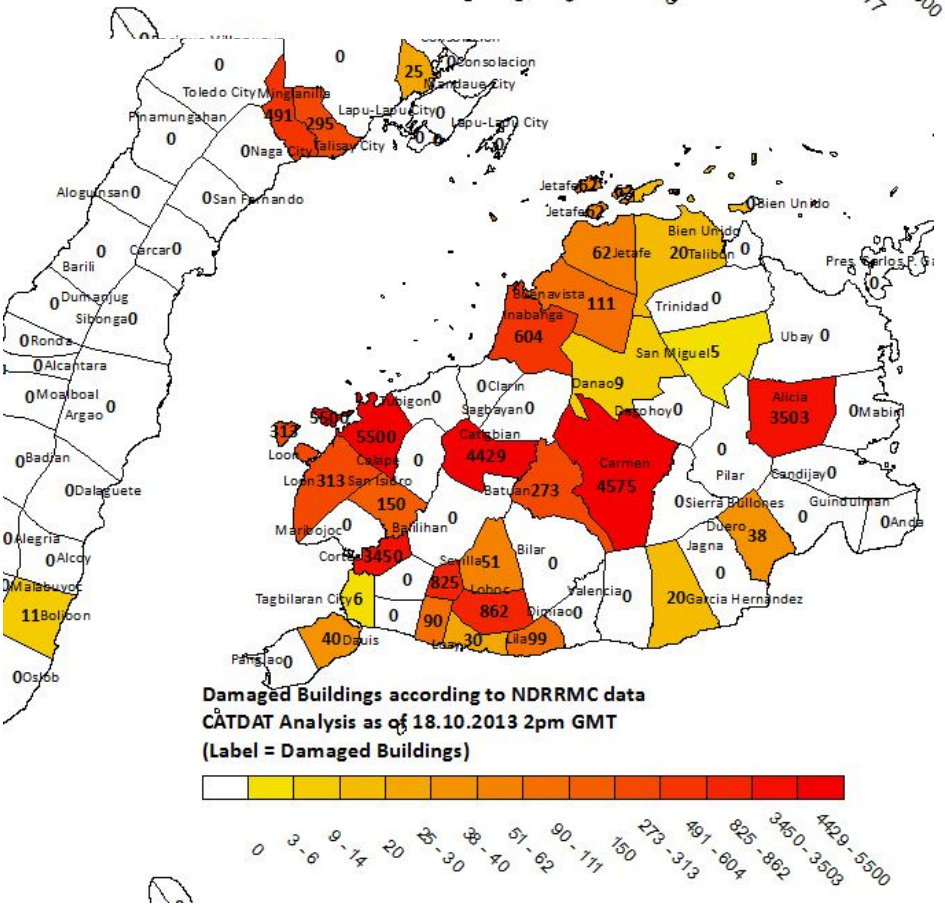


It can be seen that around 100-200mm of rain may fall in the next 5 days in Bohol, increasing the chances of major landslides, if large aftershocks occur. 200mm-300mm is the average for October on Bohol using data from 1961-1990.



