

B. HAZARD CHARACTERIZATION

B.1. Hydrometeorological Hazards

Cotabato has several areas identified as prone to natural hazards which are meteorological/hydrological and geological in nature. Natural hazards act as triggers to disasters and place the development of an area at risk. These include drought, flood, landslide due to earthquake or rain, tectonic earthquake, erosion and volcanic eruption.

Hydrometeorologic hazards are natural processes or phenomena of atmospheric, hydrologic or oceanographic nature, which may cause loss of life, injury, property damage, social and economic disruption or environmental degradation.

Hydrometeorologic hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches.

The types of hydrometeorologic hazard which the Province of Cotabato is exposed to are drought, floods, flashfloods and rain-induced landslides (RIL).

Floods/Flashfloods

Floods result when land is covered with water due to the overflowing of a source such as rivers and other bodies of water. It may also result from the accumulation of rainwater by drainage due to prolonged and heavy rains. Floods also lead to soil erosion and landslide of agricultural areas and denuded mountain slopes. River banks, streams or creeks are also susceptible to flooding and scouring.

Low-lying areas of Kabacan, Tulan, Pigcawayan, Libungan, Pikit, Midsayap, Carmen, Mlang, Pres. Roxas and Alamada are highly susceptible to flooding. These areas are classified as key rice production areas. With the occurrence of flood, the staple food production is greatly affected. While the upland portions of Alamada, Makilala and Kidapawan City which are areas planted with high value crops have also experienced occasional flashfloods both induced by heavy rains and depleted forest cover.

Based on the Hazard Map generated by MGB XII, 341 barangays in the province are highly susceptible to flood. Of the total land area of the province (656,590 hectares) 149,345.37 or 22 % is considered highly susceptible to flooding. Most of these barangays are situated in the low lying areas of the municipalities of Carmen, Kabacan, Libungan, Magpet, Kidapawan City, M'lang, Makilala, Matalam, Midsayap, Pikit, Pigcawayan, Pres. Roxas and Tulan. This is aggravated by the clogging of the

Ligawasan Marsh by water hyacinth causing backflow thus flooding areas along the marsh. Most affected are rice farmers and fisherfolks.

Flooding hazard in the province usually is present in the low-lying barangays but is more damaging in those that are along the periphery of Ligawasan Marsh.

Those that are rated as moderately susceptible are some barangays in the municipalities of Matalam, Pigcawayan, Makilala, Magpet, Banisilan, Kidapawan City, Alamada, and Antipas. Most vulnerable are those areas or communities along major tributaries. The siltation of these rivers makes it more prone to overflowing because of their decreased capacity to hold water.

The least that are affected by flooding are municipalities in the higher portions of Mt. Apo, however they are also prone to landslides and erosion.

In some areas, flooding could be attributed to defective drainage system, poor waste management and cultural practices.

Flooding causes heavy damages on crops, such as rice and corn, vital transport infrastructure facilities and housing and shelter made of light materials were commonly reported to have been affected specially along mountainous communities. Among others, in the upland areas were the erosion of mountain soils and other soils nutrients so important to sustain agricultural production.

Erosion and Landslide

Erosion and landslide refers to the slipping of a mass of land from a higher to a lower level. These may be caused by continuous heavy rain over high-elevated areas, especially denuded ones.

Rain-induced landslides (RIL) are downward and outward movement of materials including rock and soil due to various causes such as excessive rain, rapid undercutting by rivers, waves or man's activities.

Rain Induced landslide usually occurs especially during heavy rains or wet months. Mass movement and erosion are likely to happen in hilly and mountainous terrain due to soil saturation. Farming activities on the slope toes are high risk of being hit by landslide. The down slope movement of masses of earth materials may cause damages to life and poverty.

The rating parameters are as follows:

High

- Presence of active and/or recent landslides
- Presence of numerous and large tension cracks
- Areas with drainage that are prone to debris damming
- Areas with numerous landslides/escarpments

- Steep slopes
- Presence of weak/rock slope materials
- Structures (joints, beds) dipping towards the slope face
- Nearness to faults

Moderate

- Areas with indicative and/or landslides
- Presence of small tension cracks
- Moderate slopes

Low

- Low to gently sloping
- No evidence of mass movement

All municipalities of the province having areas with very steep slopes are prone to landslides. Kidapawan City is one of the landslide prone areas particularly the steep slopes of the upstream of Marbel River along Sitio Tinago, Mandarangan and Sudduhayan. Other areas which are highly susceptible to severe erosion are located in Libungan, Alamada, Banisilan, Carmen, Antipas, Magpet, Pres. Roxas, Arakan, Tulunan and Makilala. There is a need to control growth and urbanization in these areas to avoid the occurrence of disasters.

