The October 2019 Cotabato Earthquake Sequence: Parameters and impacts

Jeffrey S. Perez

DOST-PHIVOLCS Quick Response Team

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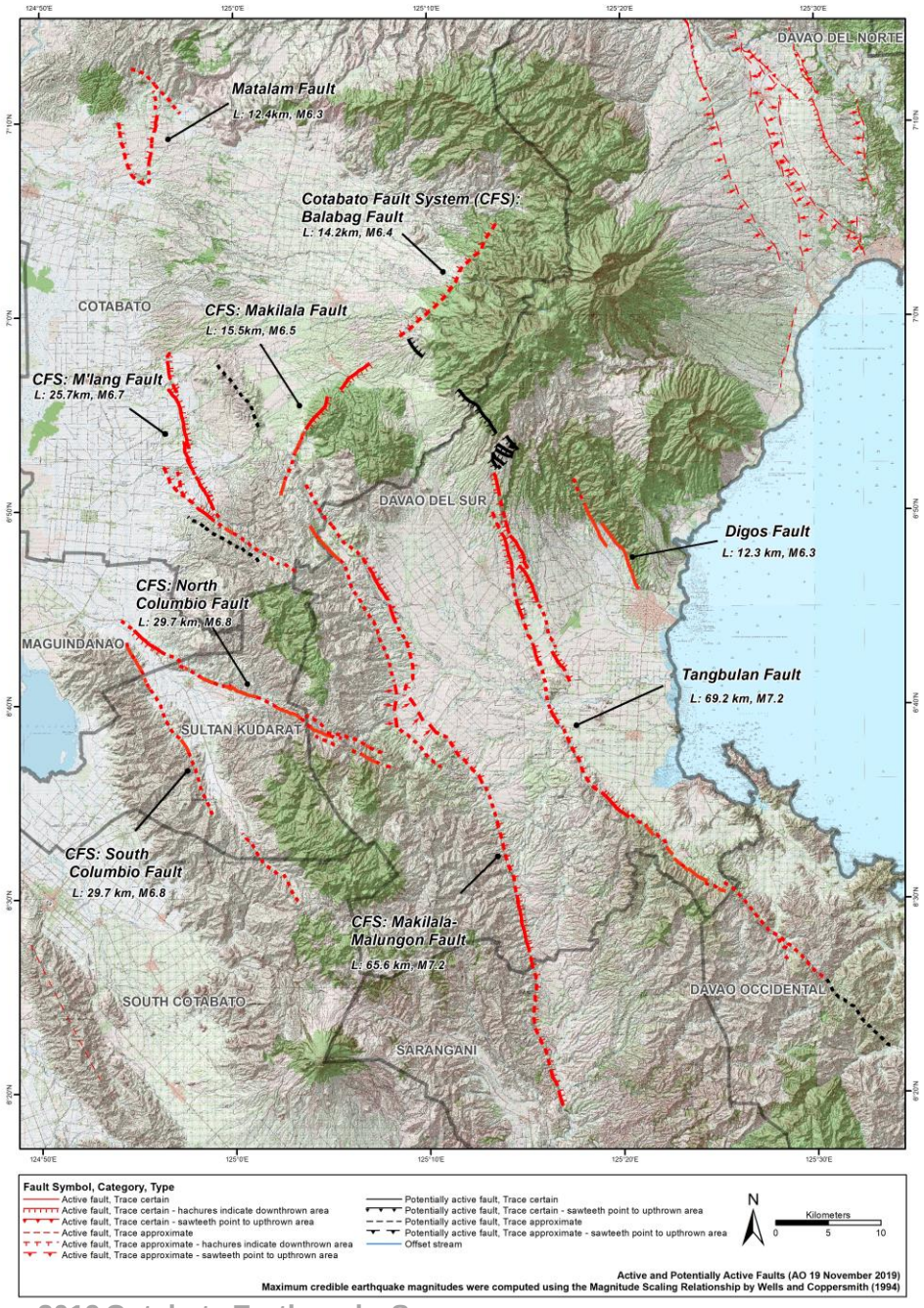
Department of Science and Technology – Philippine Institute of Volcanology and Seismology

Jeffrey S. Perez
Maria Isabel T. Abigania
Miguel Florido G. Abitang
Ranier G. Amilbahar
Ericson B. Bariso
Manolito P. Begonia
Hermes V. Daquipa
June Rostom A. Danganan
Margarita P. Dizon
Dave Benedict B. Emerenciana
Flenson Jay C. Gallardo
Giovy F. Ganipan
Florinette B. Garcia
Alvin T. Garil
Robinson F. Jorgio
Eduardo T. Lauron
Deo Carlo E. Llamas
Robjunelieaaa B. Lim
Margarita Andrea P. Mahor
Gerald A. Malipot
Fatima M. Moncada
Kathleen L. Papiona
Ron Stephen D. Pitapit
Roderick D. Ramos
Antonella B. Rosana
Milo S. Tabigue
John Harold B. Tabuzo
Nathan Azriel S. Veracruz



The October 2019 Series of Earthquakes in Cotabato and Vicinity

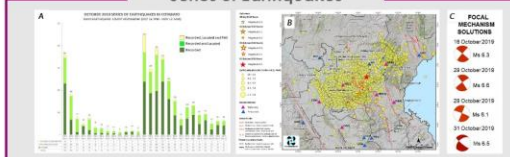
DOST-PHIVOLCS

Summary

In October 2019, a series of strong shallow earthquakes struck the province of Cotabato and vicinity. These earthquakes occurred on October 16, 7:37 PM Philippine Standard Time (PST) at magnitude 6.3, on October 29, 9:04 AM and 10:42 AM at magnitudes 6.6 and 6.1, respectively, and on October 31, 9:11 AM at magnitude 6.5. The depths of these earthquakes range from 7 to 9 km. Initial information on the hypocenters of the earthquakes and their focal mechanism solutions suggest that they are generated by the Cotabato Fault System, a system of strike-slip faults transecting the provinces of Cotabato, Davao del Sur, Maguindanao, Sarangani, South Cotabato, and Sultan Kudarat. Due to the quick succession of these events, damages to structures were severe and widespread. Geologic impacts, especially landslides, were also numerous.

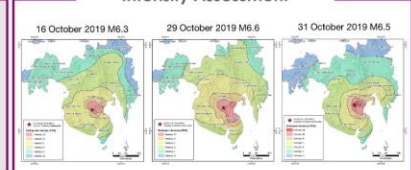
The DOST-PHIVOLCS Quick Response Team (QRT) was immediately deployed on 18 October 2019 and 30 October 2019 to: 1) conduct earthquake information dissemination and education for local government units (LGUs) and locals in the affected areas; 2) conduct field surveys to determine the earthquakes' geologic impacts and effects to structures; 3) deploy temporary seismic stations for continuous aftershocks monitoring; and 4) assist the LGUs, together with the Mines and Geosciences Bureau, in assessing selected evacuation/relocation sites in terms of earthquake hazards. Based on field investigations, the geologic impacts included numerous tension cracks and earthquake-induced landslides, especially near the epicentral region in Makilala, Kidapawan City, and Tulunan in Cotabato; and in Magsaysay and Bansalan in Davao del Sur. Liquefaction was manifested by lateral spreading, sandboils, sandblows, road buckling, ground undulation, and subsidence in low-lying and water-saturated areas of M'lang, Kabacan, Pikit, Tulunan, Makilala, and Magpet in Cotabato; Hagonoy, Magsaysay, Matanao, Digos City, Malalag, and Padada in Davao del Sur; and Pagagawan, Maguindanao. Moreover, locations of landslides and severe damage to structures after the October 31 M6.5 earthquake follow a northeast-trend and are concentrated on the central portion of Makilala and eastern portion of Kidapawan City, Cotabato where, based on the PHIVOLCS Earthquake Intensity Scale (PEIS), Intensity VIII (Very Destructive) was observed. Other damage to structures and other geologic impacts (e.g. liquefaction and tension cracks) were observed in areas where the intensity was either PEIS VII (Destructive) or PEIS VI (Strong). Poor engineering and the use of substandard construction materials were the major contributing factors to the damages.

Series of Earthquakes



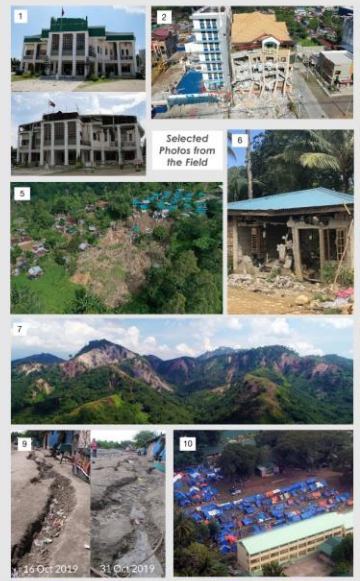
The histogram [A] and map [B] above illustrate the respective time-frequency and spatial distribution of the series of earthquakes. The spikes in daily earthquake count show that the M6.3, M6.6, and M6.5 earthquakes are separate events. These main events' Centroid Moment Tensor (CMT) solutions [C] show similar predominantly strike-slip mechanisms of the earthquakes. Subsequent smaller-magnitude earthquakes are aftershocks which decay through time. While the M6.3 aftershocks follow the normal decaying trend, the occurrence of the M6.6, M6.1, and M6.5 earthquakes and their aftershocks, complicate the histogram as the cumulative daily aftershocks of the three events were compounded. This indicates that the aftershocks which are strong enough to be felt will persist for at most 2 months. Most felt events had been reported where the earthquakes are clustered: west-southwest of Tulunan to Makilala and east of Kidapawan City to north of Mount Apo. Six (6) temporary seismic stations were also deployed to further constrain the locations of earthquakes in the area.

Intensity Assessment



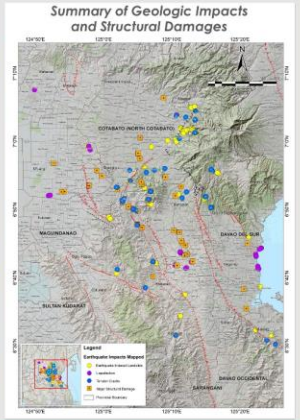
These isoseismal maps show the areas affected by varying levels of ground shaking during the 16 October 2019 M6.3, 29 October 2019 M6.6, and 31 October 2019 M6.5 events. The highest felt intensity was at PEIS VII (Destructive) for the M6.3 and M6.6 events; and PEIS VIII (Very Destructive) for the M6.5 event.

Impacts



1. The municipal hall of Magsaysay, Davao del Sur suffered extensive damage during the October 16 M6.3 event which progressed to total damage without collapse during the October 31 M6.5 event.
2. Completely damaged building with totally collapsed 1st floor. Other buildings in the area sustained slight to severe damage only.
3. Tension cracks that indicate imminent landslides were observed in Brgy. Malasila, Makilala, Cotabato.
4. Use of alternative substandard timber materials for posts and beams resulted in damaged houses and other structures.
5. Earthquake-induced landslide in Brgy. Ilomavis, Kidapawan City that buried and swept off houses along its path, and placed other upland houses at risk of further landslides.
6. Heavily damaged typical concrete hollow blocks (CHB) house due to poor construction and use of substandard materials.
7. Numerous landslides in the mountains of Makilala, Cotabato.
8. [Main photo] Lateral spreading in Brgy. Guihing, Hagonoy, Davao del Sur; [inset] Sand fissures and fountaining (the height of which is demonstrated by the LDRRM Officer) in Brgy. Aringay, Kabacan, Cotabato.
9. Liquefaction manifested by lateral spreading in Brgy. Aplaya, Hagonoy, Davao del Sur. The maximum lateral separation increased after the October 31 M6.5 earthquake.
10. Displaced families taking refuge in makeshift tents in the evacuation areas.
11. Totally collapsed houses and extensive large tension cracks in Sitio Labidangan, Upper Bala, Magsaysay, Davao del Sur prompted the QRT to recommend the immediate evacuation and relocation of all residents after the M6.3 event.

Summary of Geologic Impacts and Structural Damages



Public Engagements

DOST-PHIVOLCS QRT conducted information dissemination activities to explain the earthquake event to the people and allay their fears. Interviews with the media, as well as briefings with LGUs and private companies, were also conducted to provide updates and discuss recommendations based on the team's findings.

Recommendations

- In case of another felt earthquake, do the "Duck/Drop, Cover and Hold."
- Damaged buildings and infrastructures should be inspected by engineers after the last event (M6.5) and should not be used unless assessed as safe.
- For areas with existing tension cracks, conduct pre-emptive evacuation, and be watchful of possible landslides triggered by earthquakes or prolonged heavy rainfall.
- Formally train local masons and carpenters on the proper construction practice and use of standard construction materials. Reconstruction or construction of houses and buildings should conform with the National Building Code of the Philippines.
- Strengthen the implementation of and compliance to the National Structural and National Building Codes of the Philippines.
- Review and formulation of policies and ordinances that will address the gaps in the issuance of building permits and monitoring of building constructions.
- National and local government units in collaboration with non-government agencies should provide psychosocial support such as stress-debriefing to affected communities.

Department of Science and Technology
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY
PHIVOLCS Building, C.P. Garcia Avenue, U.P. Campus, Diliman, 1101 Quezon City, Philippines

Tel. Nos.: (+632) 8426-1468 to 79; (+632) 8926-2611 | Fax Nos. (+632) 8929-8366; (+632) 8928-3757
Website: www.phivolcs.dost.gov.ph Facebook: www.facebook.com/PHIVOLCS/ Twitter: @phivolcs_dost

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The October 2019 Cotabato Earthquake Sequence
DOST-PHIVOLCS Quick Response Team

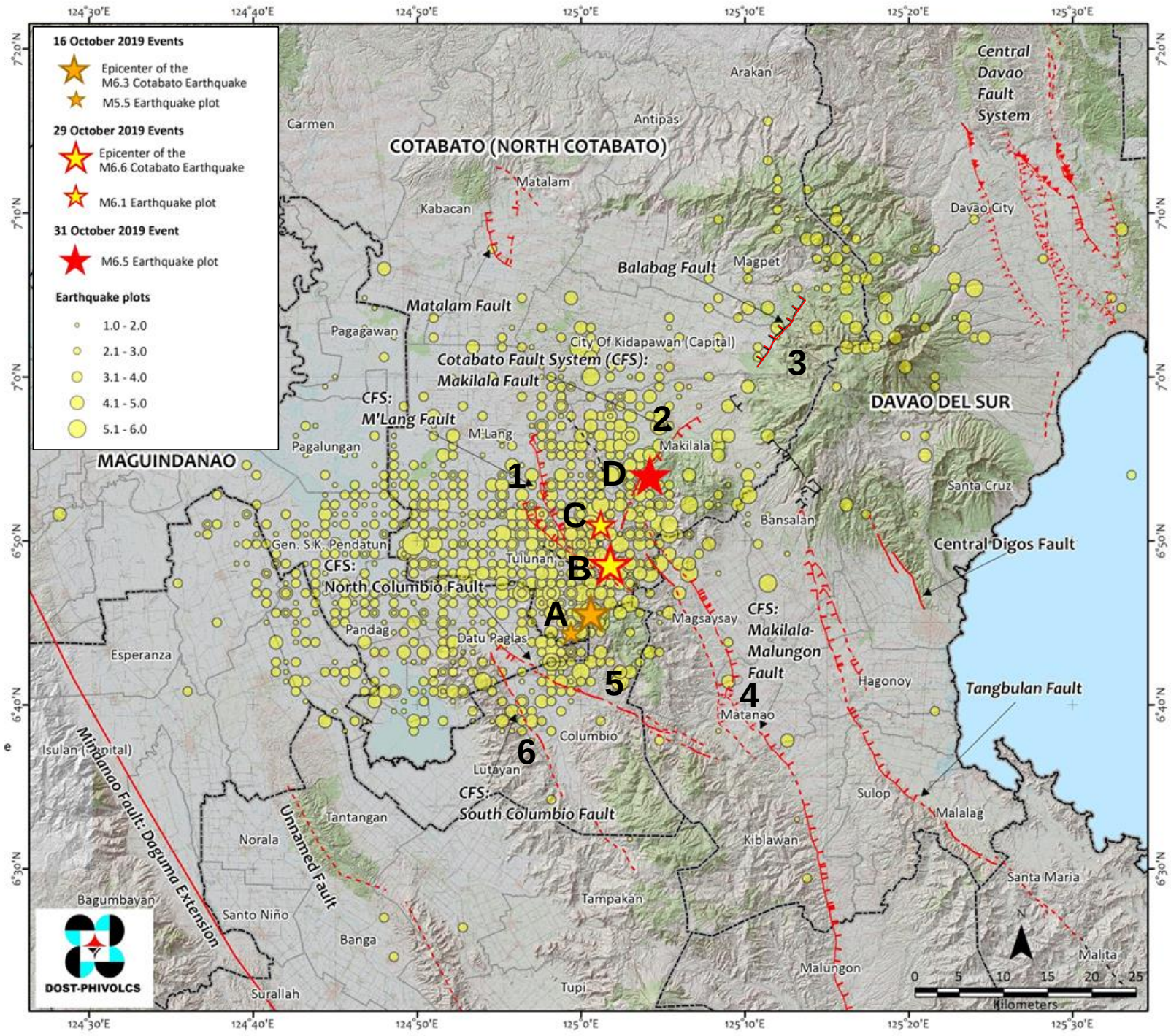
Seismicity Map
from 16 October to 5 November 2019, 3pm

