CRITICAL FLOOD PRONE AREAS

Surigao City

2004

Name of Barangay/ Sitio/ Purok	Description of Geohazard	Number of Houses/persons affected	Recommendations
1. Bonifacio : Purok 2	Flooding – from overflow of the Surigao River, aggravated from impounding of creek tributary due to small culvert drainage	31 houses	1. Redesign, reconstruct culvert across the highway 2. Formulate evacuation plan for 31 houses everytime there is continuous heavy rain
2. Bonifacio : Purok 7	Flooding – from overflow of the Surigao River, affecting whole of Purok 7	Settlement	Formulation of an Integrated Surigao City Flood Mitigation Program
3. Cabongbongan : Purok 2 and 3	Flood and riverbank scouring – due to very close distance of settlement from the Cabongbongan river bank; at least four houses were critically affected	4 houses	1. Relocation of 4 houses along riverbank. 2. Impose easement regulation along river bank 3. Study and formulation of Flood Mitigation Program
4. Cagniog : Purok 4,5,6	Flooding – due to obstruction / damming of Culvert	Settlements	1. Reconstruction / redesign of culverts 2. Construction/ improvement of drainage canals
5. Capalayan : Purok 1,2,3,4,5,6 and 8	Flood hazard – almost all settlements and ricefields were flooded last December 2003	Settlements	1. Study and formulation of Flood Mitigation Program. 2. Impose easement regulation along river bank
6. Danao : Purok 1,2 & 3	Flood hazard – due to the Suyok and Bongbong Creeks which have denuded watershed with numerous landslide –	Houses within the easement zone from the riverbank	Immediate provision of mitigating measures, such as : 1. De-siltation of creek channels 2. Revise spillway

	and erosion – prone portions causing heavy siltation of creek channels and spillway		design. 3. Imposition of easement regulation of 40 meters from the riverbank 4. Relocation of houses from the easement zone 5. Reforestation of the watershed. 6. Construction of river dike along easement zone
7. Luna : All Purok along Surigao River	Flood hazard – due to location on the natural active floodplain of Surigao River	Settlements	Formulation of an Integrated Surigao River Flood Mitigation Program
8. Mabini : Sitio Togonan Purok 5	Flood hazard – from inundation of Caningag River affecting approximately 15 houses	15 houses	1. Construction of riprap or gabion type river dike along the outer band of the river 2. Damaged spillway must be removed completely to ease the flow of water to avoid back flow effects
9. Mabua : Purok 1,2,3,4	Flashflood hazard – from Mabua creek, aggravated by poor design of the culvert drainage. One house partially damaged at Purol 1 last Dec. 19, 2003	1 house	1. Redesign culvert 2. Construct floodwall in the downstream portion of the culvert 3. Relocation of the affected house
10. Sabang : Whole Barangay	Coastal and River Flooding – due to its location at the delta of Sabang River	Barangay Settlement	Formulation of an Integrated Surigao River Flood Mitigation Program
11. San Juan	Flood hazard and riverbank scouring – due to close proximity to the Kinabutan River, less than 50 meters. 10 houses were destroyed during the December flood, 47-50 houses were affected.	10 houses	1. Formulation of an Integrated Surigao River Flood Mitigation Program 2. Relocation of houses critically affected by bank scouring

12. San Roque : Purok 4	Flood hazard – from the overflow of the Surigao River reaching houses 50 meters from the riverbank	Settlement	Formulation of Integrated Surigao City Flood Mitigation Program
13. San Roque	Flood hazard – from overflow of the Surigao River; highly risky to 7 houses in Area 1; and 17 houses in Area 2 due to flood waters reaching 200 meters from the banks	24 houses	Formulation of Integrated Surigao City Flood Mitigation Program
14. Togbongon : Sitio Songkoy Purok 7 and 1	Flashflood – critical due to proximity to main creek and bounded by steep slopes on other side.	Settlements	Relocation of houses
15. Togbongon: Sitio Ulawan Purok 6	Flashflood – due to location at edge of alluvial plain and base of slope	5 houses	Relocation of 5 houses
16. Washington : Kaskag (Riverside), Bagong Silang Purok 2	Flood hazard – seasonally flooded from Surigao River due to location in the natural floodplain in the eastern part of Surigao River delta. Flood height ranged from 2.0 – 3.2 meters in Bagong Silang (river side).	Settlements	Formulation of an Integrated Surigao River Flood Mitigation Program