Those abovementioned areas which are highly susceptible to landslides are considered areas prone to erosion. This environmental concern is caused by unsustainable vegetation.

The erosion problem in the province has reached frightening levels, over the past 10 to 15 years, 23 percent of the land area, or 149,072.40 hectares, affecting some 340 barangays has been severely eroded and only 11.4% or 75,260.34 hectares remains stable from erosion. Eighteen percent or 73,796.77 hectares (319 brgys.) are moderately eroded while an area of 273,705 hectares or 42% has been estimated to have been affected with slight erosion more or less covering 261 barangays provincewide.

This environmental problem is very alarming for it destroys soil fertility and affects so much the yield of important crops planted in the province such as plantations of high value crops of rubber, coconut, banana and other fruit trees, including the most important food crops such as rice and corn which are the major crops of our farmers. This trends calls for the appropriate and immediate attention on the part of concerned authorities / agencies.

Similarly, denudation of remaining forest cover in the province mostly found in the municipalities of Arakan, Libungan, President Roxas, Makilala, Magpet and the municipality of Alamada has become a major environmental concern in the P-PALMA and Arakan Valley Complex.

The unabated “kaingin” (charcoal production) practices and the illegal and unregulated logging threaten the environment of the place affecting approximately 60 % of the total land area of the province which has a great impact and poses a greater threat to the efficient production activities in the low lying areas of Cotabato.

Areas Susceptible to Flooding

The table below shows the flood susceptibility areas in the province. There are instances when a barangay has portions that are considered at high, moderate and low susceptibility rating.

The areas are considered as the Special Area for Agricultural Development Zone of the province mainly planted with major crops like palay, corn and coconut. Some of these areas are presently planted with rubber, banana and oil palm. Since the occurrence of these floods, agricultural activities were greatly affected and the provincial economy was hampered.

The occurrence of flood and landslide is unpredictable but is likely to happen during heavy downpour in the province as well as the neighboring provinces that will be the result of water runoff among rivers.

Table 2. Flood Susceptibility

Municipalities	Susceptibility						Total Affected Area (Has)
	High		Moderate		Low		
	No. of Brgys.	Area (Has.)	No. of Brgys.	Area (Has.)	No. of Brgys.	Area (Has.)	
Alamada	6	1,748.12	13	23,449.64	17	48,820.16	75,766.03
Aleosan	13	2,503.73	4	632.30	19	12,260.32	15,396.35
Antipas	2	364.38	13	17,235.80	11	4,022.19	21,622.37
Arakan	0	0.00	27	9,503.22	27	13,530.75	23,033.96
Banisan	2	158.64	20	25,984.09	16	10,959.22	37,101.95
Carmen	16	5,389.54	26	35,586.86	14	17,510.14	58,486.54
Kabacan	22	17,417.49	1	79.38	9	4,189.94	21,686.81
Kidapawan City	10	2,535.03	40	19,387.28	6	550.50	22,472.81
Libungan	19	3,976.35	16	6,533.56	11	8,571.78	19,081.69
Magpet	4	1,014.49	22	8,078.07	16	6,169.90	15,261.46
M'lang	33	24,251.20	20	11,163.80	0	0	35,415.00
Makilala	12	4,215.26	35	15,830.01	13	2,454.08	22,499.36
Matalam	27	11,464.36	25	8,866.73	9	7,970.44	28,301.53
Midsayap	53	19,273.22	7	1,127.67	20	3,867.39	24,268.29
Pigcawayan	38	8,867.35	25	2,650.03	2	742.01	12,259.38
Pikit	42	24,754.89	1	203.58	15	6,676.35	31,774.25
Pres. Roxas	16	4,434.75	15	9,598.06	14	6,595.71	20,628.52
Tulunan	26	16,976.57	15	16,281.35	7	4,469.54	37,727.47
TOTAL	341	149,345.37	325	205,657.87	226	159,360.42	522,783.77

