# ORIENTAL MINDORO

## DISASTER RISK/CLIMATE CHANGE ADAPTATION AND VULNERABILITY ASSESSMENT REPORT

PROVINCIAL PLANNING AND DEVELOPMENT OFFICE

# INTRODUCTION

Disasters result from the impact of a hazard on a vulnerable community or group. The first step in disaster risk assessment is hazard assessment. The purpose of a hazard assessment is to specify the nature and behavior of the potential hazards and threats that the people in the community face. However, an assessment of risks to natural disasters and climate change is not complete without an assessment of vulnerability.

Vulnerability is defined as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. (UNISDR, 2009) Vulnerability assessment involves a more in-depth analysis of vulnerability as the result of exposure to hazards and the capacity to cope and recover from a disaster. It will cover vulnerabilities to natural disaster of exposed elements at risk (population, built-up areas, agriculture, fisheries and forestry, and infrastructure and utilities) and vulnerabilities of selected strategic sectors to climate change that may be relevant to a province based on a set of indicators of sensitivity, exposure and adaptive capacity. Vulnerability assessment can also help identify priority groups or sectors that may be found to be the least capable of absorbing losses or withstanding threats posed by disasters and climate change.

Relatedly, the NEDA, through the Regional Development Coordination Staff (RDCS), in partnership with the United Nations Development Programme (UNDP) and the Australian Agency for International Development (AusAID), is implementing the project "*Integrating Disaster Risk Reduction and Climate Change Adaptation in Local Development Planning and Decision-making Processes*" or the Integrating DRR/CCA Project. It aims to mainstream the integrated concerns of disaster risk reduction and climate change adaptation into the Provincial Development and Physical Framework Plans (PDPFPs).

Considering the exposure of Oriental Mindoro to natural hazards, the Integrating DRR/CCA Project is vital to the attainment of the province's vision which is stated as *"A province with healthy, upright and empowered citizenry living in a safe and green environment, prepared and resilient to climate change and disaster risks and governed by dynamic and responsive leadership. By 2020, Oriental Mindoro is Luzon and Visayas' FOOD BASE, PREMIER tourism DESTINATION and CENTER FOR INVESTMENTS."*

# GEOGRAPHICAL, ADMINISTRATIVE/POLITICAL PROFILE

## Location and land area

Oriental Mindoro is a province of the Philippines located in the island of Mindoro under MIMAROPA region in Luzon, about 140 km southwest of Manila. The province occupies the eastern part of the island of Mindoro. It is bounded on the north by the Verde Island Passage, on the east by Tablas Strait, on the west by Occidental Mindoro, and on the south by Semirara Island (Annex 1).

The province has a total land area of 4,364.72 square kilometers or 436,472 hectares. It represents 1.5 percent of the total land area of the country and 16 percent of the MIMAROPA Region. Oriental Mindoro is composed of 14 municipalities and 1 component city, Calapan City, which is also the provincial capital. It is divided into two districts, District I (Puerto Galera, San Teodoro, Baco, Calapan City, Naujan, Victoria, Socorro, Pola) and District II (Pinamalayan, Gloria, Bansud, Bongabong, Roxas, Mansalay, Bulalacao).

The biggest municipality is Naujan with an area of 258 sq km and accounts for 12.10 percent of the province's land area. The smallest is the municipality of Roxas sharing only 1.99 percent with an area of 87.10 square kilometers.

**Table 1.** Land area and number of barangays by city/municipality

| Municipality | Land Area (sq km) | % to Total | No. of Barangays |
|---|---|---|---|
| Baco | 241.70 | 5.54 | 27 |
| Bansud | 260.00 | 5.96 | 13 |
| Bongabong | 498.20 | 11.41 | 36 |
| Bulalacao | 305.12 | 6.99 | 15 |
| Calapan City | 265.20 | 6.08 | 62 |
| Gloria | 230.80 | 5.29 | 27 |
| Mansalay | 513.10 | 11.76 | 17 |
| Naujan | 528.00 | 12.1 | 70 |
| Pinamalayan | 277.30 | 6.35 | 37 |
| Pola | 130.20 | 2.98 | 23 |
| Puerto Galera | 223.50 | 5.12 | 13 |
| Roxas | 87.10 | 1.99 | 20 |
| San Teodoro | 369.10 | 8.46 | 8 |
| Socorro | 149.40 | 3.42 | 26 |
| Victoria | 286.00 | 6.55 | 32 |
| **TOTAL** | **4,364.72** | **100** | **426** |

***Source: PPDO***

Naujan is the most numbered barangay with 70 while San Teodoro has the least number of barangays with 8.

## Urban and Rural Barangays

As of 2007, the province has 59 urban and 367 rural barangays. Pinamalayan registered the highest urban population of 25,717 in 2007, while Calapan City posted only 20,127.

**Table 2.** Urban-Rural Population and Density, Oriental Mindoro, 2007

| City/Municipality | No. of Brgys. | | Population | | Population Density |
|---|---|---|---|---|---|
| | Urban | Rural | Urban | Rural | |
| **Oriental Mindoro** | **59** | **367** | **157,897** | **577,872** | **172** |
| Baco | 1 | 26 | 2,717 | 31,410 | 146 |
| Bansud | 3 | 10 | 12,245 | 23,419 | 138 |
| Bongabong | 1 | 35 | 1,306 | 59,821 | 124 |
| Bulalacao | 4 | 11 | 8,858 | 21,330 | 101 |
| Calapan City | 5 | 57 | 20,127 | 96,849 | 453 |
| Gloria | 6 | 21 | 13,106 | 27,455 | 178 |
| Mansalay | 3 | 14 | 11,682 | 32,292 | 89 |
| Naujan | 4 | 66 | 9,165 | 81,464 | 175 |
| Pinamalayan | 9 | 28 | 25,717 | 51,402 | 282 |
| Pola | 2 | 21 | 1,296 | 31,339 | 252 |
| Puerto Galera | 3 | 10 | 9,920 | 18,115 | 134 |
| Roxas | 4 | 16 | 16,748 | 29,963 | 555 |
| San Teodoro | 1 | 7 | 1,990 | 13,049 | 42 |
| Socorro | 6 | 20 | 8,394 | 29,658 | 256 |
| Victoria | 7 | 25 | 14,626 | 30,306 | 159 |

*Source: NSO/NSCB, 2007*

## Existing settlement pattern

The 1993-2002 Provincial Physical Framework Plan (PPFP) for Oriental Mindoro identified Calapan City as Primary Urban Center B or Large Town. The City, which is the seat of the Provincial Government, is also the center of education, trade and commerce of the entire province and the Regional Government Center of the MIMAROPA Region.

Pinamalayan and Roxas, the flourishing municipalities of the province, were identified as Secondary Urban Center B or medium town. (draft PDPFP)

By the year 2020, Pinamalayan and Roxas are expected to change from Medium Town or Primary Urban Center A to Large Town or Primary Center B. Pinamalayan will continue its present role as trade center for the central portion of the province and jump-off points to adjacent islands/provinces such as Marinduque.

Roxas will retain its role as trade center for the southern portions of the province and jump-off points to adjacent provinces within the Visayas Region.

## Land Classification

Based on the 2009 land classification statistics from NAMRIA, approximately 222,895 hectares are certified alienable and disposable land and 213,577 hectares are forest land, of which, 213,429 hectares are classified and 148 hectares are unclassified. The 2008 Philippine

Forestry Statistics, Forest Management Bureau – Department of Environment and Natural Resources indicated that of the province's total land area, 79,299 hectares are established timberland and 85,659 hectares are established forest reserve. National parks cover 44,289 hectares and 3,680 hectares are for civil reservation.

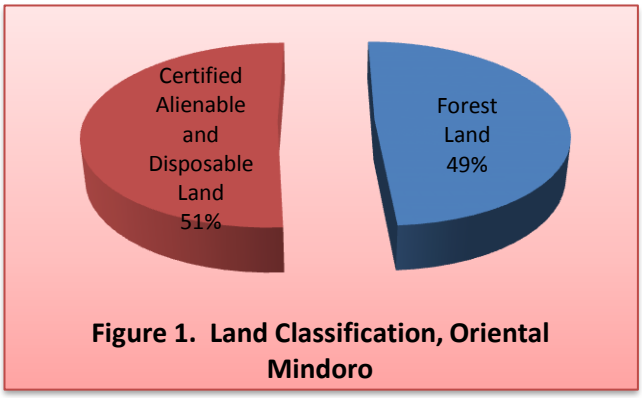



**Figure 1. Land Classification, Oriental Mindoro**

## Water Resources

The province, with an estimated coastline of 342 kilometers, has a total of 310,788.73 hectares of municipal waters. The municipality of Bulalacao recorded the largest municipal water with 59,250.33 hectares and San Teodoro, the smallest covering 4,520.20 hectares.

The Mindoro provinces have a series of outward flowing watersheds which are interlocked in the mountainous upper reaches and descend steeply, with the coast on each side of the island. The northern and eastern portions of Oriental Mindoro have watersheds which formed a broad sedimentary plain extending from the middle reaches to the shoreline, occasionally intruded by sedimentary or volcanic hills.

From the north, the watersheds, named after the main river corresponding river systems, are Mag-asawang Tubig, Naujan-Victoria; Baco-Bucayao, Pola; Balete, Gloria; Sumagui-Batasu, Bansud; Bongabong, Kabilyan, Baroc, Mansalay, and Bulalacao.

There are approximately 53 creeks and rivers found in the province, with length ranging from 213 to 234 kilometers. Malbog River is the shortest river system in the province, with a length of 213 km while the longest river system is the Nag-iba river system with a length of 234 km.

## Climate Profile

The province has two climate types: Type I and Type III. Type I is characterized by two pronounced seasons, dry and wet. Type III has no pronounced season, relatively dry from November to April and wet during the rest of the year.

Based on 1971-2000 normal values, the highest recorded temperature in the province occurs within the months of March to May with 28.3$^{o}$C and the lowest during December to February at 26.4$^{o}$C. Within the same period, the highest rainfall record of 894.3mm occurred from June to August and the lowest occurred within the months of December to February with 260.3mm.

From the years 1948 to 2009, Oriental Mindoro experienced a total of 105 tropical cyclones of which, 50 percent were typhoons, 36 percent were tropical storms, 12 percent were tropical depressions and 1 percent was a super typhoon. The most number of tropical cyclones in a month occurred in November with 25 while February had the least with only 1.

## Projected Climate Change

By the year 2020, the projected temperature for the province under medium and high range emission scenarios are highest within the months of March, April and May. On the other hand, the months of June, July and August will have the most rainfall for both scenarios. Table 3 shows the changes in temperature and rainfall.

**Table 3.** Projected temperature and rainfall in Oriental Mindoro, 2020.

| Scenario | Temperature | | | | | | | | Rainfall | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Change in Temperature | | | | Projected Temperature | | | | Change in Rainfall | | | | Projected Rainfall | | | |
| | DJF | MAM | JJA | SON | DJF | MAM | JJA | SON | DJF | MAM | JJA | SON | DJF | MAM | JJA | SON |
| High Range Emission* | 0.6 | 0.7 | 0.7 | 0.6 | 27.0 | 29.0 | 28.3 | 27.9 | -14 | 7 | 33 | -2 | 246.6 | 276.4 | 927.2 | 788.8 |
| Medium Range Emission* | 0.8 | 1 | 1.1 | 0.9 | 27.2 | 29.3 | 28.7 | 28.2 | -3 | -15 | 1 | 6 | 257.1 | 254.2 | 894.8 | 797.4 |
| Low Range Emission** | 0.4 | 0.5 | 0.6 | 0.7 | 26.8 | 28.8 | 28.2 | 28.0 | | | | | | | | |

** based on 1971-2000 normal values*
*** based on 1990-2000 normal values*

By 2050, temperature can reach 30°C from March to April while 911.8mm of rainfall can be expected from June to August. The details are presented in Table 4.

**Table 4.** Projected temperature and rainfall in Oriental Mindoro, 2050.

| Scenario | Temperature | | | | | | | | Rainfall | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Change in Temperature | | | | Projected Temperature | | | | Change in Rainfall | | | | Projected Rainfall | | | |
| | DJF | MAM | JJA | SON | DJF | MAM | JJA | SON | DJF | MAM | JJA | SON | DJF | MAM | JJA | SON |
| High Range Emission* | 1.4 | 1.7 | 1.7 | 1.5 | 27.8 | 30 | 29.3 | 28.8 | -21 | 7.3 | 18 | -3 | 239.7 | 276.6 | 911.8 | 788 |
| Medium Range Emission* | 1.8 | 2.0 | 2.2 | 1.9 | 28.2 | 30.3 | 29.8 | 29.2 | 22 | -11.5 | 5.3 | 2.9 | 281.9 | 257.8 | 899.6 | 794.1 |
| Low Range Emission** | 1.3 | 1.2 | 1.3 | 1.5 | 27.7 | 29.5 | 28.9 | 28.8 | | | | | | | | |

** based on 1971-2000 normal values*
*** based on 1990-2000 normal values*

# HAZARD PROFILE

## *Hazard characterization*

Oriental Mindoro is vulnerable to many natural hazards. It is affected by tropical cyclones, earthquake, tsunami and floods. An average of four typhoons hit the province in a year. Flashflood occurred twice every five years while an earthquake happened in 1994. The most frequent hazard that affects the province is flood which results from either typhoon or excessive rainfall.

Typhoon Utor (Feria) in 2001 is the worst of these disasters that caused the loss of 223 human lives. Two typhoons in 2006, namely typhoon Seniang and Caloy destroyed a total of 186,346 houses and affected 81,860 families, respectively.

Flashfloods that happened in December 2005 brought damage to 304 or 71% of the total number of barangays affecting 82,834 families or 288,464 persons. Total estimated damages amounted to PhP325,450,000.00.

The 1994 Mindoro Earthquake with magnitude of 7.1- centered 11 km N22°W of Baco, Mindoro, near Verde Island that generated a local destructive tsunami is the scariest disaster that hit the whole province. The combined effects of the earthquake and tsunami killed a total of 83 people, injured 430, damaged or destroyed 7,566 houses, entirely broken down the communications system, disrupted water supply, knocked out power over wide areas, damaged roads, destroyed or damaged 67 bridges, and sunk numerous fishing boats.

These natural hazards brought considerable damage to lives and properties of Mindoreños amounting to PhP1,030,700,490.00and have greatly affected the production and marketing of agricultural products. A list of some of the major disasters that occurred in the province is presented in Annex 2.

### Hydrometeorological hazards

Hydrometeorological 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. These include flood and rain-induced landslides.

### a. Flooding

Flood is defined as an overflow or inundation that comes from a river or other body of water and causes or threatens damage. It is any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream.

- ***Sources of flooding***

The whole island of Mindoro is threaded with myriads of rivers and streams (Figure 2). Among these prominent rivers posing immediate hydrologic hazards in the area are

Bucayao and Mag-asawang Tubig Rivers that flow in the alluvial plain of Calapan, Naujan and Victoria; and the Bongabong and Baroc Rivers in Bongabong and Roxas, respectively.

The Aglubang-Mag-Asawang Tubig River Complex flows north starting from the interior mountains of Gloria, with the Aglubang flowing through Sablayan in Occidental Mindoro and re-entering the territorial area of Oriental Mindoro in Victoria, passing by the Ibolo River which joins its flow towards the Mag-AsawangTubig and Panggalaan Rivers. From Victoria the Mag-AsawangTubig flows north then eastwards towards the coast of the municipality of Naujan. (*draft PDPFP*)

Highly susceptible areas for flooding in the form of overbank river flooding and sheet flooding are confined within the floodplain and on the downstream most portions of the river systems inundation levels from 0.5 to more than 1.0 meter in depth (Annex 3).

Eighty five barangays or 19.95 percent of the total 426 barangays in Oriental Mindoro are identified as highly susceptible to flooding. While Calapan City has the most number of barangays with high susceptibility, the municipality with the highest percentage to total is Baco at 62.96 percent followed by Roxas at 60 percent.

**Table 5.** Number and percentage of barangays by flood susceptibility level by municipality

| City/ Municipality | High | | Moderate-Moderate to High | | None to Low-Low-Low to Moderate | | None | | Total No. of Barangays |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % to total | No. | % to total | No. | % to total | No. | % to total | |
| Baco | **17** | **62.96** | 6 | **22.22** | 3 | **11.11** | 1 | **3.70** | 27 |
| Bansud | **1** | **7.69** | 8 | **61.54** | 4 | **30.77** | 0 | **0.00** | 13 |
| Bongabong | **17** | **47.22** | 12 | **33.33** | 7 | **19.44** | 0 | **0.00** | 36 |
| Bulalacao | **0** | **0.00** | 6 | **40.00** | 8 | **53.33** | 1 | **6.67** | 15 |
| Calapan City | **19** | **30.65** | 33 | **53.23** | 10 | **16.13** | 0 | **0.00** | 62 |
| Gloria | **1** | **3.70** | 18 | **66.67** | 8 | **29.63** | 0 | **0.00** | 27 |
| Mansalay | **0** | **0.00** | 6 | **35.29** | 11 | **64.71** | 0 | **0.00** | 17 |
| Naujan | **11** | **15.71** | 44 | **62.86** | 11 | **15.71** | 4 | **5.71** | 70 |
| Pinamalayan | **2** | **5.41** | 16 | **43.24** | 17 | **45.95** | 2 | **5.41** | 37 |
| Pola | **2** | **8.70** | 2 | **8.70** | 19 | **82.61** | 0 | **0.00** | 23 |
| Puerto Galera | **0** | **0.00** | 5 | **38.46** | 7 | **53.85** | 1 | **7.69** | 13 |
| Roxas | **12** | **60.00** | 2 | **10.00** | 6 | **30.00** | 0 | **0.00** | 20 |
| San Teodoro | **0** | **0.00** | 6 | **75.00** | 1 | **12.50** | 1 | **12.50** | 8 |
| Socorro | **0** | **0.00** | 7 | **26.92** | 19 | **73.08** | 0 | **0.00** | 26 |
| Victoria | **3** | **9.38** | 19 | **59.38** | 10 | **31.25** | 0 | **0.00** | 32 |
| **ORIENTAL MINDORO** | **85** | **19.95** | **190** | **44.60** | **141** | **33.10** | **10** | **2.35** | **426** |

*Source: DRA Report*

- ***Conditions contributing to flooding***

Conditions that cause floods include typhoons as well as heavy or steady rain for several hours or days that saturate the ground. Flash floods occur suddenly due to rapidly rising water along a stream or low lying area.

Based on geographical and hydrological studies, flooding occurs when large volume of water discharges from Mag-asawangTubig and Bucayao Rivers. Water discharges from these rivers come from Aglubang and Ibulo rivers and upstream small tributaries which merge at the foot of the mountain between Naujan and Victoria, (Flood Rehabilitation Plan, 2006).


**Figure 2.** Major Rivers of Oriental Mindoro[1]

- ***Character of flooding in area (locations, area affected, threat expected)***

Based on the Oriental Mindoro Historical Disaster Data (1993-2010), five flashfloods struck Oriental Mindoro. December 2005 flashfloods occurred in almost all municipalities in the province wherein only the municipality of Gloria was not affected. This was brought about by the three-day rainfall reaching a total of 194 millimeters on 6 December and 77 millimeters on 17 December 2005 (as reported by PAGASA). Heavy rainfall resulted to large

[1] Provincial Flood Mitigation Program 2011/ Google Earth

discharges in both Mag-asawang Tubig and Bucayao Rivers. Family victims totaled 82,834 or 288,464 persons. Three casualties in Calapan City and Pinamalayan were reported due to drowning.The total infrastructure damages estimated at PhP158.98 million while agricultural losses pegged at PhP166.47 million for the December 6, 17 and 27, 2005 flashfloods.

**Figure 3**. Wide areas of Calapan City under water http://www.zambales.gov.ph/jan06news8.html - **THE OFFICIAL WEBSITE OF THE LEAGUE OF PROVINCES OF THE PHILIPPINES)**

**Figure 4.** Incessant rains cause a sudden rise of floodwaters in Naujan. Photo courtesy of Naujan Mayor Romar Marcos (+) (http://mindoropost.com/2010/01/26/oriental-mindoro-among-10-most-flood-prone-areas-in-rp-says-denr/)

Water from Aglubang and Ibulo rivers, including discharges from smaller tributaries upstream merged at the foot of the mountain between Villa Cerveza, Victoria, and San Andres Putik, Naujan. The confluence of Aglubang and Ibulo rivers formed the Mag-asawang Tubig River in the area at the transition from the mountainous terrain to sprawling floodplains of Naujan, Calapan and parts of Victoria and Baco. During high water discharge, considerable water volume of flow from Mag-asawang Tubig River was diverted to Bucayao River.

The diversion of water occurred in two locations at the western bank of Mag-asawang Tubig River:

- just above the point of confluence of Aglubang and Ibulo Rivers due to greater flow contribution, hence, greater momentum and flow of water from Aglubang River, and
- opposite Muyod in Villa Cerveza, Victoria as the flow was deflected by the solid high ground flows diverted from Mag-asawang Tubig merged further downstream and eventually joined the flow in Bucayao River.

This resulted in exceptionally high water level in Bucayao River beyond its capacity and breached the dike due to scouring at the curved section of the river in Sitio Buhuan of Barangay Comunal in the City of Calapan. As a result, the large volume and uncontrollable flow of water spilled over the areas of Calapan City, Naujan and some parts of Victoria and Baco, causing flooding in above-mentioned areas.

Heavy rains on 17 January 2010 resulted to the overflowing of riverbanks along Bucayao and Mag-asawang Tubig Rivers. Said weather disturbance triggered flooding in 56 barangays of the municipalities of Naujan and Baco affecting 1,875 and 2,277 families respectively. Five barangays in the municipality of Victoria and Calapan City were also affected by flashflood with 1,724 families or 8,528 persons. With this disaster 2 people were reported dead and 346 injured. Total damage to infrastructure facilities and agricultural crops/livestock amounted to PhP27.81 million and PhP0.69 million, respectively.

**Table 6.** Matrix for Past Flood Events in Oriental Mindoro

| DESCRIPTION | POPULATION/AREAS AFFECTED | IMPACTS |
|---|---|---|
| **December 6, 2005 - Flashflood -Heavy rainfall resulted to large discharges in both Mag-asawang Tubig and Bucayao Rivers** | 163 brgys. (Calapan City, Naujan, Victoria, Socorro, Pola, Pinamalayan & Baco). A total of 30,420 families or 155,274 persons were affected. | Two casualties |
| **December 17 and 27, 2005 - Flashflood - Typhoon Quedan and continuous heavy rains contributed to overflow of some major rivers and its tributaries** | 141 barangays of Baco, Naujan, Victoria and Calapan City; and Pinamalayan, Bansud, Bongabong, Roxas, Mansalay and Bulalacao. A total of 23,364 families were affected. | Registered one death. Infrastructure damage posted to PhP158.98 million while agricultural losses pegged at PhP166.47 million for the December 6, 17 and 27, 2005 flashfloods. |

| DESCRIPTION | POPULATION/AREAS AFFECTED | IMPACTS |
|---|---|---|
| | Calapan City, Baco, Naujan, San Teodoro, Puerto Galera. A total of 29,050 families or 133,190 persons were affected. | |
| **January 17, 2010 -Flashflood - Heavy rains in the mountain area resulted to the overflowing of riverbanks along Bucayao and Mag-asawang Tubig Rivers** | Naujan-41 barangays. A total of 1,875 families or 9,375 persons were affected. | Registered two casualties Infrastructure damage posted to PhP3.7 million while agricultural losses pegged at PhP29.66 million. |
| | Baco-15 barangays - Alag, Burbuli, Sta Rosa I, Catwiran I, Catwiran II, Sta Cruz, Tagumpay, Malapad, Poblacion, Bangkatan, Dulangan I, Dulangan II, Dulangan III, Putican Cabulo, and Pulang Tubig. A total of 2,277 families or 11,376 persons were affected. | Agricultural losses pegged at PhP10.28 million. |
| **January 17, 2010 -Flashflood - Continuous heavy rains** | 5 brgys. (Calapan & Victoria). A total of 1,724 families or 8,528 persons were affected. | Three hundred forty six were injured. One and 2,064 houses totally and partially damaged, respectively. Infrastructure damage posted to PhP27.81 million while agricultural losses pegged at PhP0.69 million. |
| **October 8, 2010 -Flashflood - Continuous heavy rains** | Four barangays were affected namely: Pagalagala, Nabuslot, Sto. Niño and Anoling of the municipality of Pinamalayan. A total of seven families or 35 persons were affected. | Registered one death. Agricultural losses pegged at PhP6.94 million. |

*Source: PPDO, PSWDO, OCD*

In the early morning of 8 October 2010, flashflood occurred in Pinamalayan due to continuous heavy rains. Four barangays were affected namely: Pagalagala, Nabuslot, Sto. Niño and Anoling. A total of seven families comprising 35 persons were affected and one person was reported dead. Agricultural damage pegged at PhP6.94 million.

- ***Frequency of occurrence or likelihood of flooding***

The province is located along the typhoon belt. Of the province's total area, about 30 percent is flood prone. Most municipalities are coastal and situated in the floodplains of rivers. Three major rivers, the Baco, Bucayao and Mag-asawangTubig drain the excess water from CalapanCity, Naujan, Baco, San Teodoro and Victoria.

Among the lowland and coastal areas in Calapan City, Barangay Masipit has the most probability to flooding. Other barangays which are susceptible to flooding are Del Razon and Guinhawa in Pinamalayan, Lumangbayan in San Teodoro, Bayuin and Malugay in Socorro and San Narciso in Victoria. (CCHAMP)

The maps from NAMRIA which were presented in the "Lessons Learned from the 2011 Floods (The Philippines Country Report)" by PAGASA-DOST showed the province of Oriental Mindoro as having "1 in 1 year" frequency of tropical cyclone occurrence (Annex 4).

It is also number 9 in the Top 10 flood prone provinces in the country. The other provinces are Pampanga, Nueva Ecija, Pangasinan, Tarlac, Maguindanao, Bulacan, Metro Manila, North Cotabato and Ilocos Norte (Annex 5).

**b. Rain-induced Landslides.**

Rainfall has been known as the most common factor in occurring landslides. In general, infiltration of rainfall in soil causes to increase soil water pressure, reduce matric suction and increase the weight of soil mass and finally, soil strength decreases and landslide occurs.[2]

Rainfall-induced landslides can be triggered by two main mechanisms: shear failure due to build-up of pore water pressure and erosion by surface water runoff when flow velocity exceeds a critical value[3].

## Geologic Hazards

A geologic hazard is a natural geologic event that can endanger human lives and threaten human property.[4]

**a. Earthquake Ground shaking**

- ***Geological considerations***

Earthquake is the shaking of the Earth's surface caused by rapid movement of the Earth's rocky outer layer and the first main earthquake hazard is the effect of ground shaking. The intensity of shaking varies depending on a number of factors namely earthquake magnitude, distance from the epicenter, degree of ground consolidation and thickness of soil overburden. Ground shaking as a result of a shallow seated and large magnitude earthquake leads to other secondary hazards such as liquefaction, ground rupture along faults and landslides, fires and toppling of buildings which may result to deaths, property damage and sort to long term effects to the economy.

PHIVOLCS map was used to create earthquake induced hazard maps of the province generated by NEDA IV-B in coordination with the Provincial Planning and Development Office. The ground shaking hazard map of the province (Annex 6) depicts the active faults of Aglubang River and Central Mindoro, and the earthquake generators near the province such as Lubang Fault, East Mindoro Trench and Manila Trench.

Raster based iteration maps are reprojected to UTM Zone 51, Luzon Datum, converted to vector format and processed using ArcGis 9.3. PHIVOLCS Earthquake Intensity Scale (PEIS) from 1 to 10 is used as the unit of categorization on the severity of earthquake effects in the

[2] Physical Geography Research Quarterly (http://journals.ut.ac.ir/page/article-frame.html?langId=en&articleId=316688 )
[3]The Smithsonian/NASA Astrophysics Data System(*http://adsabs.harvard.edu/abs/2009AGUFMNH44A..08N*)
[4]http://www.nationalatlas.gov/articles/geology/a_geohazards.html

Philippines. A scale of seismic intensity is a way of measuring or rating the effects of an earthquake at different sites.

**Table 7.** Matrix for Ground Shaking Hazard

| Municipalities | Susceptibility Levels | | | Total land area (sq km) |
|---|---|---|---|---|
| | High | Moderate | Low | |
| Puerto Galera | | | | |
| | Aninuan | | | 21.73 |
| | Balatero | | | 14.32 |
| | Dulangan | | | 12.94 |
| | Palangan | | | 3.87 |
| | Sabang | | | 4.48 |
| | San Antonio | | | 1.13 |
| | San Isidro | | | 8.53 |
| | Santo Niño | | | 5.32 |
| | Sinandigan | | | 4.56 |
| | Tabinay | | | 97.68 |
| | Villaflor | | | 46.77 |
| | Poblacion | | | 3.76 |
| | Baclayan | | | 27.38 |
| | **Total** | | | **252.47** |

*Source: MGB*

- ***Past earthquake and impacts***

The November 15, 1994 Mindoro earthquake which affected all the municipalities in the province occurred at 03:15AM (local time) with magnitude 7.1, an epicenter of 13.5° N, 121.1° E, and a hypocenter of 15 km. This was tectonic in origin, related to movement along zones of weakness transecting the Philippine Archipelago along an active fault which is now called Aglubang River Fault.