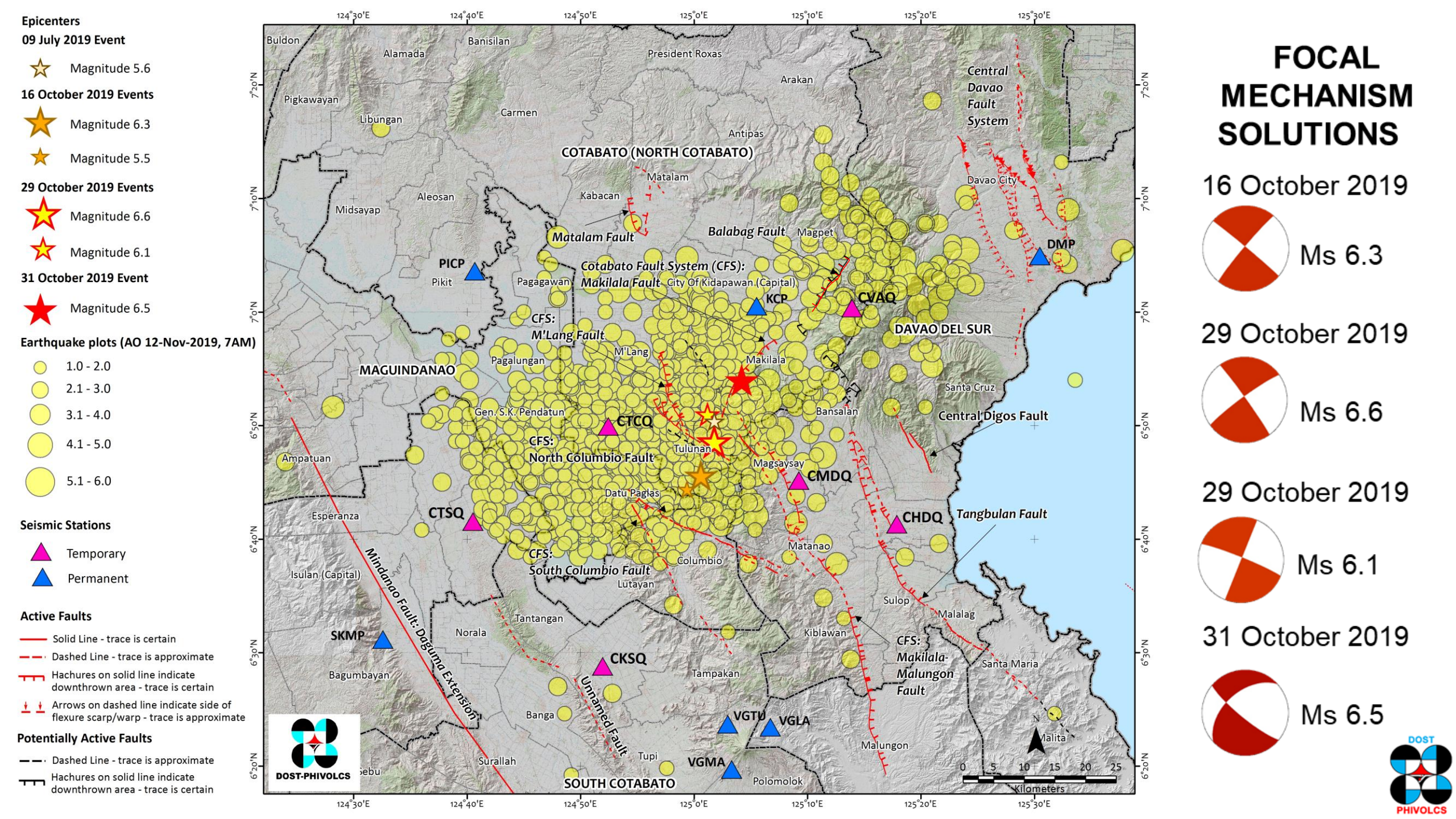
Epicenters

A. M6.3 – Oct. 16, 2019
B. M6.6 – Oct. 29, 2019
C. M6.1 – Oct. 29, 2019
D. M6.5 – Oct. 31, 2019

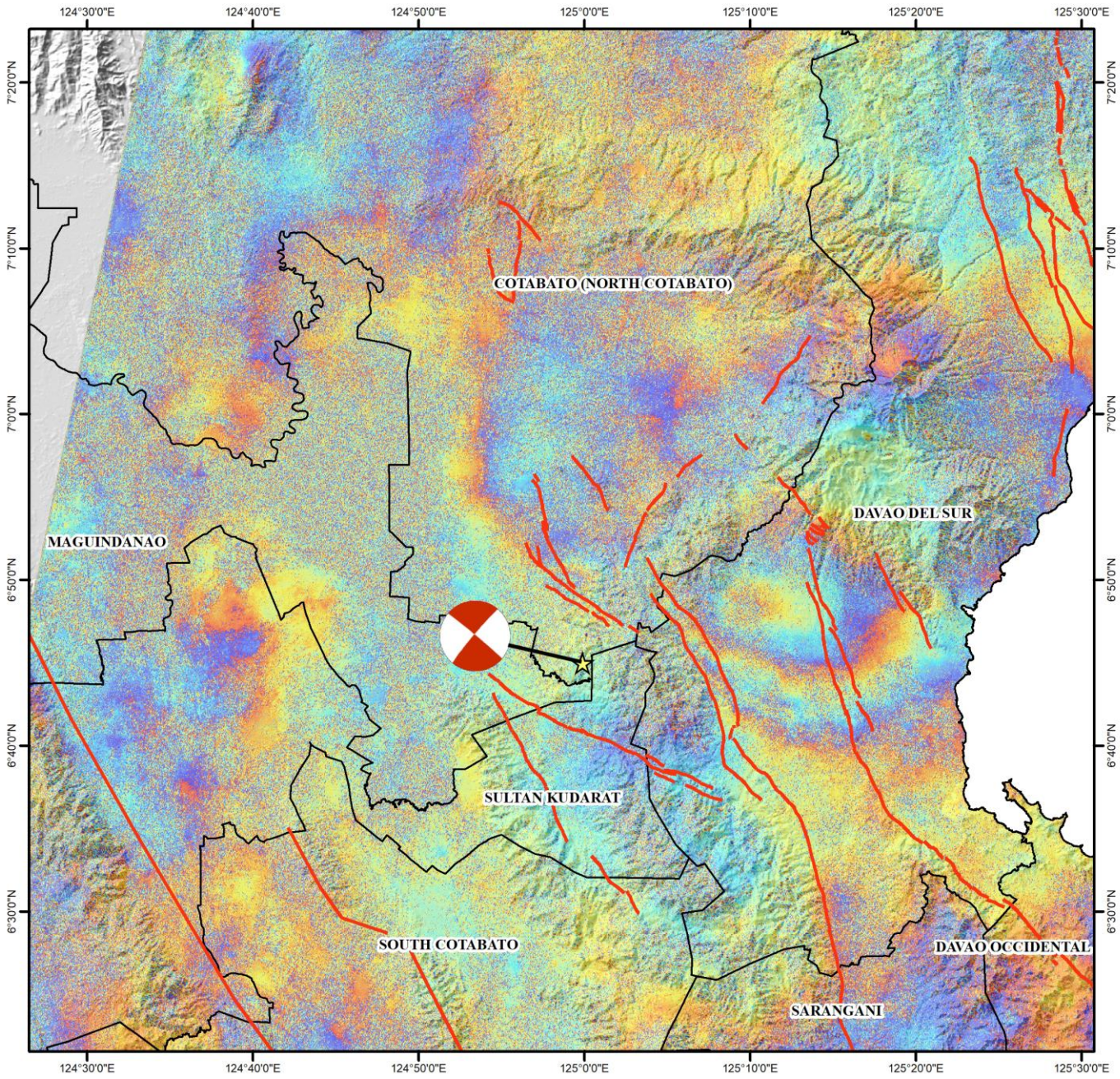
Cotabato Fault System

1. M'lang Fault
2. Makilala Fault
3. Balabag Fault
4. Makilala-Malungon Fault
5. North Columbio Fault
6. South Columbio Fault




Epicenters
09 July 2019 Event
Magnitude 5.6
16 October 2019 Events
Magnitude 6.3
Magnitude 5.5
29 October 2019 Events
Magnitude 6.6
Magnitude 6.1
31 October 2019 Event
Magnitude 6.5
Earthquake plots (AO 12-Nov-2019, 7AM)
1.0 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
Seismic Stations
Temporary
Permanent
Active Faults
Solid Line - trace is certain
Dashed Line - trace is approximate
Hachures on solid line indicate downthrown area - trace is certain
Arrows on dashed line indicate side of flexure scarp/warp - trace is approximate
Potentially Active Faults
Dashed Line - trace is approximate
Hachures on solid line indicate downthrown area - trace is certain
DOST-PHIVOLCS
Buldon
Banisilan
Alamada
President Roxas
Arakan
Pigkawayan
Libungan
Carmen
Antipas
COTABATO (NORTH COTABATO)
Matalam
Kabacan
Aleosan
Midsayap
Central Davao Fault System
Davao City
Matalam Fault
Balabag Fault
Magpet
DMP
PICP
Pikit
Pagagawan
Cotabato Fault System (CFS): Makilala Fault
City Of Kidapawan (Capital)
KCP
CVAQ
CFS: M'Lang Fault
DAVAO DEL SUR
M'Lang
Pagalungan
Makilala
MAGUINDANAO
Santa Cruz
Gen. S.K. Pendatun
CTCQ
Bansalan
Central Digos Fault
CFS: North Columbio Fault
Tulunan
Ampatuan
Magsaysay
CMDQ
Datu Paglas
Esperanza
CTSQ
CHDQ
Tangbulan Fault
Mindanao Fault: Daguma Extension
Matanao
CFS: South Columbio Fault
Columbio
Isulan (Capital)
Lutayan
Sulop
Malalag
Tantangan
SKMP
Norala
Kiblawan
CFS: Makilala-Malungon Fault
CKSQ
Santa Maria
Bagumbayan
Tampakan
Unnamed Fault
Banga
VGTU
VGLA
Malungon
Malita
Surallah
Tupi
VGMA
SOUTH COTABATO
Polomolok
0 5 10 15 20 25
Kilometers
124°30'E
124°40'E
124°50'E
125°0'E
125°10'E
125°20'E
125°30'E
7°20'N
7°10'N
7°0'N
6°50'N
6°40'N
6°30'N
6°20'N
FOCAL MECHANISM SOLUTIONS
16 October 2019
Ms 6.3
29 October 2019
Ms 6.6
29 October 2019
Ms 6.1
31 October 2019
Ms 6.5
DOST
PHIVOLCS

The DinSAR map shows pattern of asymmetric fringes with a discontinuity oriented NW-SE which could possibly indicate the surface expression of the causative fault of the 16 October 2019 earthquake event. A net displacement of approximately 12 cm is observed.



Phase Map of the 16 October 2019 M6.3 North Cotabato Earthquake

N

0 15 30
Kilometers

High : 3.14
Low : -3.14

Epicenter

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

LOS Range

FD Azimuth

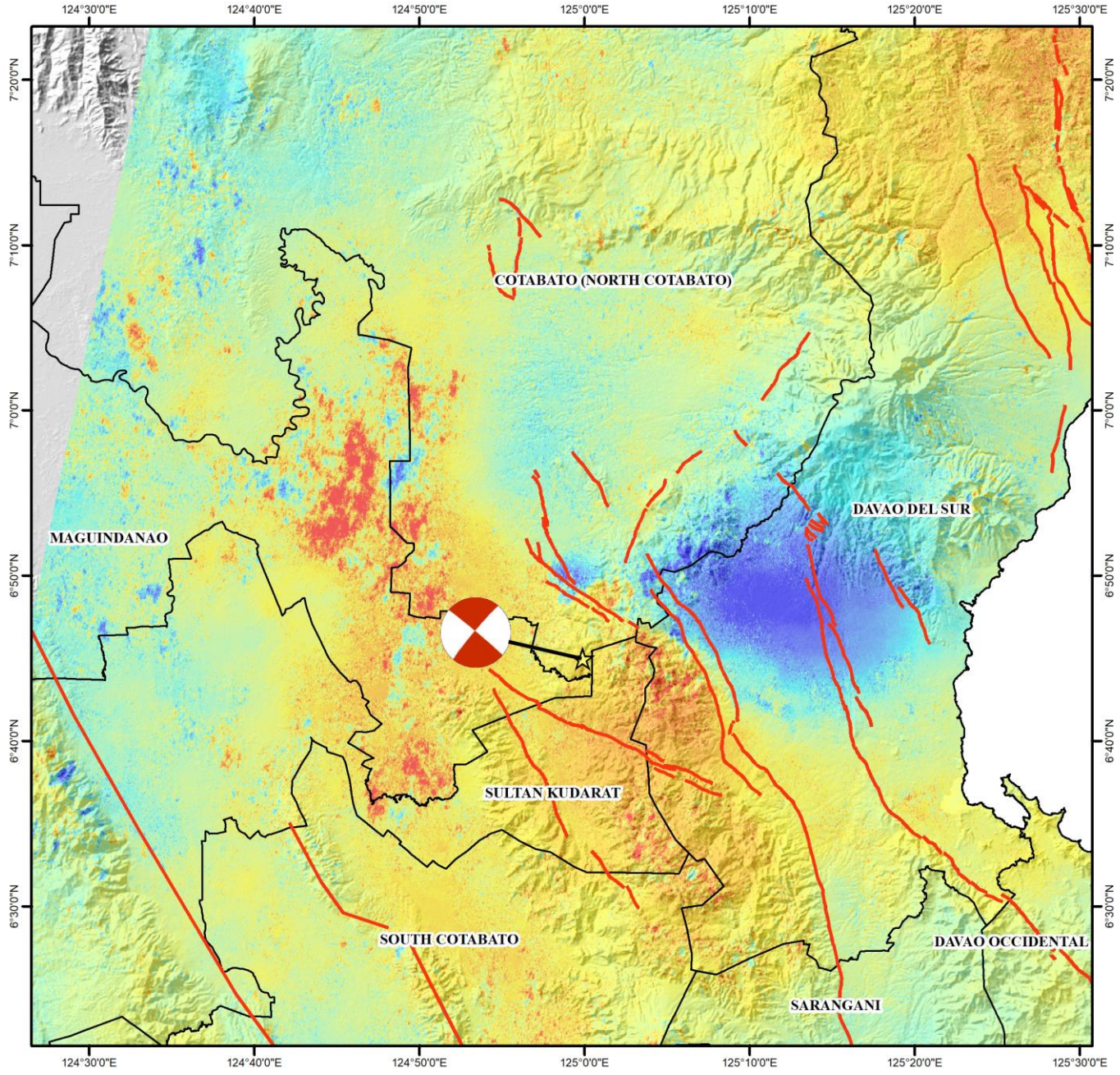
Acquisition Dates: 14 October 2019 (Pre-event)
26 October 2019 (Post-event)

Processing software: ISCE

Filters: Topography;
Power spectrum phase filtering;
Ionospheric filtering;
Low coherence masking

Data Source: Sentinel 1A, ESA;
SRTM, NASA-JPL; Prov. Boundaries, PSA;
Active Faults and Focal Mechanism, PHIVOLCS

The Line Of Sight (LOS) map shows a discontinuity oriented NW-SE which could possibly indicate the surface expression of the causative fault of the 16 October 2019 earthquake event. A LOS displacement of approximately 12 cm is observed. The blue shade indicates movement away from the satellite and the red shade indicates movement towards the satellite.



Line Of Sight Map of the 16 October 2019 M6.3 North Cotabato Earthquake

N

0 15 30
Kilometers

High : 95.294 mm

Low : -92.2991 mm

Epicenter

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

LOS Range

FD Azimuth

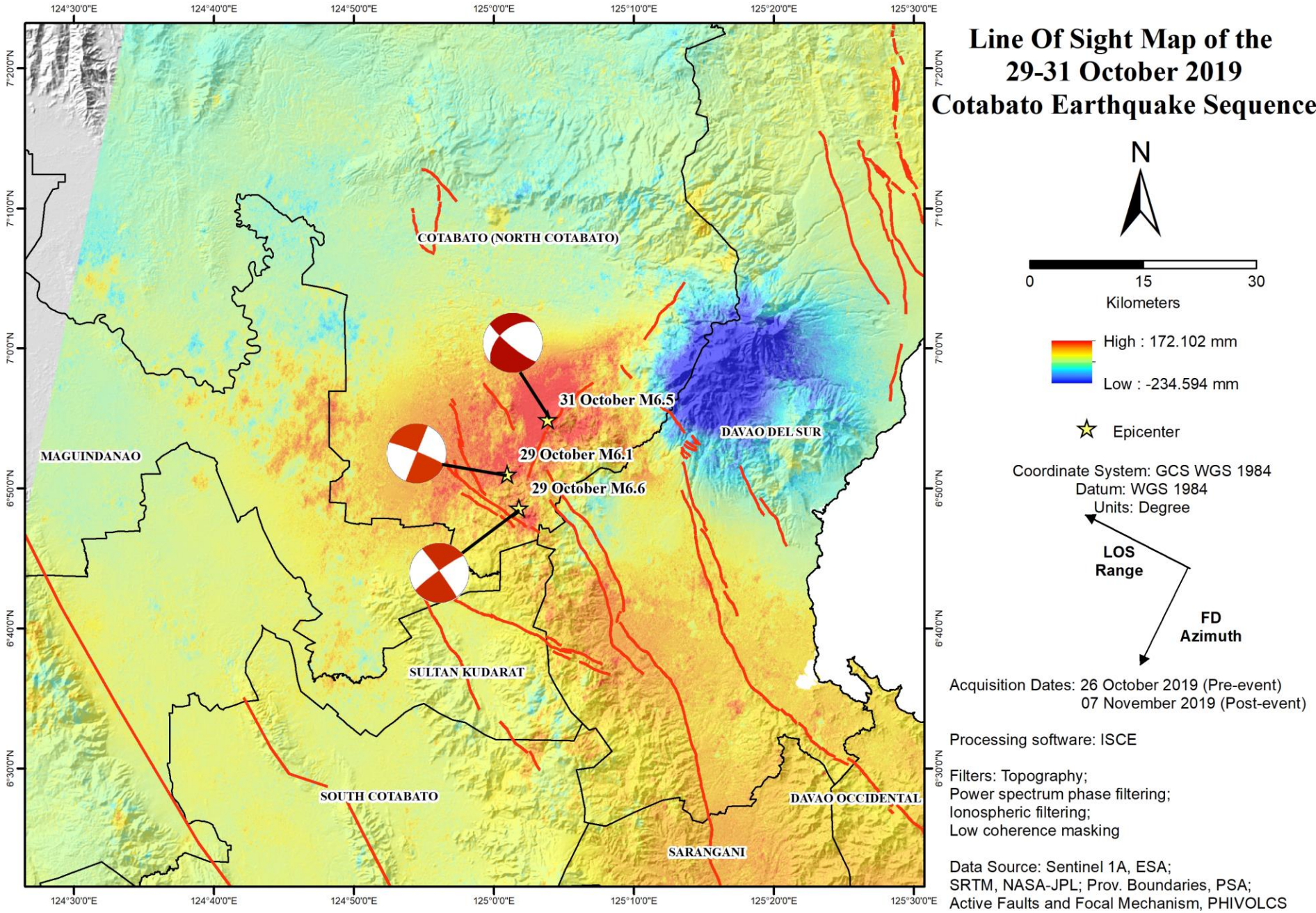
Acquisition Dates: 14 October 2019 (Pre-event)
26 October 2019 (Post-event)

Processing software: ISCE

Filters: Topography;
Power spectrum phase filtering;
Ionospheric filtering;
Low coherence masking

Data Source: Sentinel 1A, ESA;
SRTM, NASA-JPL; Prov. Boundaries, PSA;
Active Faults and Focal Mechanism, PHIVOLCS

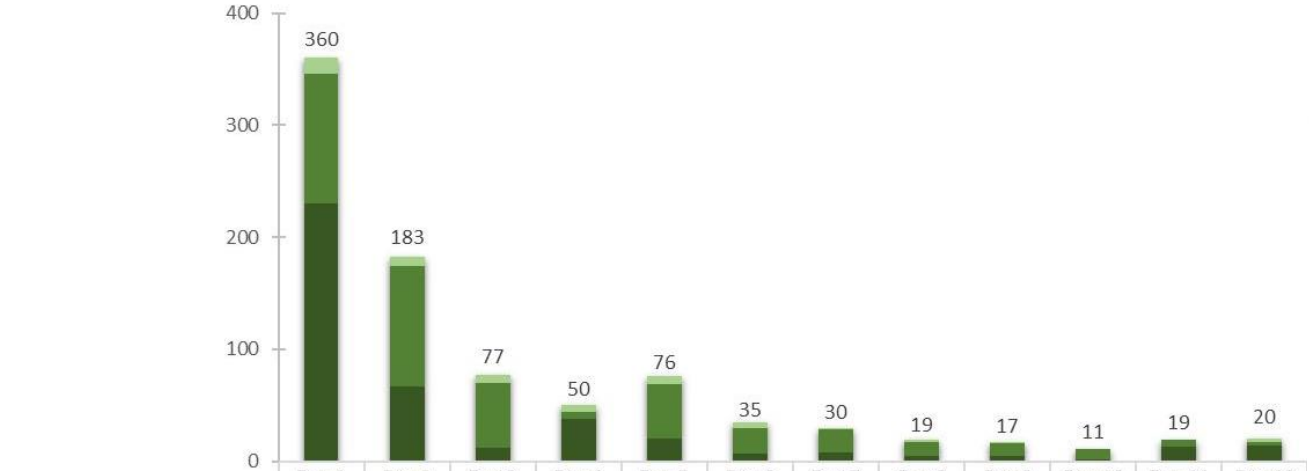
The Line Of Sight (LOS) map shows a discontinuity oriented NE-SW which could possibly indicate the surface expression of the causative fault of the 29-31 October 2019 earthquake event. A LOS displacement of approximately 40 cm is observed. The blue shade indicates movement away from the satellite and the red shade indicates movement towards the satellite.