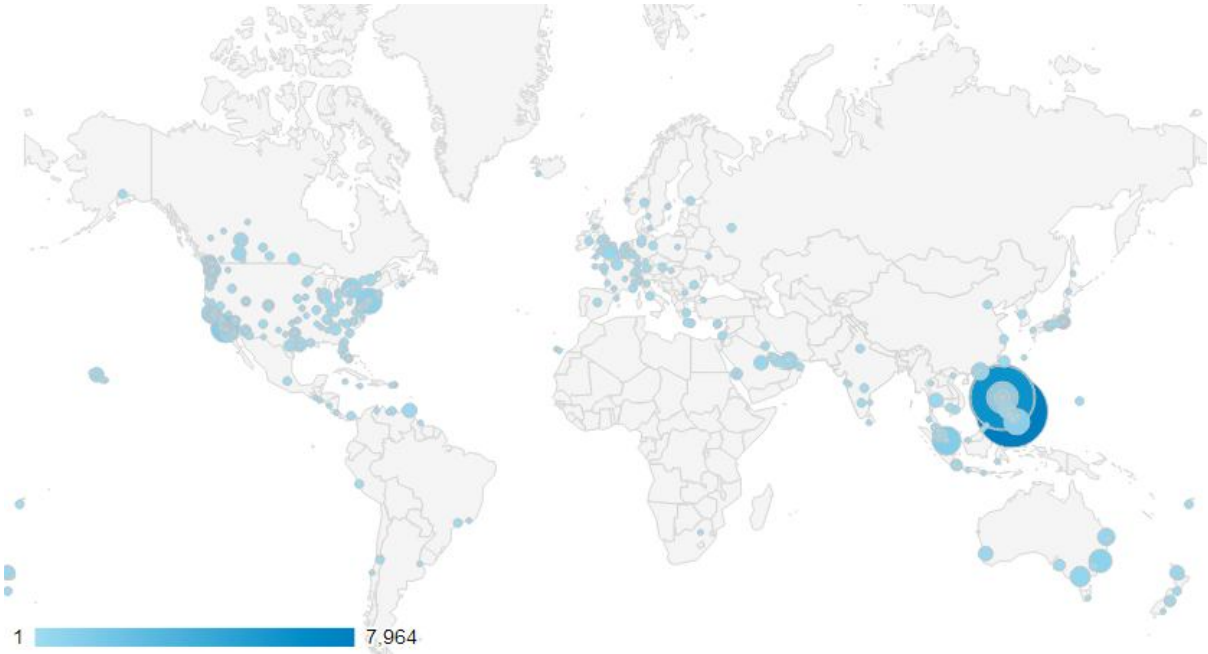

3,426,000 people are reported to be affected (this should increase slightly)
Affected up to 2pm GMT 17.10.2013 (no. of people)
NDRRMC data, CATDAT analysis
0
6380 - 10440
11560 - 16310
17100 - 23570
24700 - 33020
39450 - 46570
58000 - 96790
113200 - 200800
331300 - 350500
866200
Danao City 119252
Balamban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





8688 houses have been counted as destroyed, 25910 houses counted as damaged, as of 19.10.2013.

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.



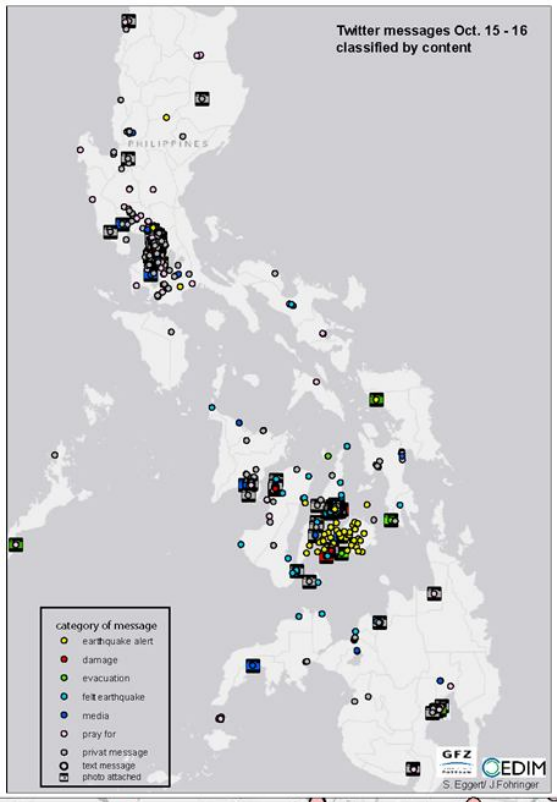
The social sensoring project of CEDIM at GFZ and KIT (Joachim Fohringer) has also been active with characterising photos from Twitter responses. Here is the link to these photos and the location of the twitter response.