Table No. 3. Historical Hazard Occurrences and Description					
HAZARD AND DESCRIPTION	AFFECTED AREA/POPULATION		IMPACT		
	Barangay	Population	No. of Casualties	No. Of Houses Damaged	Damage to other Properties
FLOOD/FLASHFLOODS					
1. June 9, 2010 -Continuous rainfall & backflow of water from Rio Grande which resulted to flooding of low lying communities and Increasing number of IDP	Bulacaon, Kadingilan, Bulucaon, LibunganTorreta, Datumantil, Lower Bager, Buricain, Malagakit, Tubon, Simsiman, Banucagon, Matilac, Upper Pangangkalan, Lower Pangangakann, Cabpangi, Balacayon	2,390 families (11789 persons) displaced	1 drowned		
2. A strong rain started on June 9, 2011 @ 3:45 pm and lasted for about 2 hours and 20 mins. The water from upland areas flows to the low land and causes flood in 10 barangays of the municipality of Tulan. Some of the residence has evacuated but some decided to stay on the higher ground near their houses.	Bacong (river banks), Galidan, La Esperanza, Sibsib, Poblacion, New Panay, Dungos, Popoyon, Bual, Damawato, Tambac, Minapan, Nabundasan, Bagumbayan, Banayal, Bituan, Bual, Daig, F. Cajelo, Kanibong, New Culasi	4531 families (13593 persons) displaced			Rice & corn crops
3. June 14, 2011- It started with a heavy rain due to typhoon Cheding and typhoon Dodong affecting 14 brgys of Midsayap. Flood rose from knee to waist deep damaging houses and submerging crops	Mudseng, Rangaban, Kadigasan, Baliki, Nabalawag, Palongoguen, Kadigasan,Kudarangan, Macasendeg, Olandang, Lomopog, Damatulan, Sambulawan, Tumbras	5,998 families (29,990 persons) displaced		88	Rice & corn crops

<p>4. June 9, 2011 - a flash flood occurred at 13 brgy's in the Municipality of Mlang after days of heavy rainfall affecting houses, farms, household of residents</p>	<p>New barbasa, Bagontapay, Buayan, Langkong, Dugong, Sangat, Dungoan, Inas, Bialong, Lika, New Antique, Tibao, Lepaga, Tawantawan, Malayan, Katipunan, New Antique, New Consolacion</p>	<p>1,092 families (4,250 persons) displaced</p>			
<p>5. June 6, 2011 - Heavy rains from 3:00 pm until 9:00pm caused the rise of water level in Binay, Magpet. Idaoman river is the receiving point of the water both from Binay rivers & Logdeck creek. There were 47 households along the riverside that were affected. Although there was no casualty, most of their belongings, and farm animals including the pipes of their water system were carried away by the strong current of flood waters. Eight houses were severely damaged.</p>	<p>Idaoman, Cabangbangan, Greenhills, Poblacion, Mabuhay, Poblacion 5,8,9,9a,11,18, Tuel</p>	<p>726 families (1,305 persons) displaced</p>		<p>140</p>	<p>Rice, corn</p>
<p>6. June 2011. CARMEN. Accumulation of water from Bukidnon and Kabacan Rivers connecting the main Rio Grande River that causes flashflood</p>	<p>Gen. Luna, Nasapian, Kibayao, Palangalan, Tacupan, Tupig, Ugalingan</p>	<p>1914 families (10,379 persons) displaced</p>			
<p>7. August 4, 2008. M'LANG. A Flashflood occurred in the municipality of Mlang around 8 pm after heavy rains. 18 barangays were affected including Pob. A & B caused by Mlang River overflow. Several homes were damaged, families displaced & livestock projects affected and infrastructure.</p>	<p>Poblacion A & B, Inas, PulangLupa, Pag-asa</p>	<p>390 families & 1950 persons</p>	<p>1 dead & 3 injured</p>		