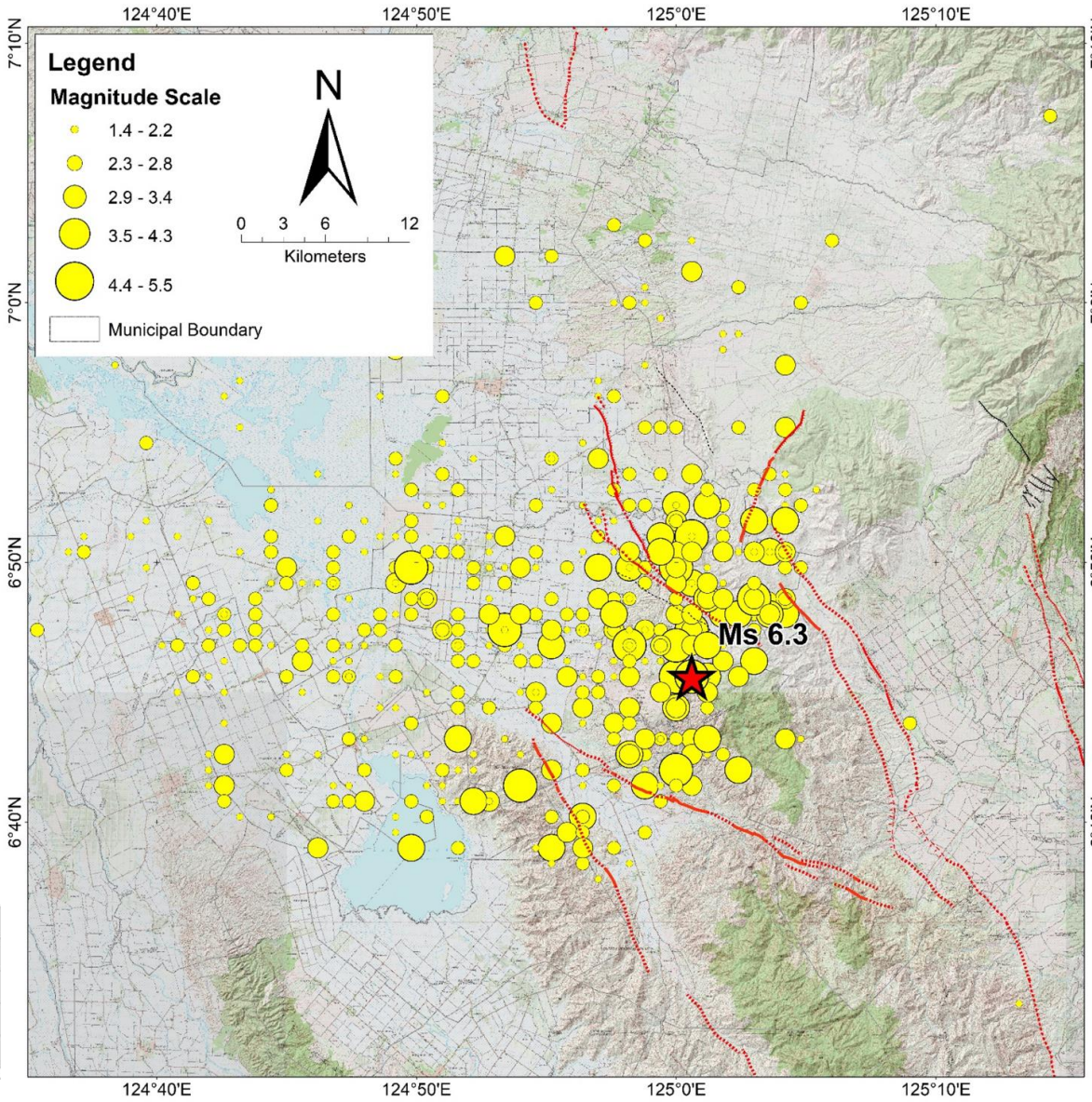
The October 2019 Cotabato Earthquake Sequence

Plotted earthquakes as of 04:00 PM (PST)
28 October 2019

Recorded: 900
Plotted: 478
Felt: 56
Magnitude Range: 1.5 – 5.5



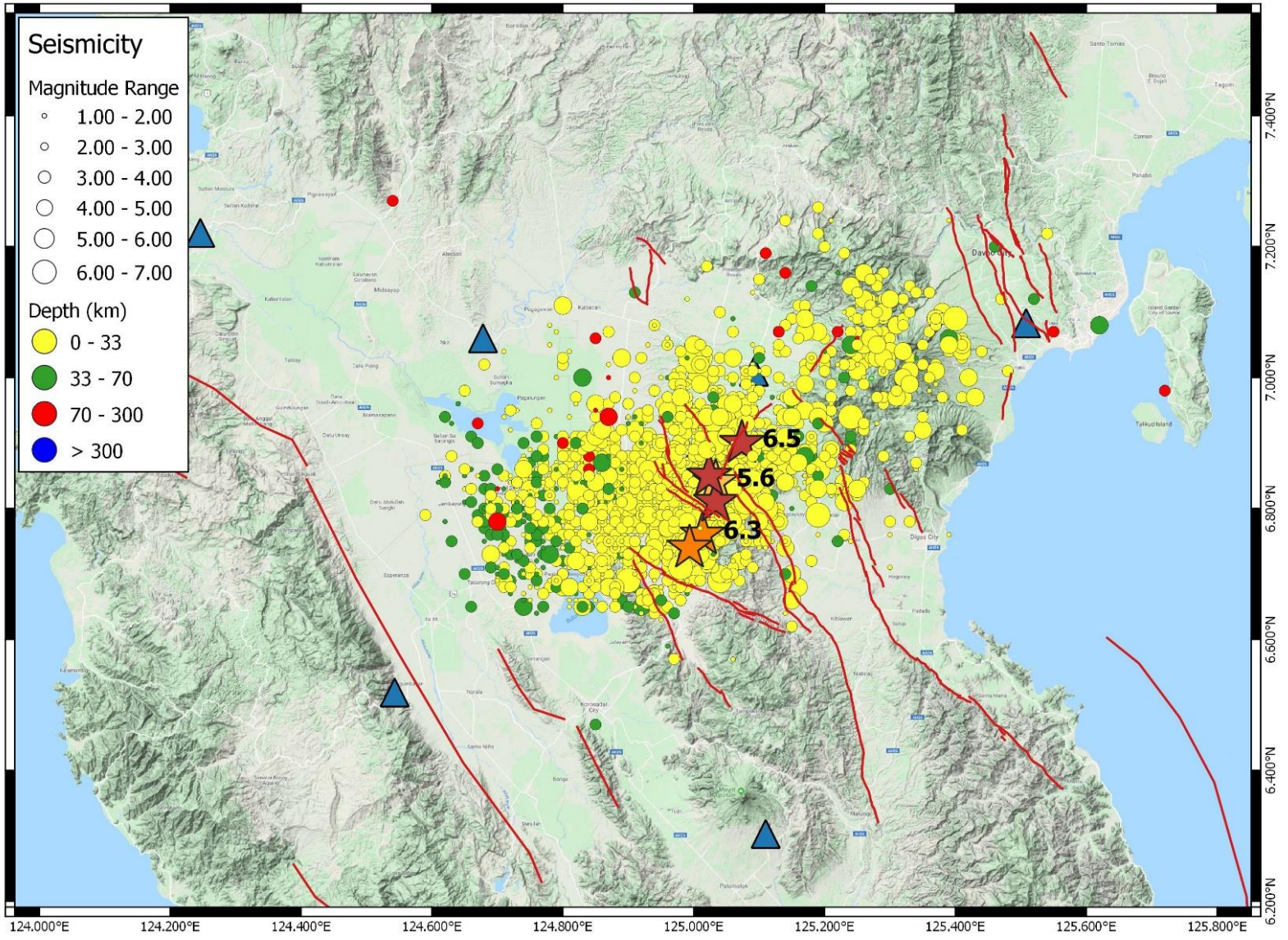
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12
Recorded, Located and Felt	14	9	7	6	7	5	2	2	1	0	0	3
Recorded and Located	116	107	58	6	49	23	20	12	11	9	6	3
Recorded	230	67	12	38	20	7	8	5	5	2	13	14
TOTAL	360	183	77	50	76	35	30	19	17	11	19	20



The October 2019 Cotabato Earthquake Sequence

Plotted Earthquakes as of 02 December 2019 12:00AM

Recorded	3890
Plotted	1705
Felt	246
Mag. Range	1.4-5.0
Ref. Station	PICP



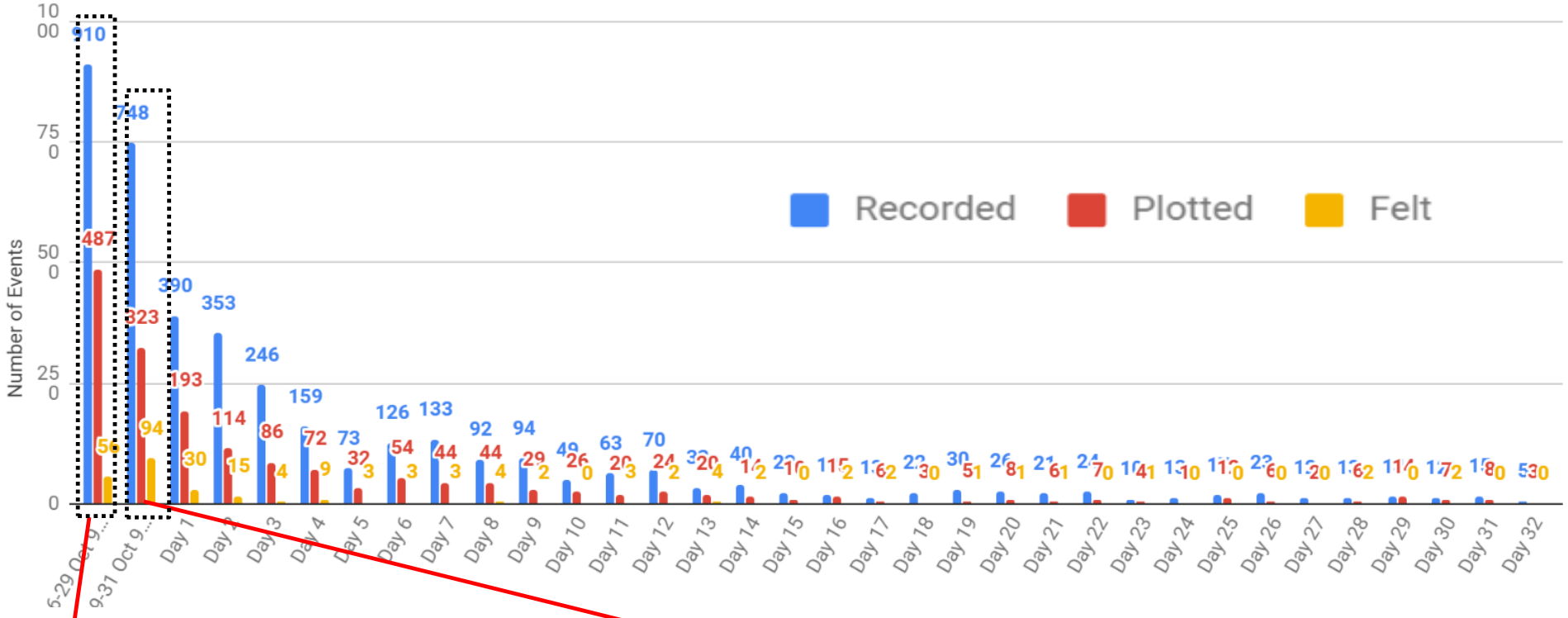
The October 2019 Cotabato Earthquake Sequence

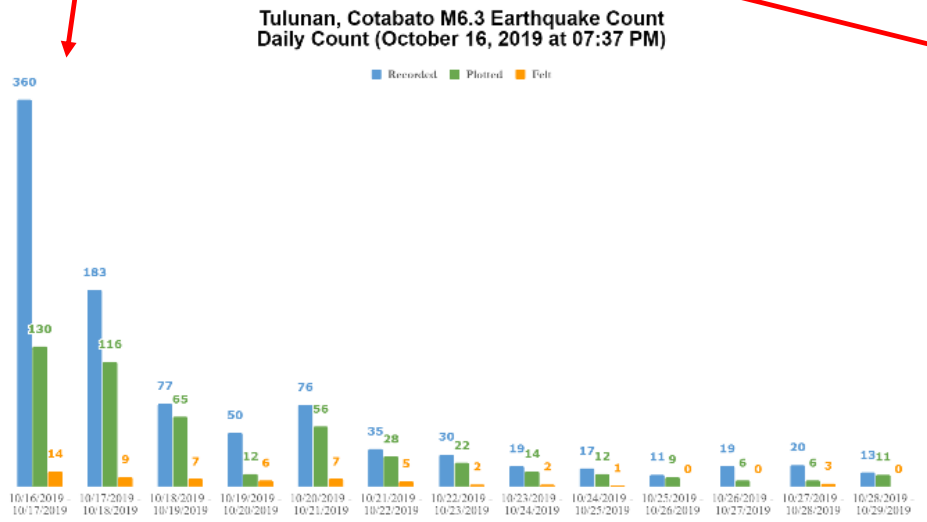
as of 12:00AM
December 02, 2019

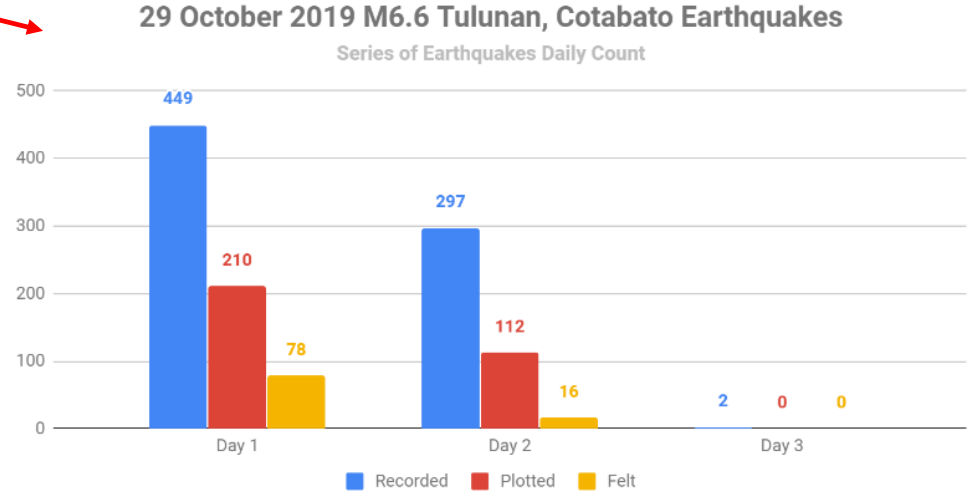
Recorded	3890
Plotted	1705
Felt	246
Mag. Range	1.4-5.0
Ref. Station	PICP

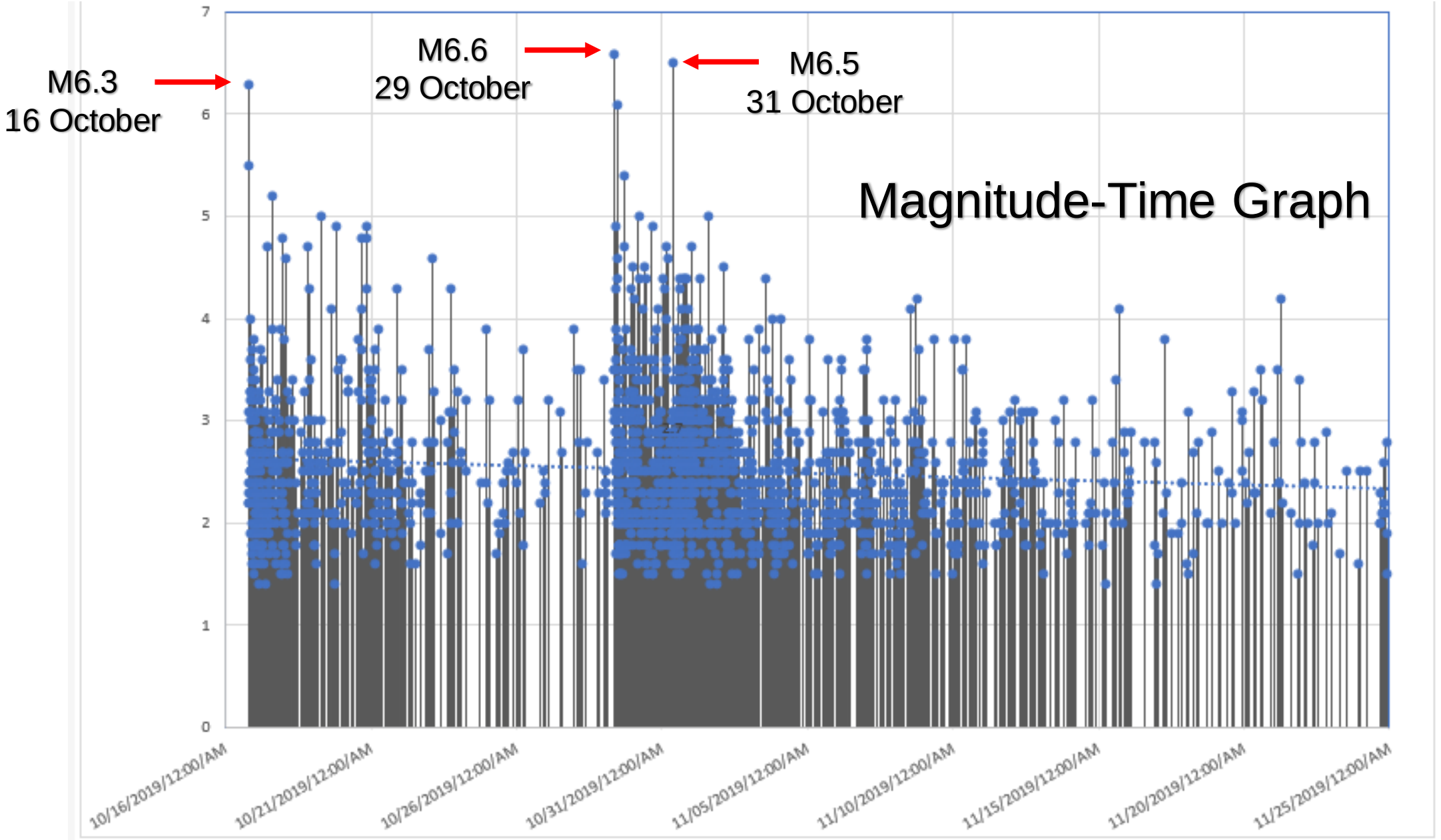
After the 31 October 2019 M6.5

Recorded	2232
Plotted	895
Felt	96
Mag. Range	1.4-5.0
Ref. Station	PICP





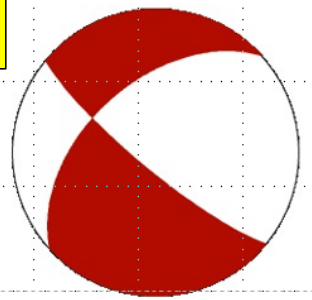



M6.3
16 October
M6.6
29 October
M6.5
31 October
Magnitude-Time Graph
7
6
5
4
3
2
1
0
10/16/2019/12:00/AM
10/21/2019/12:00/AM
10/26/2019/12:00/AM
10/31/2019/12:00/AM
11/05/2019/12:00/AM
11/10/2019/12:00/AM
11/15/2019/12:00/AM
11/20/2019/12:00/AM
11/25/2019/12:00/AM