Damaged infrastructure includes 24 bridges, 8 of which were rendered impassable for days, isolating villages and towns in the interior. Roads with a combined span of 500 km likewise sustained damage. The main pier and adjacent terminal building at Calapan Harbor was damaged, limiting ferry access for a period immediately after the earthquake (EERI, 1995).

Three major power plants, two in Luzon Grid and one in Visayas, tripped during the earthquake causing brown outs in Mindoro Island and parts of Leyte and Samar. Some areas in Metro Manila also experienced brief power interruption. Water supply was also disrupted due to ruptured water lines and the lack of electricity to run pumps. Power was partially restored in Mindoro before the end of November, but it took another month before the power situation in the province was normalized.

**Figure 5.** Portion of road damaged by the 1994 earthquake

Total cost of rehabilitating damaged buildings and infrastructures is placed at PhP5.15 million.

**Table 8.** Matrix for Past Earthquake and Tsunami Events in Oriental Mindoro

| Description | Population/Areas Affected | Impacts |
|---|---|---|
| **March 1965 Tsunami** | Coastal barangays of Pola (Tagumpay, Puting Cacao, Tiguihan, Pahilahan, Tagbakin, Batuhan, Buhay na Tubig, Bakawan) | |
| **Nov. 15, 1994 - 7.1 intensity earthquake** | All municipalities. A total of 22,452 families or 132,712 persons were affected. | 83 dead, 430 injured and eight were reported missing. One thousand one hundred thirty and 6,036 houses totally and partially damaged, respectively. |
| | | Infrastructure damage posted to PhP447.631 million while agricultural losses pegged at PhP65.39 million. |
| **Tsunami waves up to 1.5m high** | Coastal barangays of Baco and Calapan | |

*Source: PPDO, PSWDO, OCD*

**b. Earthquake-related hazards**

- **Tsunami**

Tsunami is the related hazard of earthquake and is defined as an impulsively generated sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or exploding volcanic islands.

***Areas Affected***

There are two documented occurrences of tsunamis in Oriental Mindoro. The first tsunami occurred in March 1675 which affected the coastal areas of Pola. The second occurred on November 15, 1994 after the 7.1 - magnitude earthquake. Approximately five minutes after the tremor, tsunami waves struck along a 40 km stretch of the northern and eastern shoreline of Mindoro Island, from Puerto Galera up to Pinamalayan. The tsunami totally destroyed 1,530 houses and killed 41 people.

As per official report of the Provincial Social Welfare and Development Office (PSWDO), about 22,452 families were affected. Casualties numbered 83 confirmed dead and 430 injured. The municipality of Baco sustained the biggest number of casualties, with 41 confirmed deaths from drowning due to the tsunami that hit the coastal area of Malaylay, San Andres, Baco. Calapan City has the second most number of casualties, with 17 deaths from Barangay Wawa, also a coastal area. Almost half of the casualties were children below 10 years old who were drowned.

Damage to property include some 7,566 houses: 1,530 totally and 6,036 partially washed away by tsunami. The municipalities of Calapan and Baco had the biggest number of totally destroyed houses. However, Naujan and Gloria had the biggest number of partially damaged houses with 2,204 and 1,138 houses, respectively.

In Calapan City, the floating 7.2 megawatt power barge was swept inland by the tsunami. This ran aground two kilometers away from its original location.

***Threat Expected***

Assuming tsunami height of three meters at coastline, tsunami inundation zones were modeled for Mindoro Island coastlines. Earthquake parameters used in modeling is the Manila Trench with magnitude 7.2, 7.9 and 8.2. The tsunami hazard map (Fig. 6) was developed for the Tsunami Risk Mitigation Program '06-'07 purpose of PHIVOLCS-DOST but could also be used by governments as a basis for land-use planning. This indicative map is based on maximum computed wave height and inundation using worst case scenario earthquakes from major offshore source zones. The indicated wave height decreases away from the shoreline.

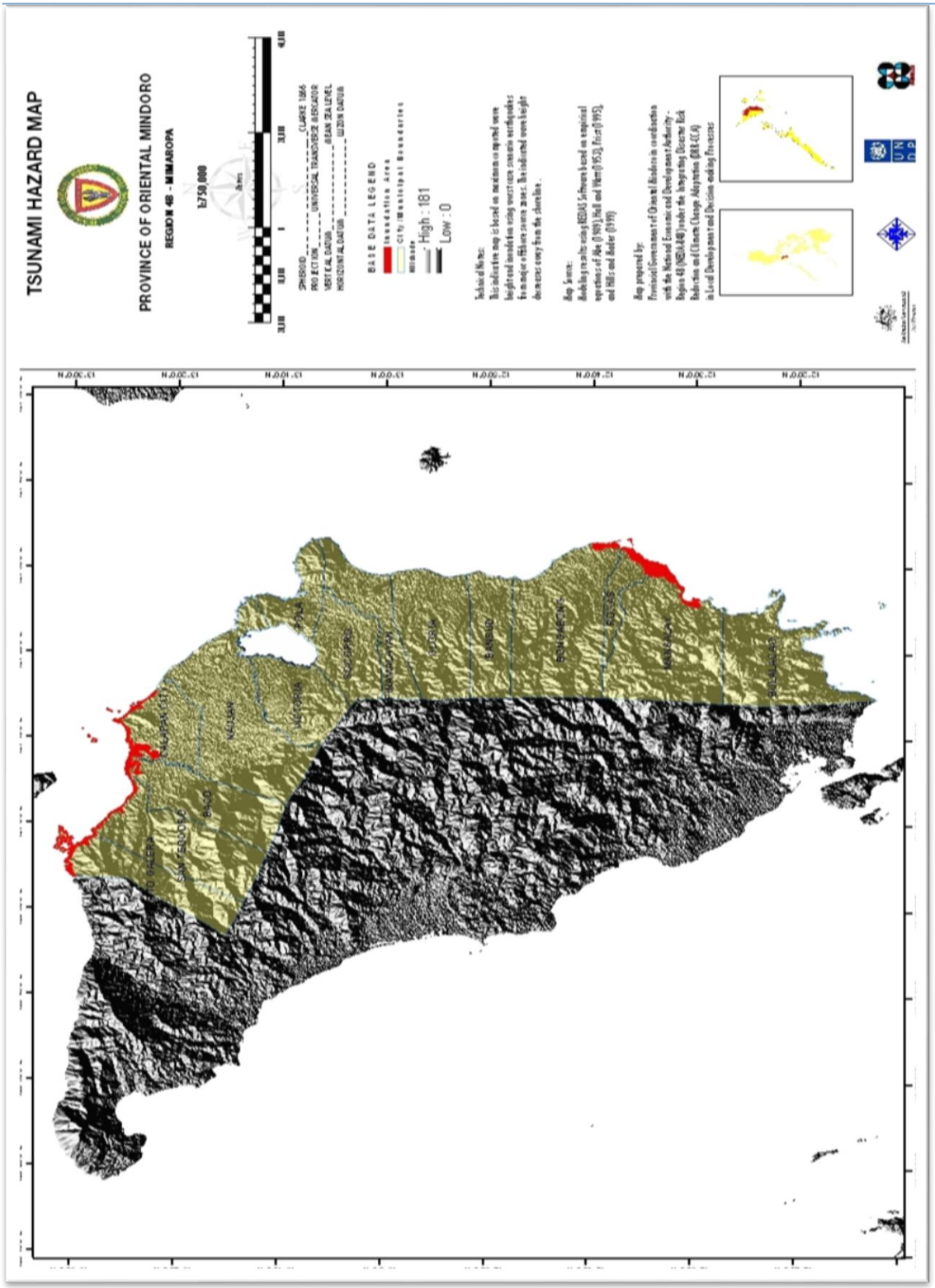



**Figure 6.** Tsunami hazard map

The modeled inundation depth for a three-meter tsunami is indicated in shades of red. A high degree of agreement between the calculated inundation zone and the areas actually destroyed can be seen in the Earthquake Tsunami Map. These areas can be found in the municipalities of Puerto Galera, Baco, San Teodoro and Calapan City with five-meter inundation depth. Six barangays of Puerto Galera namely: Sinandigan, Palangan, Poblacion, Tabinay, Dulangan and Villaflor have an inundation depth of six meters. In addition, five barangays of Roxas namely San Jose, Bagumbayan, Dangay, Paclasan and San isidro and three barangays of Bongabong namely Cawayan, Dayhagan, and San Jose have an inundation depth of 3.65 meters. And lastly, the barangays of the municipality of Mansalay namely Wasig, B Del Mundo, Manaul, Cabalwa and Poblacion have an inundation of 3.72 meters.

The results of the scenario show that there are residential areas that would be hit, including tourism, education, electric and gas utilities, health and human services, transportation facilities such as national and municipal ports located in Calapan City, Roxas and Puerto Galera and other institutional/industrial establishments. A total of 118,048 population and 496 square kilometers of land area would be affected.

This tsunami inundation map was prepared to assist cities and municipalities in identifying their tsunami hazard. It is intended for local jurisdictional, coastal evacuation planning uses only. This map and the information presented herein, is not a legal document and do not meet disclosure requirements neither for real estate transactions nor for any other regulatory purpose.

The inundation map has been compiled with best currently available scientific information. The inundation line represents the maximum considered tsunami run up from a number of extreme, yet realistic, tsunami sources. Tsunamis are rare events; due to a lack of known occurrences in the historical record, this map includes no information about the probability of any tsunami affecting any area within a specific period of time.

- **Liquefaction**

Liquefaction is the mixing of sand or soil and groundwater (water underground) during the shaking of a moderate or strong earthquake. When the water and soil are mixed, the ground becomes very soft and acts similar to quicksand. If liquefaction occurs under a building, it may start to lean, tip over, or sink several feet. The ground firms up again after the earthquake has past and the water has settled back down to its usual place deeper in the ground.

Liquefaction prone areas can be found in beach zones, sand pits, sand bars, tombolos, wide coastal plains, deltaic plains, flood plains, abandoned river meanders, former beds, former or existing marshland, and swamplands. Areas underlain by lahar deposits, especially those that will preferentially receive the finer sandy fractions of active lahar flows are also susceptible to liquefaction (Punongbayan, 1998).

***Threat Expected***

Most of the coastal areas and the alluvial plains of the northeastern part of the province are considered vulnerable to flooding/liquefaction and lateral spreading. The narrow zone extending 500 meters on both sides of the active faults is also vulnerable to liquefaction.

Liquefaction hazard map of the province of Oriental Mindoro (Fig. 7) indicates the areas prone to liquefaction at varying susceptibility levels. The liquefaction potential categories shown on this map depend on the probability of having an earthquake within a 100-year period that will be strong enough to cause liquefaction in those zones. High liquefaction potential means that there is a 50% probability of having an earthquake within a 100-year period that will be strong enough to cause liquefaction. Moderate means that the probability is between 10% and 50%, low between 5 and 10%, and very low less than 5%.

The map predicts the approximate percentage of each designated area that will liquefy and show surface manifestations of liquefaction for a magnitude 7.7 earthquake with an average depth of 25.8 km. It also depicts the hazard at a regional scale and should not be used for site-specific design and consideration. Subsurface conditions can vary abruptly and borings are required to address the hazard at a given location. Some areas in all the municipalities and component city of Oriental Mindoro will have moderate to low susceptibility.

**Table 9.** Matrix for Liquefaction Hazard by Municipality

| Municipalities | Susceptibility Levels | | | Total land area (sq km) |
|---|---|---|---|---|
| | High | Moderate | Low | |
| **Baco** | | | Malaylay Island | 298,170 |
| **Baco** | | All Barangays | All Barangays | 241.70 |
| **Bansud** | | All Barangays | All Barangays | 260.00 |
| **Bongabong** | | All Barangays | All Barangays | 498.20 |
| **Bulalacao** | | All Barangays | All Barangays | 305.12 |
| **Bulalacao** | | Buyayao Island | Buyayao Island | 298,170 |
| **Calapan** | | All Barangays | All Barangays | 265.20 |
| **Gloria** | | All Barangays | All Barangays | 230.80 |
| **Mansalay** | | All Barangays | All Barangays | 513.10 |
| **Naujan** | | | Naujan Lake | 81,250 |
| **Naujan** | | All Barangays | All Barangays | 528.00 |
| **Pinamalayan** | | All Barangays | All Barangays | 277.30 |
| **Pola** | | All Barangays | All Barangays | 130.20 |
| **Puerto Galera** | | | All Barangays | 223.50 |
| **Roxas** | | All Barangays | All Barangays | 87.10 |
| **San Teodoro** | | All Barangays | All Barangays | 369.10 |
| **Socorro** | | All Barangays | All Barangays | 149.40 |
| **Victoria** | | All Barangays | All Barangays | 286.00 |
| | | **Total** | | **681,954.72** |

*Source: MGB*

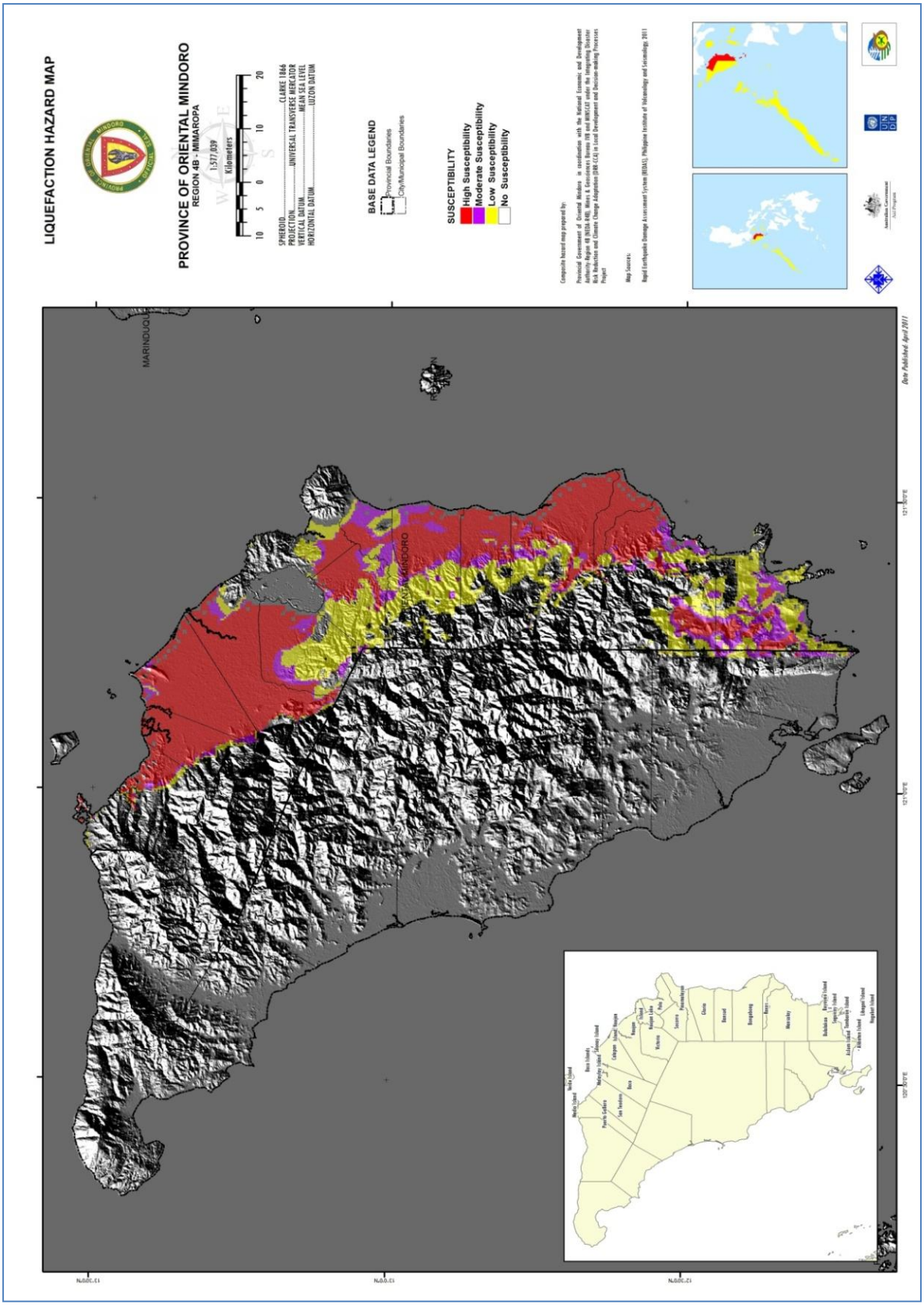



**Figure 7.** Liquefaction hazard map

- **Earthquake Induced Landslide**

Earthquake triggered landslide is an earthquake associated hazard as a result of severe ground shaking leading to slope failure. This can be in the form of rapidly moving detached masses and bits of pieces of soil and rock materials. In general, steep slopes with weathered bedrock or soft rock units, hilly to mountainous areas exposed to high precipitation rate slopes modified by road cuts, quarrying operations, river erosion and denuded forests are areas highly prone to landslide occurrences (Punongbayan, 1998).

***Threat Expected***

Earthquake induced landslide hazard map (Annex 7) was produced by generating three iterations based on the identified three scenario earthquakes. Raster based iteration maps are reprojected to UTM Zone 51, Luzon Datum, converted to vector format and processed using ArcGis 9.3.

The landslide susceptibility map (Annex 8) shows that the municipalities of Puerto Galera, Baco, Victoria, Socorro, Pinamalayan, Gloria, Bansud, Bongabong, Mansalay and Bulalacao are highly susceptible. On the other hand, the municipalities of Puerto Galera, San Teodoro, Baco, Naujan, Victoria, Pola, Socorro, Pinamalayan, Gloria, Bansud, Bongabong, Mansalay, Roxas and Bulalacao are moderately susceptible to landslides. And finally, the city/municipalities of Calapan, Puerto Galera, San Teodoro, Baco, Victoria, Pola, Socorro, Pinamalayan, Gloria, Bansud, Bongabong, Mansalay, Roxas, Bulalacao, Naujan and Naujan Lake are low susceptible to earthquake induced landslide.

**Table 10**. Matrix for Earthquake-Induced Landslide Hazard by Municipality

| Municipalities | Susceptibility Levels | | | Total land area (sqkm) |
|---|---|---|---|---|
| | High | Moderate | Low | |
| Baco | All Barangays | All Barangays | All Barangays | 241.70 |
| Bansud | All Barangays | All Barangays | All Barangays | 260.00 |
| Bongabong | All Barangays | All Barangays | All Barangays | 498.20 |
| Bulalacao | All Barangays | All Barangays | All Barangays | 305.12 |
| Calapan | | | All Barangays | 265.20 |
| Gloria | All Barangays | All Barangays | All Barangays | 230.80 |
| Mansalay | All Barangays | All Barangays | All Barangays | 513.10 |
| Naujan | | | Naujan Lake | 81,250 |
| Naujan | | All Barangays | | 528.00 |
| Pinamalayan | All Barangays | All Barangays | All Barangays | 277.30 |
| Pola | | All Barangays | All Barangays | 130.20 |
| Puerto Galera | All Barangays | All Barangays | All Barangays | 223.50 |
| Roxas | | All Barangays | All Barangays | 87.10 |
| San Teodoro | | All Barangays | All Barangays | 369.10 |
| Socorro | All Barangays | All Barangays | All Barangays | 149.40 |
| Victoria | All Barangays | All Barangays | All Barangays | 286.00 |
| **Total** | | | | **5,614.72** |

*Source: MGB*

### c. Scenarios for Geologic Hazards

Based on the Rapid Earthquake Damage Assessment System (REDAS) Seismicity Assessment using the Seismological Observation and Earthquake Prediction Division (SOEPD) and National Earthquake Information Center – U.S. Geological Survey (NEIC-USGS) databases, there are five active faults affecting the province of Oriental Mindoro. However, only the three with highest observed magnitude events were used in identifying three scenarios for the computation of fatality and property damage:

**Table 11.** Length, epicenter, and magnitude of active faults in Oriental Mindoro.

| SCENARIO | FAULT SOURCE/NAME | FAULT LENGTH (Kms) | REDAS Simulation Parameters | | |
|---|---|---|---|---|---|
| | | | Epicenter | | Magnitude |
| | | | Longitude | Latitude | |
| 1 | **Manila Trench** | 227 | 120.734 | 12.762 | **7.9** |
| 2 | **Lubang Fault** | 175 | 121.166 | 13.506 | **7.7** |
| 3 | **Central Mindoro Fault** | 116 | 121.07 | 13.306 | **7.5** |
| 3 | **Southern Mindoro Fault** | 42 | 121.27 | 12.45 | **7.5** |
| | **Aglubang Lubang** | 45 | 121.186 | 13.25 | **7.2** |

## Climate-related hazards

Climate-related hazards and temporal deviation of weather characteristics from the norm in a particular region and in a particular season, are dangerous to life and economic activity.[5]

### a. Drought

**Drought** is an extended period when a region notes a deficiency in its water supply whether surface or underground water. Generally, this occurs when a region receives consistently below average precipitation. It can have a substantial impact on the ecosystem and agriculture of the affected region. [6]

High risk to water stagnation and medium risk to soil fertility, ground water depletion and mass movement resulting to drought is being experienced in the municipality of Bulalacao (barangays Maujao and Milagrosa). Barangays with high risk to drought are Manaul (Mansalay), General Esco (Naujan) and Alcate (Victoria). Other barangays which are likely to experience drought are Del Razon and Gunihawa in Pinamalayan, and Bayuin and Malugay in Socorro. (CCHAMP)

[5] A.V. Kislov and A.N. Krenke. Climate-Related Hazards, Natural Disaster Vol. II
[6] Wikipedia

**b. El Niño/La Niña**

El Niño and La Niña are variations in the temperature of the surface of the tropical eastern Pacific Ocean and in air surface pressure in the tropical western Pacific. The two variations are coupled: the warm oceanic phase, El Niño, accompanies high air surface pressure in the western Pacific, while the cold phase, *La Niña*, accompanies low air surface pressure in the western Pacific.[7]

Oriental Mindoro is also exposed to the onslaught of El Niño or prolonged dry spell. Based on PAGASA data, the El Niño climatic averages showed that there was significant increase of 135.0% hours solar radiation and decrease of 55.0 mm rainfall from January to February 2010. The below normal rainfall activity was due to weak or early termination of north-east monsoon. (CCHAMP)

[7] Wikipedia

## CONSEQUENCE ANALYSIS

### A. CONSEQUENCE IN TERMS OF FATALITY

#### 1. Flood

According to the Global Assessment Report on Disaster Risk Reduction 2011[8], the average numbers exposed to major river basin flooding every year between 1970 and 2010 increased by 114 percent (from 32.5 to 69.4 million annually).

The estimated fatality due to flood in Oriental Mindoro is presented in Table 12. The computed values showed Calapan City as having the highest estimated fatality for frequent, likely and rare floods. On the other hand, the municipality of San Teodoro has the lowest estimated fatality due to flood with only 0.00912 for frequent, 0.04432 for likely and 0.07402 for rare events.

**Table 12.** Estimated fatality due to flood

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM FLOOD | | |
|---|---|---|---|
| | Frequent | Likely | Rare |
| Baco | 0.31681 | 0.79203 | 1.33171 |
| Bansud | 0.11826 | 0.76299 | 1.35914 |
| Bongabong | 0.50092 | 1.30827 | 2.12587 |
| Bulalacao | 0.04364 | 0.16212 | 0.32752 |
| Calapan City | 0.95679 | 3.29355 | 5.29017 |
| Gloria | 0.19423 | 0.91815 | 1.52078 |
| Mansalay | 0.07157 | 0.45352 | 1.06972 |
| Naujan | 0.40849 | 1.99567 | 3.64787 |
| Pinamalayan | 0.21082 | 1.02002 | 1.84020 |
| Pola | 0.09286 | 0.30842 | 0.54486 |
| Puerto Galera | 0.03773 | 0.13717 | 0.22794 |
| Roxas | 0.54061 | 1.20248 | 2.06060 |
| San Teodoro | 0.00912 | 0.04432 | 0.07402 |
| Socorro | 0.03655 | 0.48742 | 1.02686 |
| Victoria | 0.15214 | 0.90809 | 1.72255 |

[8] http://www.preventionweb.net/english/hyogo/gar/2011/en/what/chapter2_2.html

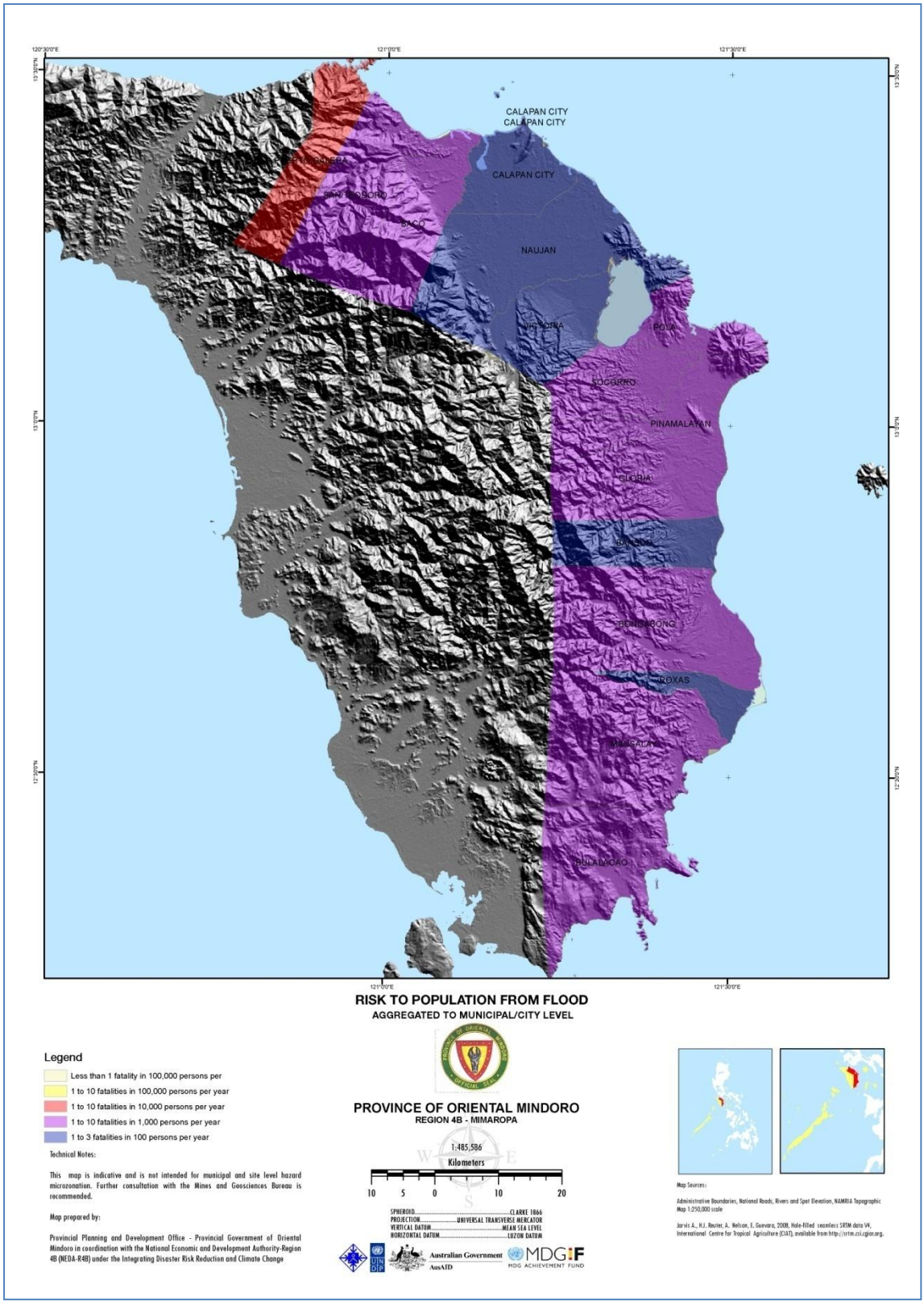



**Figure 8.** Map of risk to population from flood

## 2. Rainfall-induced landslide (RIL)

The term "landslide" describes a wide variety of processes that result in the downward and outward movement of slope-forming materials including rock, soil, artificial fill, or a combination of these. The materials may move by falling, toppling, sliding, spreading, or flowing.[9]

In the majority of cases the main trigger of landslides is heavy or prolonged rainfall. The importance of rainfall as a trigger for landslides cannot be underestimated. A global survey of landslide occurrence in the 12 months to the end of September 2003 revealed that there were 210 damaging landslide events worldwide. Of these, over 90% were triggered by heavy rainfall.[10]

In the province of Oriental Mindoro, the estimated fatality from RIL for frequent events was highest in the municipality of Pinamalayan with 1.9959. This was followed by Pola and Bongabong with 0.9959 and 0.9621, respectively. For likely events, Pinamalayan was still highest at 6.2606 estimated fatality followed by Mansalay with 4.4234. While Calapan City has the least estimated RIL fatality for both frequent and likely events with only 0.1050 and 0.3253, respectively, it was highest for rare events with 34.6553.