<p>8. Aug. 1, 2009. ALAMADA. Accumulation of water due to prolonged heavy rain and overflowing from the rivers connecting to Cotabato City and land erosion of Bgy.Mirasol in Alamada North Cotabato</p>	<p>Bgys of Buluan, Cabpangi, Bulucaon, Capayuran, Kimarayag, Midpapan 1, New Panay, North Manuangan, Pob. 1, Pob. 2, Pob 3, Presbitero, Upper Baguer, Tubon& Prado-Pigcawayan, Bgy. Sinimulang – S, Baguer&Gumaga – Libungan, Central and Upper Labas -Midsayap, North Cotabato</p>	<p>1450 families & 7837 persons</p>	<p>5 dead, 3 injured and 1 missing</p>		
<p>9. Heavy and continuous rain for successive days resulted to the overflowing of Pagalungan and Paidu Pulangi Rivers. The flood have severely caused damages to people, properties, crops, livelihood and hampered the delivery of basic services to 42 barangays of Pikit</p>	<p>Bagoinged, Balabak, Balong, Barungis, Balungis, Batulawan (SitiPunol), Bualan, Buliok, Bulod, Bulol, Dalingaoen, Damasalak, Fort Pikit, Gli-gli, Gokotan, Inug-ug, Kabasalan, katilakan, kilambog, Lagunde, Langayen, Macabual, Macasendeg, Manaulanan, Nabundas, Nunguan, PaiduPulangi, Pamalian, Panicupan, Punol, Rajamuda, Silik, Takepan, Talitay, Tinutulan</p>	<p>10,793 families (49,886 persons) displaced</p>	<p>1 dead</p>		<p>corn & palay crops</p>
<p>10. Flash flood usually occurs during the month of May, June, July-August and September. The low-lying barangays of Pikit are the most seriously affected owing to its proximity to Ligawasan Marsh</p>	<p>34 barangays affected by flash flood. The remaining 8 barangays were considered sloping/upland barangays</p>				<p>1. corn- 1,064 has. 2. Palay- 997 has 3. Vegetable s- 20 has</p>
RAIN INDUCED LANDSLIDE					
<p>Makilala. 3 km Crack Landlines caused by heavy rain</p>	<p>Leboce, Biangan, New Bulatukan, Villaflores, Cabilao, Bulakanon, San Vicente, Malungon, Guangan, Rodero</p>				<p>collapsed road</p>

GROUND RAPTURE					
Alamada in 2000	Brgy. Guling, Sitio Maracabac	5 families	2 houses		
Makilala in 2008	Brgy. Kisante		2 houses		200 m roads
EARTHQUAKE INDUCED LANDSLIDE					
Makilala. Land Cracks	Malasila	3 families	3 houses		

Flooding/Flashflood in Municipality of Pigcawayan, July 2009



Source: Provincial Social Welfare & Development Office

Drought

Drought is a condition of an abnormally dry weather within a geographic region which may extend to many months or years. The immediate cause of drought is rainfall deficit although there could be other causes such as the incursion of warm surface waters into the normally colder waters; human-induced changes in ground surface and soil; increased atmospheric carbon dioxide and greenhouse gases. Cotabato Province experienced drought in the 1994, 1998, 2002 and in the early part of 2010.

The experienced drought in Cotabato Province resulted to the lack of food to some residents in the province due to hampered crop production. Some people in the hinterlands opted to eat wild yam (kayos) and other root crops for survival. This wild yam contains poisonous substance but is edible if properly prepared but this resulted to deaths to some children considering their less resistance to toxic substances.

B.2. Geologic Hazards

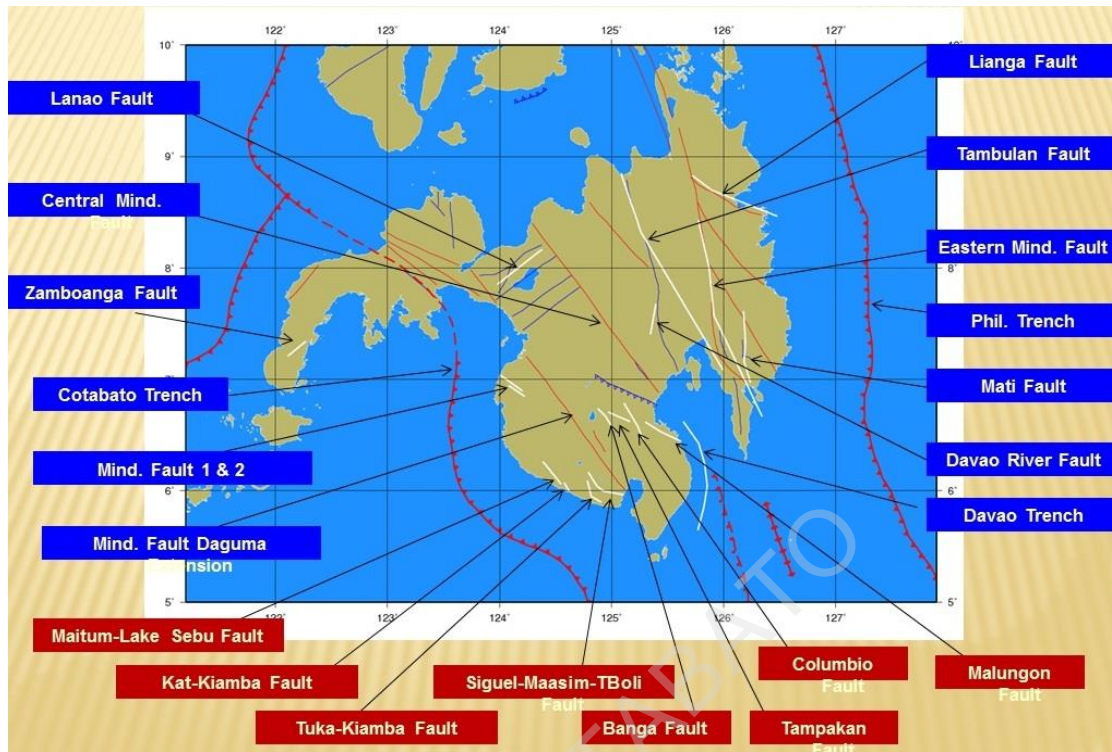
Geologic hazards results from geologic processes acting on or beneath the earth's surface. These include movement of plates in the earth's crust or from local concentrations of heat and are a source of hazards to people and their natural and built-up environment on the earth's surface. The types of geologic hazard which the Province of Cotabato is exposed to are: earthquake and earthquake-induced hazards such as ground shaking, liquefaction, and earthquake-induced landslide (EIL).