Ground motion modelling result for the M6.5 event vs. actual ground motion

SWIFT Centroid Moment Tensor Solution:

Input



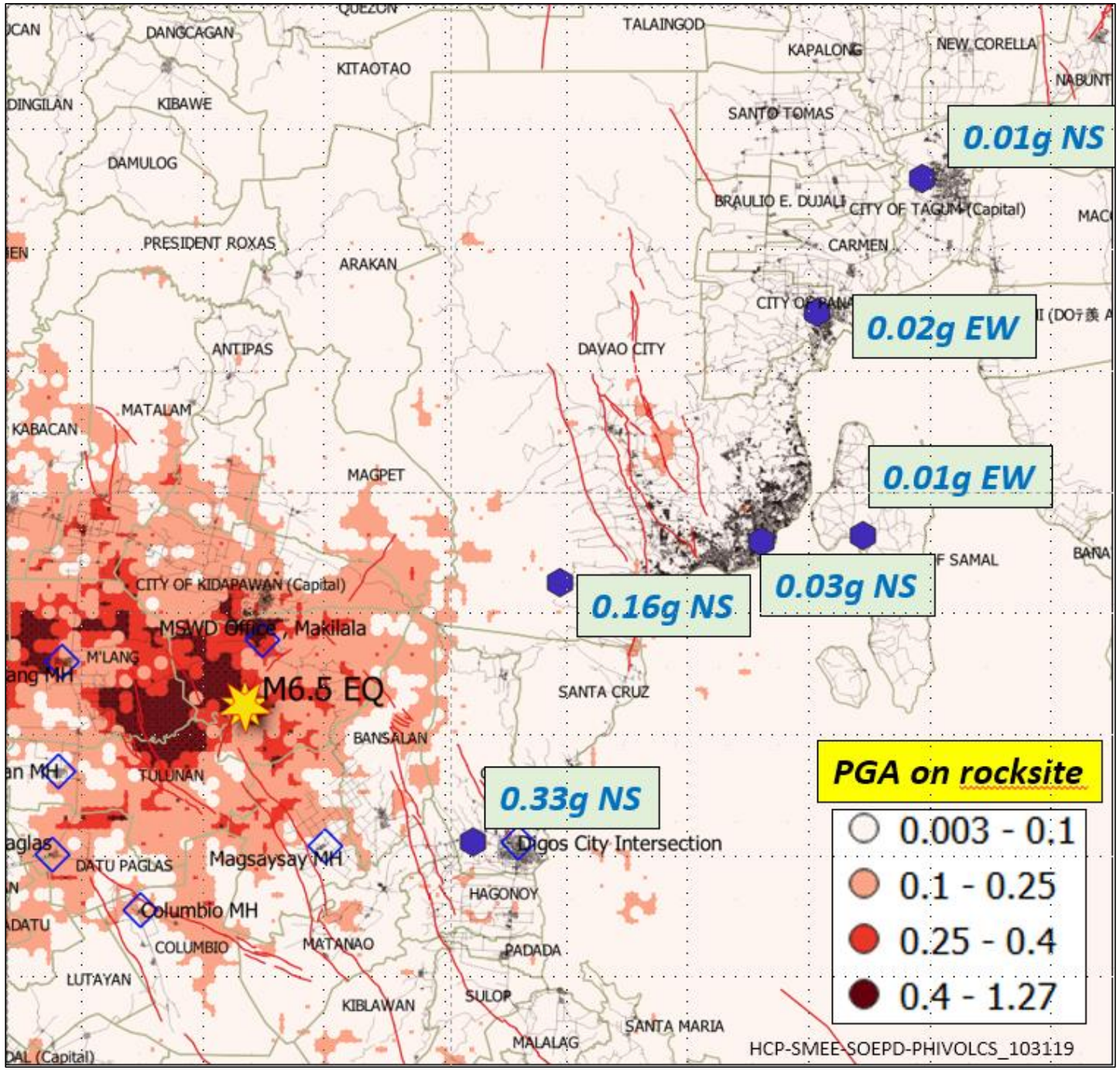
Moment magnitude (M_w) = 6.5

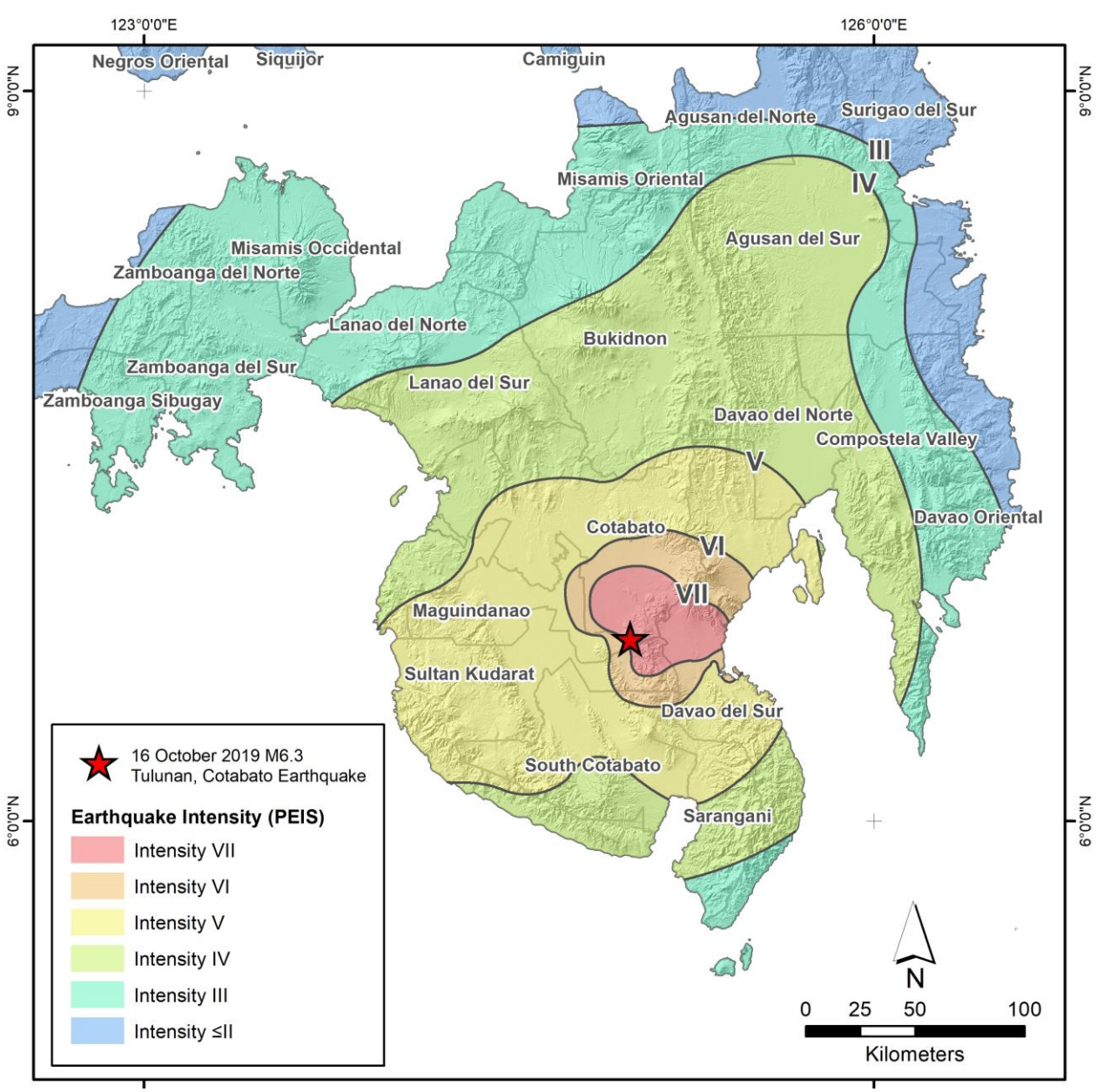
Seismic moment (M_0) = 7.30×10^{18} Nm

(Lon, Lat, Depth) = (125.10°E, 6.80°N, 5 km)

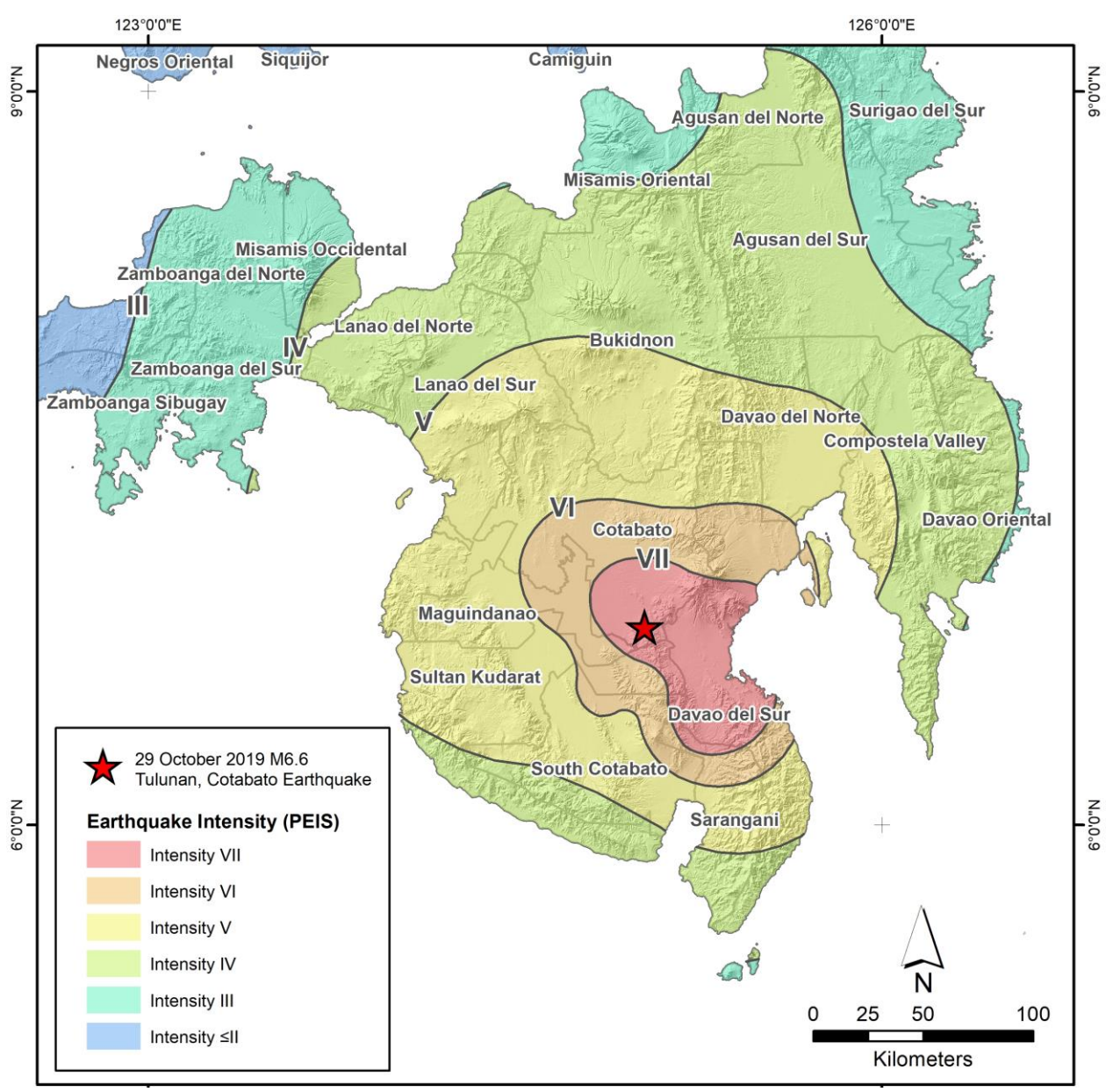
(Strike 1, Dip 1, Rake 1) = (228°, 50°, –167°)

(Strike 2, Dip 2, Rake 2) = (129°, 80°, –41°)