**Table 13**. Estimated fatality from RIL

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM RIL | | |
|---|---|---|---|
| | Frequent | Likely | Rare |
| Baco | 0.4186 | 1.1322 | 10.1372 |
| Bansud | 0.4922 | 1.3352 | 10.5770 |
| Bongabong | 0.9621 | 2.6762 | 18.0875 |
| Bulalacao | 0.3746 | 3.5724 | 8.3707 |
| Calapan City | 0.1050 | 0.3253 | 34.6553 |
| Gloria | 0.2795 | 0.7471 | 12.0946 |
| Mansalay | 0.7703 | 4.4234 | 12.8439 |
| Naujan | 0.8573 | 2.7775 | 27.1082 |
| Pinamalayan | 1.9959 | 6.2606 | 23.0381 |
| Pola | 0.9959 | 3.5970 | 9.6921 |
| Puerto Galera | 0.4727 | 3.0685 | 7.5899 |
| Roxas | 0.1985 | 0.6796 | 13.9912 |
| San Teodoro | 0.6705 | 2.4747 | 4.2112 |
| Socorro | 0.2449 | 1.4415 | 11.3347 |
| Victoria | 0.3975 | 1.3858 | 13.4331 |

The *Risk to Population from Rain-Induced Landslide Map* shows that only Calapan City has 1 to 10 fatalities in 100 persons per year. The rest of the province has 1 to 23 fatalities per year.

[9] http://www.eoearth.org/article/Landslide
[10] http://en.wikipedia.org/wiki/Causes_of_landslides

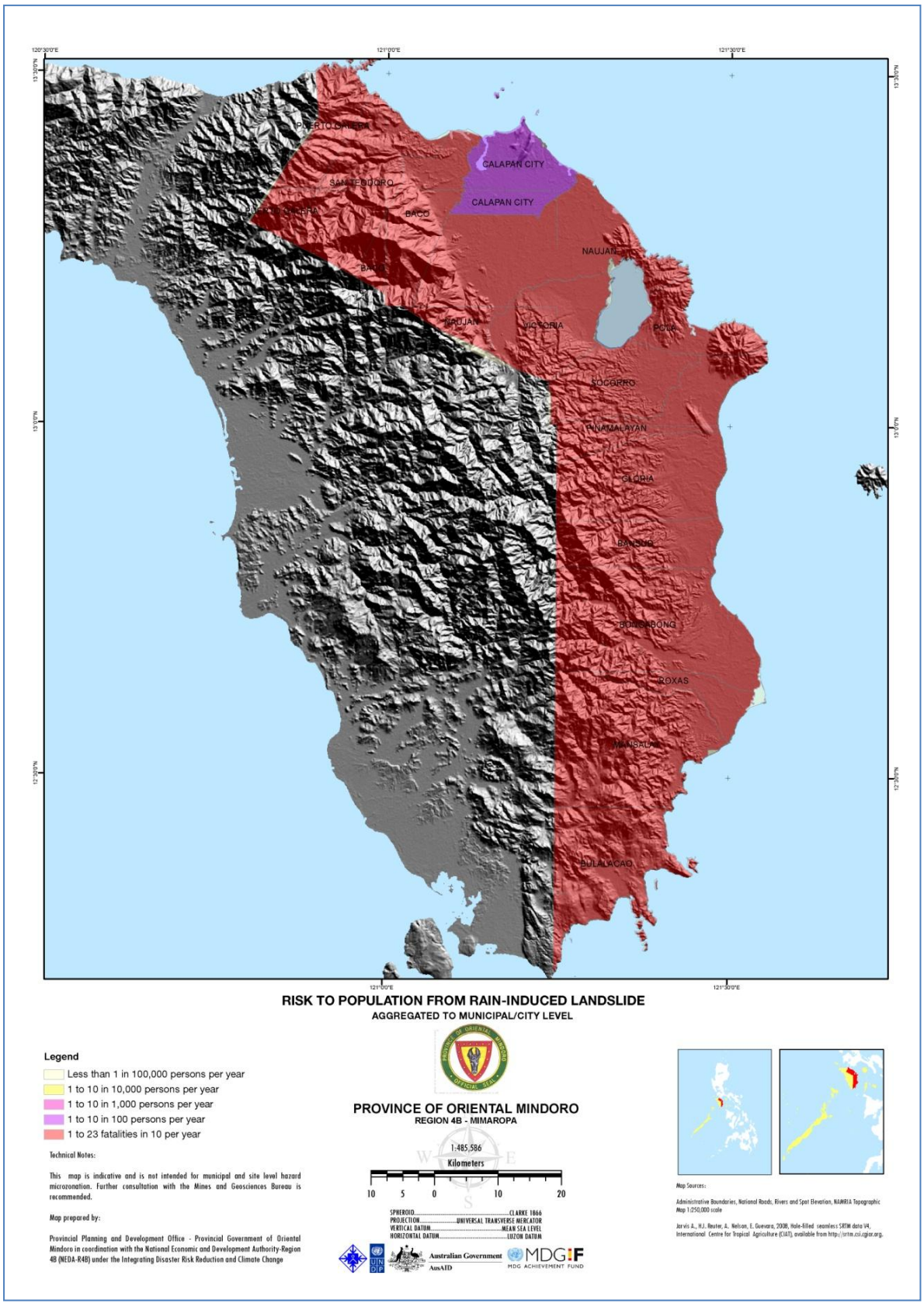



**Figure 9.** Map of risk to population from rain-induced landslide

### 3. Ground shaking

The estimated fatality from ground shaking was computed for three scenarios and one composite.

In scenarios 1 and 2, the municipality of Naujan has the largest affected area with 50, 148.90 hectares, followed by Bongabong with 48,566.49 hectares. However, in terms of affected population and number of fatality, Calapan City will have the highest figures with 116,976 and 351, respectively. Naujan is second with 90,629 affected population and 272 fatalities. Roxas has the least affected area with 8,497.54 hectares but San Teodoro has the smallest number of affected population of 15,039 and 45 fatalities.

**Table 14.** Estimated fatality from ground shaking, scenarios 1 and 2

| CITY/MUNICIPALITY | ESTIMATED FATALITY | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 24,483.12 | 34,127 | 0.003 | 102 |
| Bansud | 19,115.93 | 35,664 | 0.003 | 107 |
| Bongabong | 48,566.49 | 61,127 | 0.003 | 183 |
| Bulalacao | 32,523.56 | 30,188 | 0.003 | 91 |
| Calapan City | 18,412.09 | 116,976 | 0.003 | 351 |
| Gloria | 32,020.71 | 40,561 | 0.003 | 122 |
| Mansalay | 46,682.83 | 43,974 | 0.003 | 132 |
| Naujan | 50,148.90 | 90,629 | 0.003 | 272 |
| Pinamalayan | 19,614.64 | 77,119 | 0.003 | 231 |
| Pola | 12,123.88 | 32,635 | 0.003 | 98 |
| Puerto Galera | 18,850.40 | 28,035 | 0.003 | 84 |
| Roxas | 8,497.54 | 44,279 | 0.003 | 133 |
| San Teodoro | 29,081.42 | 15,039 | 0.003 | 45 |
| Socorro | 20,616.06 | 38,052 | 0.003 | 114 |
| Victoria | 20,699.21 | 44,932 | 0.003 | 135 |

Scenario 3 shows a slight decrease in affected population and number of fatality. Calapan City still has the most number of affected population of 110,445 and 331 fatalities followed by Naujan then Pinamalayan with 262 and 199 estimated number of fatalities, respectively.

**Table 15**. Estimated fatality from ground shaking, scenario 3.

| CITY/MUNICIPALITY | ESTIMATED FATALITY | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 244.76 | 33,623 | 0.003 | 101 |
| Bansud | 191.16 | 32,480 | 0.003 | 97 |
| Bongabong | 485.66 | 56,737 | 0.003 | 170 |
| Bulalacao | 326.61 | 24,260 | 0.003 | 73 |
| Calapan City | 183.94 | 110,445 | 0.003 | 331 |
| Gloria | 320.21 | 38,026 | 0.003 | 114 |
| Mansalay | 466.92 | 41,345 | 0.003 | 124 |
| Naujan | 501.05 | 87,277 | 0.003 | 262 |
| Pinamalayan | 195.95 | 66,453 | 0.003 | 199 |
| Pola | 121.18 | 31,411 | 0.003 | 94 |
| Puerto Galera | 188.44 | 18,339 | 0.003 | 55 |
| Roxas | 84.98 | 39,202 | 0.003 | 118 |
| San Teodoro | 290.75 | 13,785 | 0.003 | 41 |
| Socorro | 206.12 | 37,813 | 0.003 | 113 |
| Victoria | 206.75 | 42,143 | 0.003 | 126 |

The composite estimated fatality from ground shaking showed Calapan City as having the most number of affected population and fatality while San Teodoro has the lowest.

**Table 16**. Estimated fatality from ground shaking, composite scenario

| CITY/MUNICIPALITY | ESTIMATED FATALITY | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR FOR FATALITY | NUMBER OF FATALITY |
| Baco | 244.83 | 33,694 | 0.003 | 101 |
| Bansud | 191.16 | 32,480 | 0.003 | 97 |
| Bongabong | 485.66 | 56,737 | 0.003 | 170 |
| Bulalacao | 326.61 | 24,260 | 0.003 | 73 |
| Calapan City | 184.12 | 110,638 | 0.003 | 332 |
| Gloria | 320.21 | 38,026 | 0.003 | 114 |
| Mansalay | 466.92 | 41,345 | 0.003 | 124 |
| Naujan | 501.71 | 87,674 | 0.003 | 263 |
| Pinamalayan | 196.24 | 67,244 | 0.003 | 202 |
| Pola | 121.26 | 31,437 | 0.003 | 94 |
| Puerto Galera | 188.59 | 18,535 | 0.003 | 56 |
| Roxas | 84.98 | 39,202 | 0.003 | 118 |
| San Teodoro | 290.91 | 13,794 | 0.003 | 41 |
| Socorro | 206.16 | 37,831 | 0.003 | 113 |
| Victoria | 206.99 | 42,197 | 0.003 | 127 |

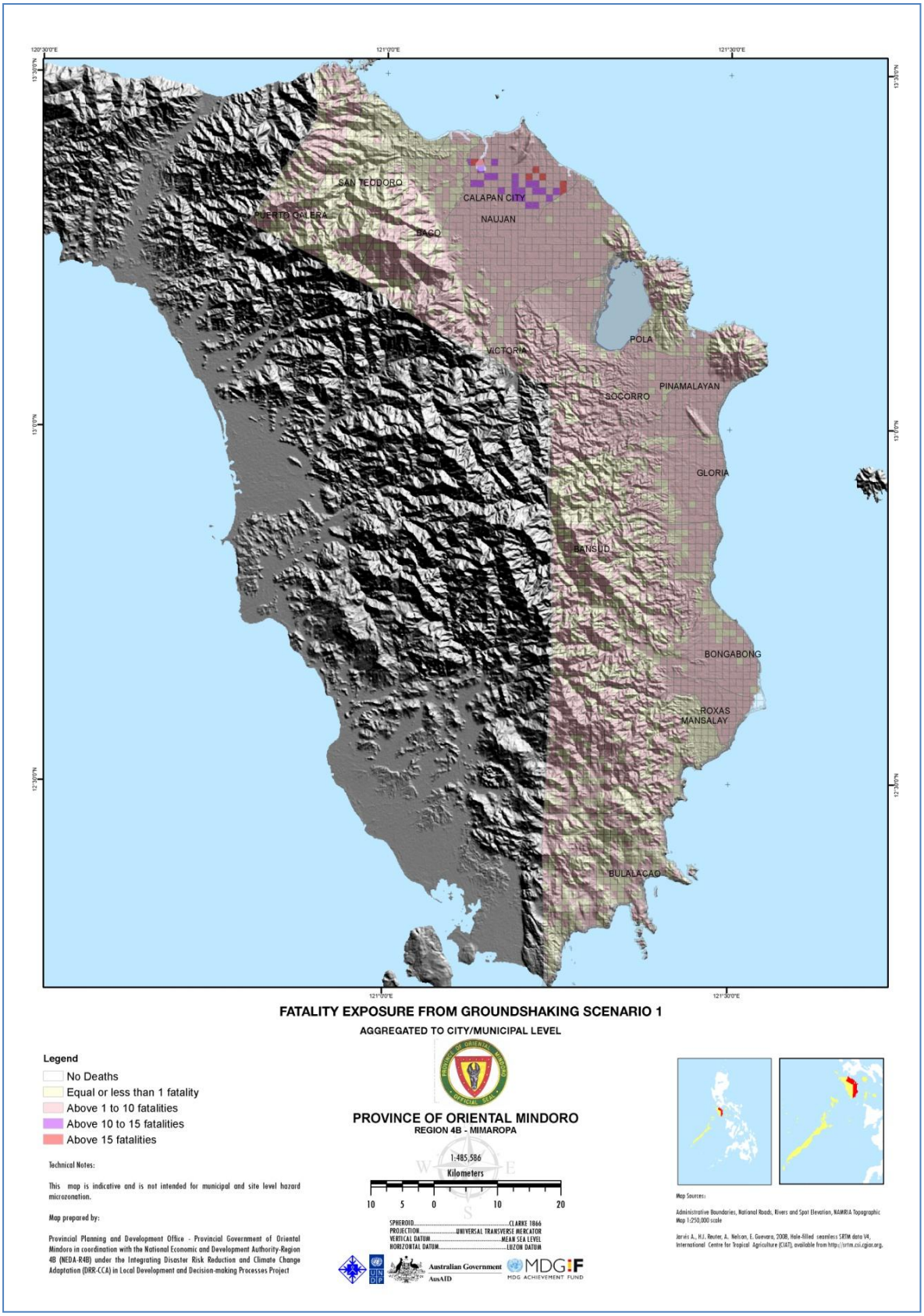



**Figure 10.** Map of fatality exposure from ground shaking, scenario 1

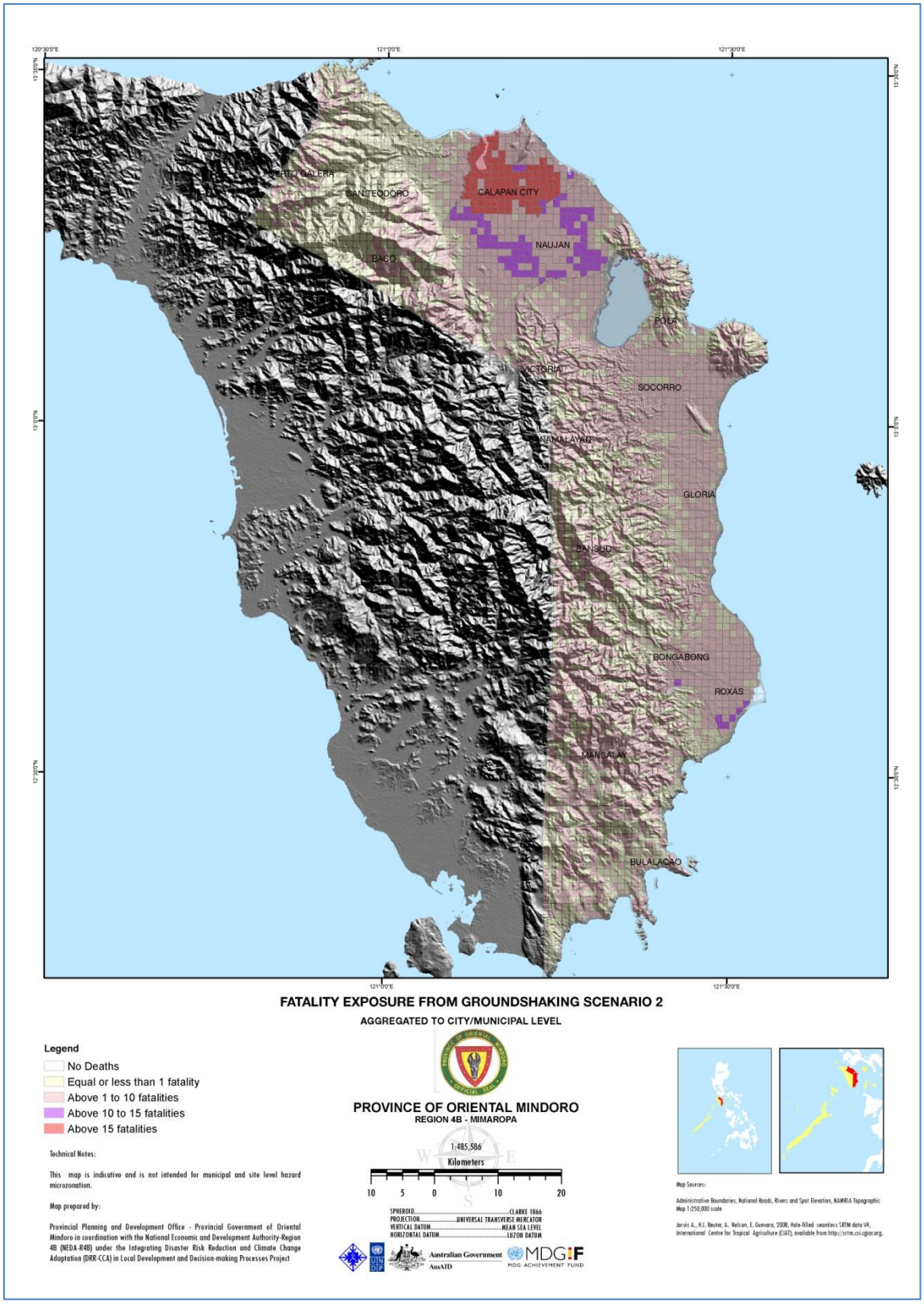



**Figure 11.** Map of fatality exposure from ground shaking, scenario 2

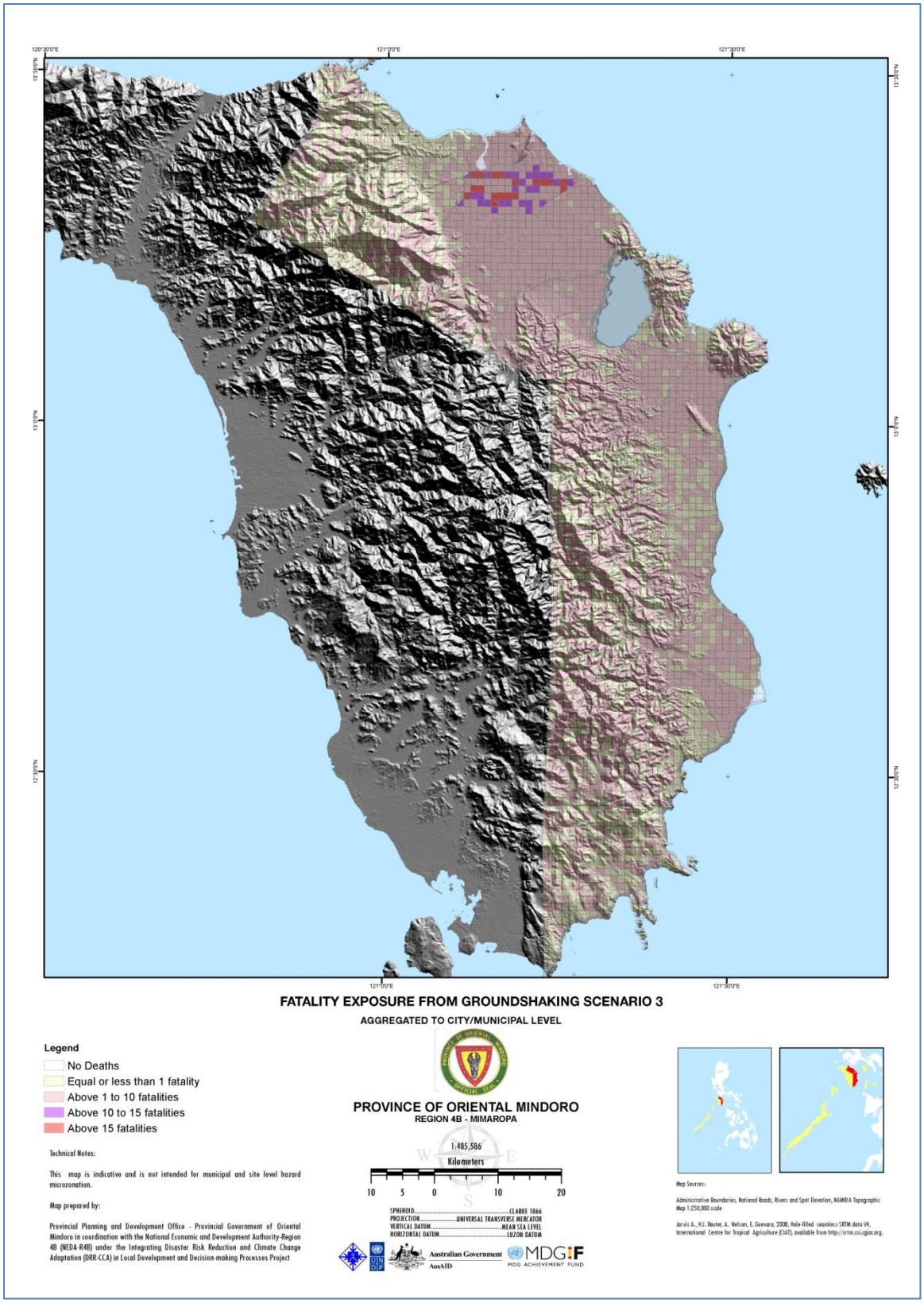



**Figure 12.** Map of fatality exposure from ground shaking, scenario 3

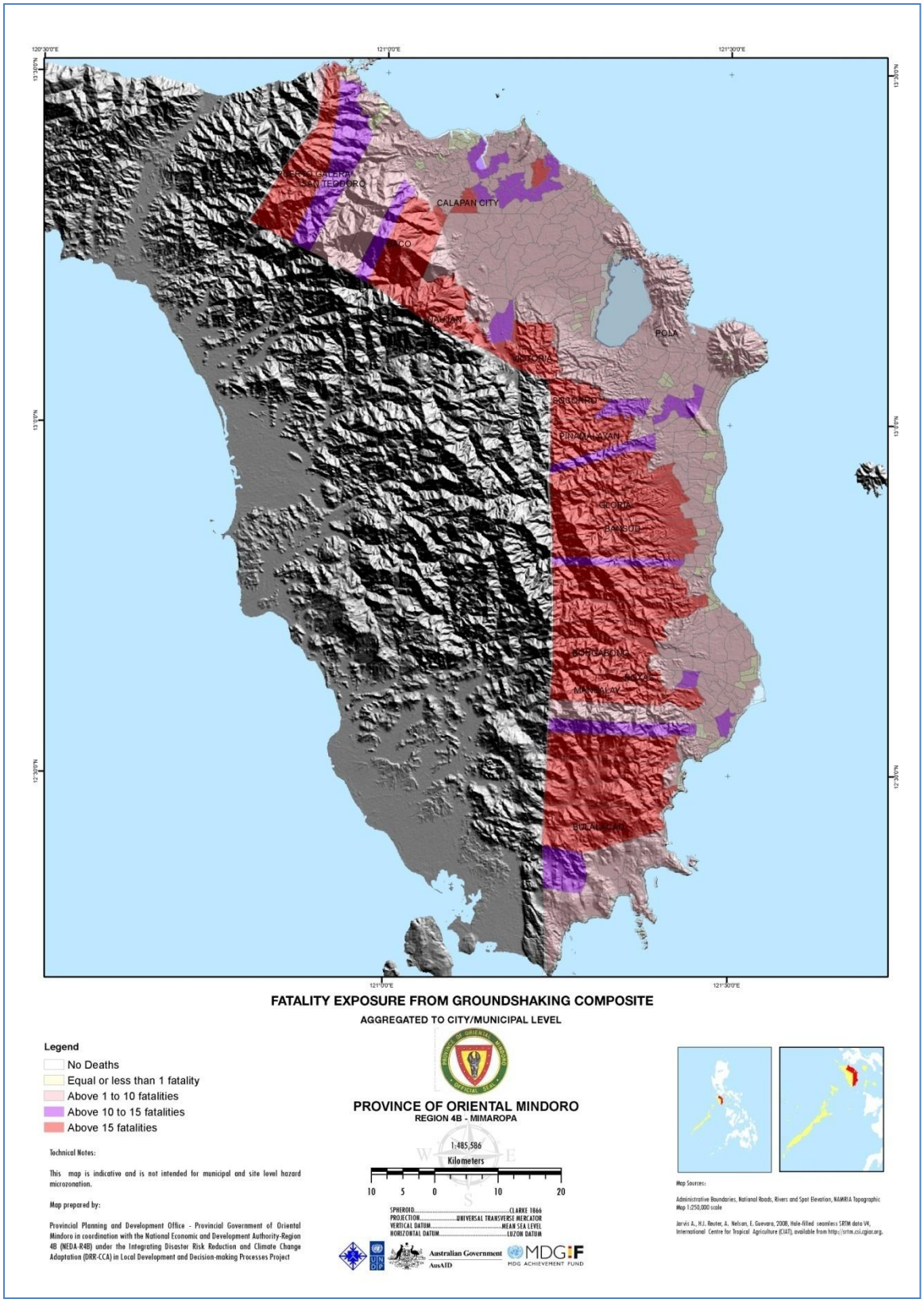



**Figure 13.** Map of fatality exposure from ground shaking, composite

## 4. Earthquake-induced landslide

The most abundant types of earthquake-induced landslides are rock falls and slides of rock fragments that form on steep slopes.[11]

In a publication by the Food and Agriculture Organization of the United Nations (Forests and landslides: The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia), it was mentioned that "the impacts of earthquake-induced landslides are escalating because of rising population densities and economic development in areas once thought remote or too steep for development. Widespread landsliding due to earthquakes is restricted to rare large earthquakes. Earthquakes smaller than magnitude six contribute negligible amounts to total landslide volumes. However, a single large earthquake can initiate thousands of landslides in an area up to 250 km or more from the epicenter, although the vast majority occurs on or near the fault-line."[12]

The estimated fatality from earthquake-induced landslide in Oriental Mindoro was also computed in three scenarios. The first scenario showed Mansalay as having the most number of affected population with 10,457 while Roxas has the least with approximately 895 people (Annex 9).

For the second scenario, the municipality of Mansalay still has the highest number of affected population with 10,447 followed by Puerto Galera (9,694 ) and Pola (8,704). Roxas has the least number with three fatalities (Annex 10). In the third scenario, Mansalay's estimated number of fatality is highest at 31 followed by Pola with 25 and Bongabong with 18 (Annex 11).

The composite scenario for earthquake-induced landslide showed a total of 72,395 affected population and 219 estimated fatalities. Fifteen percent of the affected population or 10,665 are in Mansalay.