Earthquake

An earthquake is a weak to violent shaking of the ground produced by the sudden movement of rock materials below the earth's surface. Earthquakes are caused either by the sudden movement along faults and trenches (tectonic), or by movement of magma beneath volcanoes (volcanic).

There are active faults that traverse the Province of Cotabato. There are likewise numerous active faults in the main island of Mindanao which may affect the Province. The municipalities of President Roxas, Antipas, Magpet and Arakan are proximate to the Central Mindanao Fault. Faults and trenches are also known as the "earthquake generators".

Map No. 4: Active Faults and Trenches Map in Mindanao



Ground Shaking/Liquefaction

The main hazard created by seismic earth movements is ground shaking. This term is used to describe the vibration of the ground during an earthquake.

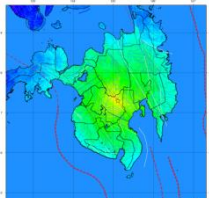
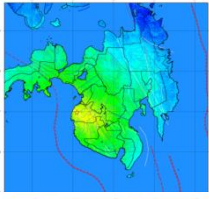
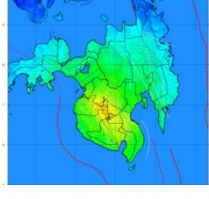
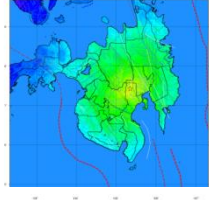
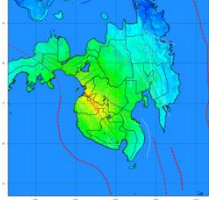
Liquefaction is a process where particles of loosely-consolidated and water-saturated deposits of sand are re-arranged into a more compact state. This results in the squeezing of water and sediments towards the surface in the form of “sand fountain” and creating a condition resembling a “quicksand”. In this phenomenon, the strength of the soil is reduced to a point where it is unable to support structures.

The severe shaking in an earthquake can cause natural slopes to weaken and fail, resulting to landslides. Earthquake-induced landslides can be divided into three main categories: disrupted slides and falls, coherent slides, and lateral spreads and flows.

The Philippines uses the PHIVOLCS Earthquake Intensity Scale (PEIS) to help explain the intensity assigned to a specified location based on observations made on the consequences from the earthquake event.

The preparation of earthquake maps was based on the active faults and trenches in Mindanao. The Rapid Earthquake Damage Assessment System (REDAS) of the PHIVOLCS was the main software used to simulate earthquake scenarios based on case scenarios may affect within and near the province. Knowing this earthquake generators help us manage the impact and other disasters by assessing the risk and hazard locations in relation to populations, property, natural resources, and most importantly in disaster preparedness by recommending preventive and mitigating solutions, prioritizing search and rescue task, identifying staging area locations, operational branches and divisions, and other important incident management needs.

Shown below is the information about the epicenter, magnitude and depth of the five (5) worst case scenario earthquake which was simulated in the REDAS software:

	Name of Fault/Trench	Epicenter		Magnitude (Ms)	Depth (Kilometers)
		Longitude	Latitude		
	CENTRAL MINDANAO FAULT	125.1125	7.294289	7.0	2
	MINDANAO FAULT DAGUMA EXTENSION	124.3275	7.099289	7.2	2
	BANGA FAULT	124.8825	6.732489	7.3	2
	DAVAO RIVER FAULT	125.3525	7.42489	7.0	2
	MINDANAO 1 FAULT	125.1125	7.294289	7.0	2