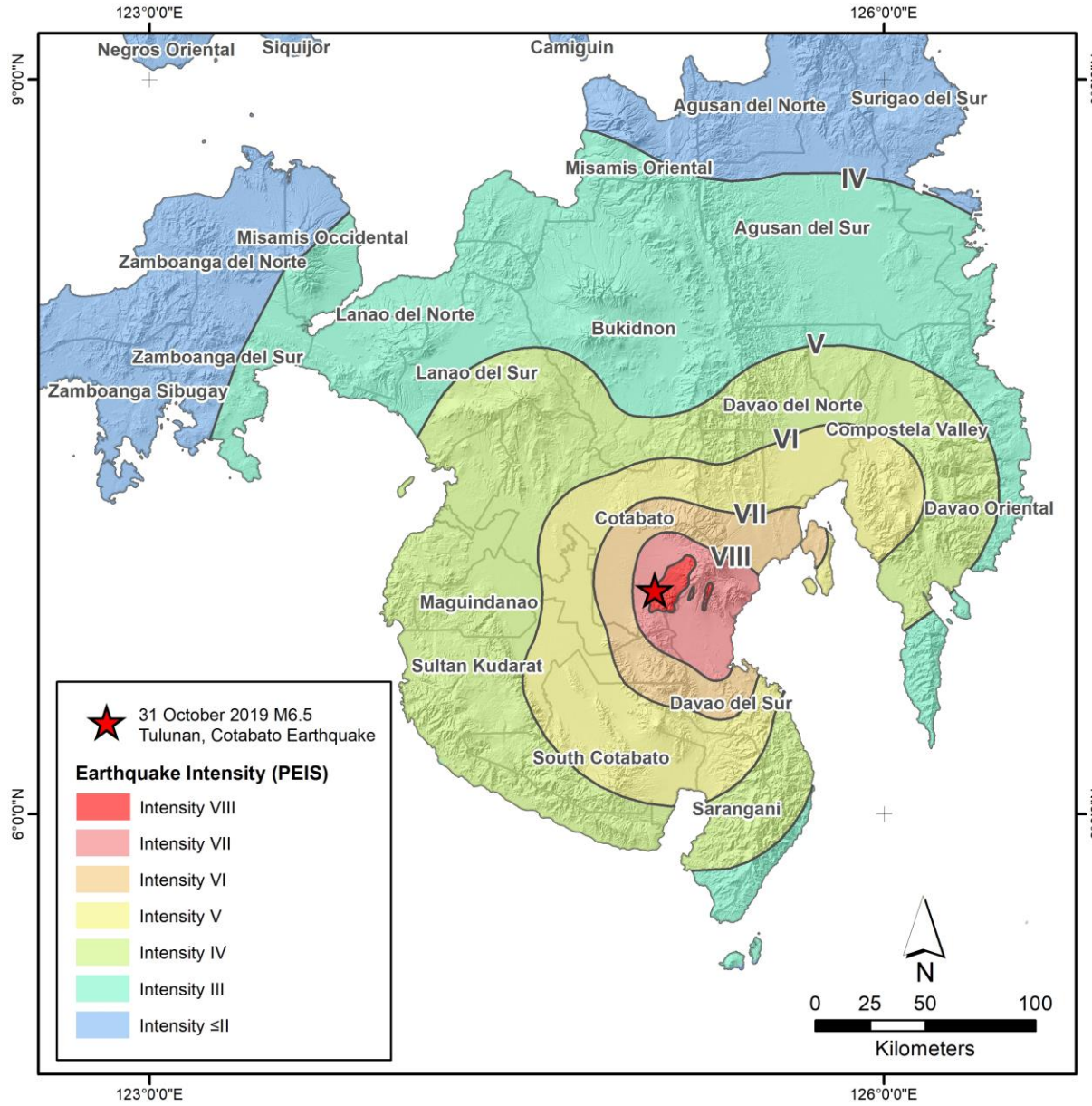




16 October 2019 M6.3



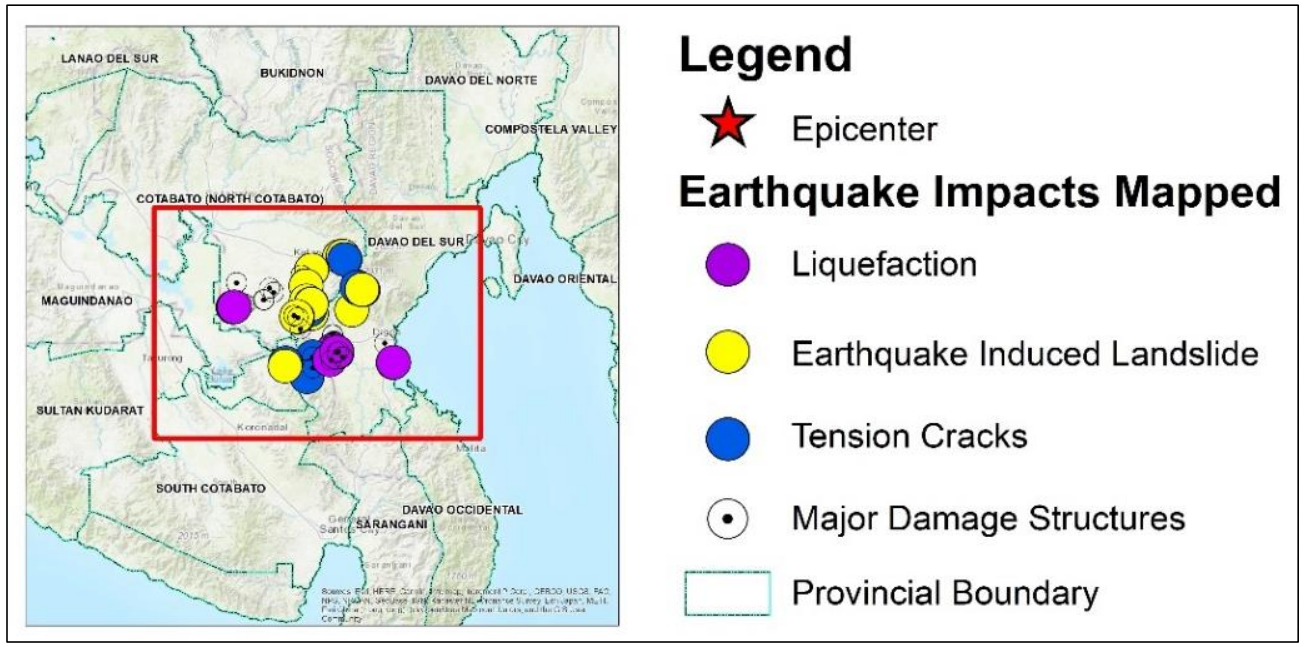
29 October 2019 M6.6

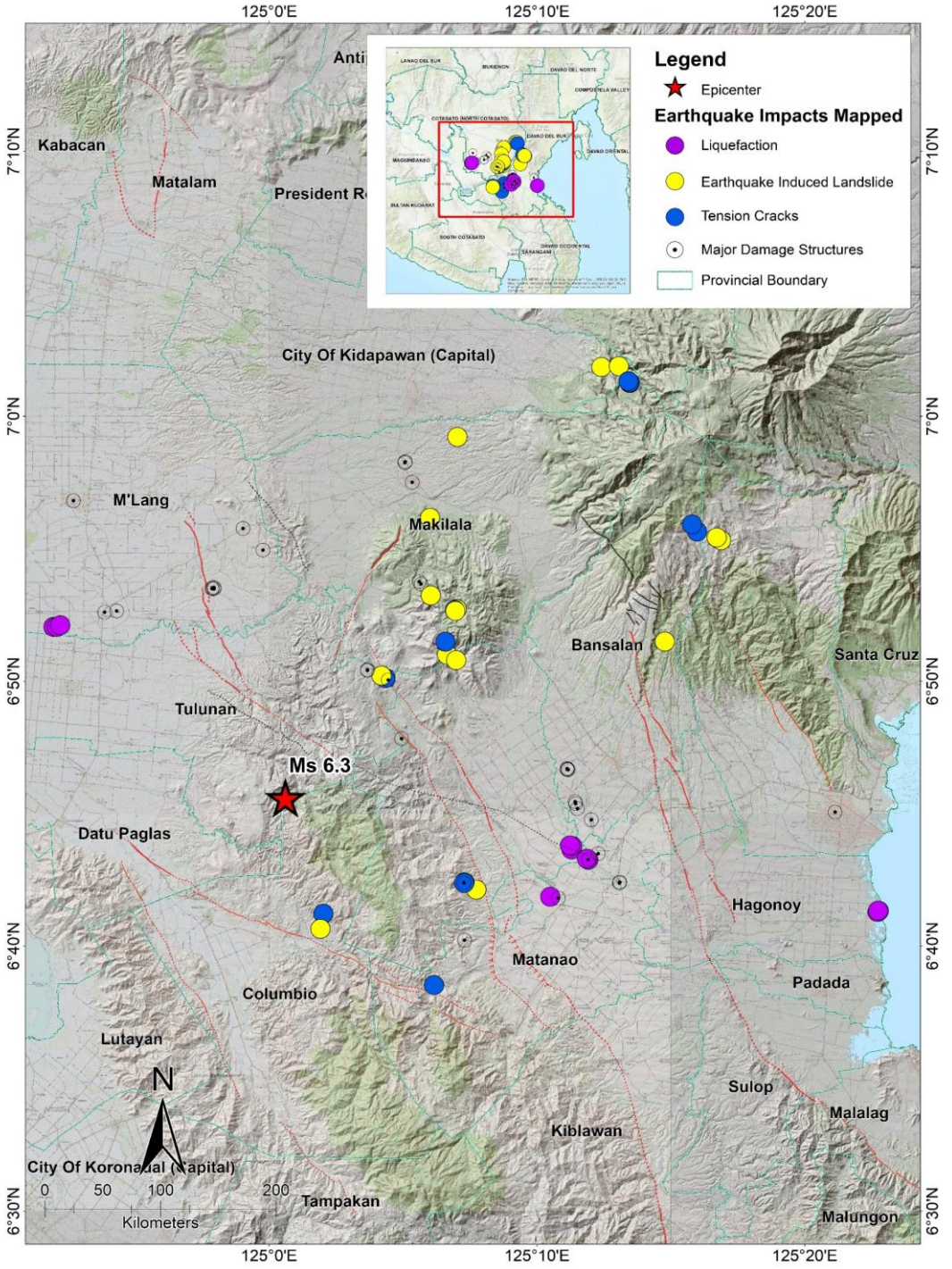


Earthquake Intensity based on PHIVOLCS Earthquake Intensity Scale (PEIS)	Province	City/Municipality
Intensity VIII (Very Destructive)	Cotabato	Brgy. Ilomavis, Brgy. Perez, and Brgy. Balabag in Kidapawan City
		Steep mountainous areas in Brgy. Buhay, Brgy. Batasan, Brgy. Malasila, Brgy. Sto. Nino, Brgy. Kisante, Brgy. Malabuan, Brgy. Luayon, Brgy. Bato, Brgy. Mabuhay, Brgy. Upper Indangan, Brgy. Buena Vida, Brgy. Malongon in Makilala; Purok 1, Brgy. Daig inTulunan
	Davao del Sur	Ridge crests and steep slopes in So. Bandera, Brgy. Balabag, and Brgy. Kapatagan in Digos City
Intensity VII (Destructive)	Davao del Sur	Matanao, Magsaysay, Hagonoy, Digos City, Sulop, Padada, Bansalan, Magsaysay
	Cotabato	Magpet, Tulunan, the rest of Kidapawan City and Makilala
Intensity VI (Very Strong)	Cotabato	Tulunan, M'lang
	Davao del Sur	Sta. Cruz
	Independent/Chartered Cities	Davao City

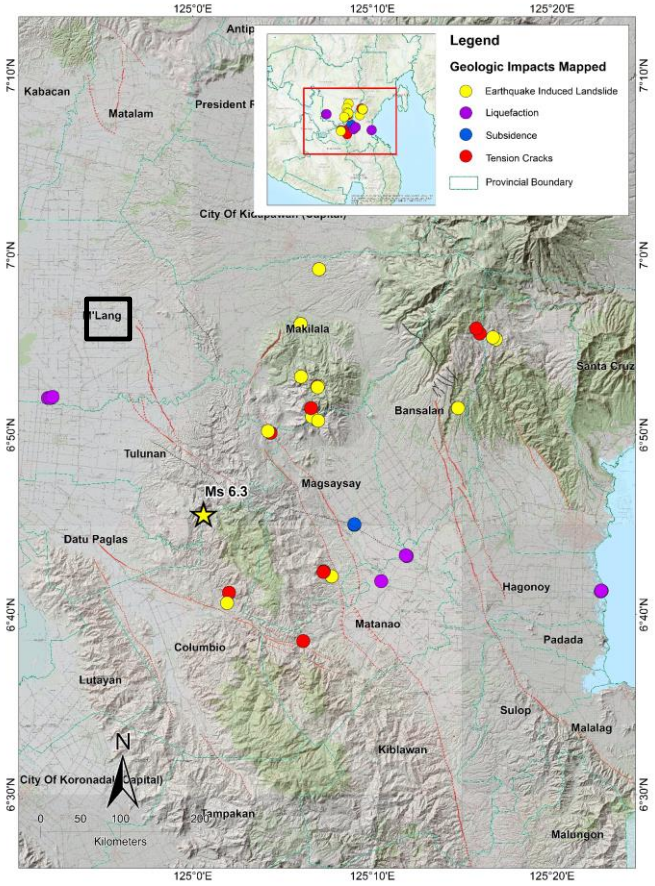
31 October 2019 M6.5

Mapped earthquake impacts after the M6.3 (16 October 2019) event





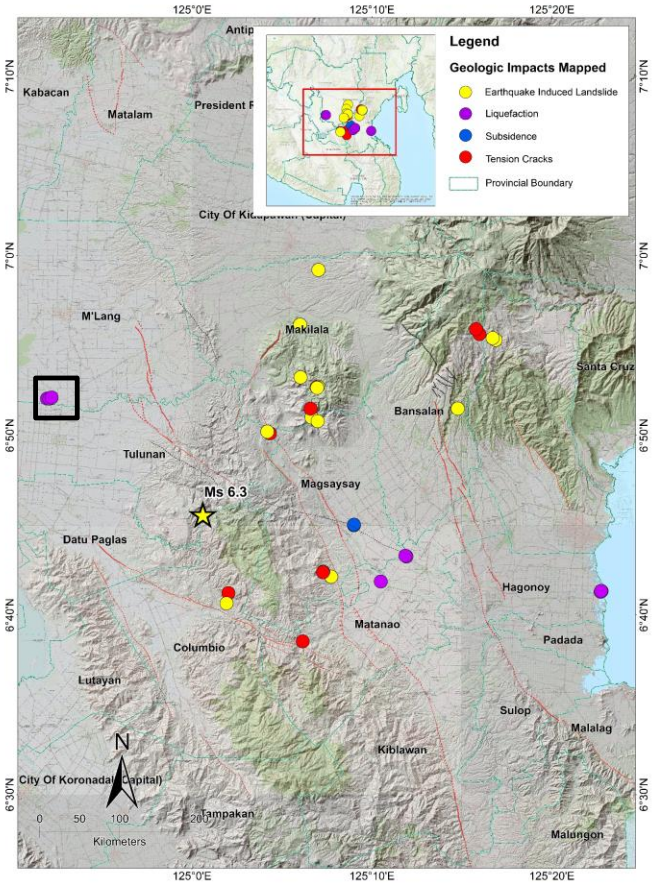
M’lang, Cotabato



Damaged SB Hall in M’lang, Cotabato

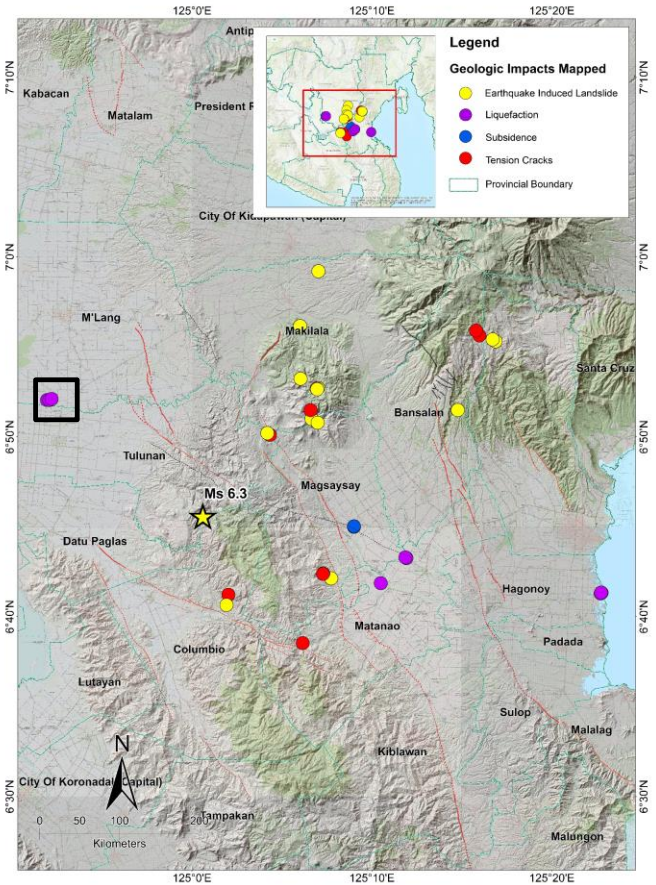
Totally collapsed wall of a house in Brgy. Bagontapay, M'lang (lumber post were installed post-shaking to prevent total collapse of the roof)

Purok 8, Brgy. Lipaga, M'lang, Cotabato



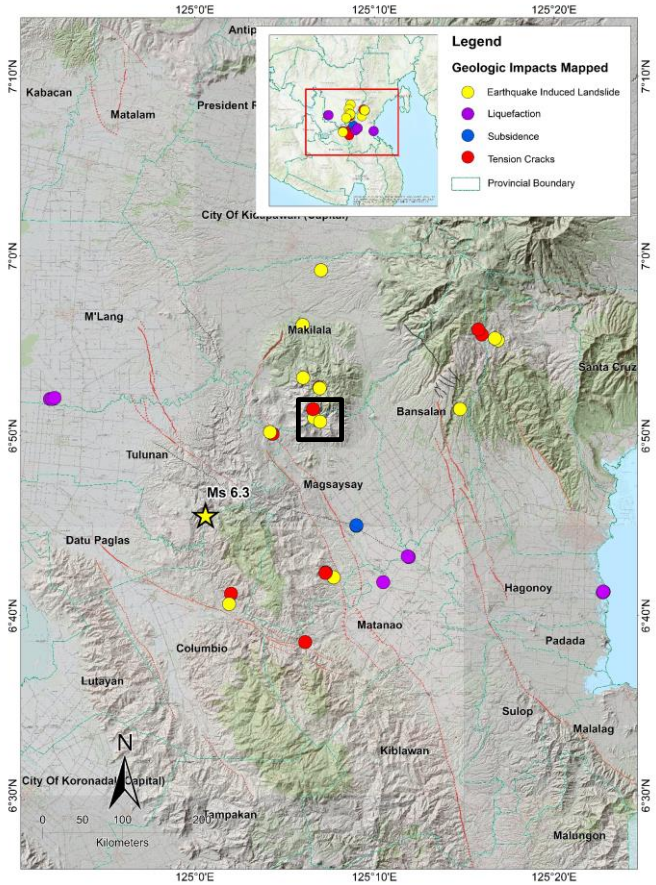
Lateral spread and sandboil

Purok 8, Brgy. Lipaga, M'lang, Cotabato



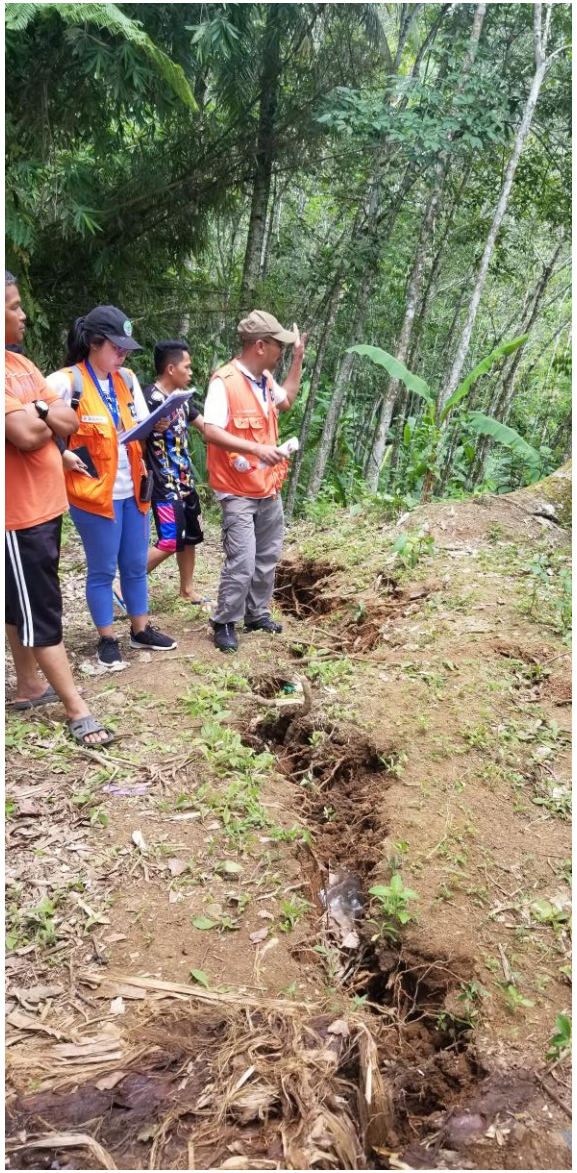
Linear crack formed dividing the basketball court with occurrence of sandboils

Sitio Labidangan, Brgy. Upper Bala, Magsaysay, Cotabato

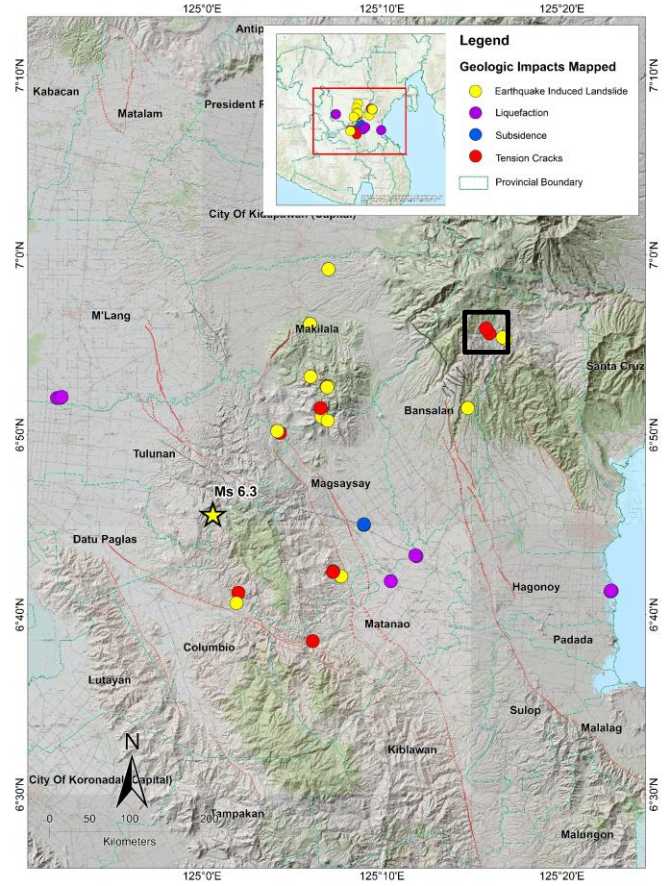


Out of 74 houses (wooden and semi-concrete houses), 25 houses were totally damaged and 36 heavily damaged because of poor construction and was affected by tension cracks.