**Table 17.** Estimated fatality from earthquake-induced landslide, composite scenario

| CITY/MUNICIPALITY | ESTIMATED FATALITY | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 131.76 | 3,268 | 0.003 | 10 |
| Bansud | 62.98 | 3,381 | 0.003 | 10 |
| Bongabong | 153.55 | 6,247 | 0.003 | 19 |
| Bulalacao | 94.58 | 2,567 | 0.003 | 8 |
| Calapan City | - | - | 0.003 | - |
| Gloria | 69.94 | 1,400 | 0.003 | 4 |
| Mansalay | 264.35 | 10,665 | 0.003 | 32 |
| Naujan | 75.38 | 5,353 | 0.003 | 16 |
| Pinamalayan | 27.87 | 2,351 | 0.003 | 7 |

[11] http://en.wikipedia.org/wiki/Causes_of_landslides
[12] http://www.fao.org/docrep/016/ba0126e/ba0126e00.pdf

| | | | | |
|---|---|---|---|---|
| Pola | 29.90 | 8,870 | 0.003 | 27 |
| Puerto Galera | 161.49 | 9,845 | 0.003 | 30 |
| Roxas | 5.86 | 895 | 0.003 | 3 |
| San Teodoro | 230.33 | 6,381 | 0.003 | 19 |
| Socorro | 55.30 | 5,314 | 0.003 | 16 |
| Victoria | 82.35 | 5,858 | 0.003 | 18 |

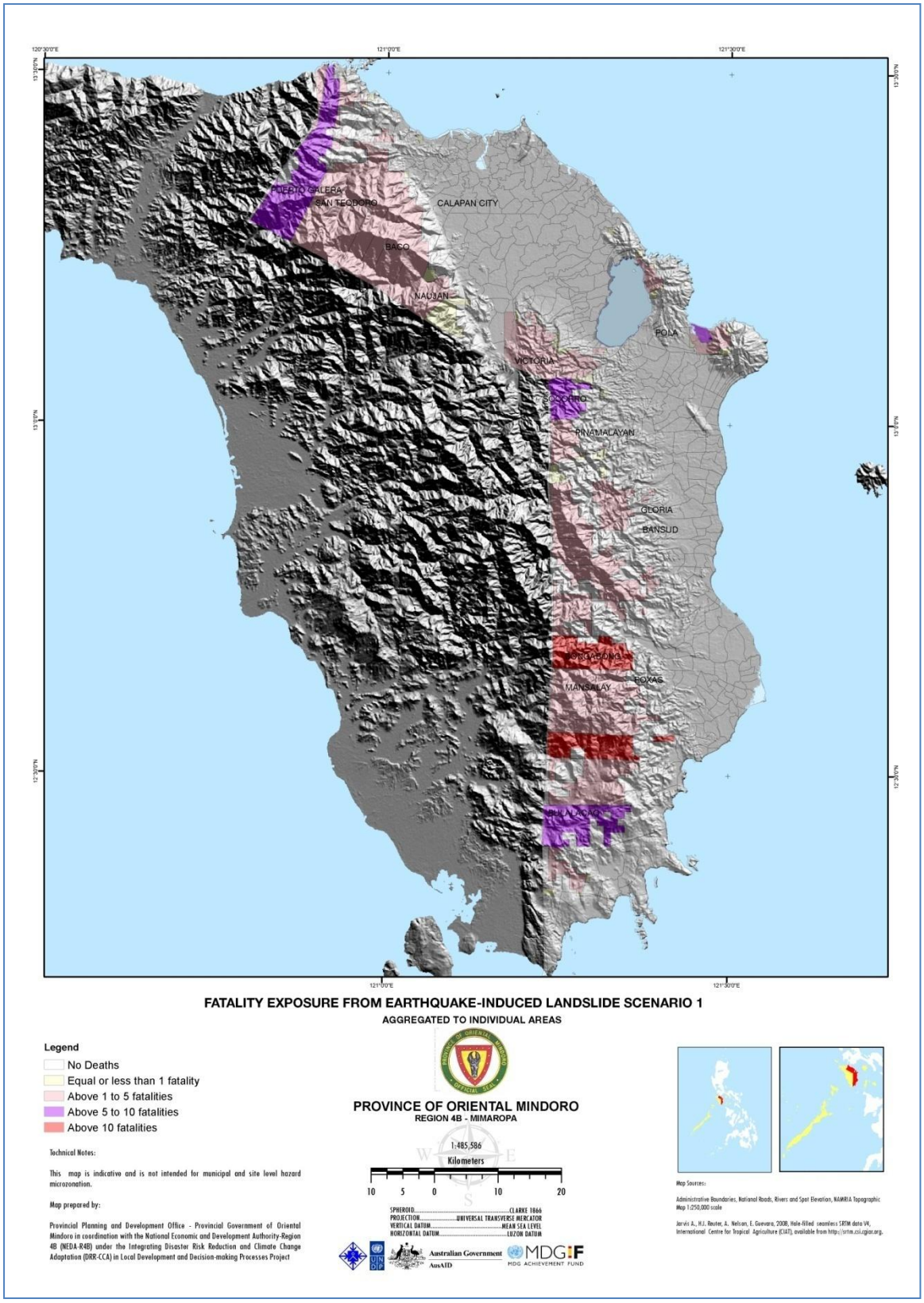



**Figure 14.** Map of fatality exposure from earthquake-induced landslide, scenario 1

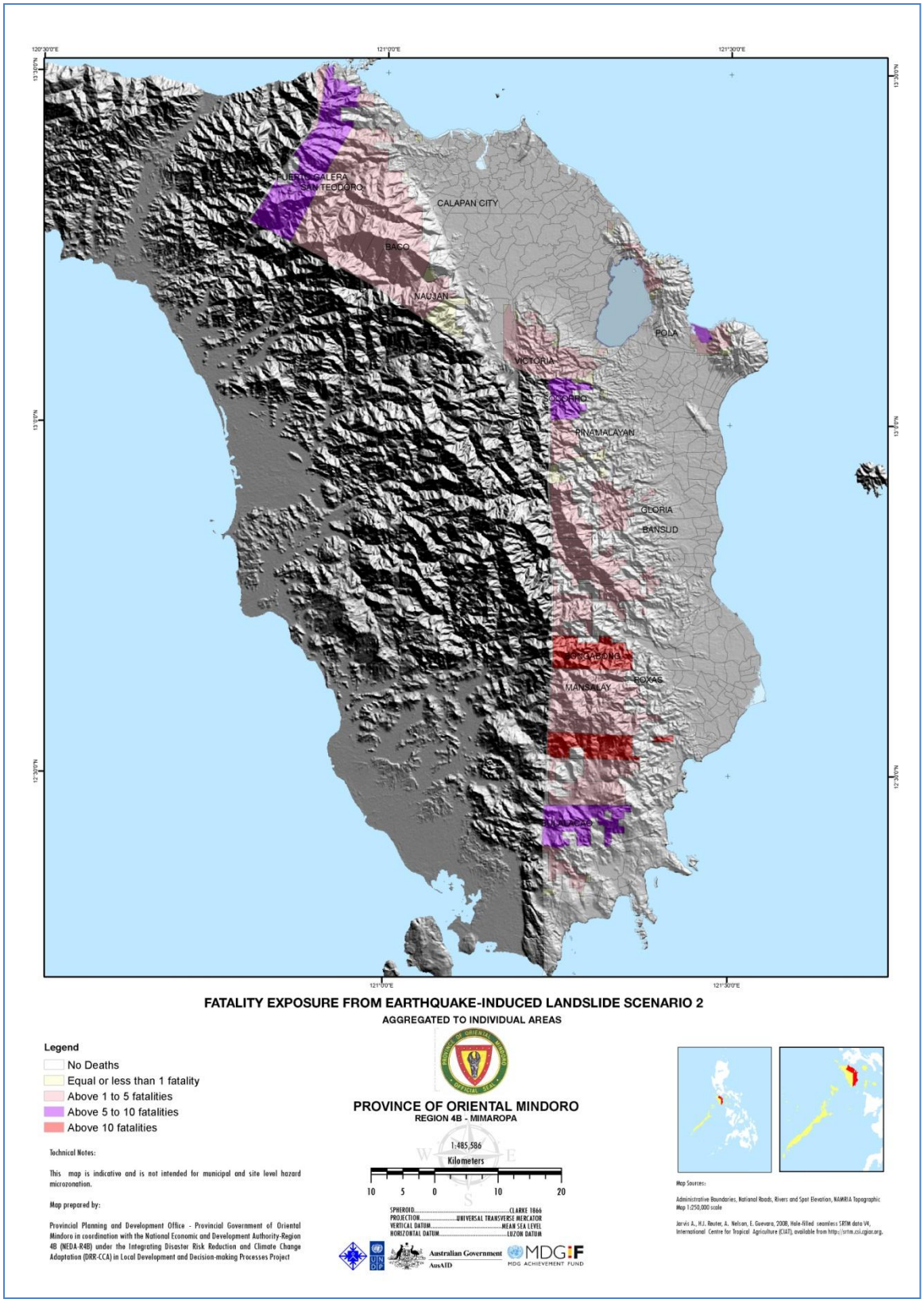



**Figure 15.** Map of fatality exposure from earthquake-induced landslide, scenario 2

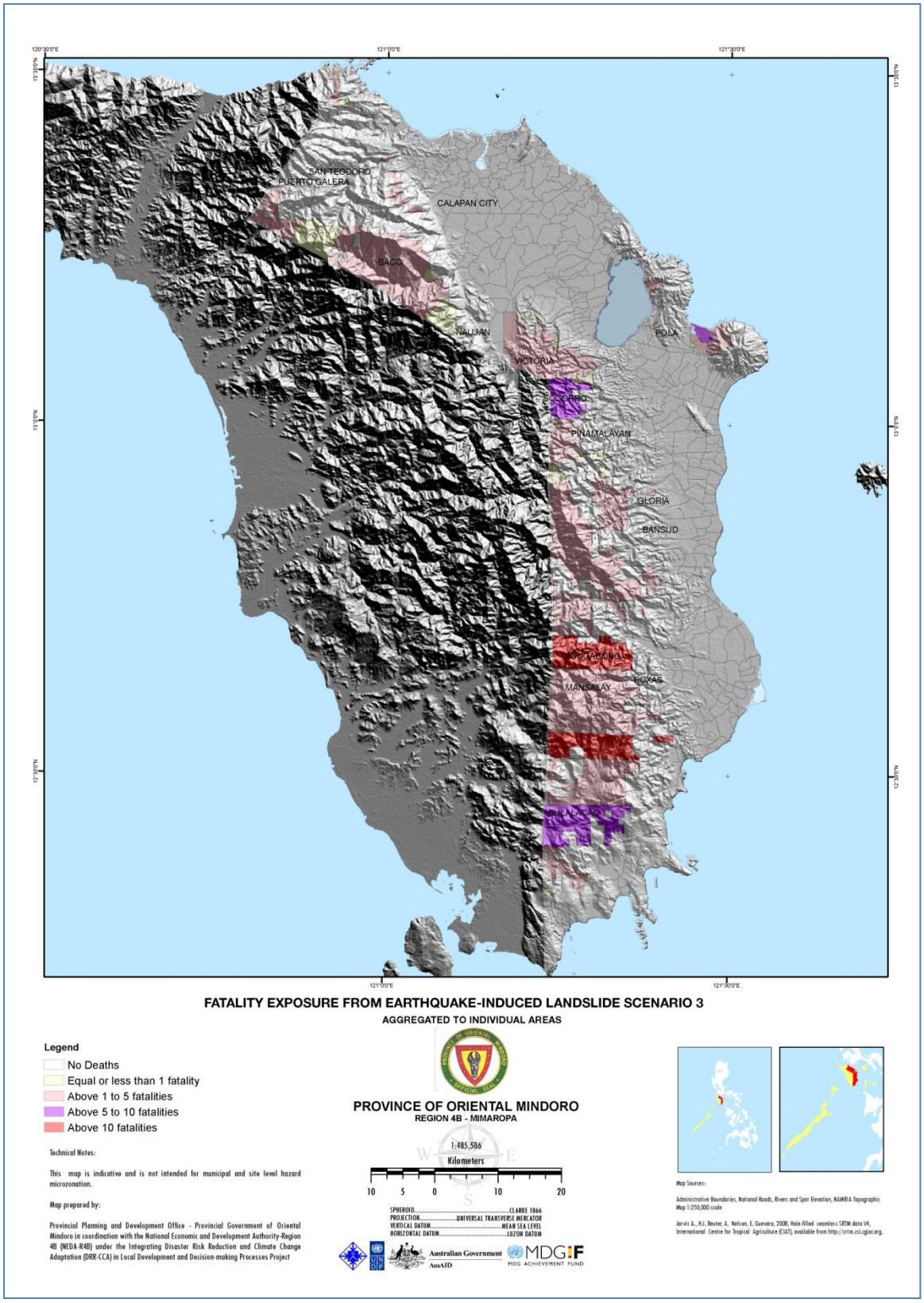



**Figure 16.** Map of fatality exposure from earthquake-induced landslide, scenario 3

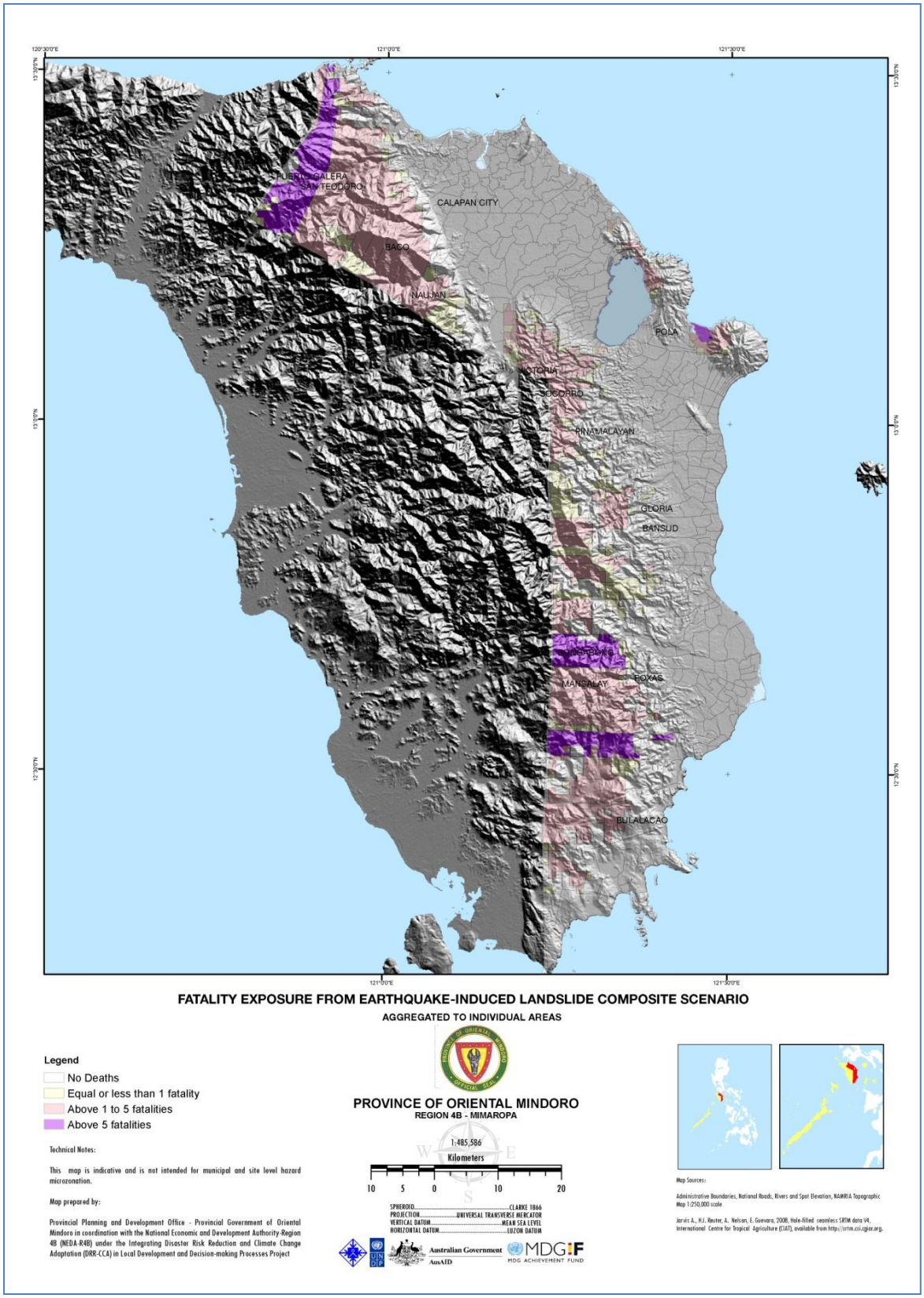



**Figure 17.** Map of fatality exposure from earthquake-induced landslide, composite scenario

## 5. Liquefaction

Liquefaction which involves the temporary loss of strength of sands and silts can have devastating effects during large earthquakes. Three scenarios were used to estimate the fatality from liquefaction. Scenario 1 has the highest number of affected population and fatalities among the three. Calapan City has the most number of affected population in the first scenario with 84,314 and 253 estimated fatalities. Naujan is second with 65,595 affected population and 197 fatalities followed by Bongabong and Pinamalayan. The municipality of Bulalacao has only 120 affected population and no fatality. (Annex 12)

For the second scenario (Annex 13), Calapan City has still the most number of affected population and estimated number of fatalities. Bulalacao still has the least with only 284 people affected and one estimated fatality. In scenario 3, Naujan will have the most affected population followed closely by Calapan City. On the other hand, San Teodoro will be the least affected with no estimated fatality. (Annex 14)

For the composite scenario, Naujan has the largest affected area with 337.30 square kilometers but Calapan City will have the most number of affected population and fatalities with 107,792 and 323, respectively. Puerto Galera will be least affected by liquefaction with only 622 people affected and two estimated fatalities.

**Table 18.** Estimated fatality from liquefaction, composite scenario

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM LIQUEFACTION | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 83.48 | 27,439 | 0.003 | 82 |
| Bansud | 79.12 | 25,588 | 0.003 | 77 |
| Bongabong | 216.09 | 39,713 | 0.003 | 119 |
| Bulalacao | 44.32 | 4,921 | 0.003 | 15 |
| Calapan City | 178.80 | 107,792 | 0.003 | 323 |
| Gloria | 197.02 | 34,248 | 0.003 | 103 |
| Mansalay | 102.82 | 20,952 | 0.003 | 63 |
| Naujan | 337.30 | 69,050 | 0.003 | 207 |
| Pinamalayan | 107.40 | 35,278 | 0.003 | 106 |
| Pola | 39.42 | 12,524 | 0.003 | 38 |
| Puerto Galera | 0.39 | 622 | 0.003 | 2 |
| Roxas | 60.43 | 29,524 | 0.003 | 89 |
| San Teodoro | 29.56 | 3,503 | 0.003 | 11 |
| Socorro | 141.40 | 31,311 | 0.003 | 94 |
| Victoria | 97.37 | 31,408 | 0.003 | 94 |