Source : Geo-Hazard Survey, DENR-MGB 13, 2004

BARANGAYS SUSCEPTIBLE TO LANDSLIDES

Surigao City

EARTHQUAKE-INDUCED				RAIN-INDUCED			
Low	***Low to Moderate***	***Moderate to High***	***Low to High***	***Low***	***Low to Moderate***	***Moderate to High***	***Low to High***
Anomar	Alang-Alang	Trinidad	Bonifacio	Balibayon	Anomar	Bonifacio	Capalayan
Baybay	Alegria	Washington	Danao	Orok	Cagniog	Cabongbongan	Danao
Buenavista	Bilabid		Ipil		Luna	Canlanipa	Mabini
Cagutsan	Cabongbongan		Libuac			Ipil	Mabua
Cantiasay	Cagniog		Mabini			Lipata	Mapawa
Lipata	Canlanipa		Mabua			Nabago	Mat-i
Lisondra	Capalayan		Mat-i			Punta Bilar	Poctoy
Luna	Catadman		Poctoy			Quezon	San Roque
Nabago	Mapawa		Punta Bilar			Rizal	Serna
Sidlakan			Quezon			Taft	Silop
Silop			Rizal			Trinidad	Sukailang
Talisay			San Jose			Washington	Togbongon
			San Roque				
			Serna				
			Sukailang				
			Togbongon				

Source : Geo-Hazard Map, DENR-MGB, 2007

TROPICAL CYCLONES AFFECTING SURIGAO CITY

(PSWS No. 2 Levels and Above)

2000 – 2009

Year	Total Cyclones entering PAR	Category	Name	Date (s)	Maximum Sustained Winds (kph)
2009	22	Depression	Bising	Feb. 13-14	45
		Depression	Urduja	Nov. 23-25	55
2008	21	Storm	Ambo	Apr. 13-15	65
		Storm	Quinta	Nov. 6-9	85
		Depression	Rolly	Nov. 7-9	45

2007	13	Typhoon	Lando	Nov. 19-20	130
2006	20				
2005	18				
2004	25	Storm	Gener	Jan. 7-11	65
		Depression	Pablo	Sept. 15-17	55
2003	25	Depression	Zigzag	Dec. 24-27	55
2002	13	Depression	Caloy		
2001	17				
2000	19				

Source : PAGASA, www.typhoon2000.ph

BARANGAYS SUSCEPTIBLE TO STORM SURGES

Surigao City

Alang-alang	Cagutsan	Lisondra	San Juan
Alegria	Canlanipa	Mabua	San Pedro
Aurora	Cantiasay	Manjagao	Sidlakan
Balibayon	Catadman	Nabago	Sugbay
Baybay	Danawan	Nonoc	Taft
Bilabid	Day-asan	Punta Bilar	Talisay
Bitaugan	Ipil	Sabang	Washington
Buenavista	Libuac	San Isidro	Zaragosa
Cagniog	Lipata	San Jose	

Source : Geo-Hazard Map, PAGASA, 2007

Earthquake Ground Shaking

The active earthquake generators in the city are the Philippine Fault Zone transecting the city in its western boundary with the Province of Surigao del Norte and the other one is the Philippine Trench off the Coast of Siargao Island. Any movement by these two (2) active earthquake generators will produce a worst case scenario and ground shaking reaching as much as Intensity VII to Intensity VIII based on the PHILVOLCS Earthquake Intensity Scale (PEIS).

All of the city's 54 barangays are affected by ground shaking conditions with all of the 33 mainland barangays categorized at Intensity VII including five (5) island barangays located in Bilabid and Bayagnan Islands. The remaining 15 island barangays in the Islands of Nonoc, Hanigad, Sibale and Hikdop fall under Intensity VIII.

BARANGAYS AFFECTED BY GROUND SHAKING (A Projection)

Surigao City

INTENSITY VIII		INTENSITY VII
Anomar	Nonoc	Alang-Alang
Balibayon	Orok	Alegria
Bitaugan	Poctoy	Aurora
Bonifacio	Punta Bilar	Bilabid
Cabongbongan	Quezon	Baybay
Cagniog	Rizal	Buenavista
Cagutsan	Sabang	Cantiasay
Canlanipa	San Isidro	Catadman
Capalayan	San Jose	Danawan
Danao	San Juan	Libuac
Day-asan	San Roque	Lisondra
Ipil	Serna	Nonoc
Lipata	Silop	San Pedro
Luna	Sugbay	Sidlakan
Mabini	Sukailang	Talisay
Mabua	Taft	Zaragosa
Manjagao	Tobongon	
Mapawa	Trinidad	
Mat-i	Washington	
Nabago		

Source : Geo Hazard Map, PHILVOLCS, 2007

With the above projected scenario of a worst case Intensity VIII ground shaking affecting the mainland where the urban area, the central business district, the government center, all utility providers, major ports and other infrastructure are located, there is a high level of risk and potential loss of lives and properties involved.