Sitio Labidangan, Brgy. Upper Bala, Magsaysay, Cotabato

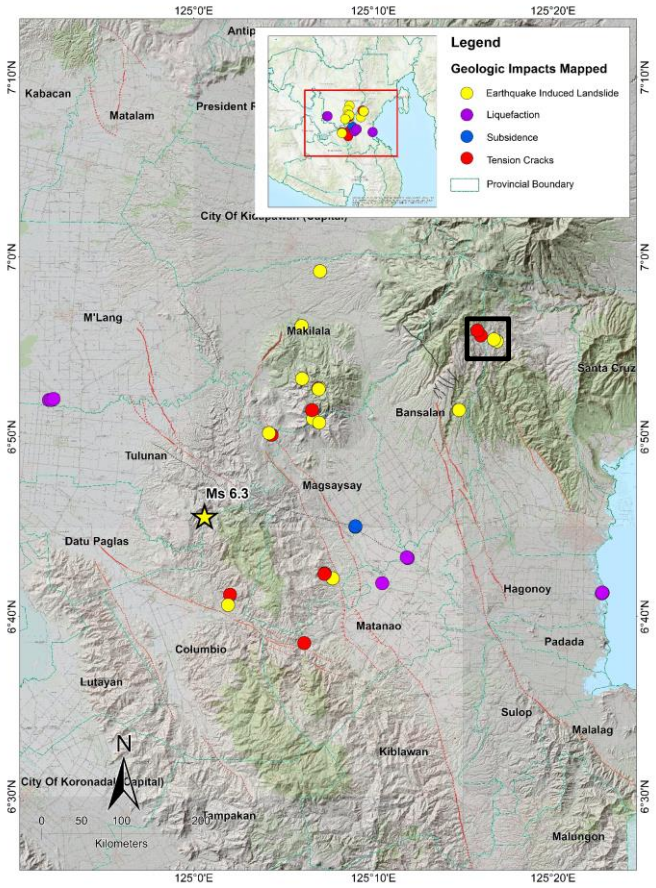


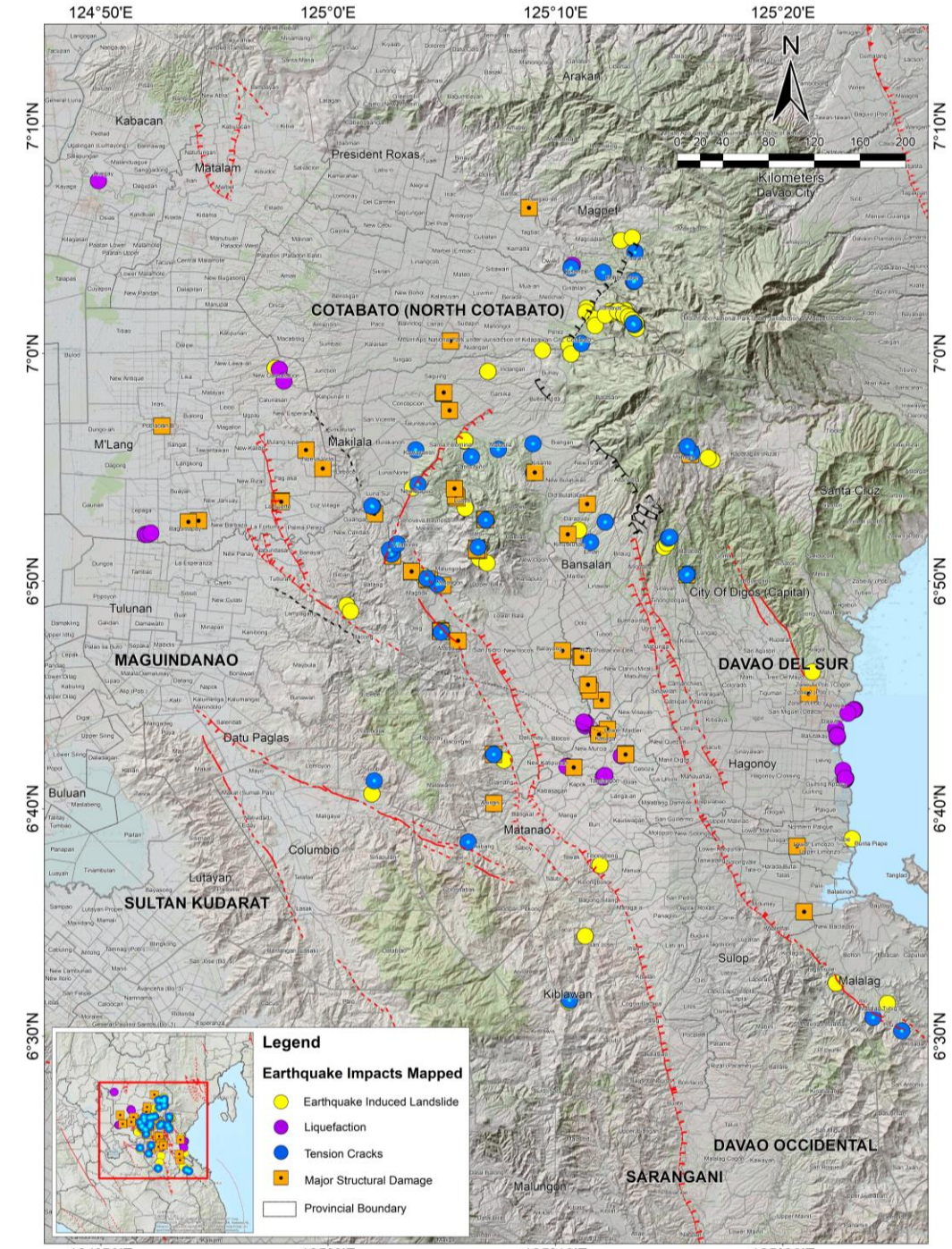
Purok Venus, Brgy. Managa, Bansalan, Davao del Sur



Shallow-seated landslide crown is approx. 8 m away from the national road with presence tension cracks.

Purok Venus, Brgy. Managa, Bansalan, Davao del Sur





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Earthquake Impacts – Summary

Province	Municipality	Landslides	Tension Cracks	Lique-faction	Damages
		No. of Barangays Affected			
Cotabato	Kidapawan City	1			
	Alamada				1
	Aleosan				1
	Antipas	1			
	Arakan	1			
	Kabacan			2	1
	Makilala	11	2	1	12
	M'Lang	1	1	2	3
	Magsaysay	3	1		6
	Midsayap				1
	Pikit			3	1
	Tulunan	2	1		2
Davao Del Sur	Digos City				1
	Bansalan	4	3		3
	Hagonoy			1	
	Matanao	2	1	2	4


Makilala

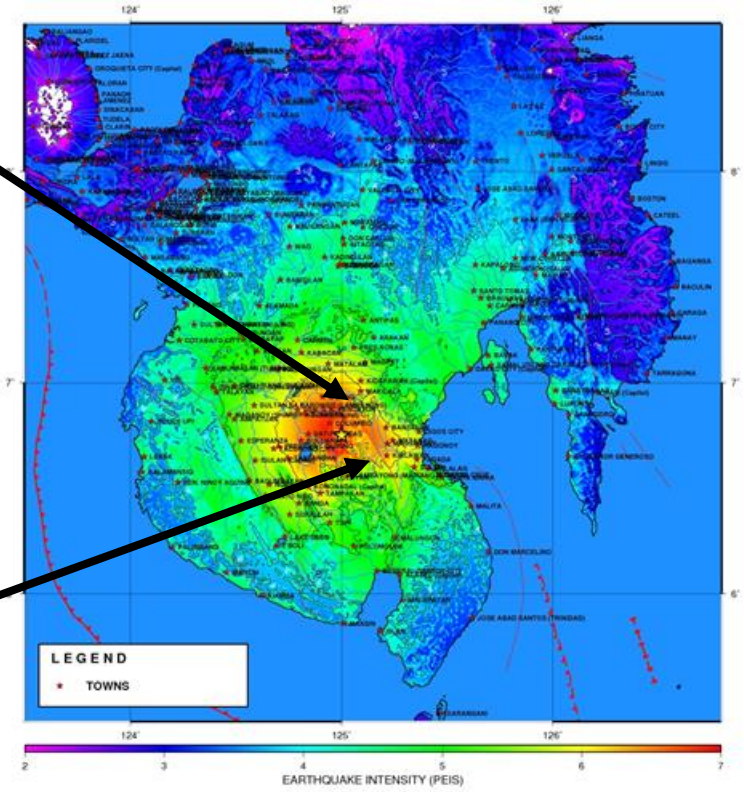

Digos City

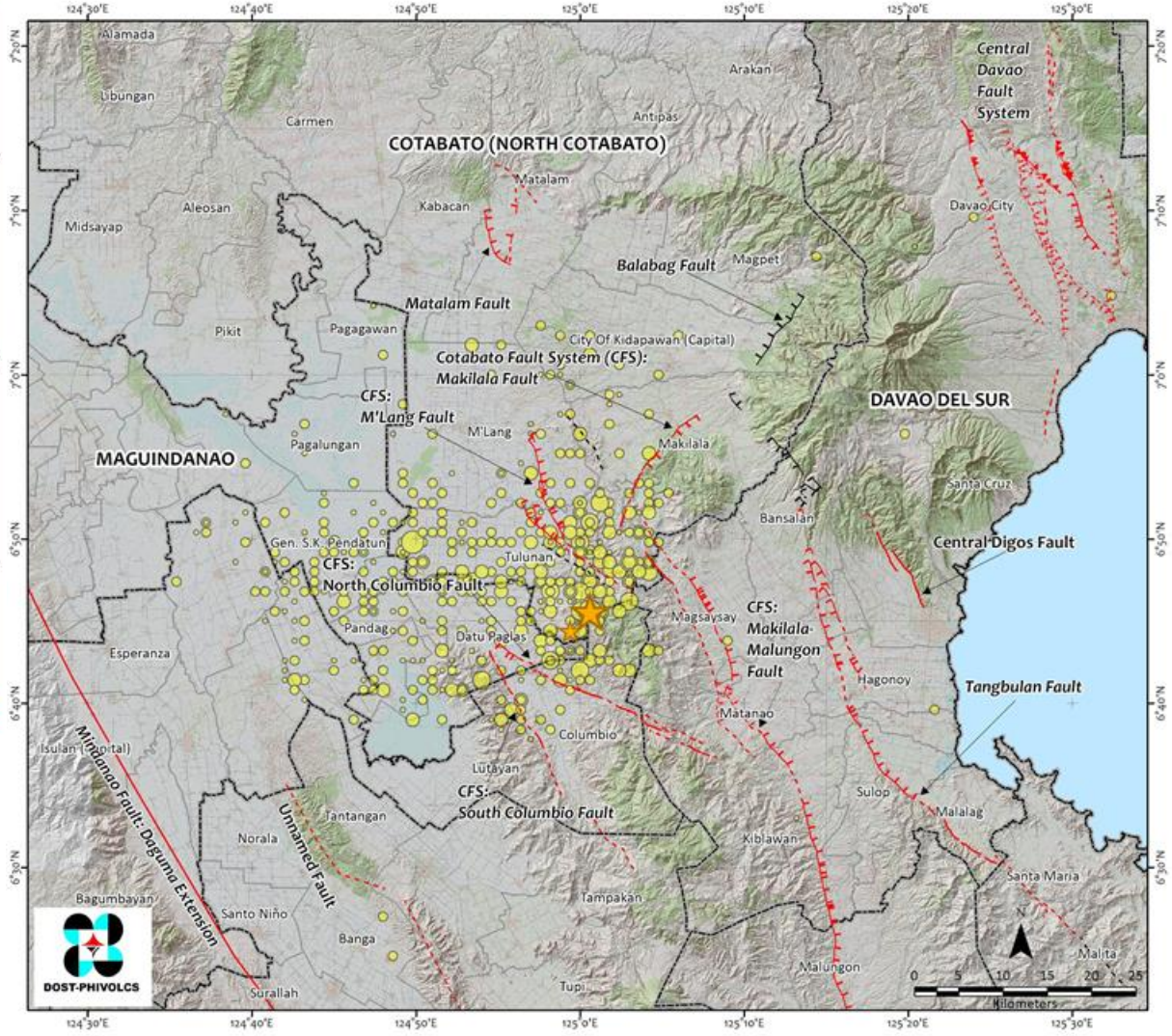
16 October 2019 M6.3 Tulunan, Cotabato Earthquake

Location: 23 km S62°E of Tulunan, Cotabato (9 km depth)

Magsaysay Municipal Hall

Brgy. Paraiso Birthing Hall



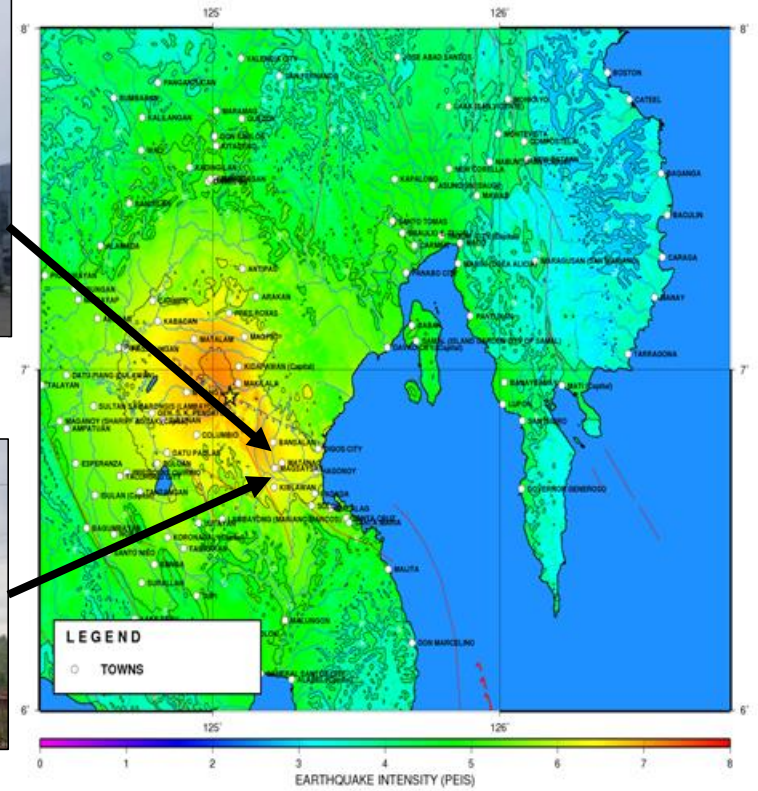


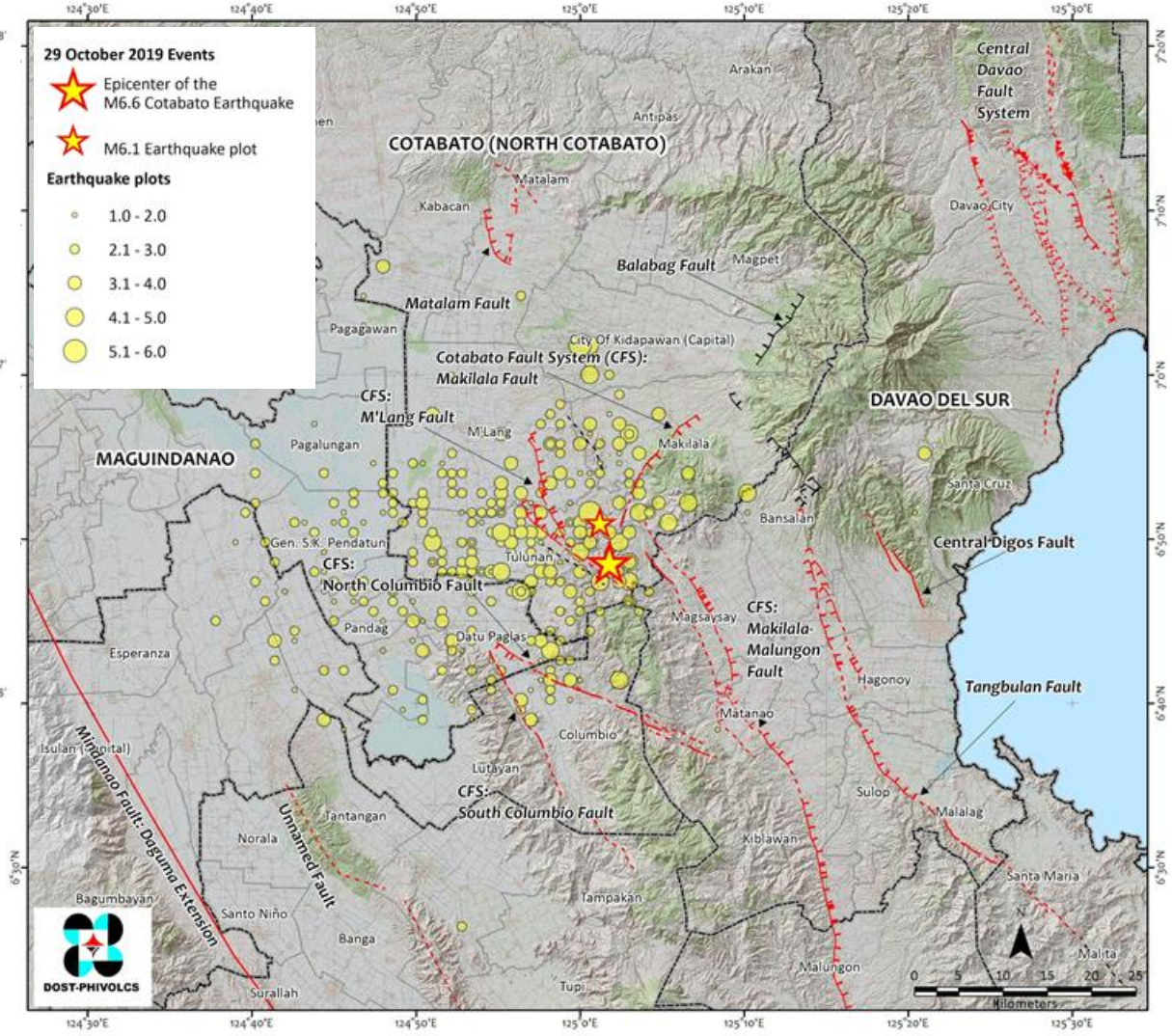
29 October 2019 M6.6 Tulunan, Cotabato Earthquake

Location: 22 km S79°E of Tulunan, Cotabato (7 km depth)

Magsaysay Municipal Hall

Brgy. Paraiso Birthing Hall





Earthquake Impacts: Ground Shaking

Eva's Building before the earthquakes. (Photo © 2019 Google, taken March 2016)

Eva's Building damaged during the October 31 2019 M6.5 event. Photo by the PHIVOLCS QRT (10312019)

Earthquake Impacts: Damaged buildings


M6.3 (16 October 2019)


M6.6 (29 October 2019)

Daig Elementary School,Tulunan, Cotabato


M6.5 (31 October 2019)

Earthquake Impacts: Damaged buildings

Makilala DRRMO after the 16 October 2019 M6.3 (left) and 29 October 2019 M6.6 (right) earthquakes

Earthquake Impacts: Ground Shaking

Totally collapsed house in Brgy. Sto. Nino, Makilala

Totally collapsed house in Brgy. Kisante, Makilala

Earthquake Impacts: Ground Shaking

Major damage with collapsed CHB wall in mixed-material house in Brgy. Asinan, Matanao

Completely collapsed CHB house that was constructed on a steep area in Brgy. Asinan. Tension cracks were also observed in front of this house.