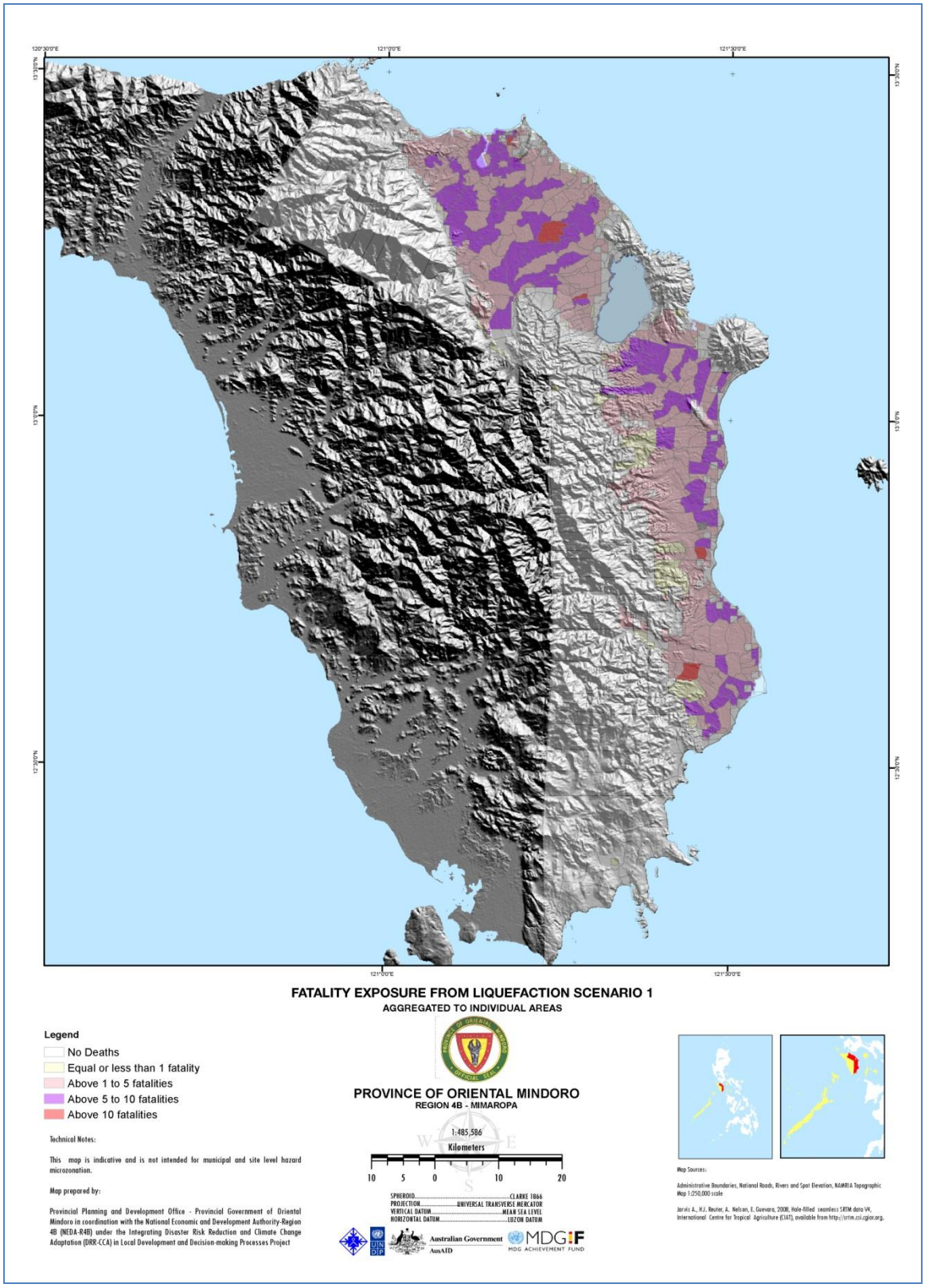



**Figure 18.** Map of fatality exposure from liquefaction, scenario 1

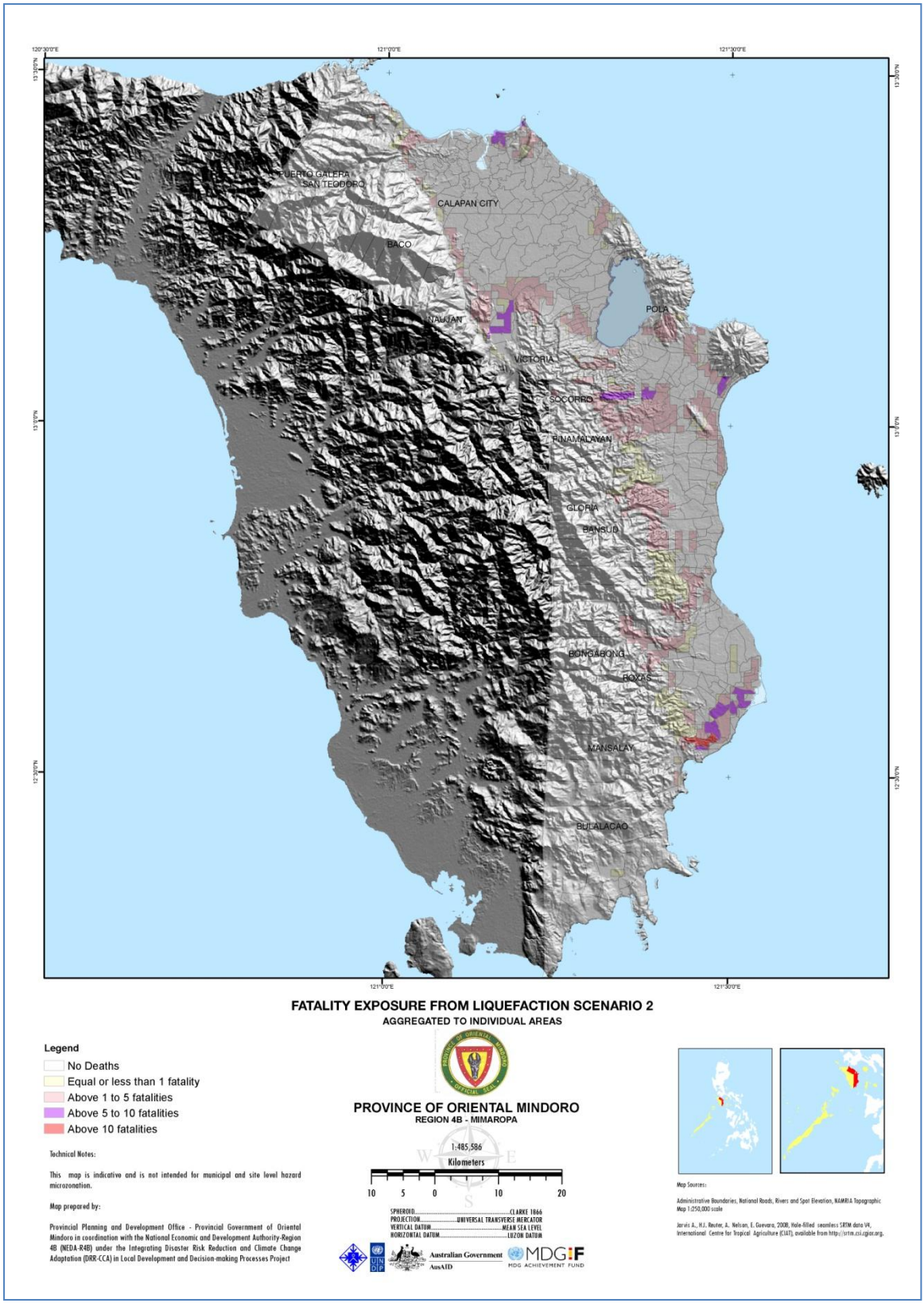



**Figure 19.** Map of fatality exposure from liquefaction, scenario 2

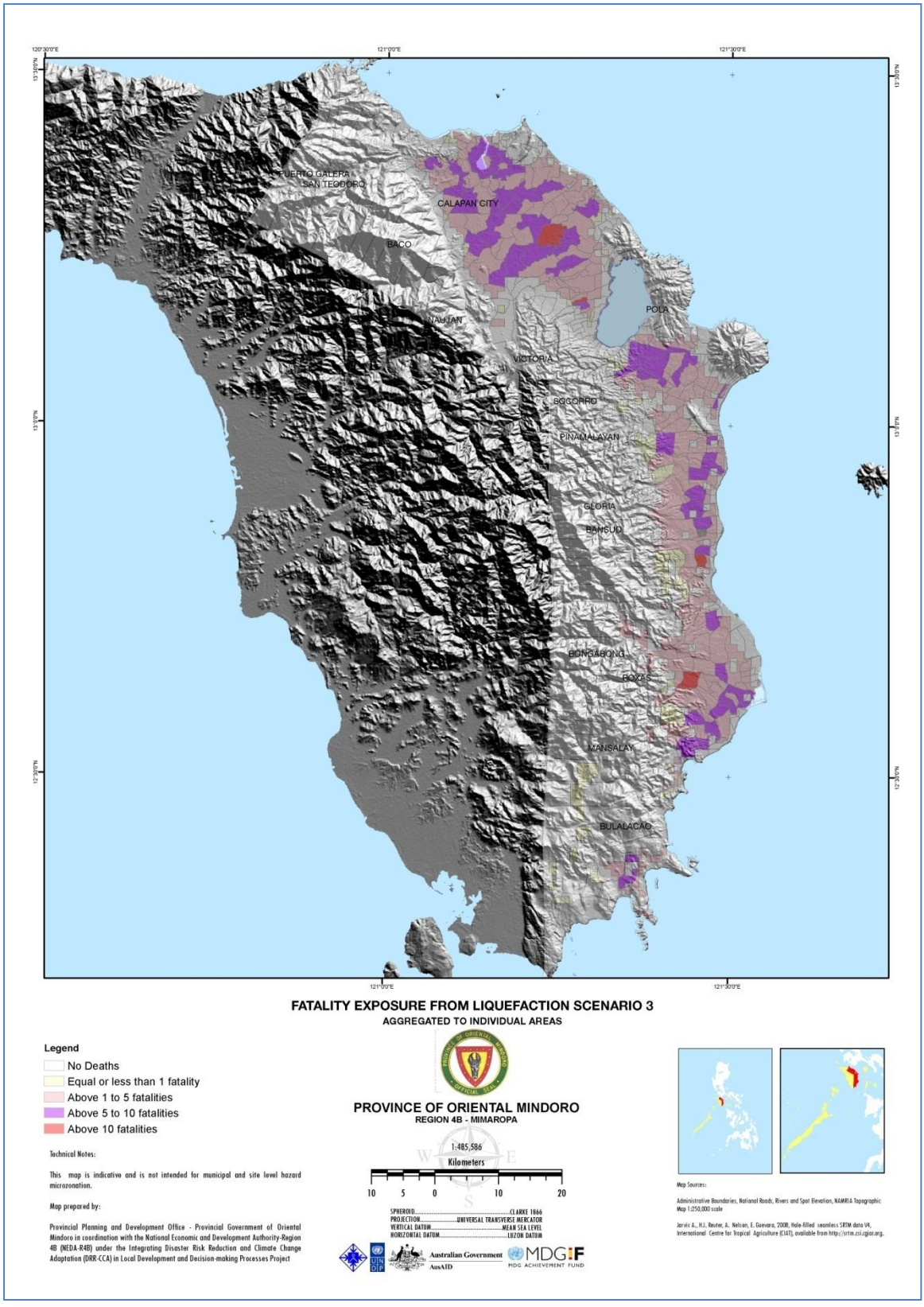



**Figure 20.** Map of fatality exposure from liquefaction, scenario 3

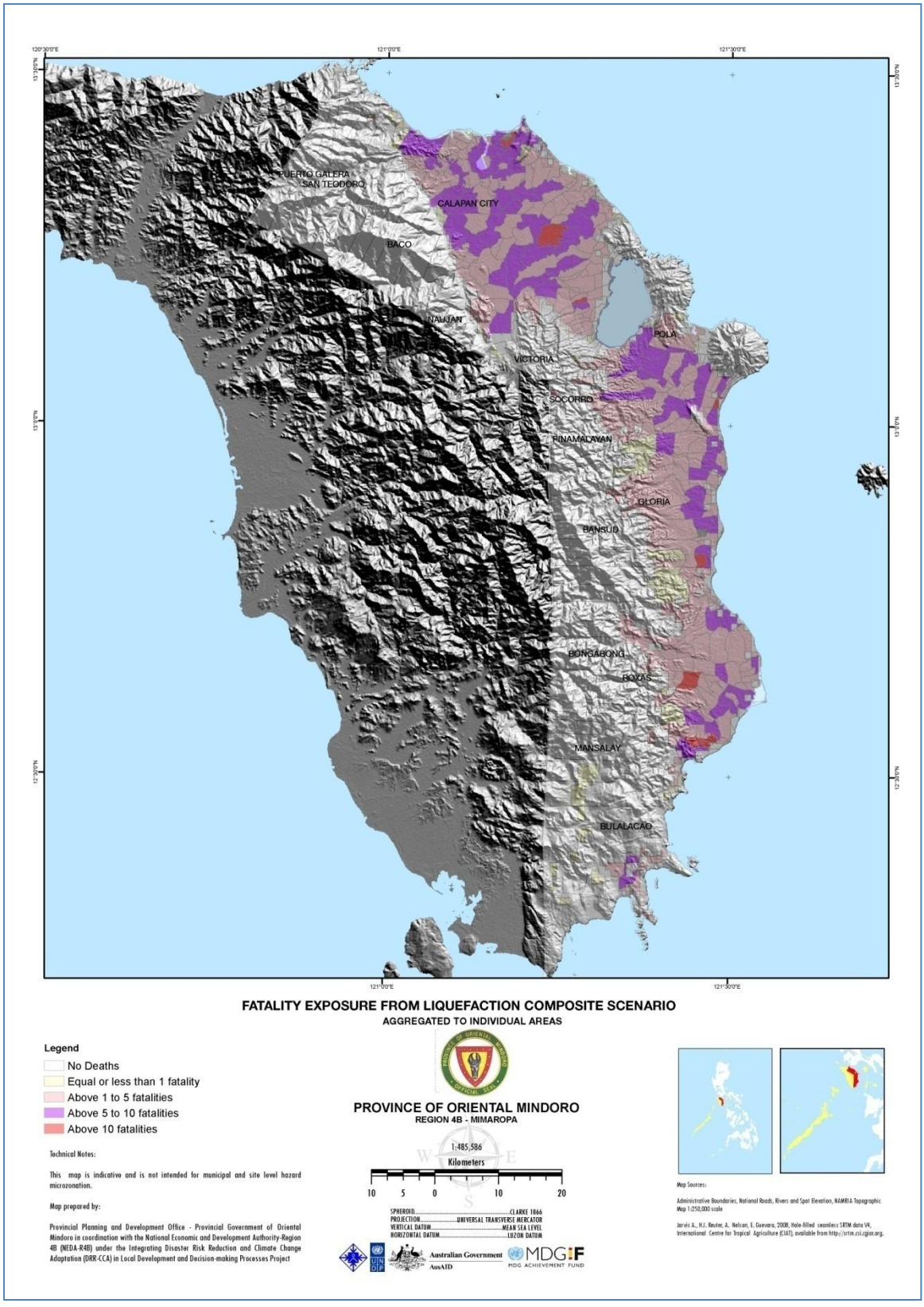



**Figure 21.** Map of fatality exposure from liquefaction, composite scenario

## 6. Tsunami

In the past, tsunamis were sometimes referred to as "tidal waves" by the general public, and as "seismic sea waves" by the scientific community. The term "tidal wave" is a misnomer; although a tsunami's impact upon a coastline is dependent upon the tidal level at the time a tsunami strikes, tsunamis are unrelated to the tides. Tides result from the imbalanced, extraterrestrial, gravitational influences of the moon, sun, and planets.

The term "seismic sea wave" is also misleading. "Seismic" implies an earthquake-related generation mechanism, but a tsunami can also be caused by a nonseismic event, such as a landslide or meteorite impact.[13]

In Oriental Mindoro, only Calapan City and the municipalities of Baco, Bongabong, Mansalay, Puerto Galera, Roxas, and San Teodoro have estimated fatality from tsunami. Roxas, Calapan City and Puerto Galera where the province's major ports are located have high affected population and fatalities.

**Table 19.** Estimated fatality from tsunami

| CITY/ MUNICIPALITY | ESTIMATED FATALITY FROM TSUNAMI | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 6.64 | 2,475 | 0.003 | 7 |
| Bansud | - | - | - | - |
| Bongabong | 5.52 | 3,753 | 0.003 | 11 |
| Bulalacao | - | - | - | - |
| Calapan City | 11.07 | 14,894 | 0.003 | 45 |
| Gloria | - | - | - | - |
| Mansalay | 11.85 | 7,427 | 0.003 | 22 |
| Naujan | - | - | - | - |
| Pinamalayan | - | - | - | - |
| Pola | - | - | - | - |
| Puerto Galera | 12.24 | 11,364 | 0.003 | 34 |
| Roxas | 15.81 | 18,772 | 0.003 | 56 |
| San Teodoro | 3.65 | 1,021 | 0.003 | 3 |
| Socorro | - | - | - | - |
| Victoria | - | - | - | - |

[13] http://www.ess.washington.edu/tsunami/general/physics/meaning.html

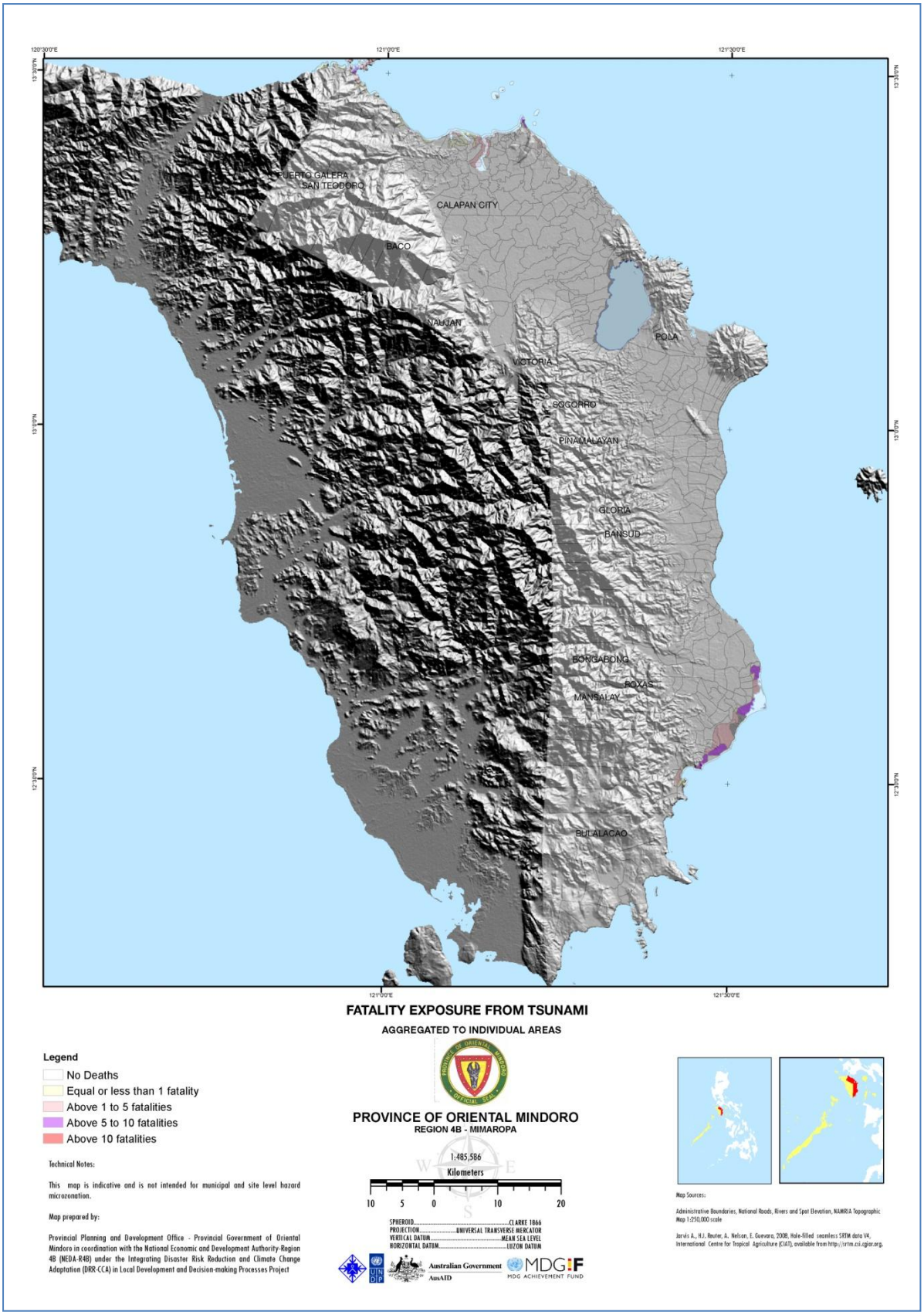



**Figure 22.** Map of fatality exposure from tsunami

## B. CONSEQUENCE IN TERMS OF DAMAGE TO PROPERTY

### 1. Flood

When floods occur, the impact on communities is extensive. Properties, infrastructure, the environment and the local economy are affected.

In Oriental Mindoro, Naujan has the highest estimated damage to agriculture, fishery and forestry from frequent, likely and rare floods. Puerto Galera, which is the prime tourism destination in the province has the least estimated damage with only PhP1.5M for frequent, PhP7.3M for likely and PhP13.9M for rare events.

**Table 20.** Estimated damage to agriculture, fishery and forestry from flood

| CITY/MUNICIPALITY | ESTIMATED DAMAGE FROM FLOOD | | |
|---|---|---|---|
| | FREQUENT | LIKELY | RARE |
| Baco | 60,860,192.92 | 168,284,451.08 | 320,694,398.90 |
| Bansud | 8,787,944.97 | 56,794,744.08 | 98,030,444.98 |
| Bongabong | 93,348,525.27 | 282,531,199.49 | 481,175,107.48 |
| Bulalacao | 7,598,530.59 | 25,652,032.28 | 42,445,883.96 |
| Calapan City | 82,050,870.86 | 433,519,296.23 | 695,664,501.48 |
| Gloria | 9,605,373.82 | 68,480,124.49 | 128,164,346.49 |
| Mansalay | 14,183,507.89 | 93,036,246.34 | 194,142,566.51 |
| Naujan | 101,047,664.82 | 631,967,758.04 | 1,171,101,816.78 |
| Pinamalayan | 17,549,076.87 | 126,729,678.55 | 288,050,645.43 |
| Pola | 19,535,068.71 | 58,648,083.01 | 107,699,327.05 |
| Puerto Galera | 1,529,778.30 | 7,311,574.07 | 13,906,367.66 |
| Roxas | 48,366,940.66 | 108,807,305.06 | 172,284,360.60 |
| San Teodoro | 7,791,334.21 | 37,483,047.36 | 69,308,769.25 |
| Socorro | 11,470,948.53 | 115,643,035.75 | 260,395,659.22 |
| Victoria | 32,978,684.18 | 190,520,129.60 | 412,700,298.83 |
| **TOTAL** | **516,704,442.60** | **2,405,408,705.43** | **4,455,764,494.62** |

The estimated damage to built-up areas for frequent flood events is largest in Calapan City, the provincial capital with PhP56,183,794.70. However, for likely and rare events, Mansalay has the highest estimated damage at PhP59,274,375.16 and PhP95,631,086.79, respectively. On the other hand, Bansud has the least estimated damage to built-up areas for frequent flood events with PhP107,008.59. For likely events, Bongabong has the least estimated damage with PhP786,509.19 while Naujan is lowest for rare events with only PhP1,423,751.98 estimated damage.

**Table 21.** Estimated damage to built-up areas from flood

| CITY/MUNICIPALITY | ESTIMATED DAMAGE TO BUILT-UP AREAS | | |
|---|---|---|---|
| | Frequent | Likely | Rare |
| Baco | 3,645,029.91 | 7,290,059.82 | 10,934,992.07 |
| Bansud | 107,008.59 | 3,576,692.37 | 5,364,990.64 |
| Bongabong | 246,870.84 | 786,509.19 | 2,448,531.60 |
| Bulalacao | 992,400.69 | 4,518,542.17 | 9,184,508.53 |
| Calapan City | 56,183,794.70 | 19,484,954.52 | 81,664,914.73 |
| Gloria | - | 19,197,720.18 | 28,796,323.08 |
| Mansalay | 1,372,962.81 | 59,274,375.16 | 95,631,086.79 |
| Naujan | 229,211.85 | 949,176.47 | 1,423,751.98 |
| Pinamalayan | 160,691.44 | 1,817,751.95 | 2,726,603.59 |
| Pola | 2,901,717.70 | 5,803,435.40 | 8,705,075.35 |
| Puerto Galera | 1,795,481.79 | 4,611,824.71 | 6,917,675.29 |
| Roxas | 1,048,886.77 | 3,803,010.34 | 13,943,818.95 |
| San Teodoro | - | 3,486,090.93 | 5,229,089.69 |
| Socorro | - | 2,444,733.05 | 3,667,066.82 |
| Victoria | 1,933,124.08 | 6,668,601.79 | 13,984,500.74 |
| **TOTAL** | **70,617,181.17** | **243,713,478.05** | **390,622,929.85** |

Critical infrastructure refer mostly to facilities that provide basic services to the public such as schools, barangay health stations, rural health centers, airports, seaports and government facilities. There are 666 critical infrastructure in the province of which, 49 percent are at risk.

Calapan City which has the most number of critical infrastructure has the highest estimated damage to critical infrastructure from flood. For frequent flood events, it was estimated at PhP45.9M while for likely and rare floods, the estimated damage were PhP170.3M and PhP284.03M, respectively. San Teodoro, which has one critical infrastructure, has a PhP10.9M estimated damage during rare flood events.

**Table 22.** Estimated damage to critical infrastructure from flood

| CITY / MUNICIPALITY | ESTIMATED DAMAGE TO CRITICAL INFRASTRUCTURE | | | TOTAL NUMBER OF CRITICAL INFRA-STRUCTRE | CRITICAL INFRA-STRUCTURE TOTAL RISK |
|---|---|---|---|---|---|
| | Frequent | Likely | Rare | | |
| Baco | 22,000,000.00 | 55,280,000.00 | 91,330,000.00 | 49 | 27.5400 |
| Bansud | 1,980,000.00 | 29,470,000.00 | 50,820,000.00 | 39 | 14.7100 |
| Bongabong | 26,960,000.00 | 67,170,000.00 | 106,370,000.00 | 72 | 33.4700 |
| Bulalacao | 1,680,000.00 | 3,380,000.00 | 9,110,000.00 | 8 | 1.7300 |
| Calapan City | 45,950,000.00 | 170,310,000.00 | 284,030,000.00 | 133 | 85.3500 |
| Gloria | 12,680,000.00 | 85,650,000.00 | 138,490,000.00 | 86 | 42.8200 |
| Mansalay | 7,740,000.00 | 36,530,000.00 | 84,540,000.00 | 60 | 18.3400 |
| Naujan | 12,460,000.00 | 74,030,000.00 | 143,430,000.00 | 72 | 37.0100 |

| | | | | | |
|---|---|---|---|---|---|
| Pinamalayan | 7,160,000.00 | 53,230,000.00 | 98,400,000.00 | 78 | 26.6800 |
| Pola | 5,760,000.00 | 15,380,000.00 | 30,080,000.00 | 15 | 7.7200 |
| Puerto Galera | - | 2,980,000.00 | 6,690,000.00 | 3 | 1.5200 |
| Roxas | 8,090,000.00 | 16,230,000.00 | 24,310,000.00 | 7 | 8.1600 |
| San Teodoro | - | - | 10,930,000.00 | 1 | 0.0900 |
| Socorro | 190,000.00 | 17,180,000.00 | 36,070,000.00 | 23 | 8.6600 |
| Victoria | 610,000.00 | 26,930,000.00 | 46,740,000.00 | 20 | 13.4600 |
| **Total** | **153,260,000.00** | **653,750,000.00** | **1,161,340,000.00** | **666** | **327.2600** |

The total estimated flood damage to roads was highest during rare events at PhP11,747,992,639.00. In terms of road total risk, Naujan and Calapan City were highest with PhP731.252M and PhP724.1M, respectively. Roads in Puerto Galera have the least estimated damage with PhP33.958M. For rare flood events, roads in Calapan City and the municipalities of Naujan, Victoria and Pinamalayan have more than One Billion Pesos estimated damage.

**Table 23.** Estimated damage to roads from flood

| CITY/ MUNICIPALITY | ESTIMATED DAMAGE TO ROADS FROM FLOOD | | | |
|---|---|---|---|---|
| | Frequent | Like | Rare | Road Total Risk |
| Baco | 27,381,519.86 | 345,004,633.44 | 555,173,576.00 | 173,493,661.98 |
| Bansud | 23,353,922.95 | 193,848,856.66 | 293,358,591.00 | 97,332,810.19 |
| Bongabong | 130,259,938.88 | 462,845,315.67 | 707,682,423.00 | 232,455,668.08 |
| Bulalacao | 29,439,882.24 | 178,731,639.83 | 364,531,807.00 | 90,494,759.47 |
| Calapan City | 281,039,685.79 | 1,440,331,953.41 | 2,292,255,380.00 | 724,100,712.68 |
| Gloria | 29,132,336.71 | 284,894,067.18 | 501,834,545.00 | 143,612,771.72 |
| Mansalay | 27,223,867.06 | 204,365,549.04 | 339,547,533.00 | 102,855,501.06 |
| Naujan | 194,158,992.90 | 1,449,049,054.45 | 2,652,258,865.00 | 731,252,119.96 |
| Pinamalayan | 58,181,159.06 | 500,762,350.05 | 1,058,162,941.00 | 253,838,859.24 |
| Pola | 29,831,437.12 | 79,082,154.65 | 183,657,800.00 | 40,219,518.82 |
| Puerto Galera | 13,740,200.22 | 67,250,391.73 | 125,729,069.00 | 33,958,525.07 |
| Roxas | 100,258,611.66 | 231,738,912.22 | 383,170,311.00 | 116,617,431.48 |
| San Teodoro | 12,005,249.91 | 107,112,228.01 | 223,680,449.00 | 54,274,436.22 |
| Socorro | 21,184,293.69 | 321,398,080.06 | 746,468,683.00 | 163,456,811.36 |
| Victoria | 75,125,188.48 | 711,786,010.48 | 1,320,480,666.00 | 359,338,996.52 |
| **Total** | **1,152,316,286.53** | **6,578,201,196.88** | **11,747,992,639.00** | **3,317,302,583.85** |

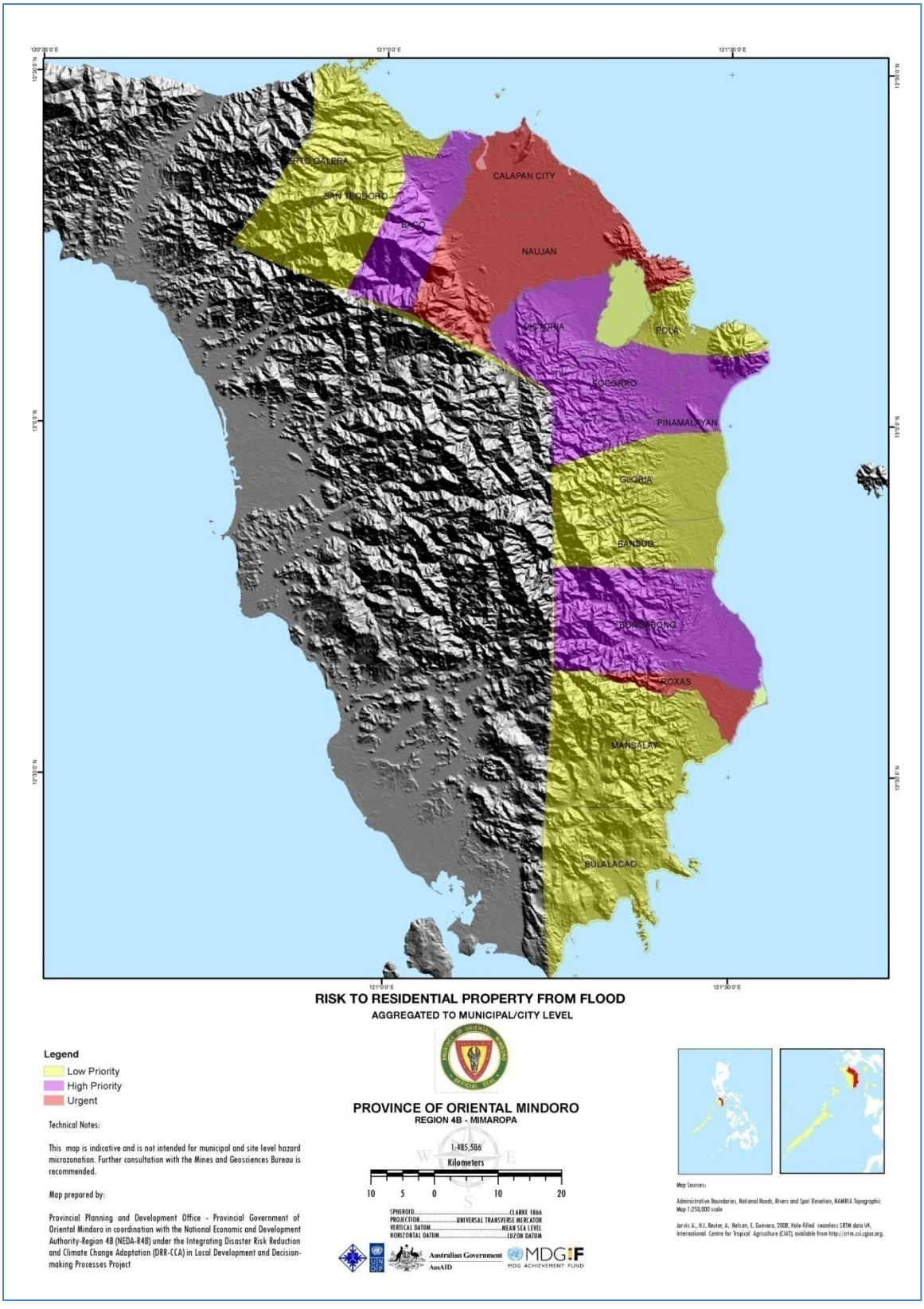



**Figure 23.** Map of risk to agricultural property from flood

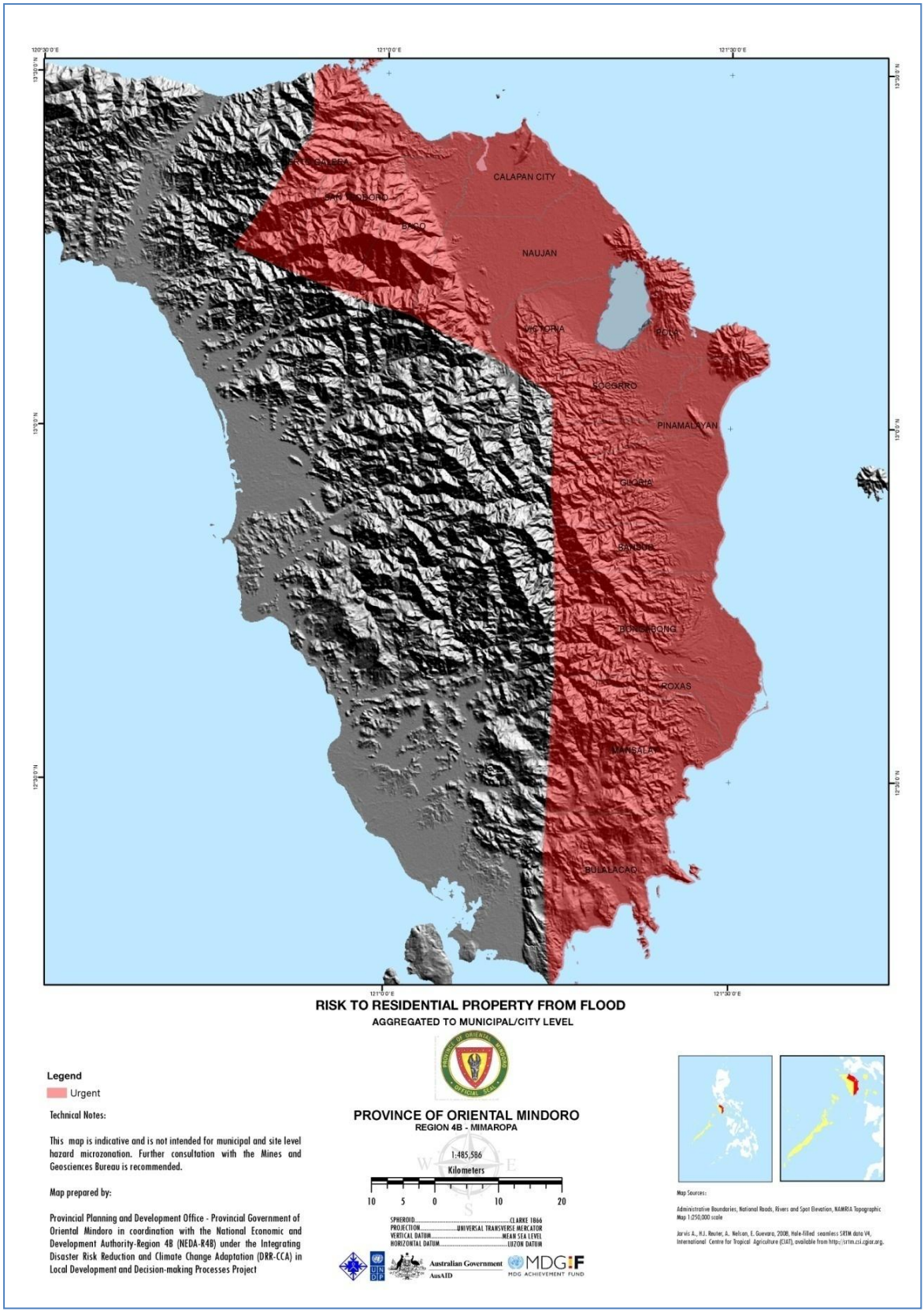



**Figure 17.** Map of risk to residential property from flood

## 2. Rainfall-induced landslides (RIL)

Rainfall-induced landslides also cause damage to properties. For rare RIL events, Naujan has the highest estimated damage in agriculture, fishery and forestry with as much as PhP1.171B. This was followed by Calapan City with PhP695.664M and Bongabong with PHP481.175M.

**Table 24.** Estimated damage to agriculture, fishery and foresty from RIL

| CITY/MUNICIPALITY | ESTIMATED DAMAGE TO AGRICULTURE, FISHERY AND FORESTRY (AFF) FROM RIL | | |
|---|---|---|---|
| | FREQUENT | LIKELY | RARE |
| Baco | 60,860,192.92 | 168,284,451.08 | 320,694,398.90 |
| Bansud | 8,787,944.97 | 56,794,744.08 | 98,030,444.98 |
| Bongabong | 93,348,525.27 | 282,531,199.49 | 481,175,107.48 |
| Bulalacao | 7,598,530.59 | 25,652,032.28 | 42,445,883.96 |
| Calapan City | 82,050,870.86 | 433,519,296.23 | 695,664,501.48 |
| Gloria | 9,605,373.82 | 68,480,124.49 | 128,164,346.49 |
| Mansalay | 14,183,507.89 | 93,036,246.34 | 194,142,566.51 |
| Naujan | 101,047,664.82 | 631,967,758.04 | 1,171,101,816.78 |
| Pinamalayan | 17,549,076.87 | 126,729,678.55 | 288,050,645.43 |
| Pola | 19,535,068.71 | 58,648,083.01 | 107,699,327.05 |
| Puerto Galera | 1,529,778.30 | 7,311,574.07 | 13,906,367.66 |
| Roxas | 48,366,940.66 | 108,807,305.06 | 172,284,360.60 |
| San Teodoro | 7,791,334.21 | 37,483,047.36 | 69,308,769.25 |
| Socorro | 11,470,948.53 | 115,643,035.75 | 260,395,659.22 |
| Victoria | 32,978,684.18 | 190,520,129.60 | 412,700,298.83 |
| Total | 516,704,442.60 | 2,405,408,705.43 | 4,455,764,494.62 |

Built-up areas in the province are also affected by RIL. In case of rare RIL event, Calapan City, which has the most number of establishments and projected number of households, would incur the largest damage amounting to PhP181,664,914.73. It is followed by Mansalay with PhP95,631,086.79. Other municipalities such as Bulalacao, Pola, Puerto Galera, Bansud, San Teodoro, Socorro, Pinamalayan, Bongabong and Naujan have below Ten Million Pesos estimated damages during rare RIL event.