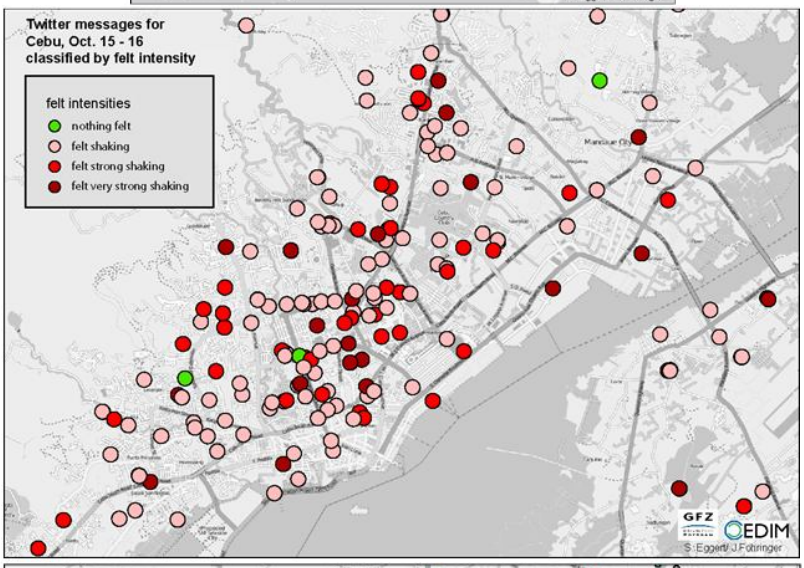
We analyze twitter messages related to the Oct. 15 Philippines earthquake to see where and what kind of information people affected by the event send. In total, ca. 2000 twitter messages sent within two days after the main shock were used for further analysis.

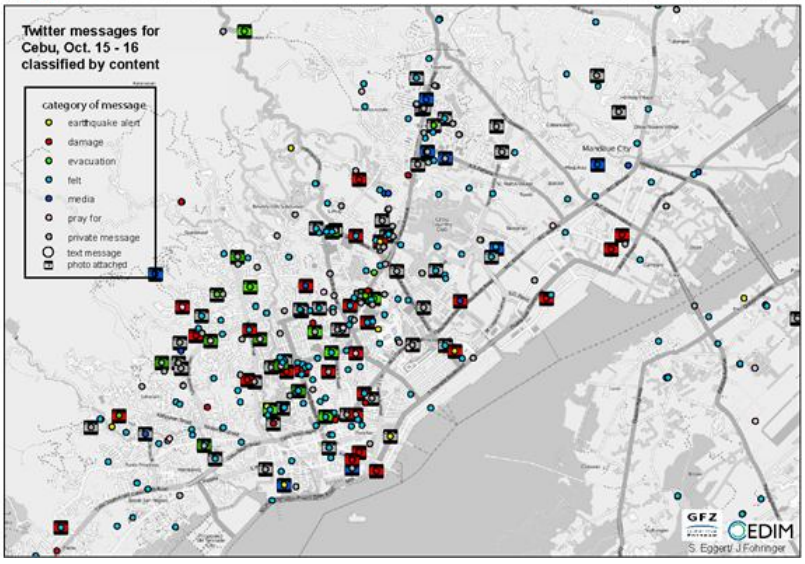
To see the spatial distribution of the messages, we created a heat map. Apart of the world wide reaction on the earthquake, the main concentration of tweets is located on Philippines Island. The hotspot Manila, the country's capital, reflects the national reaction on the event. More interesting is the hotspot Cebu, the closest and therefore most affected city to the epicenter. Therefore, further analyses are focused on that area.

In a second step, we divided the messages into pure text messages and messages with a photo attached. Pictures taken or distributed by the author can be taken as a hint to proof the content and to gain a visual impression of the in-situ situation. Figure 1 and 2 show the distribution of tweets (circle = text, camera = text + photo) national wide and as a zoom into the city of Cebu. While messages calling for spiritual support or containing personal information are distributed all over the country, messages related to damage, evacuation and felt shaking are located in the epicentral area.

Finally, we extracted all messaged related to felt shaking and categorized them roughly by three categories: felt nothing, shaking, strong shaking, and very strong shaking. In this first analysis, the categories are not based on any standard values; they are just done roughly by scanning the message content. Again, the highest intensities are felt within the epicentral area and are concentrated in the city of Cebu.


Twitter messages Oct. 15 - 16
classified by content
PHILIPPINES
category of message
earthquake alert
damage
evacuation
felt earthquake
media
pray for
privat message
text message
photo attached
GFZ
EDIM
S. Eggert/ J.Fohringer


Twitter messages for
Cebu, Oct. 15 - 16
classified by felt intensity
felt intensities
nothing felt
felt shaking
felt strong shaking
felt very strong shaking
Mandaue City
GFZ
EDIM
S. Eggert/ J.Fohringer


Twitter messages for
Cebu, Oct. 15 - 16
classified by content
category of message
earthquake alert
damage
evacuation
felt
media
pray for
private message
text message
photo attached
Mandaue City
GFZ
EDIM
S. Eggert/ J.Fohringer

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islands
souvenirs

A Chocolate Hill landslide - Deep-seated rock slump