Earthquake Impacts: Ground Shaking

A structure that was not damaged by the recent earthquakes

Wooden house built near the liquefied area in Poblacion, Matanao was able to withstand both the M6.6 and M6.5 quakes

Earthquake Impacts: Liquefaction

Lateral spread that appeared in Brgy. Tamlangon after the M6.6 earthquake that has worsened after the M6.5 earthquake

Sandboils observed in Brgy. Tamlangon after the M6.6 earthquake

Earthquake Impacts: Liquefaction

Lateral spreading in Brgy. Aplaya, Hagonoy, Davao del Sur

Earthquake Impacts: Damaged roads

These segments of the national road in Brgy. Kisante, Makilala, Cotabato were damaged after the M6.5 event

Earthquake Impacts: Earthquake-induced landslides


Landslide in Brgy. Bato and Malabuan
(photo from aerial survey, 10312019)


Landslide in Brgy. Bato and Malabuan
(photo from drone survey, 10312019)


Landslide in Brgy. Buhay, Makilala

COTABATO FAULT SYSTEM EARTHQUAKE GEOHAZARDS

Legend

Earthquake-Induced Landslide (EIL)

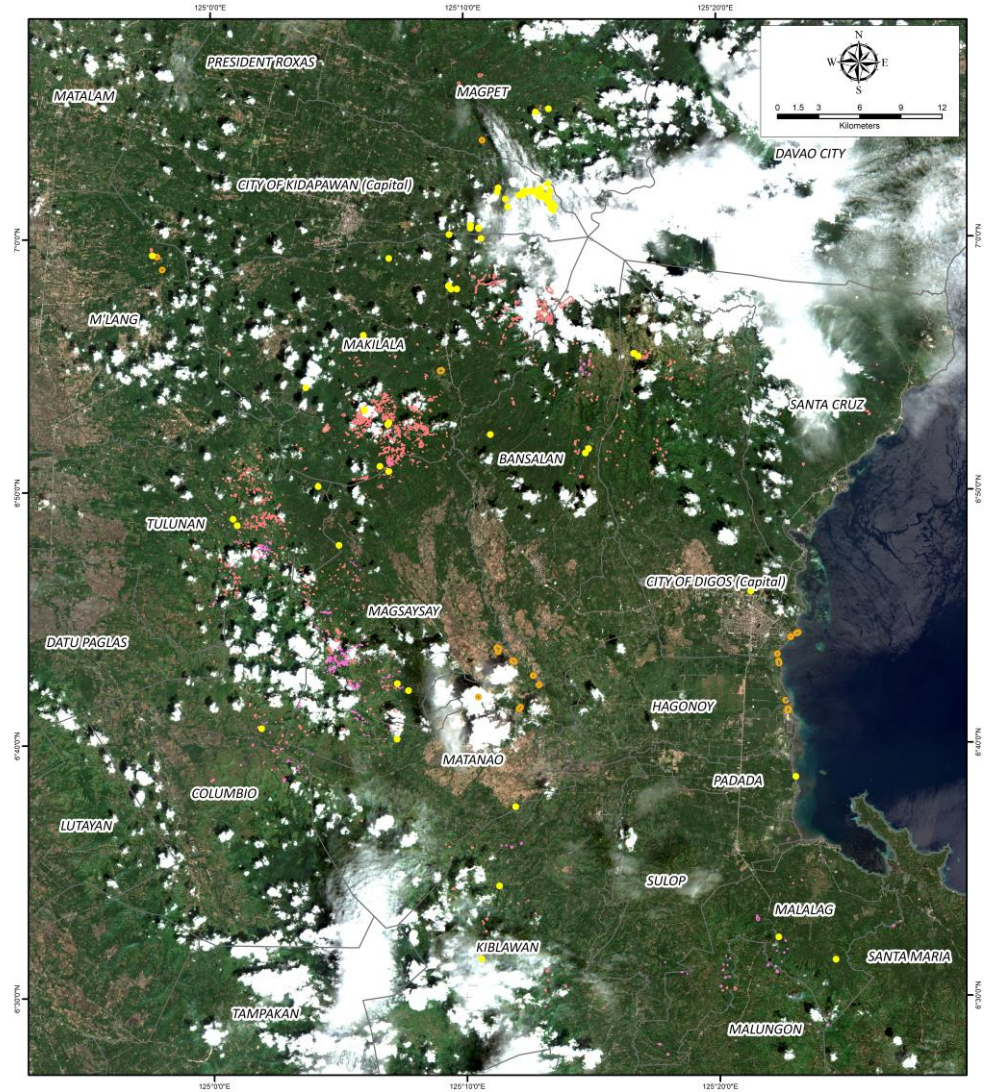
- EIL Survey Points
- EIL Oct.16 Event
- EIL Oct. 29/31 Event

Liquefaction

- Liquefaction Survey Points
- Liquefaction

Administrative Boundary

- Municipal Boundary



Legend

Earthquake-Induced Landslide (EIL)
- EIL Survey Points
- EIL Oct.16 Event
- EIL Oct. 29/31 Event

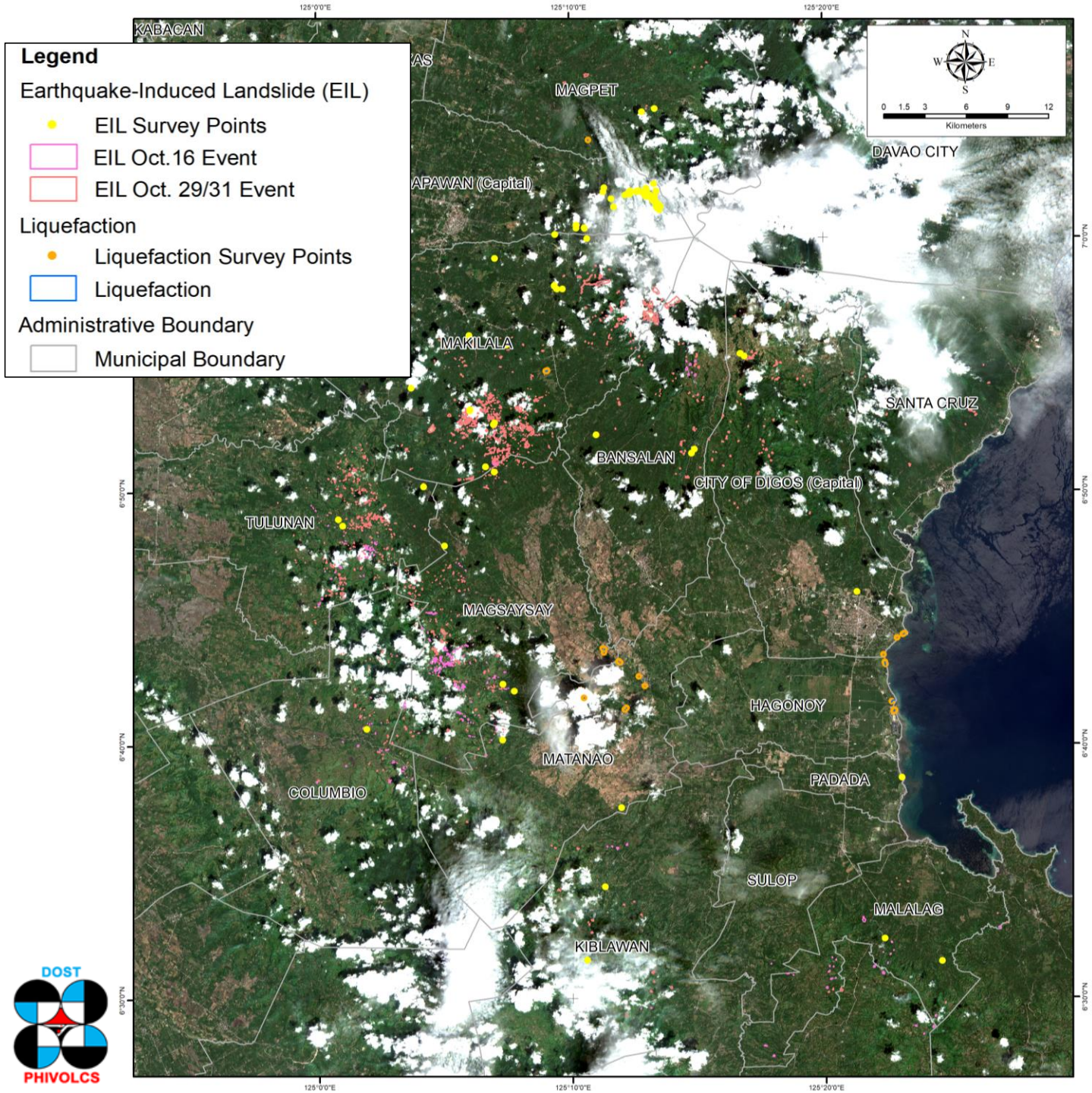
Liquefaction
- Liquefaction Survey Points
- Liquefaction Inventory

Administrative Boundary
- Municipal Boundary

DATA SOURCES:
Sentinel-2B Imagery © ESA (2019), 08 November 2019
Administrative boundary from PSA, 2016
Earthquake-Induced Landslide and Liquefaction Delineation based from PHIVOLCS-Quick Response Team, 2019

MAP PRODUCED BY:
Department of Science and Technology - Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS), November 2019

DOST-PHIVOLCS



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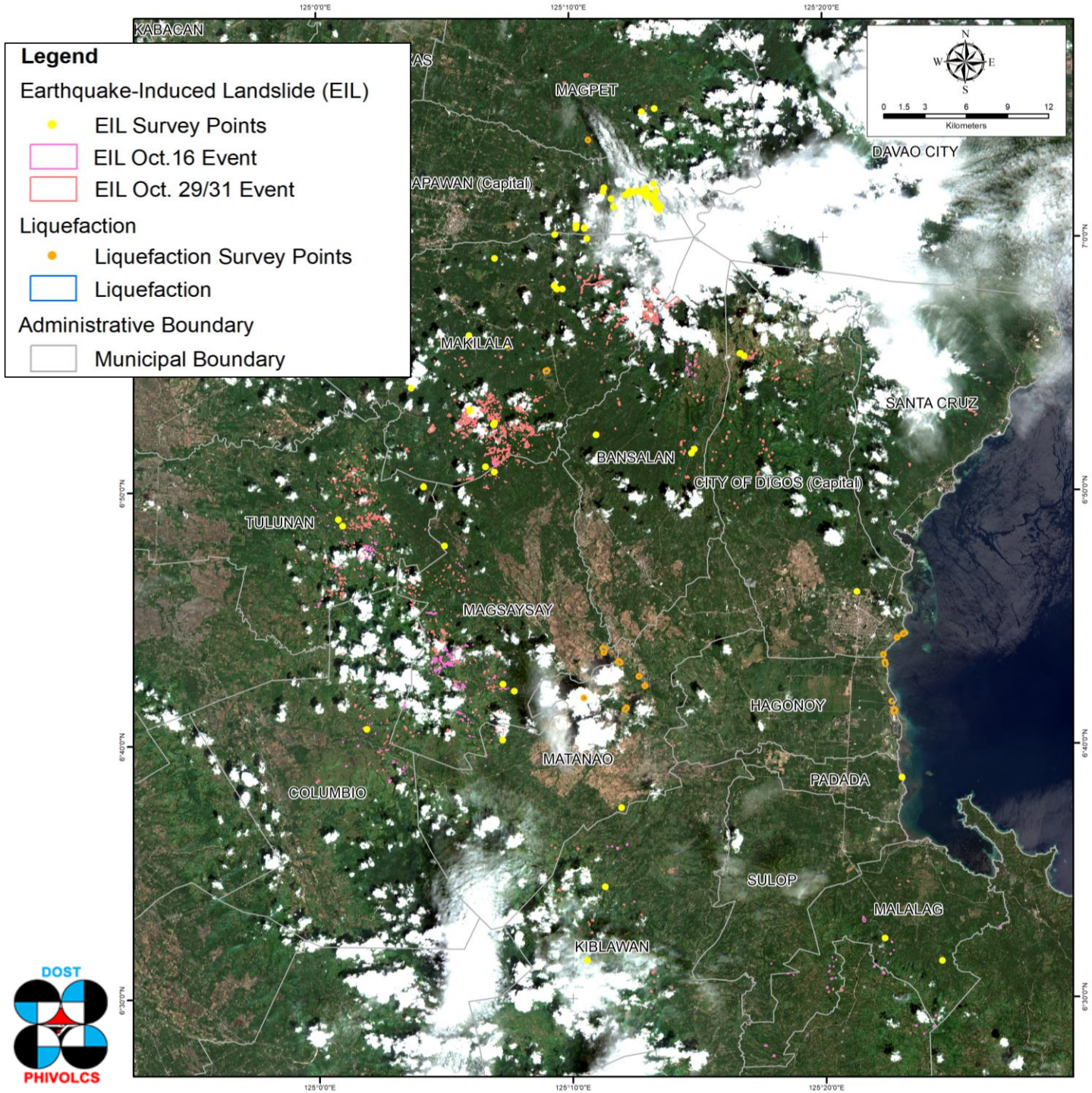
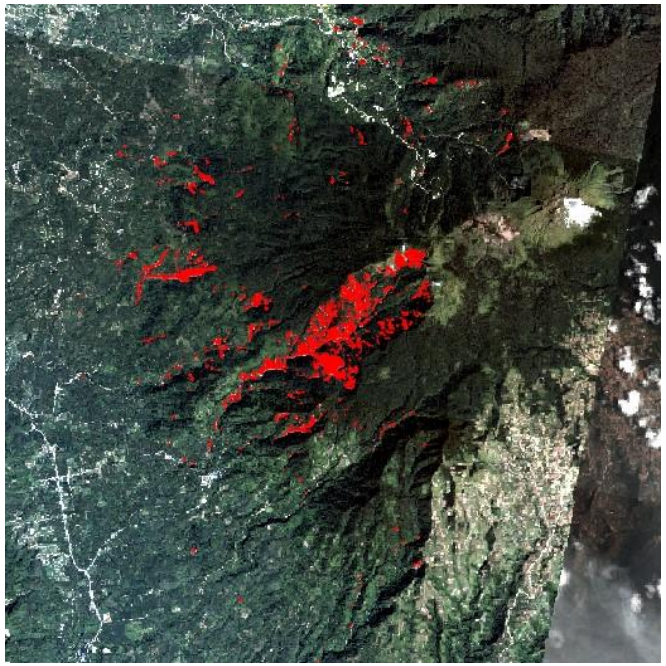
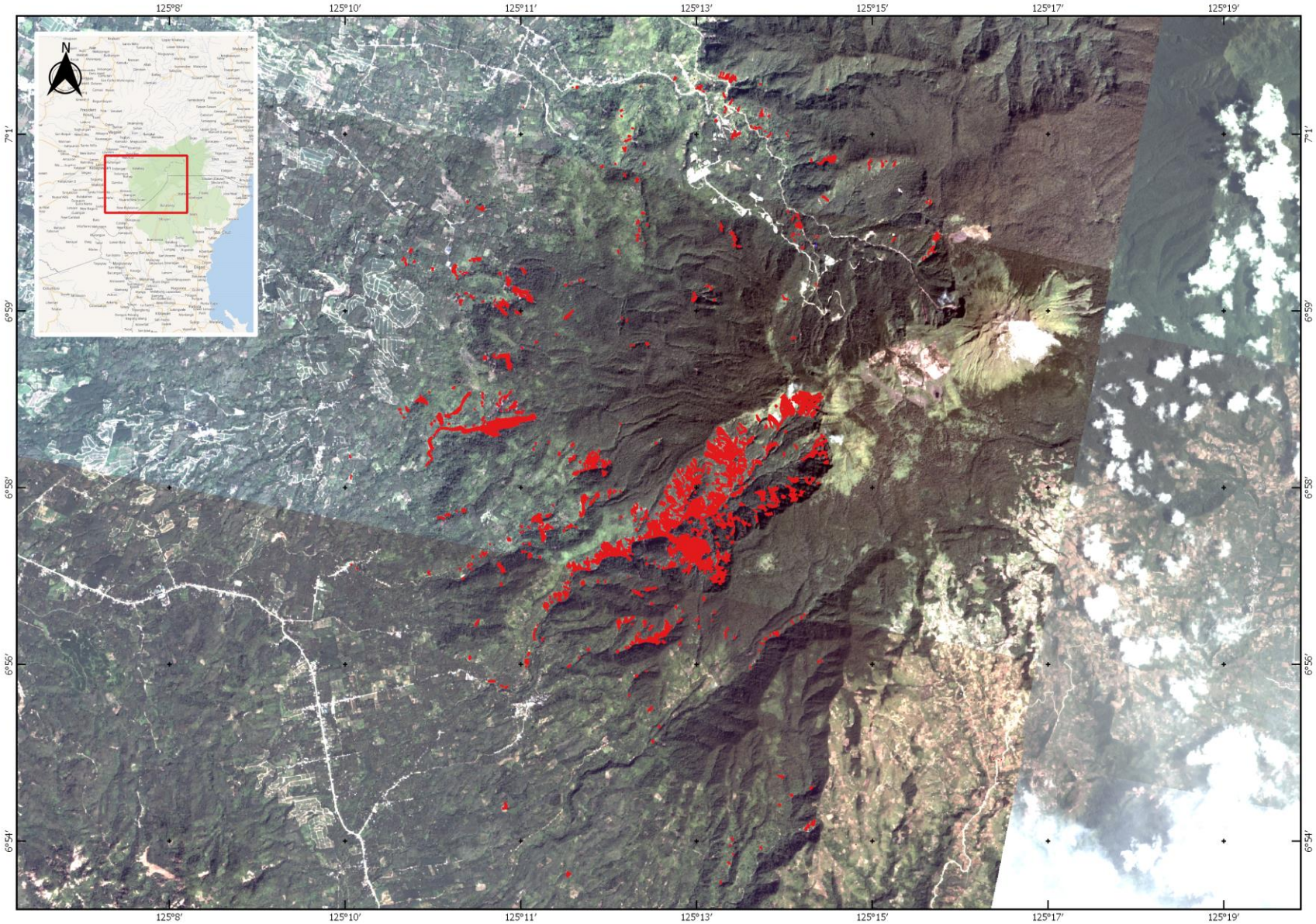




From DOST-ASTI (Makilala and Kidapawan City



Legend

Potential Landslide Areas

Cartographic Information

Coordinate System: WGS 84/UTM Zone 51N

0 1 2 3 4 5 6 km

POTENTIAL LANDSLIDE AREAS

Kidapawan City and Makilala, Cotabato as of 15 November 2019

DOST

DOST-Advanced Science and Technology Institute

Map Information

This map shows the areas potentially affected by earthquake-induced landslides in Kidapawan City and Makilala, Cotabato. The DATOS Team used its AI models to predict the baresoil and vegation cover from Planetscope satellite images. Areas with changes from vegetation to baresoil are interpreted as potential landslide areas.

Data Sources

Planet images captured on 11/09/2019 and 11/15/2019, provided by the PEDRO Center.