**Table 25.** Estimated damage to built-up areas from RIL

| CITY/MUNICIPALITY | ESTIMATED DAMAGE TO BUILT-UP AREAS FROM RIL | | |
|---|---|---|---|
| | Frequent | Likely | Rare |
| Baco | 3,645,029.91 | 7,290,059.82 | 10,934,992.07 |
| Bansud | 107,008.59 | 3,576,692.37 | 5,364,990.64 |
| Bongabong | 246,870.84 | 786,509.19 | 2,448,531.60 |
| Bulalacao | 992,400.69 | 4,518,542.17 | 9,184,508.53 |
| Calapan City | 56,183,794.70 | 119,484,954.52 | 181,664,914.73 |

| | | | |
|---|---|---|---|
| Gloria | - | 19,197,720.18 | 28,796,323.08 |
| Mansalay | 1,372,962.81 | 59,274,375.16 | 95,631,086.79 |
| Naujan | 229,211.85 | 949,176.47 | 1,423,751.98 |
| Pinamalayan | 160,691.44 | 1,817,751.95 | 2,726,603.59 |
| Pola | 2,901,717.70 | 5,803,435.40 | 8,705,075.35 |
| Puerto Galera | 1,795,481.79 | 4,611,824.71 | 6,917,675.29 |
| Roxas | 1,048,886.77 | 3,803,010.34 | 13,943,818.95 |
| San Teodoro | - | 3,486,090.93 | 5,229,089.69 |
| Socorro | - | 2,444,733.05 | 3,667,066.82 |
| Victoria | 1,933,124.08 | 6,668,601.79 | 13,984,500.74 |
| **Total** | **70,617,181.17** | **243,713,478.05** | **390,622,929.85** |

Estimated damages to roads from rare RIL event amount to PhP4,446,964.77, of which, 18 percent accounts for the municipality of Naujan with PhP797,846.27. Calapan City is next with PhP688,442.14 while Bansud has the lowest with PhP94,120.44. On the other hand, lower damages are estimated for frequent and likely RIL events with only PhP40,289.94 and PhP394,684.92, respectively.

**Table 26.** Estimated damage to roads from RIL

| CITY/MUNICIPALITY | ESTIMATED DAMAGE TO ROADS FROM RIL (PhP) | | |
|---|---|---|---|
| | Frequent | Likely | Rare |
| Baco | 245.56 | 1,008.17 | 169,053.97 |
| Bansud | 686.44 | 2,776.40 | 94,120.44 |
| Bongabong | 311.37 | 12,250.92 | 228,255.05 |
| Bulalacao | 165.34 | 111,924.50 | 280,676.52 |
| Calapan City | 565.25 | 1,481.92 | 688,442.14 |
| Gloria | - | 2,928.53 | 163,088.42 |
| Mansalay | 1,100.30 | 26,046.62 | 128,682.58 |
| Naujan | 135.01 | 1,517.55 | 797,846.27 |
| Pinamalayan | 2,060.98 | 11,490.23 | 372,579.92 |
| Pola | 11,139.95 | 44,589.98 | 177,022.53 |
| Puerto Galera | 3,030.79 | 49,300.36 | 154,988.42 |
| Roxas | - | - | 114,951.09 |
| San Teodoro | 18,633.87 | 99,349.71 | 228,334.68 |
| Socorro | 878.69 | 25,802.04 | 425,830.87 |
| Victoria | 1,336.39 | 4,217.99 | 423,091.87 |
| **Total** | **40,289.94** | **394,684.92** | **4,446,964.77** |

Lower damages to critical infrastructure were estimated for frequent, likely and rare RIL events. For frequent RIL events, only the municipalities of Bongabong, Pinamalayan and Pola have estimated damage at PhP182.00 each. For likely events, total estimated damage amounting to PhP3,006.50 is shared by the municipalities of Mansalay with PhP611.00,

Bulalacao with PhP579.50, Bongabong with PhP477.00, Bansud with PhP247.00 and Baco, Pinamalayan and Pola with PhP364.00 each.

**Table 27.** Estimated damage to critical infrastructure from RIL

| CITY/ MUNICIPALITY | ESTIMATED DAMAGE TO CRITICAL INFRASTRUCTURE FROM RIL | | | | | | |
|---|---|---|---|---|---|---|---|
| | FREQUENT | LIKELY | RARE | MUNICIPALITY | FREQUENT | LIKELY | RARE |
| Baco | - | 364 | 4,316.85 | Pinamalayan | 182 | 364 | 4,316.85 |
| Bansud | - | 247 | 1,955.25 | Pola | 182 | 364 | 4,115.85 |
| Bongabong | 182 | 477 | 4,486.35 | Puerto Galera | - | - | 1,336.50 |
| Bulalacao | - | 579.5 | 1,785.75 | Roxas | - | - | 2,854.35 |
| Calapan City | - | - | 3,569.85 | San Teodoro | - | - | 2,186.10 |
| Gloria | - | - | 3,770.85 | Socorro | - | - | 3,770.85 |
| Mansalay | - | 611 | 4,687.35 | Victoria | - | - | 3,400.35 |
| Naujan | - | - | 3,400.35 | **Total** | **546** | **3,006.50** | **49,953.45** |

### 3. Ground Shaking

Ground shaking is one of the natural hazards affecting Oriental Mindoro owing to the presence of two major faults in the province – the Aglubang Fault and Central Mindoro Fault. It could bring damage to houses, buildings, roads, bridges and other utility installations. For the purpose of this consequence analysis, the cost of damage was estimated for three scenarios of which, the third scenario has the highest estimated damage.

In scenario 1, the total affected road measures 1,097.46 kilometers and the cost of built-up is only PhP7.1 which is the same with scenarios 2 and 3. The total cost of critical infrastructure is PhP92,493,528.50. Calapan City which has the most number of schools, hospitals and other critical infrastructure has the biggest cost with PhP20,890,103.00 estimated damage. Naujan and Bongabong are the other municipalities with more than Ten Billion Pesos damage to critical infrastructure.

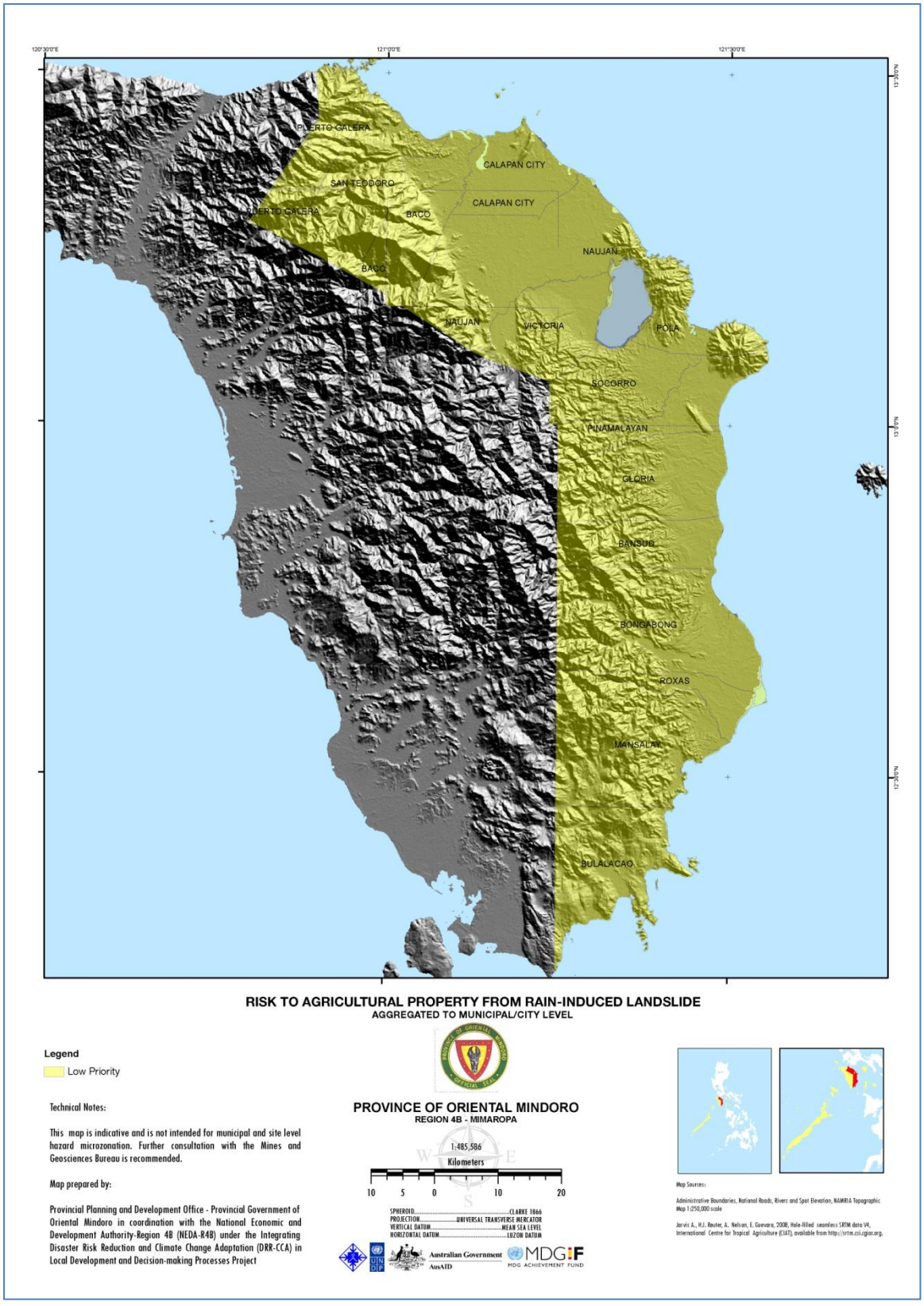



**Figure 25.** Map of risk to agricultural property from rain-induced landslide

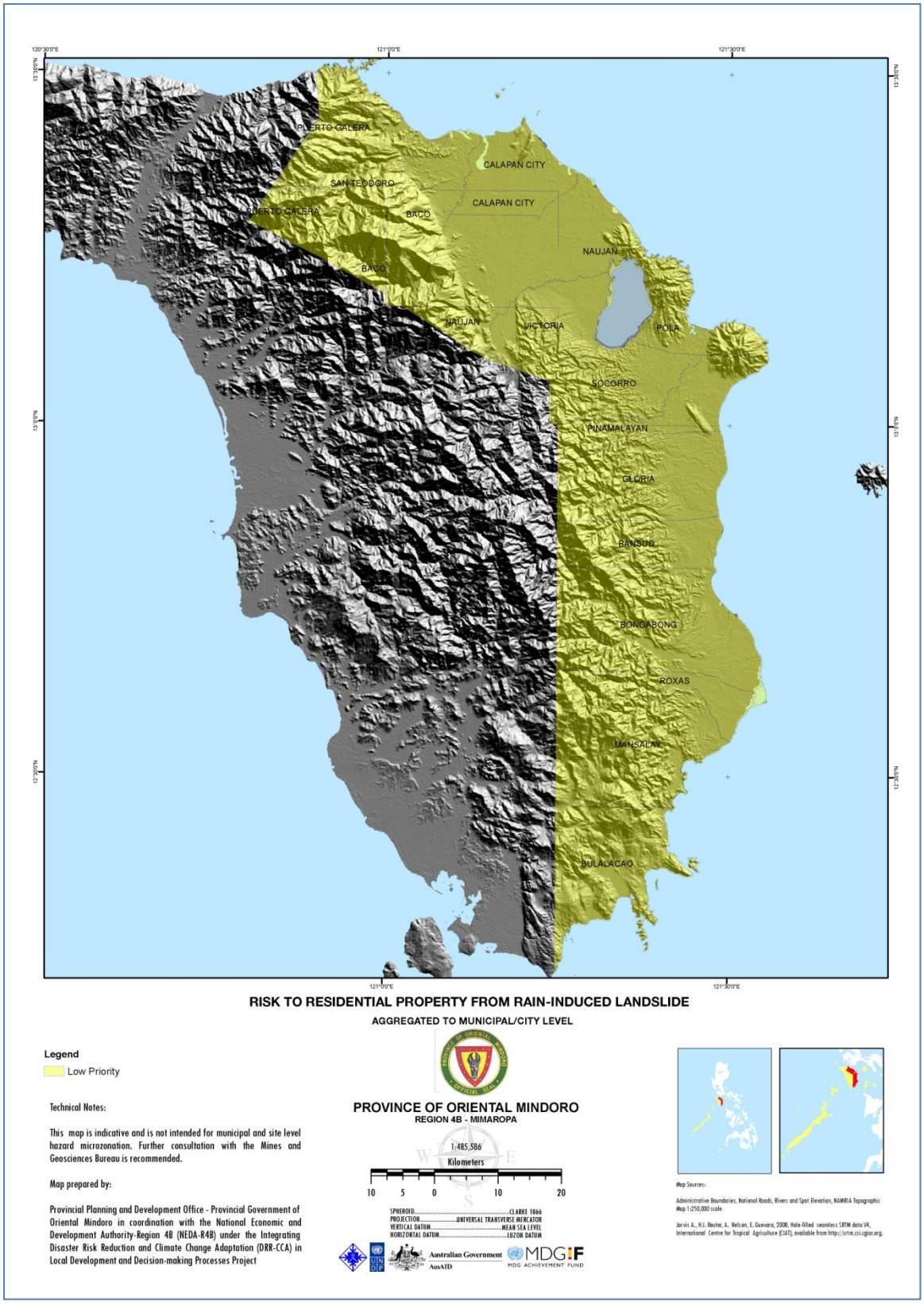



**Figure 26.** Map of risk to residential property from rain-induced landslide

Naujan has the longest affected road with 239.32 kilometers which could have as much as Php332,883,087.86 estimated damage. It is followed by Calapan City with 197.85 kilometers affected road and PhP290,462,363.70 estimated damage.

**Table 28.** Estimated affected area, affected road, and cost of ground shaking damages to built-up, critical infrastructure and road, scenario 1

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Kilometer) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRASTRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|
| Baco | 1.61 | 46.10 | 0.21 | 8,595,614.00 | 71,567,760.85 | 80,163,375.06 |
| Bansud | 0.79 | 20.29 | 0.09 | 4,928,870.00 | 39,844,312.49 | 44,773,182.58 |
| Bongabong | 0.36 | 44.80 | 0.04 | 10,293,604.00 | 94,533,312.23 | 104,826,916.27 |
| Bulalacao | 1.70 | 34.28 | 0.19 | 841,057.50 | 100,121,662.34 | 100,962,720.03 |
| Calapan City | 26.79 | 197.85 | 3.40 | 20,890,103.00 | 290,462,363.70 | 311,352,470.10 |
| Gloria | 4.24 | 34.61 | 0.54 | 9,349,930.50 | 68,295,390.74 | 77,645,321.78 |
| Mansalay | 13.85 | 18.52 | 1.75 | 4,824,666.50 | 46,455,577.01 | 51,280,245.26 |
| Naujan | 0.20 | 239.32 | 0.01 | 10,353,929.00 | 332,883,087.86 | 343,237,016.87 |
| Pinamalayan | 0.31 | 94.93 | 0.04 | 7,391,336.50 | 141,013,943.53 | 148,405,280.07 |
| Pola | 1.94 | 54.27 | 0.25 | 3,216,846.50 | 68,917,798.41 | 72,134,645.16 |
| Puerto Galera | 0.13 | 28.13 | 0.02 | 848,677.50 | 54,135,139.75 | 54,983,817.27 |
| Roxas | 2.06 | 18.09 | 0.26 | 2,057,019.00 | 46,030,513.49 | 48,087,532.75 |
| San Teodoro | 0.15 | 46.51 | 0.02 | 925,449.00 | 92,754,642.27 | 93,680,091.29 |
| Socorro | 0.54 | 120.14 | 0.07 | 3,890,899.00 | 180,268,402.50 | 184,159,301.57 |
| Victoria | 2.12 | 99.62 | 0.27 | 4,085,526.50 | 173,731,940.95 | 177,817,467.72 |

For scenario 2, the total urban cost would be PhP59,110,774,225.36 wherein cost of roads account for 99.9 percent or PhP59,108,802,946.70. The most damage will be incurred by Naujan with PhP14.66B, followed by Calapan City with PhP8.88B, Socorro with PhP6.56B and Pinamalayan with PhP6.51B. Bansud has the least total urban cost amounting to PhP313,880,866.42.

**Table 29.** Estimated affected area, affected road, and cost of ground shaking damages to built-up, critical infrastructure and road, scenario 2

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Has) | TOTAL AFFECTED ROAD (Km) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|
| Baco | 1.61 | 1,110.44 | 0.21 | 179,196.00 | 1,540,527,271.98 | 1,540,706,468.19 |
| Bansud | 0.79 | 180.59 | 0.09 | 91,357.50 | 313,789,508.83 | 313,880,866.42 |
| Bongabong | 0.36 | 1,070.07 | 0.04 | 242,998.50 | 1,948,590,246.43 | 1,948,833,244.97 |
| Bulalacao | 1.70 | 2,323.61 | 0.19 | 19,867.50 | 4,147,778,741.04 | 4,147,798,608.73 |
| Calapan City | 26.79 | 7,026.07 | 3.40 | 377,502.00 | 8,883,811,225.42 | 8,884,188,730.82 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gloria | 4.24 | 571.82 | 0.54 | 227,862.00 | 889,857,317.52 | 890,085,180.06 |
| Mansalay | 13.85 | 569.78 | 1.75 | 105,118.50 | 1,019,124,697.92 | 1,019,229,818.17 |
| Naujan | 0.20 | 13,522.88 | 0.01 | 188,758.50 | 14,655,771,142.30 | 14,655,959,900.81 |
| Pinamalayan | 0.31 | 8,283.88 | 0.04 | 189,163.50 | 6,511,650,477.26 | 6,511,839,640.80 |
| Pola | 1.94 | 3,186.41 | 0.25 | 75,988.50 | 3,372,279,139.35 | 3,372,355,128.10 |
| Puerto Galera | 0.13 | 959.77 | 0.02 | 20,047.50 | 1,037,251,489.64 | 1,037,271,537.16 |
| Roxas | 2.06 | 224.61 | 0.26 | 48,591.00 | 498,569,757.40 | 498,618,348.66 |
| San Teodoro | 0.15 | 1,224.54 | 0.02 | 21,861.00 | 1,897,969,883.25 | 1,897,991,744.27 |
| Socorro | 0.54 | 4,816.39 | 0.07 | 91,911.00 | 6,559,911,004.12 | 6,560,002,915.19 |
| Victoria | 2.12 | 4,528.50 | 0.27 | 91,048.50 | 5,831,921,044.24 | 5,832,012,093.01 |

In scenario 3, total urban cost is PhP70,537,462,113.29, of which Naujan shares 25 percent with PhP17.96B and 22 percent for Calapan City with PhP15.73B. Bansud would still incur the least damage with PhP468,287,882.88 or one percent of the total urban cost. Roads would constitute 99.9 percent of the total urban cost or PhP70,535,212,764.62 where Naujan has the highest share with PhP17.96B followed by Calapan City with PhP15.73B.

**Table 30.** Estimated affected area, affected road, and cost of ground shaking damages to built-up, critical infrastructure and road, scenario 3

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Has) | TOTAL AFFECTED ROAD (Km) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|
| Baco | 1.61 | 1,217.17 | 0.21 | 208,506.00 | 1,663,041,784.89 | 1,663,250,291.10 |
| Bansud | 0.79 | 246.75 | 0.09 | 110,970.00 | 468,176,912.79 | 468,287,882.88 |
| Bongabong | 0.36 | 1,208.17 | 0.04 | 246,388.50 | 2,278,772,676.23 | 2,279,019,064.77 |
| Bulalacao | 1.70 | 2,323.61 | 0.20 | 21,877.50 | 4,524,849,535.68 | 4,524,871,413.38 |
| Calapan City | 26.79 | 12,136.95 | 3.40 | 480,102.00 | 15,727,366,560.10 | 15,727,846,665.50 |
| Gloria | 4.24 | 742.19 | 0.54 | 310,609.50 | 1,252,259,025.00 | 1,252,569,635.04 |
| Mansalay | 13.85 | 531.52 | 1.75 | 108,508.50 | 915,899,216.53 | 916,007,726.78 |
| Naujan | 0.20 | 16,734.38 | 0.01 | 217,281.00 | 17,961,516,569.90 | 17,961,733,850.91 |
| Pinamalayan | 0.31 | 7,971.98 | 0.04 | 185,203.50 | 5,831,542,866.95 | 5,831,728,070.49 |
| Pola | 1.94 | 3,009.38 | 0.25 | 75,988.50 | 3,147,460,530.06 | 3,147,536,518.81 |
| Puerto Galera | 0.13 | 878.66 | 0.02 | 20,047.50 | 865,067,222.50 | 865,087,270.02 |
| Roxas | 2.06 | 258.47 | 0.26 | 55,273.50 | 590,649,421.10 | 590,704,694.86 |
| San Teodoro | 0.15 | 1,245.84 | 0.02 | 21,861.00 | 1,960,166,590.20 | 1,960,188,451.22 |
| Socorro | 0.54 | 5,986.94 | 0.07 | 90,216.00 | 7,970,623,968.06 | 7,970,714,184.13 |
| Victoria | 2.12 | 4,320.63 | 0.27 | 96,508.50 | 5,377,819,884.63 | 5,377,916,393.40 |

The composite scenario for ground shaking has a total urban cost of PhP2,486,480,916.26. The municipality of Naujan has the highest cost accounting for 25 percent or PhP625,758,146.78. Calapan City shares 12 percent with PhP292,976,367.15 and

Pinamalayan, which is also a growth center, shares 11 percent or PhP280,875,011.31. Bansud has the least total urban cost with PhP40,515,192.63 majority of which make up cost of damage to roads at 98 percent or PhP39,884,315.03.

**Table 31.** Estimated affected area, affected road, and cost of ground shaking damages to built-up, critical infrastructure and road, composite scenario

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Kilometer) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRASTRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|
| Baco | 1.61 | 46.10 | 0.20 | 1,596,326.50 | 71,567,760.85 | 73,164,087.55 |
| Bansud | 0.79 | 20.29 | 0.10 | 670,877.50 | 39,844,315.03 | 40,515,192.63 |
| Bongabong | 0.36 | 91.23 | 0.04 | 1,596,326.50 | 96,627,966.89 | 98,224,293.43 |
| Bulalacao | 1.70 | 86.06 | 0.22 | 670,877.50 | 125,690,264.88 | 126,361,142.60 |
| Calapan City | 26.79 | 373.54 | 3.40 | 1,511,236.50 | 291,465,127.25 | 292,976,367.15 |
| Gloria | 4.24 | 55.71 | 0.54 | 1,596,326.50 | 69,071,599.47 | 70,667,926.51 |
| Mansalay | 13.85 | 43.43 | 1.76 | 1,596,326.50 | 54,895,269.69 | 56,491,597.95 |
| Naujan | 0.20 | 694.44 | 0.03 | 1,439,481.50 | 624,318,665.25 | 625,758,146.78 |
| Pinamalayan | 0.31 | 299.51 | 0.04 | 1,596,326.50 | 279,278,684.77 | 280,875,011.31 |
| Pola | 1.94 | 177.02 | 0.25 | 1,511,236.50 | 149,879,072.86 | 151,390,309.61 |
| Puerto Galera | 0.13 | 86.74 | 0.02 | 565,785.00 | 90,586,605.34 | 91,152,390.36 |
| Roxas | 2.06 | 33.86 | 0.26 | 1,208,341.50 | 48,662,629.50 | 49,870,971.26 |
| San Teodoro | 0.15 | 151.14 | 0.02 | 925,449.00 | 165,591,629.70 | 166,517,078.72 |
| Socorro | 0.54 | 120.14 | 0.07 | 1,596,326.50 | 180,268,403.37 | 181,864,729.94 |
| Victoria | 2.12 | 179.27 | 0.27 | 1,439,481.50 | 179,212,188.69 | 180,651,670.46 |