Historically however, there are no recorded destructive or very destructive earthquakes that affect the city within the immediate vicinity of the Province of Surigao del Norte in the last 50 years or more.

EARTHQUAKE RELATED HAZARDS

Given the high probability of having strong earthquakes in the locality, among the related hazards that comes with it are : earthquake – induced landslides, liquefaction, and tsunami.

Earthquake-induced landslides have already been discussed in the earlier section. For Liquefaction, no less than 47 barangays of the city are affected, in varying degrees of

susceptibility. 32 barangays including all of the city's urban barangays and suburban areas are classified as highly susceptible, six (6) from moderate to high susceptibility, four (4) moderate, one (1) low to moderate and four (4) low.

BARANGAYS SUSCEPTIBLE TO LIQUEFACTION
Surigao City

Low (4)	Low to Moderate (1)	Moderate (4)	Moderate to High (6)	High (32)
Alang-Alang	Lisondra	Alegria	Aurora	Balibayon
Buenavista		Anomar	Baybay	Bitaugan
Libuac		Catadman	Bilabid	Bonifacio
San Jose		Zaragosa	Mabini	Cagniog
			Mat-i	Cagutsan
			Nonoc	Canlanipa
				Cantiasay
				Capalayan
				Danao
				Day-asan
				Ipil
				Lipata
				Luna
				Mabua
				Manjagao
				Nabago
				Orok
				Poctoy
				Punta Bilar
				Quezon
				Rizal
				Sabang
				San Isidro
				San Juan
				San Pedro
				San Roque
				Serna
				Sugbay
				Taft
				Talisay
				Togbongon
				Washington

Source : Geo-Hazard Map, PHILVOLCS, 2007

Given the high susceptibility of urban and suburban barangays, some of which are fully built-up with population density of more than 350 persons per square hectare, the threat is indeed great especially with existing structures not built to mitigate such hazard conditions. This threat is further amplified with the changing of the city's skyline where a great deal of new constructions are more than three (3) storeys high.

Tsunami is another earthquake-related hazard that may affect the city. No less than 38 barangays are susceptible to tsunami, especially if the tsunami is locally generated. The only consolation for the city is its relative safety from pacific originating tsunami because of the numerous islands off-shore, including the large islands of Dinagat, Siargao and Bucas Grande which acted as buffer and protective cover.

There were no recorded incidents or historical accounts of tsunami in the city. A hypothetical assessment of a possible local tsunami using the PHILVOLCS Rapid Earthquake Damage Assessment System (REDAS) would generate the following scenario, viz:

HYPOTHETICAL LOCAL TSUNAMI SCENARIO[1]
Surigao City

Earthquake Magnitude	8.0	8.0
Source Distance	100 kms.	50 kms.
Tsunami Run-up	7.1 meters	10.04 meters
Off-shore Height	2.9 meters	3.9 meters
Maximum Inundation Distance	3.54 kms.	5.70 kms.

[1]Calculations based on PHILVOLCS –REDAS Software

The above-cited local tsunami scenario is based on the probability of an earthquake occurring within the city's territorial waters or proximate to it like in the areas of the Leyte Gulf, Surigao Strait, Dinagat Sound, Bohol Sea and Hinatuan Passage. There is however no recorded earthquakes registering more than Magnitude 7.0 in the area in the last 100 years. The highest was Magnitude 6.8, Depth 40 kms., in the Dinagat Sound (10^{o} North, 125^{o}42' East) last August 23, 1975 (PHILVOLCS-REDAS).

BARANGAYS PRONE TO TSUNAMI
Surigao City

Alang-alang	Canlanipa	Mabua	San Pedro
Aurora	Cantiasay	Manjagao	Sidlakan
Alegria	Catadman	Nabago	Sugbay
Balibayon	Danawan	Nonoc	Taft
Baybay	Day-asan	Orok	Talisay
Bilabid	Ipil	Punta Bilar	Togbongon
Bitaugan	Libuac	Sabang	Washington
Buenavista	Lipata	San Isidro	Zaragosa

Cagniog	Lisondra	San Jose	
Cagutsan	Luna	San Juan	

Source : Geo-Hazard Map, PHILVOLCS, 2007