Recommendations

Evacuation and/or Relocation of the following due to landslide threat:

Makilala, Cotabato
1. Bgy. Bato
2. Bgy. Buhay
3. Bgy. Cabilao
4. Bgy. Luayon
5. Bgy. Sto Niño (Purok 1 & 2)
6. Bgy. Malabuan (Purok 12 and Sitio Basak)
7. Bgy. Poblacion (Purok Malaang)
8. Bgy. Malungon (Purok 2 & 7)

Tulunan, Cotabato
1. Bgy. Daig (Purok 1 / Center)
2. Bgy. Bacong (selected houses near Bgy. Hall)

Taken by PHIVOLCS QRT at Bgy. Luayon, Makilala

Drone photo taken by PHIVOLCS QRT at Bgy. Daig, Tulunan

Recommendations

Evacuation and/or Relocation of the following due to landslide threat:

M'Lang, Cotabato

Bgy. New Esperanza (Sitio Byao)

Bansalan, Davao del Sur

1. Bgy. Altavista (Sitio Sunop)
2. Bgy. Managa (Purok Pananag B)
3. Bgy. Anonang (Sitio Malupo)

Magsaysay, Davao del Sur

1. Bgy. Upper Bala (Sitio Labidangan)
2. Bgy. Malawanit (Purok 6)

Drone shot in Purok Pananag B, Bgy. Managa, Bansalan

Kidapawan City

Bgy. Ilomavis (Sitio Agco)

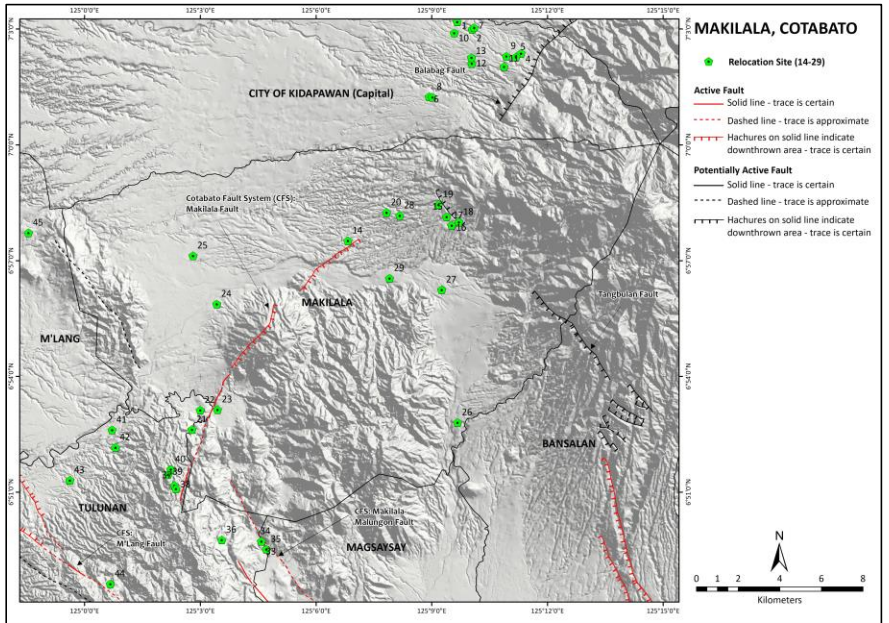
Landslide in Bgy. Malawanit, Magsaysay

Recommendations

Earthquake-Related Hazard Assessment of 45 Proposed Relocation Sites in Cotabato

1. Kidapawan City (13 sites)
2. Makilala (16 sites)
3. Tulunan (15 sites)
4. M'lang (1 site)

(as of 10 November 2019)



Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY

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HIM-Nov-19-109

11 November 2019

EMMYLOU TALIÑO-MENDOZA
Acting Governor
Cotabato Province

Dear **Honorable TALIÑO-MENDOZA:**

This pertains to your request for earthquake-related hazard assessment for the forty-five (45) proposed relocation sites for communities affected by the recent earthquakes in Cotabato Province. We are pleased to provide you the hazards assessment (in table format), including the explanations of hazard impacts and recommended actions for prevention and mitigation.

Out of the 45 sites, 37 were assessed by DOST-PHIVOLCS Quick Response Team together with DENR-Mines and Geoscience Bureau (MGB), National Housing Authority, and the LGUs. Eight (8) sites were evaluated by DENR-MGB alone. All sites will be further evaluated upon receipt of polygon-based locations.

In addition, we have attached herewith the assessment maps showing the proposed relocation sites relative to the nearest active faults in the area, for your reference. We have also included the latest Earthquake Information Primer, for your perusal. For quick conduct of hazards assessment in the future, visualization of hazards and monitoring of earthquake events, please access https://hazardhunter.georisk.gov.ph.

We hope to have provided you with the necessary information. Please do not hesitate to contact our office should you need further information or assistance.

Very truly yours,

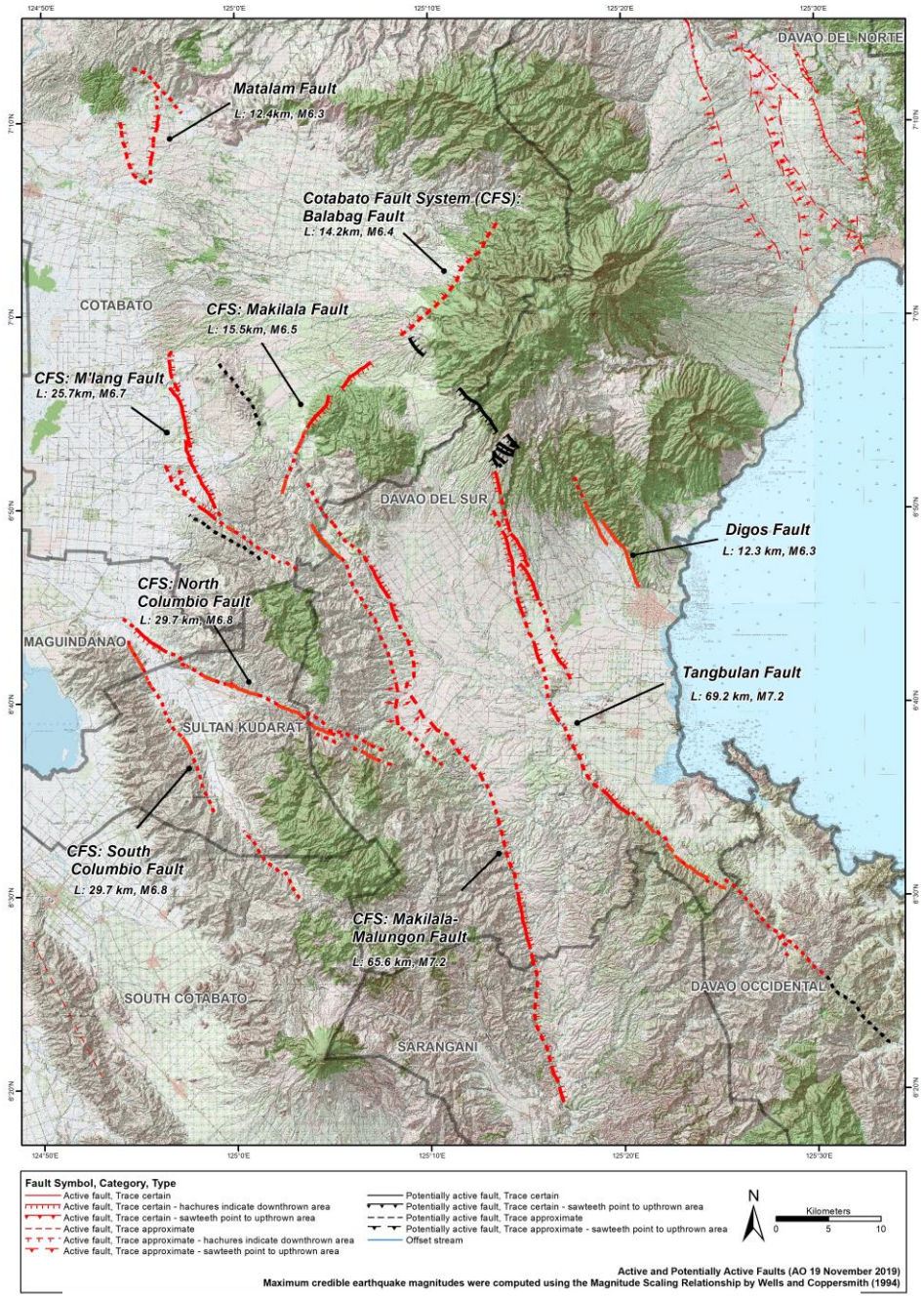
RENATO U. SOLIDUM, JR.
Undersecretary, DOST
and
Officer-in-Charge, PHIVOLCS

Postal Address: PHIVOLCS Building, C.P. Garcia Avenue, U.P. Campus
Diliman, Quezon City 1101 Philippines
Website : www.phivolcs.dost.gov.ph
Tel. Nos.: +63 2 8426-1468 to 79; +63 2 8926-2611
Fax Nos.: +63 2 8929-8366; +63 28928-3757

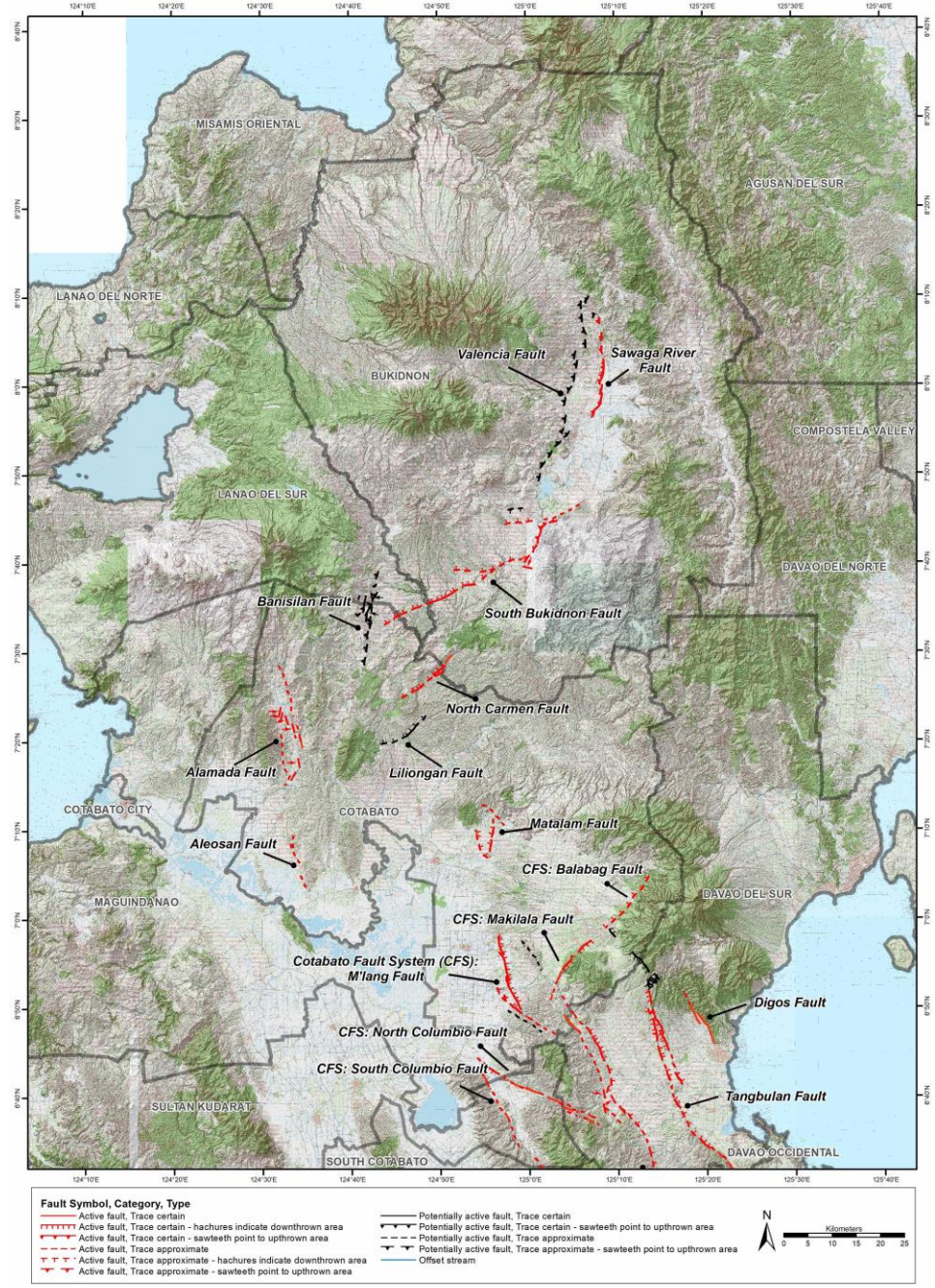
Recommendations

1. Houses and buildings, especially those with damages, should be inspected if these are still resistant to a strong shaking; those that were not damaged should be assessed if they followed the building code and can resist strong shaking; LGUs and engineering organizations should have these inspected.
2. Public should review their earthquake preparedness response during and after shaking.
3. Areas that are highly susceptible to landslides, especially those that were affected by landslides or those with tension cracks, should be avoided or vacated as strong shaking or prolonged rainfall may cause these slopes to slide.
4. Formally train local masons and carpenters on the proper construction practice and use of standard construction materials. Reconstruction or construction of houses and buildings should conform with the National Building Code of the Philippines.

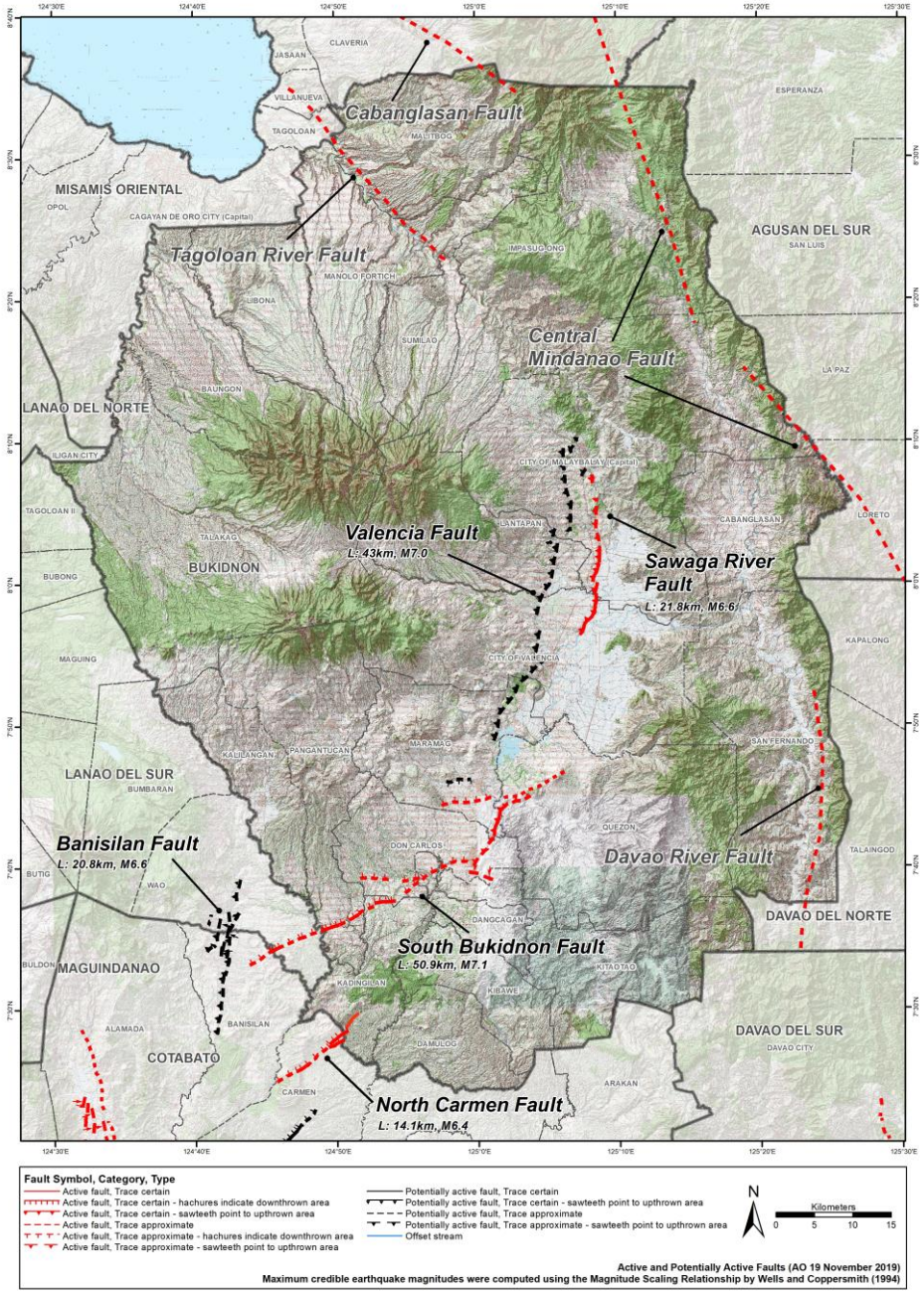
The October 2019 Cotabato Earthquake Sequence: Parameters and impacts



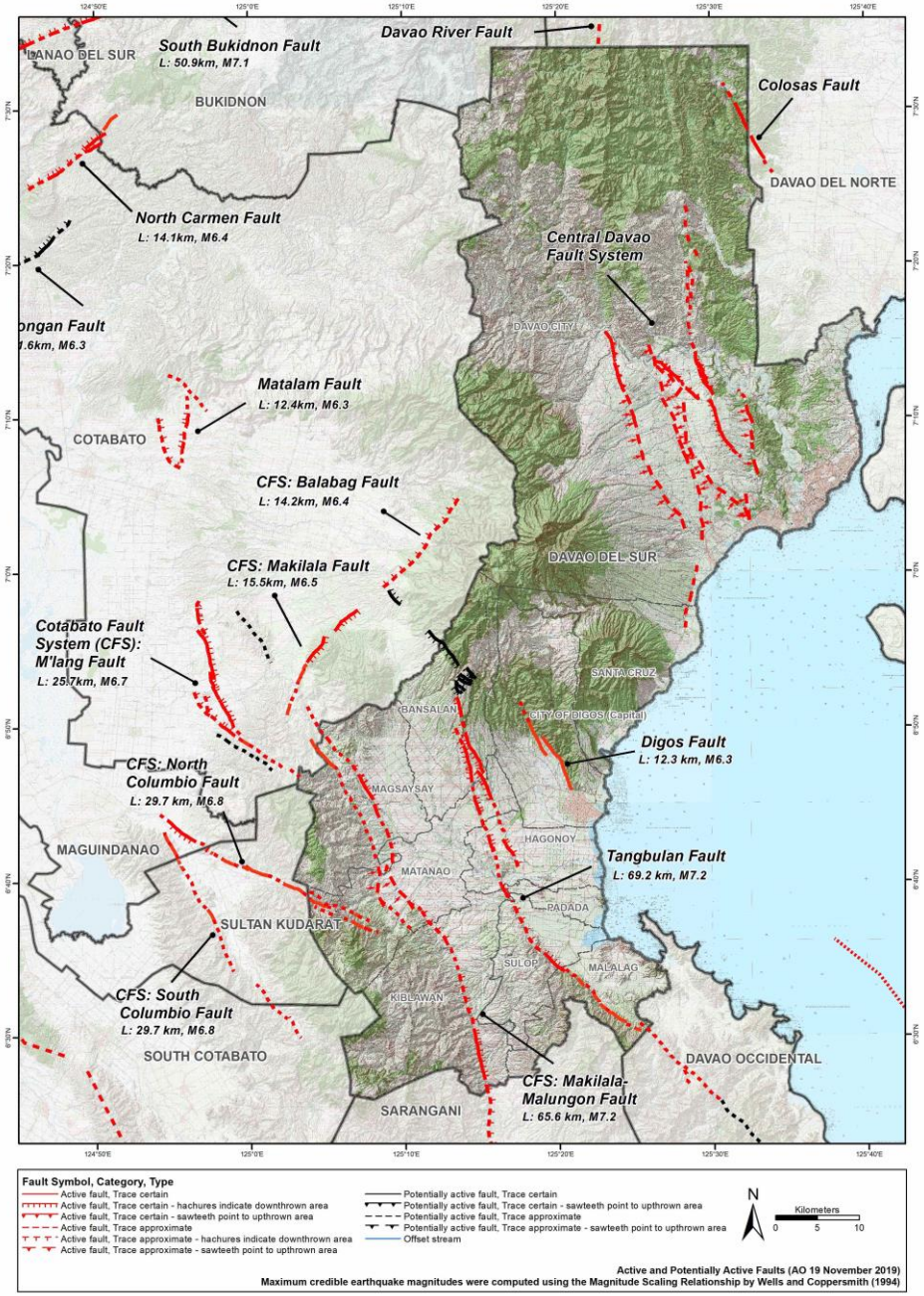
Cotabato Fault System



Bukidnon and Cotabato Active Faults



Bukidnon Active Faults



Davao Del Sur Active Faults