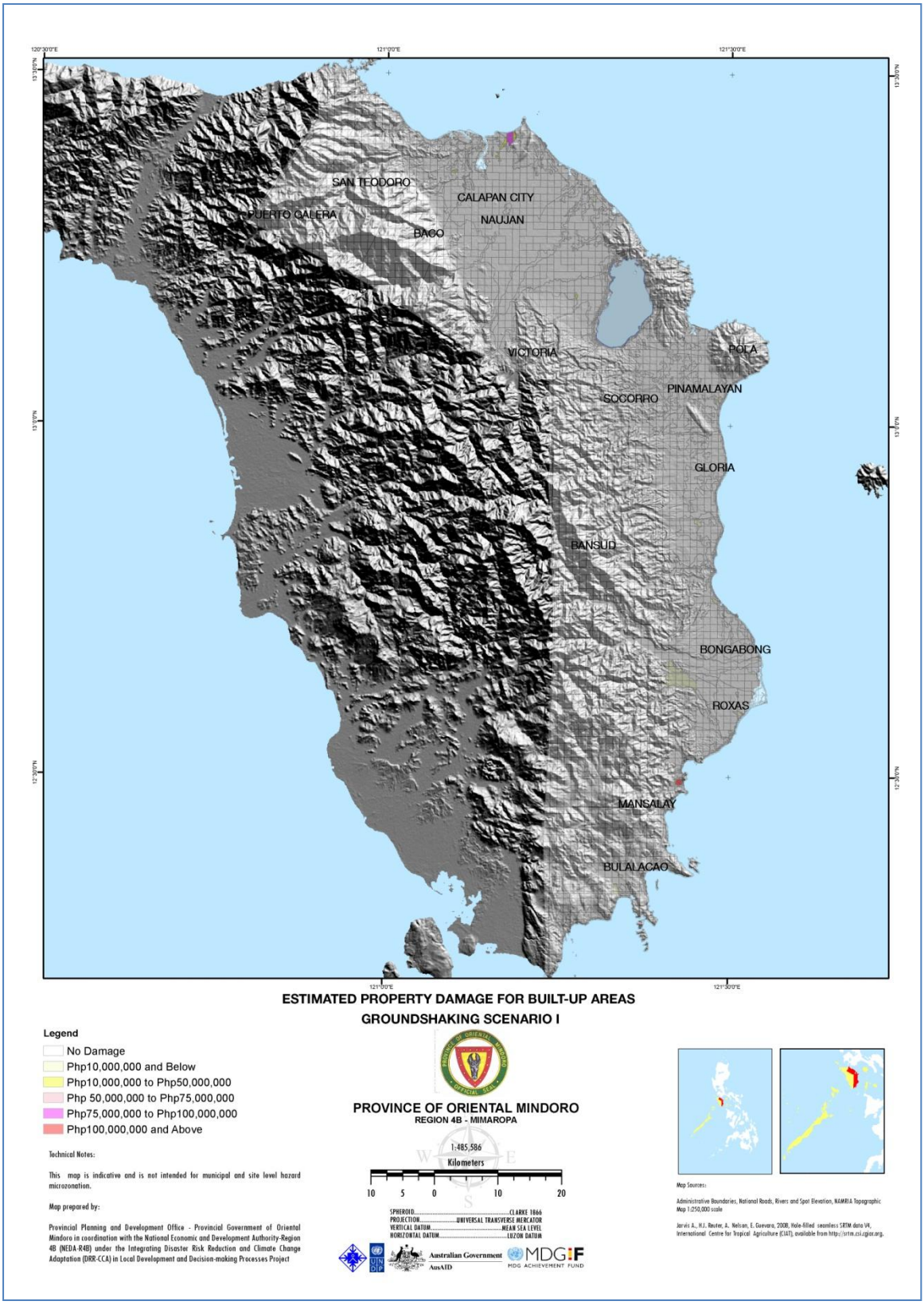



**Figure 27.** Map of estimated property damage for built-up areas from groundshaking, scenario 1

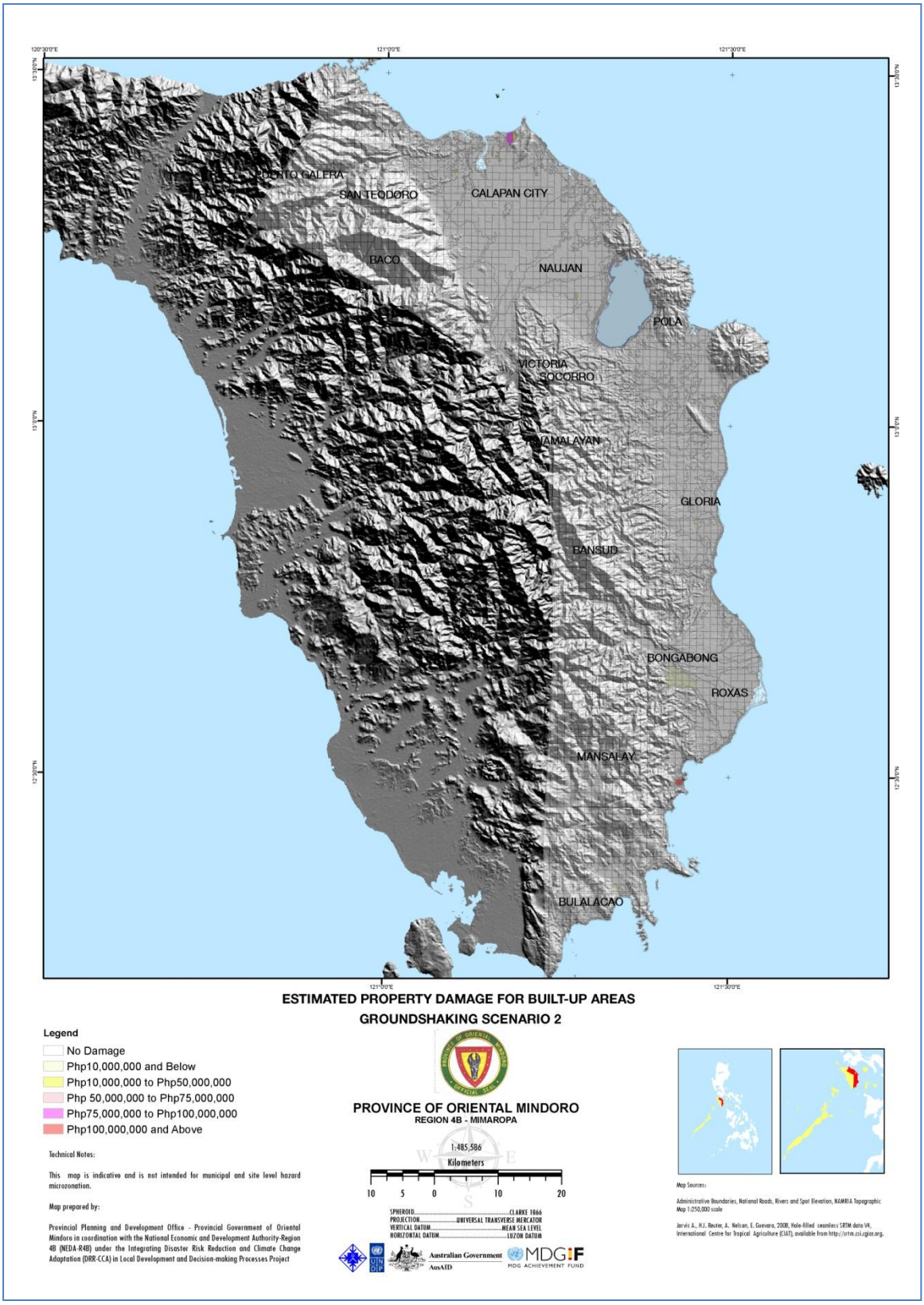



**Figure 28.** Map of estimated property damage for built-up areas from groundshaking, scenario 2

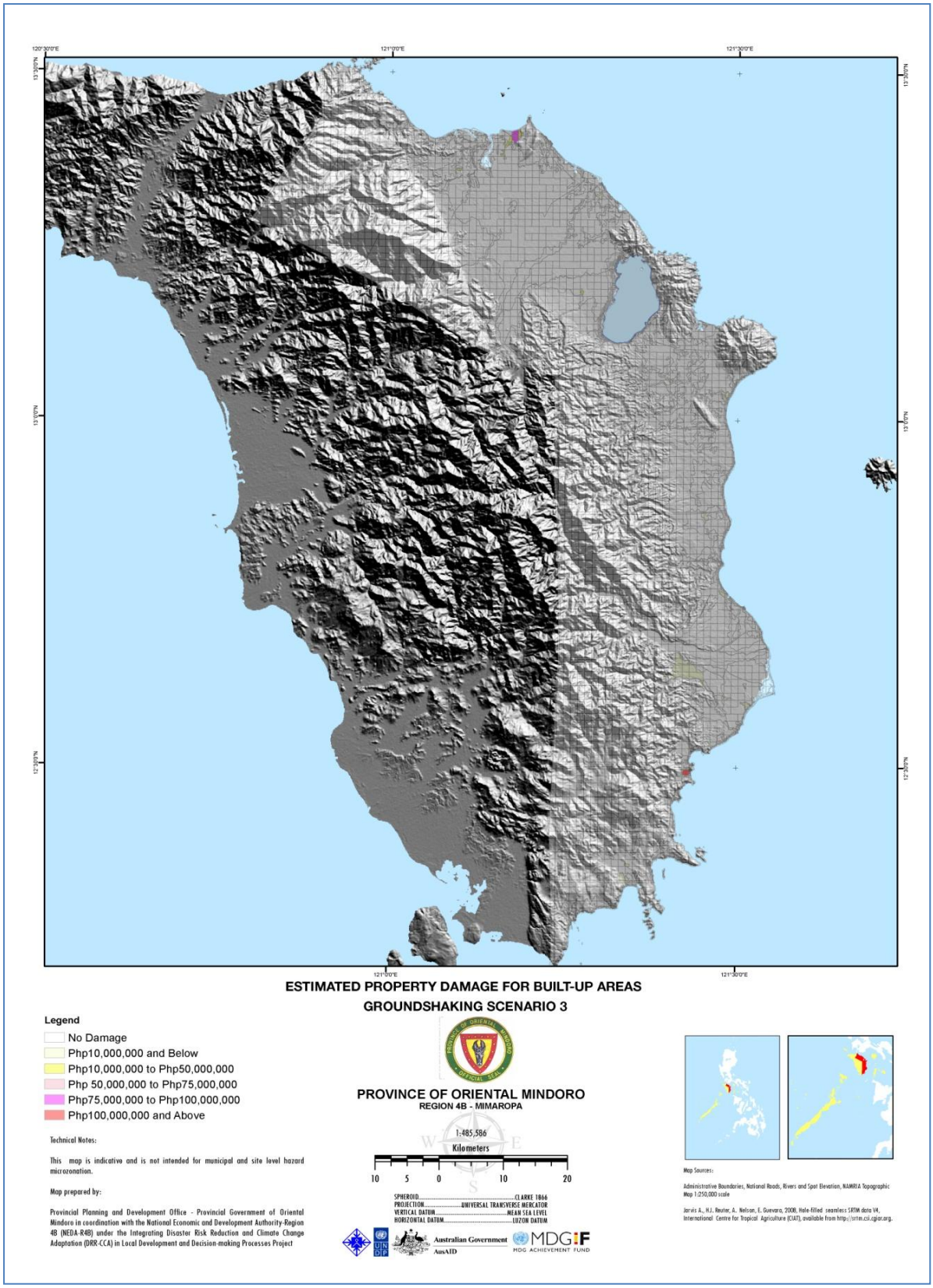



**Figure 29.** Map of estimated property damage for built-up areas from groundshaking, scenario 3

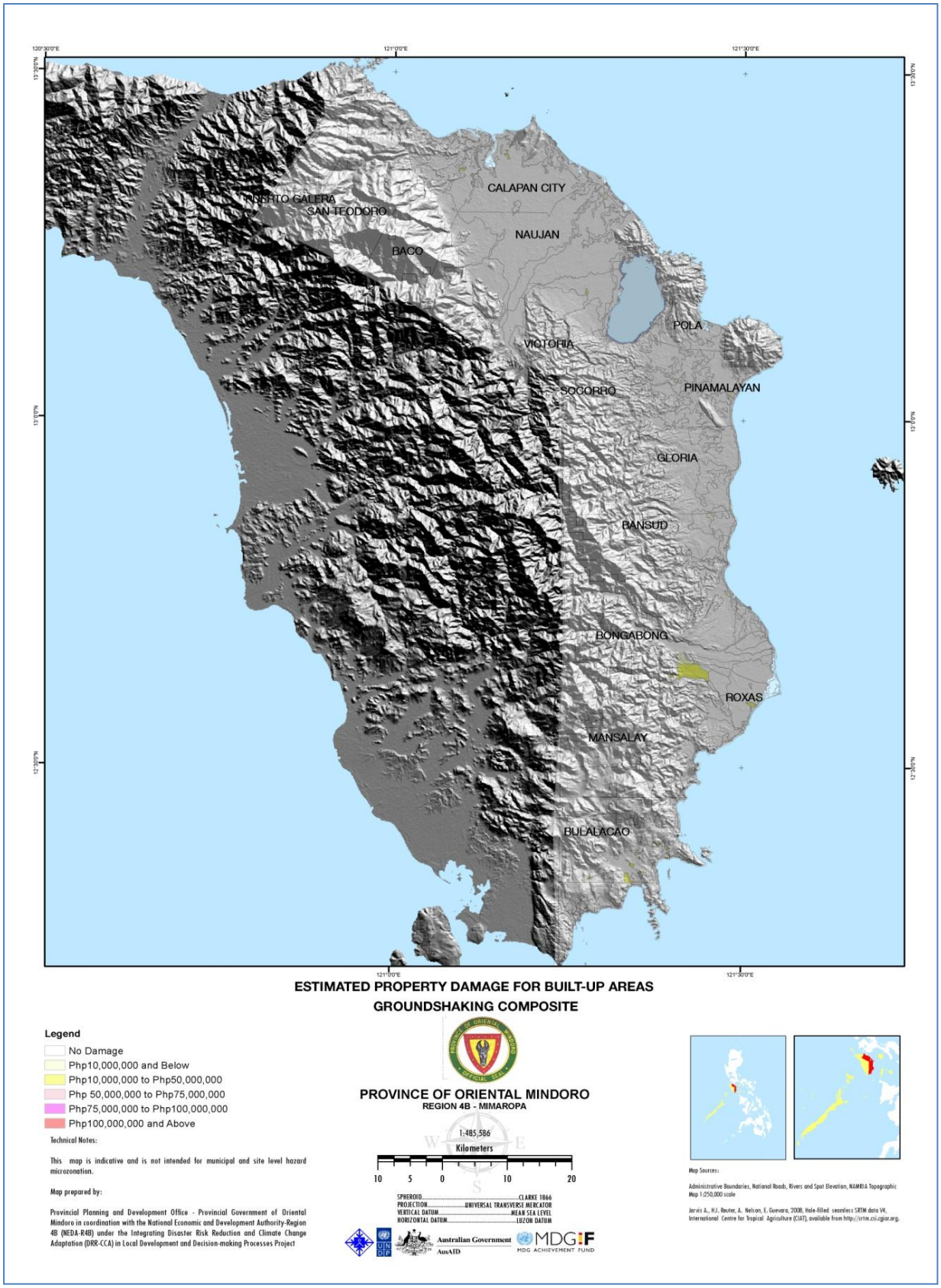



**Figure 30.** Map of estimated property damage for built-up areas from groundshaking, composite scenario

## 4. Earthquake-induced landslide

According to the Philippine Institute of Volcanology and Seismology (2006), intense ground shaking can trigger a landslide by loosening the cohesion that bonds the slope materials together, thereby making it easier for gravity to pull it downwards. Among the areas prone to landsliding are hilly and mountainous areas, steep river banks, sea cliffs and other steep slopes.

Three scenarios were used to demonstrate the estimated risk to property and infrastructure from earthquake-induced landslide. In the first scenario, the total urban cost was highest in Naujan with PhP286,557,886.37 and lowest in Bulalacao with only PhP85,090.01.

**Table 32.** Municipal risk to property and infrastructure from earthquake-induced landslide, scenario 1

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Km) | COST OF AGRICULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRASTRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 12,629.12 | 46.10 | 1,603.90 | - | - | - | - |
| Bansud | 6,150.37 | 20.29 | 781.09 | - | - | - | - |
| Bongabong | 13,077.45 | 45.62 | 1,660.85 | - | - | - | - |
| Bulalacao | 7,498.16 | 43.03 | 952.26 | 0.01 | 85,090.00 | - | 85,090.01 |
| Calapan City | - | 198.64 | - | - | - | - | - |
| Gloria | 6,452.08 | 35.22 | 819.41 | - | - | - | - |
| Mansalay | 16,806.79 | 21.72 | 2,134.47 | - | - | - | - |
| Naujan | 6,705.03 | 468.80 | 851.54 | - | - | 286,557,886.37 | 286,557,886.37 |
| Pinamalayan | 2,561.41 | 203.80 | 325.30 | - | - | 121,550,240.77 | 121,550,240.77 |
| Pola | 3,986.17 | 118.02 | 506.25 | - | 1,511,236.50 | 74,939,536.43 | 76,450,772.93 |
| Puerto Galera | 12,068.59 | 67.14 | 1,532.71 | - | 282,892.50 | 65,692,718.12 | 65,975,610.62 |
| Roxas | 585.17 | 18.99 | 74.32 | - | - | - | - |
| San Teodoro | 19,444.30 | 96.86 | 2,469.42 | - | - | 96,661,681.20 | 96,661,681.20 |
| Socorro | 4,632.35 | 240.28 | 588.30 | - | - | 180,268,403.37 | 180,268,403.37 |
| Victoria | 7,240.17 | 161.13 | 919.42 | 0.09 | 231,140.00 | 167,070,812.92 | 167,301,953.01 |

In the second scenario, Naujan has the highest total urban cost with PhP14,655,771,142.31 followed by Calapan City with PhP8,883,811,228.82, Socorro with PhP6,559,911,004.19 and Pinamalayan with PhP6,511,650,477.30. Municipal risk in terms of agriculture, forest and fishery is high in Naujan, Bongabong, Mansalay and San Teodoro with PhP5,511.41, PhP4,406.80, PhP3,667.95 and PhP3,346.35, respectively. The cost of critical infrastructure is highest in Pola with 1.5 Million Pesos.

**Table 33.** Municipal risk to property and infrastructure from earthquake-induced landslide, scenario 2

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Km) | COST OF AGRI-CULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 23,585.90 | 1,110.44 | 2,995.24 | 0.21 | - | 1,540,527,271.98 | 1,540,527,272.19 |
| Bansud | 13,357.05 | 180.59 | 1,696.18 | 0.09 | - | 313,789,508.83 | 313,789,508.92 |
| Bongabong | 34,699.61 | 1,070.07 | 4,406.80 | 0.04 | - | 1,948,590,246.43 | 1,948,590,246.47 |
| Bulalacao | 21,722.92 | 2,323.61 | 2,758.59 | 0.19 | 85,090.00 | 4,147,778,740.71 | 4,147,863,830.90 |
| Calapan City | 18,125.04 | 7,026.07 | 2,298.49 | 3.40 | - | 8,883,811,225.42 | 8,883,811,228.82 |
| Gloria | 19,010.12 | 571.82 | 2,413.76 | 0.54 | - | 889,857,317.52 | 889,857,318.06 |
| Mansalay | 28,894.40 | 569.78 | 3,667.95 | 1.75 | - | 1,019,124,697.92 | 1,019,124,699.67 |
| Naujan | 43,396.65 | 13,522.88 | 5,511.41 | 0.01 | - | 14,655,771,142.30 | 14,655,771,142.31 |
| Pinamalayan | 18,895.02 | 8,283.88 | 2,399.55 | 0.04 | - | 6,511,650,477.26 | 6,511,650,477.30 |
| Pola | 14,285.39 | 3,186.41 | 1,814.03 | 0.25 | 1,511,236.50 | 3,372,279,139.35 | 3,373,790,376.10 |
| Puerto Galera | 15,195.53 | 959.77 | 1,929.72 | 0.02 | 282,892.50 | 1,037,251,489.64 | 1,037,534,382.16 |
| Roxas | 6,551.15 | 224.61 | 831.76 | 0.26 | - | 498,569,757.40 | 498,569,757.66 |
| San Teodoro | 26,348.95 | 1,224.54 | 3,346.35 | 0.02 | - | 1,897,969,883.25 | 1,897,969,883.27 |
| Socorro | 17,577.78 | 4,816.39 | 2,232.29 | 0.07 | - | 6,559,911,004.12 | 6,559,911,004.19 |
| Victoria | 18,323.48 | 4,528.50 | 2,326.80 | 0.27 | 231,140.00 | 5,831,921,044.24 | 5,832,152,184.51 |

The same trend is observed in the third scenario with Naujan, Calapan City and Socorro having high total urban cost from earthquake-induced landslide. Bansud has the lowest cost with PhP468,176,912.88. However, for cost of critical infrastructure only three municipalities have estimated damages.

**Table 34.** Municipal risk to property and infrastructure from earthquake-induced landslide, scenario 3

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Km) | COST OF AGRI-CULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 23,578.41 | 1,217.17 | 2,994.32 | 0.21 | - | 1,663,041,784.89 | 1,663,041,785.10 |
| Bansud | 13,357.05 | 246.75 | 1,696.21 | 0.09 | - | 468,176,912.79 | 468,176,912.88 |
| Bongabong | 34,699.61 | 1,208.17 | 4,406.65 | 0.04 | - | 2,278,772,676.23 | 2,278,772,676.27 |
| Bulalacao | 21,744.44 | 2,323.61 | 2,761.27 | 0.20 | 85,090.00 | 4,524,849,535.68 | 4,524,934,625.88 |
| Calapan City | 18,107.84 | 12,136.95 | 2,296.26 | 3.40 | - | 15,727,366,560.10 | 15,727,366,563.50 |
| Gloria | 19,010.12 | 742.19 | 2,413.74 | 0.54 | - | 1,252,259,025.00 | 1,252,259,025.54 |
| Mansalay | 28,894.40 | 531.52 | 3,667.88 | 1.75 | - | 915,899,216.53 | 915,899,218.28 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Naujan | 43,330.93 | 16,734.38 | 5,503.14 | 0.01 | - | 17,961,516,569.90 | 17,961,516,569.91 |
| Pinamalayan | 18,875.63 | 7,971.98 | 2,397.25 | 0.04 | - | 5,831,542,866.95 | 5,831,542,866.99 |
| Pola | 14,277.57 | 3,009.38 | 1,813.07 | 0.25 | 1,511,236.50 | 3,147,460,530.06 | 3,148,971,766.81 |
| Puerto Galera | 15,183.14 | 878.66 | 1,928.26 | 0.02 | - | 865,067,222.50 | 865,067,222.52 |
| Roxas | 6,551.15 | 258.47 | 831.71 | 0.26 | - | 590,649,421.10 | 590,649,421.36 |
| San Teodoro | 26,335.38 | 1,245.84 | 3,344.65 | 0.02 | - | 1,960,166,590.20 | 1,960,166,590.22 |
| Socorro | 17,576.88 | 5,986.94 | 2,232.14 | 0.07 | - | 7,970,623,968.06 | 7,970,623,968.13 |
| Victoria | 18,299.77 | 4,320.63 | 2,323.77 | 0.27 | 231,140.00 | 5,377,819,884.63 | 5,378,051,024.90 |

The composite scenario in Table 35 showed total urban cost amounting to PhP2,469,285,814.75 of which, 99.9 percent or PhP2,466,960,183.53 accounts for cost of damage to roads. In this scenario, Naujan has the most estimated damage with PhP624,318,665.28 followed by Calapan City with PhP291,465,130.65 and Pinamalayan with PhP279,278,684.81.

**Table 35.** Municipal risk to property and infrastructure from earthquake-induced landslide, composite scenario

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Kilometer) | COST OF AGRI-CULTURE. FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 23,585.90 | 46.10 | 2,995.20 | 0.20 | - | 71,567,760.85 | 71,567,761.05 |
| Bansud | 13,357.05 | 20.29 | 1,696.24 | 0.10 | - | 39,844,315.03 | 39,844,315.13 |
| Bongabong | 34,699.61 | 91.23 | 4,406.81 | 0.04 | - | 96,627,966.89 | 96,627,966.93 |
| Bulalacao | 21,744.44 | 86.06 | 2,761.33 | 0.22 | 85,090.00 | 125,690,264.87 | 125,775,355.09 |
| Calapan City | 18,125.04 | 373.54 | 2,298.48 | 3.40 | - | 291,465,127.25 | 291,465,130.65 |
| Gloria | 19,010.12 | 55.71 | 2,413.74 | 0.54 | - | 69,071,599.47 | 69,071,600.01 |
| Mansalay | 28,894.40 | 43.43 | 3,667.83 | 1.76 | - | 54,895,269.69 | 54,895,271.45 |
| Naujan | 43,396.65 | 694.44 | 5,511.34 | 0.03 | - | 624,318,665.25 | 624,318,665.28 |
| Pinamalayan | 18,895.02 | 299.51 | 2,399.64 | 0.04 | - | 279,278,684.77 | 279,278,684.81 |
| Pola | 14,285.39 | 177.02 | 1,813.98 | 0.25 | 1,726,501.50 | 149,879,072.86 | 151,605,574.61 |
| Puerto Galera | 15,195.53 | 86.74 | 1,929.81 | 0.02 | 282,892.50 | 90,586,605.34 | 90,869,497.86 |
| Roxas | 6,551.15 | 33.86 | 831.74 | 0.26 | - | 48,662,629.50 | 48,662,629.76 |
| San Teodoro | 26,350.51 | 151.14 | 3,346.49 | 0.02 | - | 165,591,629.70 | 165,591,629.72 |
| Socorro | 17,577.78 | 120.14 | 2,232.29 | 0.07 | - | 180,268,403.37 | 180,268,403.44 |
| Victoria | 18,323.48 | 179.27 | 2,326.81 | 0.27 | 231,140.00 | 179,212,188.69 | 179,443,328.96 |
| **TOTAL** | **319,992.07** | **2,458.48** | **40,631.73** | **7.22** | **2,325,624.00** | **2,466,960,183.53** | **2,469,285,814.75** |

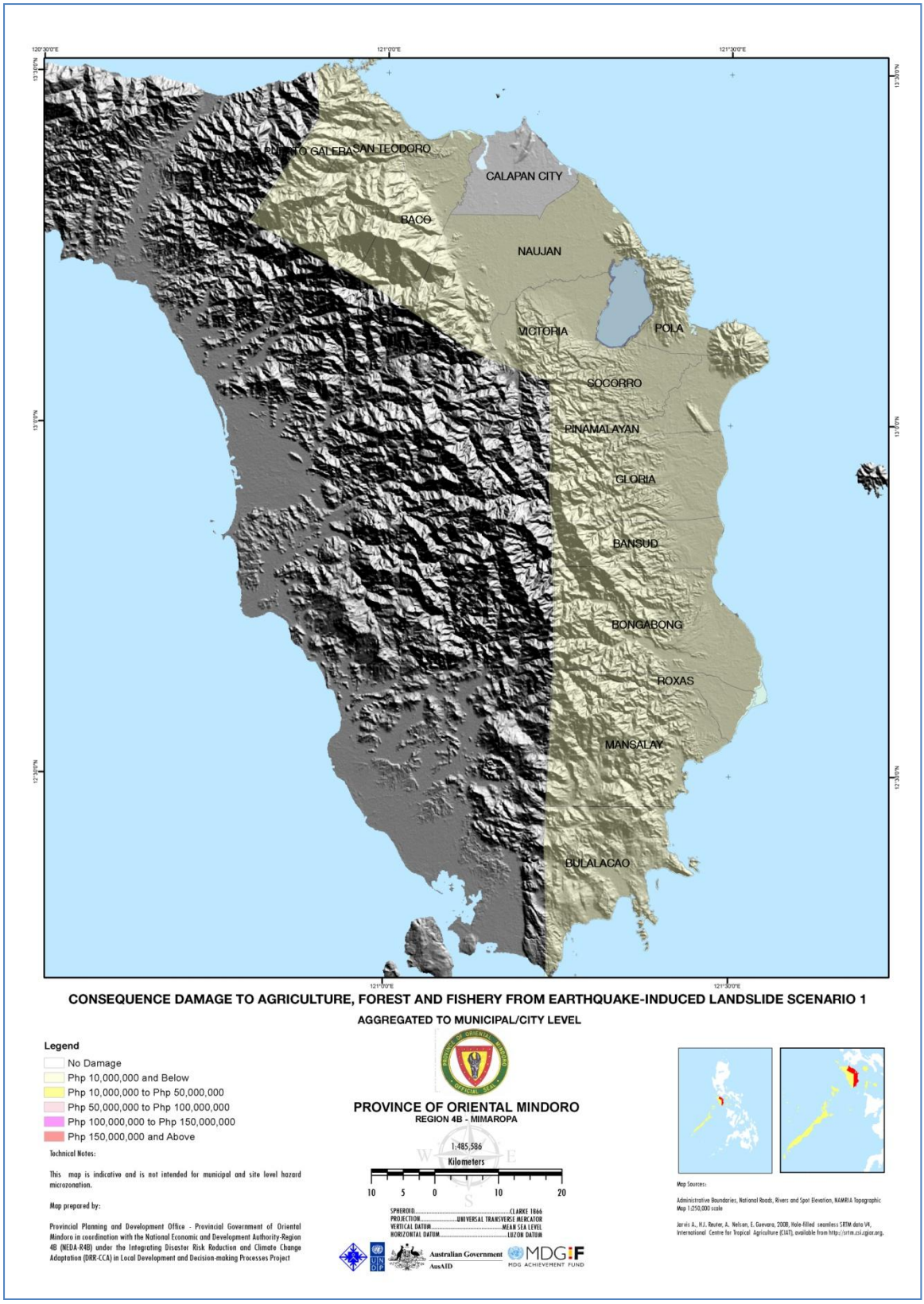



**Figure 31.** Map of consequence damage to agriculture, forest and fishery from earthquake-induced landslide, scenario 1

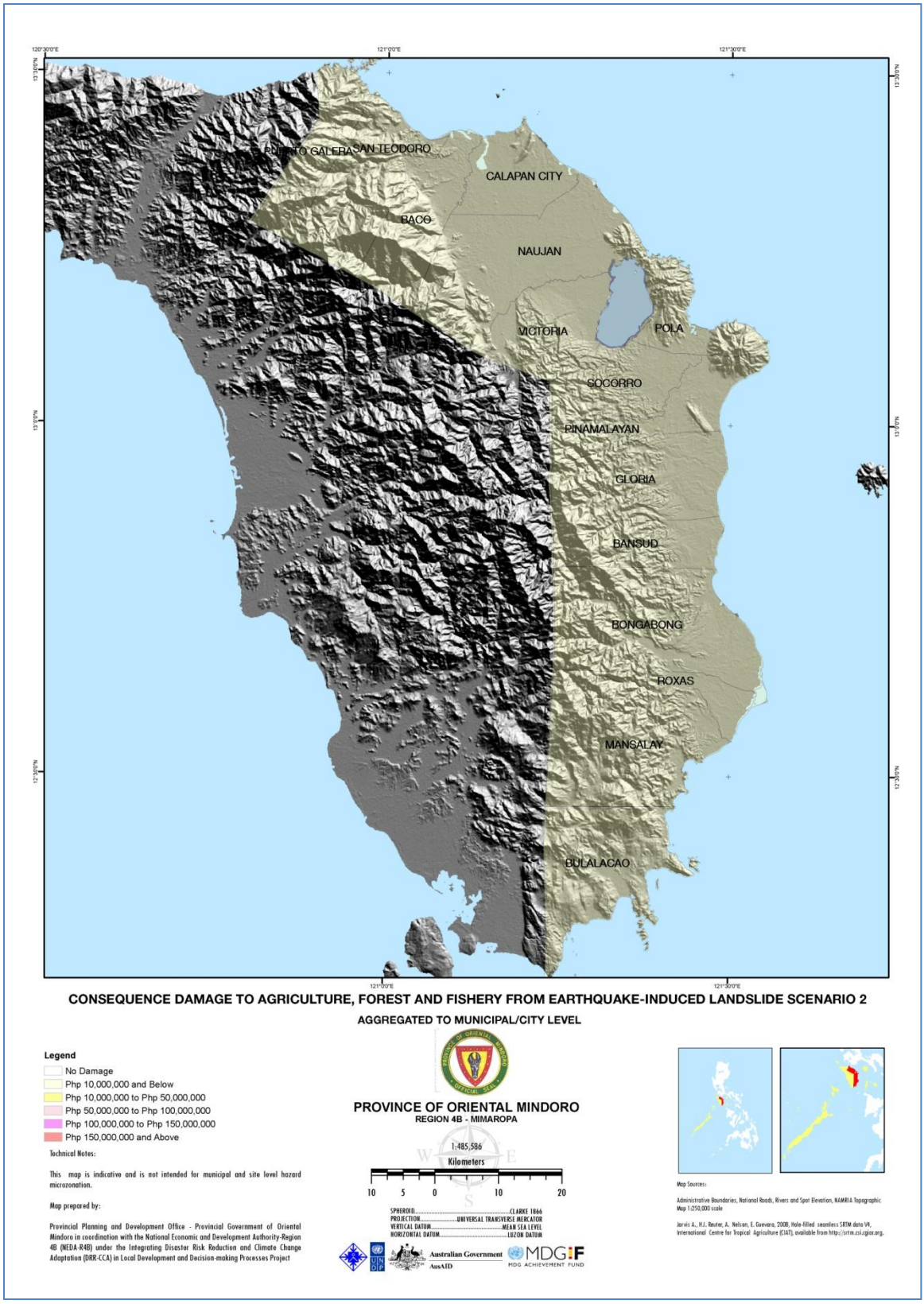



**Figure 32.** Map of consequence damage to agriculture, forest and fishery from earthquake-induced landslide, scenario 2

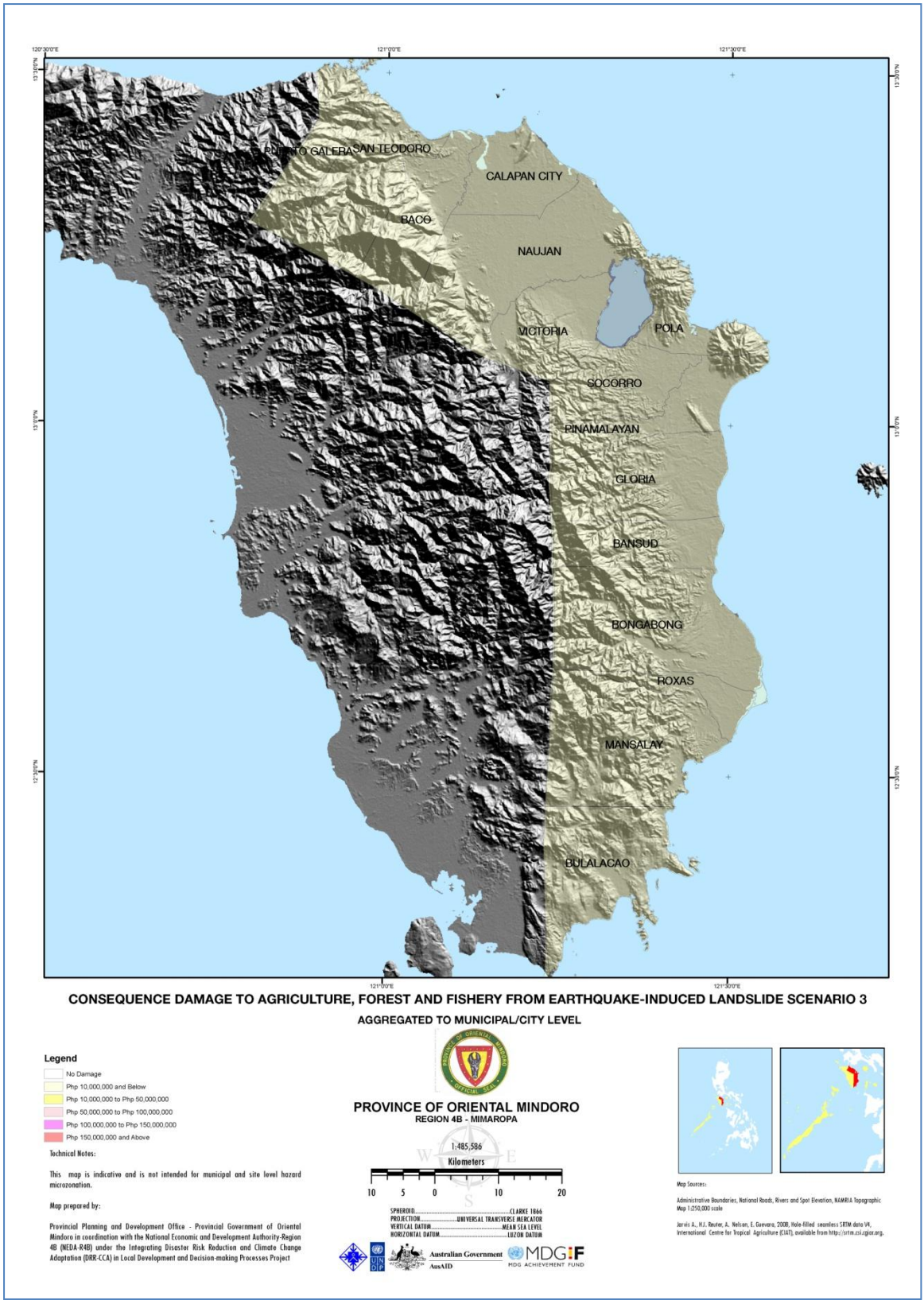



**Figure 33.** Map of consequence damage to agriculture, forest and fishery from earthquake-induced landslide, scenario 3

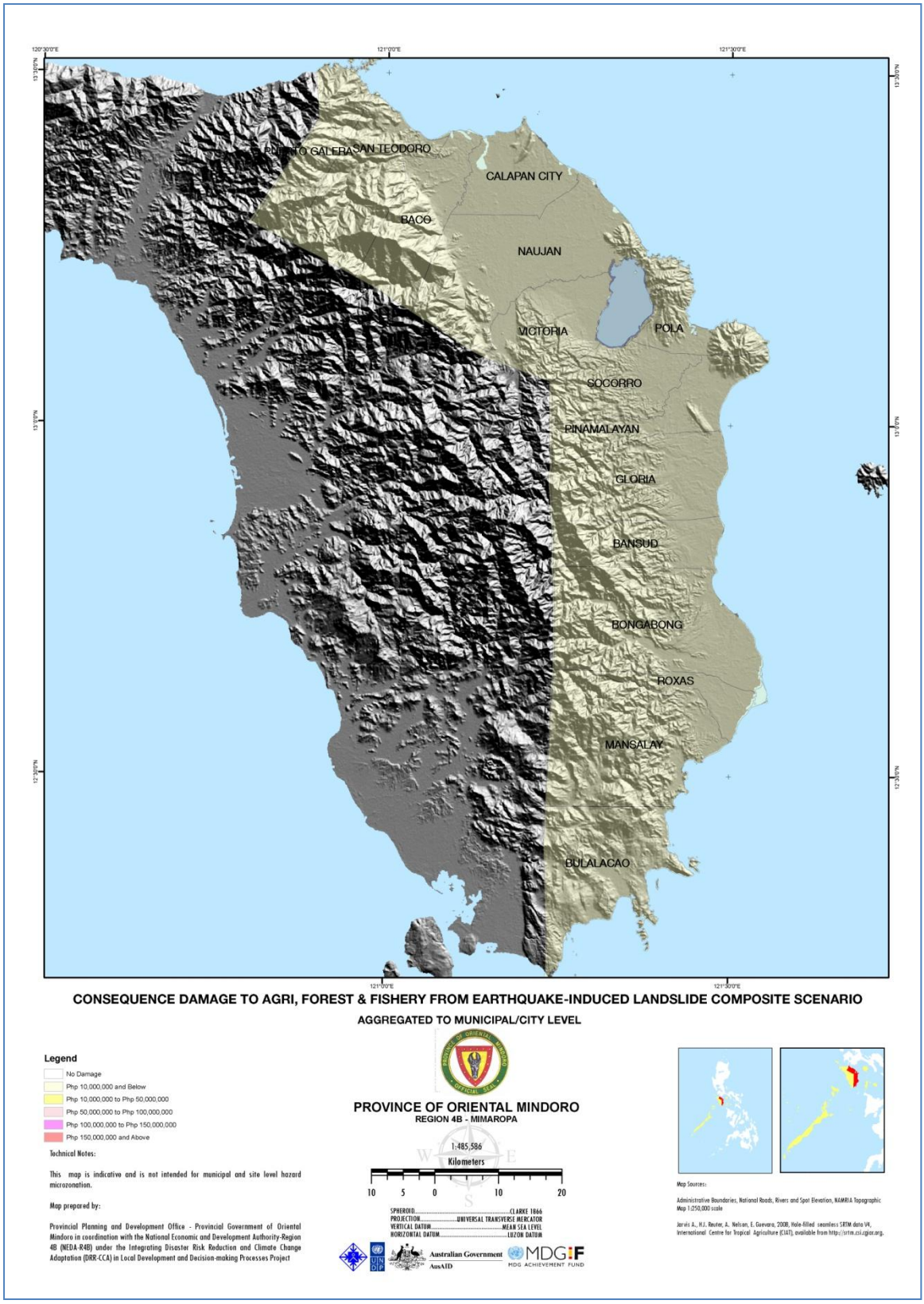



**Figure 34.** Map of consequence damage to agriculture, forest and fishery from earthquake-induced landslide, composite scenario

## 5. Liquefaction

Areas prone to liquefaction are beach zones, sand spits, sand bars, tombolos, wide coastal plains, deltaic plains, floodplains, abandoned river meanders, former lake beds, former or existing marshlands and swamplands, and in areas underlain by sandy lahar deposits (PHIVOLCS, 2006).

Like the other geologic hazards, municipal risk to property and infrastructure from liquefaction was estimated in three scenarios all of which showed that roads have the biggest share of the total urban cost.

The cost of road for scenario 1 was PhP77,254,994,698.58 with Naujan having 33 percent share at PhP25,698,579,501.80 and Mansalay having the least share with PhP122,920,655.36.

**Table 36.** Municipal risk to property and infrastructure from liquefaction, scenario 1

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Kilometer) | COST OF AGRI-CULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 7,442.80 | 1,568.90 | 945.01 | 0.20 | 8,220,964.00 | 2,074,253,524.82 | 2,082,474,489.02 |
| Bansud | 2,632.74 | 253.23 | 334.29 | 0.10 | 4,792,027.50 | 433,322,453.92 | 438,114,481.52 |
| Bongabong | 12,848.90 | 1,204.39 | 1,631.78 | 0.04 | 9,970,706.50 | 2,101,547,651.08 | 2,111,518,357.62 |
| Bulalacao | 118.79 | 602.42 | 15.08 | - | - | 125,690,264.87 | 125,690,264.87 |
| Calapan City | 16,408.43 | 14,561.83 | 2,081.83 | 2.09 | 20,092,289.00 | 18,920,556,106.70 | 18,940,648,397.79 |
| Gloria | 6,999.35 | 753.68 | 888.33 | 0.54 | 11,622,913.00 | 1,175,113,949.94 | 1,186,736,863.48 |
| Mansalay | 2,704.55 | 239.90 | 343.37 | 0.13 | 2,443,162.50 | 122,920,655.36 | 125,363,817.99 |
| Naujan | 27,656.99 | 21,472.73 | 3,512.42 | 0.01 | 11,226,736.50 | 25,698,579,501.80 | 25,709,806,238.31 |
| Pinamalayan | 9,051.08 | 7,339.18 | 1,149.50 | 0.02 | 7,511,351.50 | 7,484,052,403.42 | 7,491,563,754.94 |
| Pola | 3,779.06 | 1,416.18 | 479.95 | - | 2,611,056.50 | 1,273,972,119.31 | 1,276,583,175.81 |
| Puerto Galera | - | 335.69 | - | - | - | - | - |
| Roxas | 4,590.99 | 307.19 | 582.82 | 0.22 | 1,131,570.00 | 769,563,153.20 | 770,694,723.42 |
| San Teodoro | 1,553.76 | 300.19 | 197.33 | - | - | 435,376,948.65 | 435,376,948.65 |
| Socorro | 10,923.80 | 8,124.03 | 1,387.26 | 0.07 | 3,890,899.00 | 10,580,347,229.50 | 10,584,238,128.57 |
| Victoria | 6,759.96 | 4,847.98 | 858.35 | 0.18 | 3,340,354.00 | 6,059,698,736.01 | 6,063,039,090.19 |
| **TOTAL** | **113,471.20** | **63,327.52** | **14,407.32** | **3.60** | **86,854,030.00** | **77,254,994,698.58** | **77,341,848,732.18** |

Of the three scenarios, the second scenario (table 37) has the lowest total urban cost from liquefaction with PhP21,612,399,359.73. Calapan City has the highest cost of critical infrastructure with PhP5,551,741.50 while Naujan has the highest share in cost of road with PhP5,364,523,257.20. The lowest cost of critical infrastructure estimated is in the municipality of Baco with only PhP71,755.00 and the lowest cost of road is in Bansud with PhP84,678,486.22.

**Table 37.** Municipal risk to property and infrastructure from liquefaction, scenario 2

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Km) | COST OF AGRI-CULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 999.36 | 1,568.90 | 126.92 | - | 71,755.00 | 145,561,705.32 | 145,633,460.32 |
| Bansud | 939.84 | 241.46 | 119.37 | - | 313,690.00 | 84,678,486.22 | 84,992,176.22 |
| Bongabong | 6,099.71 | 1,182.21 | 774.65 | 0.01 | 2,540,000.00 | 487,036,932.83 | 489,576,932.84 |
| Bulalacao | 210.50 | 645.45 | 26.70 | 0.02 | - | 251,380,529.74 | 251,380,529.76 |
| Calapan City | 1,704.45 | 13,361.26 | 214.99 | 1.47 | 5,551,741.50 | 3,012,198,495.51 | 3,017,750,238.48 |
| Gloria | 4,003.75 | 803.64 | 508.47 | - | 2,410,714.00 | 294,226,866.96 | 296,637,580.96 |
| Mansalay | 2,879.30 | 294.71 | 364.06 | 1.63 | 2,212,022.50 | 274,476,348.45 | 276,688,372.58 |
| Naujan | 4,874.95 | 25,361.14 | 619.13 | - | 1,669,732.50 | 5,362,853,524.70 | 5,364,523,257.20 |
| Pinamalayan | 5,346.68 | 7,218.70 | 679.03 | 0.01 | 3,268,345.00 | 3,548,119,554.48 | 3,551,387,899.49 |
| Pola | 2,589.10 | 1,416.18 | 328.81 | - | 1,654,746.50 | 524,576,755.01 | 526,231,501.51 |
| Puerto Galera | 23.17 | 335.69 | 2.95 | - | - | - | - |
| Roxas | 2,422.00 | 277.47 | 307.52 | 0.07 | 565,785.00 | 521,004,410.40 | 521,570,195.47 |
| San Teodoro | 1,645.86 | 493.91 | 209.04 | - | - | 573,236,845.65 | 573,236,845.65 |
| Socorro | 5,151.50 | 8,657.62 | 654.20 | 0.04 | 459,740.00 | 3,822,605,701.36 | 3,823,065,441.40 |
| Victoria | 4,026.52 | 5,432.53 | 511.33 | - | 1,542,097.50 | 2,688,182,830.35 | 2,689,724,927.85 |
| **TOTAL** | **42,916.69** | **67,290.87** | **5,447.17** | **3.25** | **22,260,369.50** | **21,590,138,986.98** | **21,612,399,359.73** |

For the third scenario, only Naujan and Calapan City have more than Ten Billion Pesos total urban cost. Gloria, Baco, Bongabong, Pinamalayan, Victoria and Socorro have costs ranging from PhP1.1B to PhP7.2B while Mansalay, Bansud, Pola, Roxas and Bulalacao have PhP325M to PhP754M total urban costs.

**Table 38.** Municipal risk to property and infrastructure from liquefaction, scenario 3

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Km) | COST OF AGRI-CULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 5,537.65 | 1,217.17 | 703.13 | 0.20 | 6,762,369.00 | 1,591,474,024.04 | 1,598,236,393.24 |
| Bansud | 2,008.84 | 258.51 | 255.02 | 0.09 | 4,792,027.50 | 428,332,597.76 | 433,124,625.35 |
| Bongabong | 11,002.54 | 1,183.47 | 1,397.20 | 0.04 | 7,557,452.50 | 1,823,797,560.66 | 1,831,355,013.20 |
| Bulalacao | 3,482.91 | 860.60 | 442.23 | 0.06 | 316,230.00 | 754,141,589.22 | 754,457,819.28 |
| Calapan City | 14,600.52 | 11,294.92 | 1,853.75 | 0.43 | 14,644,052.50 | 14,575,609,446.10 | 14,590,253,499.03 |
| Gloria | 3,336.30 | 759.42 | 423.41 | 0.26 | 11,039,665.50 | 1,088,998,640.34 | 1,100,038,306.10 |
| Mansalay | 5,334.04 | 327.80 | 675.64 | 1.75 | 2,892,107.50 | 322,806,560.15 | 325,698,669.40 |
| Naujan | 23,541.67 | 19,667.65 | 2,989.78 | 0.01 | 9,788,144.00 | 22,781,797,745.60 | 22,791,585,889.61 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pinamalayan | 5,938.41 | 5,783.06 | 754.15 | 0.02 | 4,942,141.50 | 4,494,490,218.48 | 4,499,432,360.00 |
| Pola | 1,834.64 | 944.12 | 233.00 | - | 1,685,607.50 | 674,455,827.87 | 676,141,435.37 |
| Puerto Galera | - | 293.79 | - | - | - | - | - |
| Roxas | 4,558.28 | 307.19 | 578.70 | 0.19 | 1,131,570.00 | 726,146,119.00 | 727,277,689.19 |
| San Teodoro | 28.00 | 172.43 | 3.56 | - | - | - | - |
| Socorro | 7,253.47 | 5,609.75 | 921.12 | 0.07 | 3,431,159.00 | 7,200,553,970.86 | 7,203,985,129.93 |
| Victoria | 3,667.49 | 3,496.83 | 465.57 | 0.18 | 2,543,429.00 | 3,634,263,500.81 | 3,636,806,929.99 |
| **TOTAL** | **92,124.76** | **52,176.71** | **11,696.26** | **3.30** | **71,525,955.50** | **60,096,867,800.89** | **60,168,393,759.69** |

The total urban cost estimated in the composite scenario for liquefaction is PhP3,085,851,437.17 of which Naujan and Calapan City have the highest share with PhP625,989,286.78 and Php515,615,093.77, respectively. Roxas, which is another growth center in the province, has the lowest estimated total urban cost of PhP49,870,971.21.

**Table 39.** Municipal risk to property and infrastructure from liquefaction composite scenario

| CITY/ MUNICIPALITY | TOTAL AFFECTED AREA (Hectares) | TOTAL AFFECTED ROAD (Km) | COST OF AGRI-CULTURE, FOREST AND FISHERY (PhP) | COST OF BUILT-UP (PhP) | COST OF CRITICAL INFRA-STRUCTURE (PhP) | COST OF ROAD (PhP) | TOTAL URBAN COST (PhP) |
|---|---|---|---|---|---|---|---|
| Baco | 8,042.28 | 84.30 | 1,021.17 | 0.20 | 1,596,326.50 | 71,567,760.85 | 73,164,087.55 |
| Bansud | 2,730.61 | 32.06 | 346.69 | 0.10 | 1,184,910.00 | 54,789,038.76 | 55,973,948.86 |
| Bongabong | 14,301.19 | 136.85 | 1,816.19 | 0.04 | 2,267,204.00 | 193,255,933.78 | 195,523,137.82 |
| Bulalacao | 3,517.31 | 86.06 | 446.62 | 0.07 | 316,230.00 | 125,690,264.87 | 126,006,494.94 |
| Calapan City | 17,621.42 | 572.18 | 2,234.58 | 3.34 | 2,025,269.00 | 513,589,821.43 | 515,615,093.77 |
| Gloria | 7,155.49 | 105.67 | 908.21 | 0.54 | 2,267,204.00 | 138,143,198.94 | 140,410,403.48 |
| Mansalay | 5,742.67 | 65.15 | 727.46 | 1.86 | 1,058,862.50 | 109,790,539.38 | 110,849,403.74 |
| Naujan | 28,685.84 | 694.44 | 3,643.08 | 0.03 | 1,670,621.50 | 624,318,665.25 | 625,989,286.78 |
| Pinamalayan | 9,567.42 | 324.28 | 1,215.04 | 0.03 | 2,267,204.00 | 315,456,888.00 | 317,724,092.03 |
| Pola | 3,909.52 | 118.02 | 496.51 | - | 1,511,236.50 | 74,939,536.43 | 76,450,772.93 |
| Puerto Galera | 23.17 | 33.57 | 2.94 | - | - | - | - |
| Roxas | 4,750.60 | 33.86 | 603.10 | 0.21 | 1,208,341.50 | 48,662,629.50 | 49,870,971.21 |
| San Teodoro | 2,682.30 | 118.15 | 340.66 | - | - | 158,858,388.15 | 158,858,388.15 |
| Socorro | 11,860.92 | 360.41 | 1,506.28 | 0.07 | 2,267,204.00 | 360,536,806.74 | 362,804,010.81 |
| Victoria | 8,697.29 | 283.20 | 1,104.38 | 0.18 | 1,722,374.00 | 274,888,970.92 | 276,611,345.10 |
| **TOTAL** | **129,288.03** | **3,048.20** | **16,412.91** | **6.67** | **21,362,987.50** | **3,064,488,443.00** | **3,085,851,437.17** |

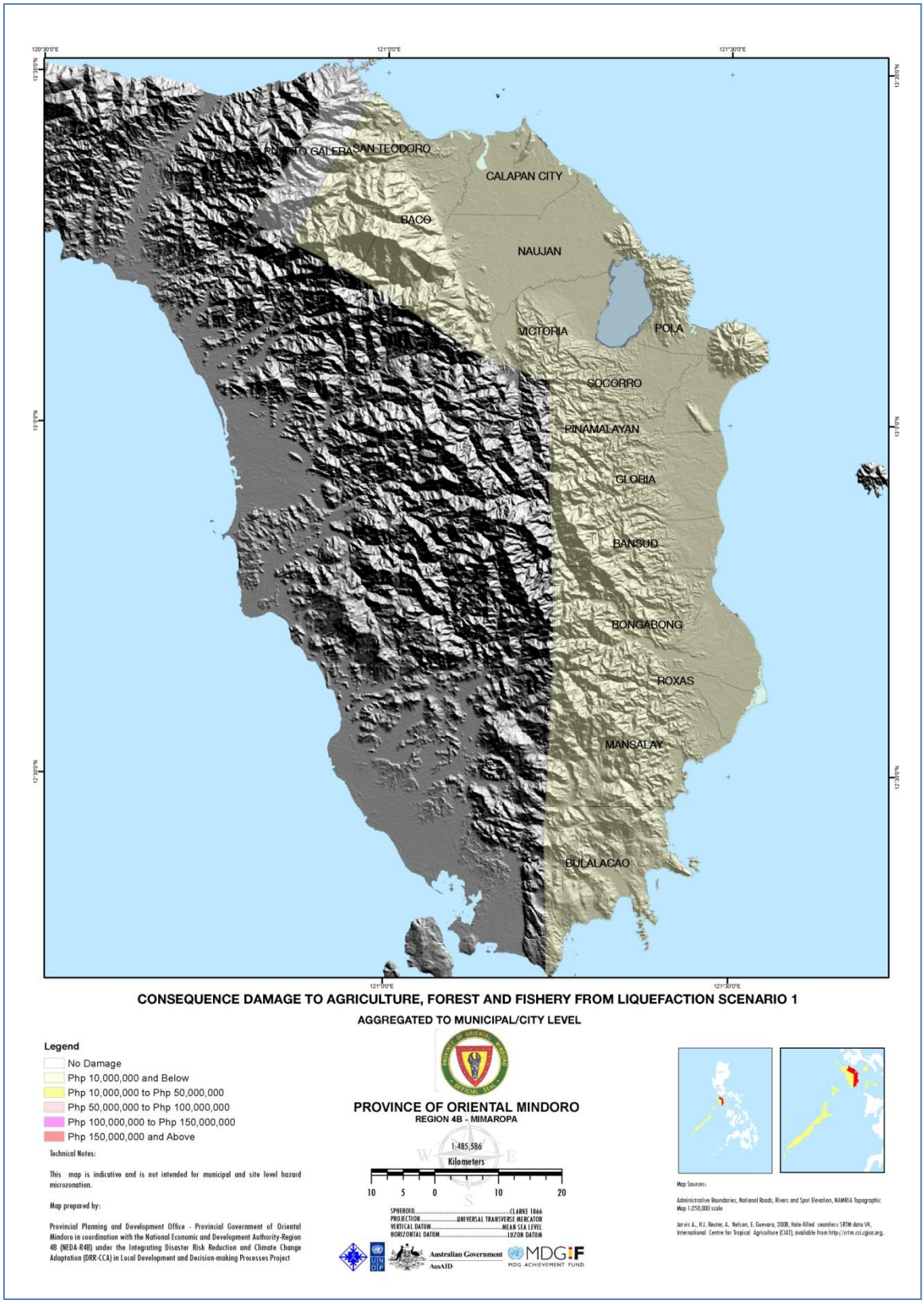



**Figure 35.** Map of consequence damage to agriculture, forest and fishery from liquefaction, scenario 1

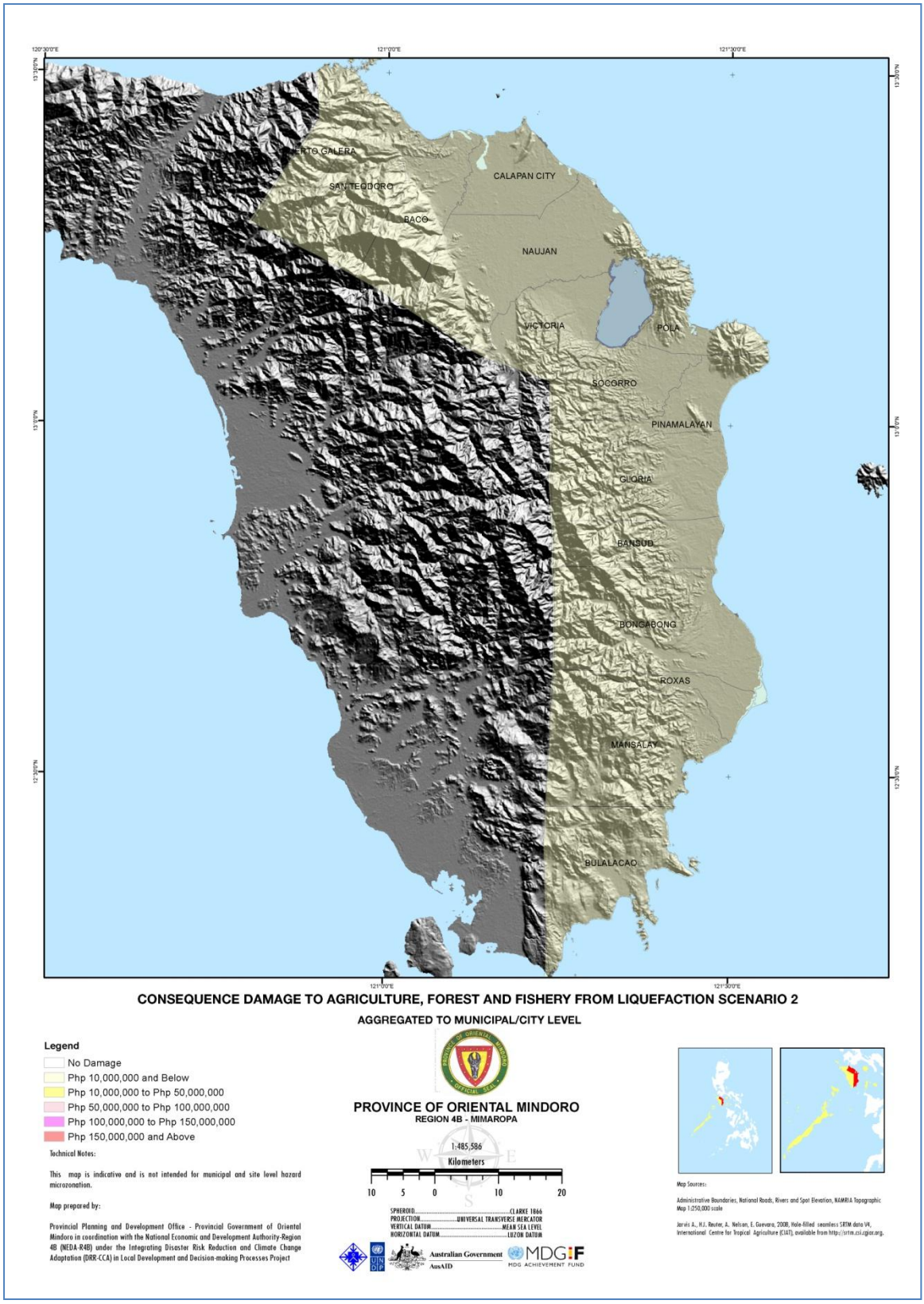



**Figure 36.** Map of consequence damage to agriculture, forest and fishery from liquefaction, scenario 2

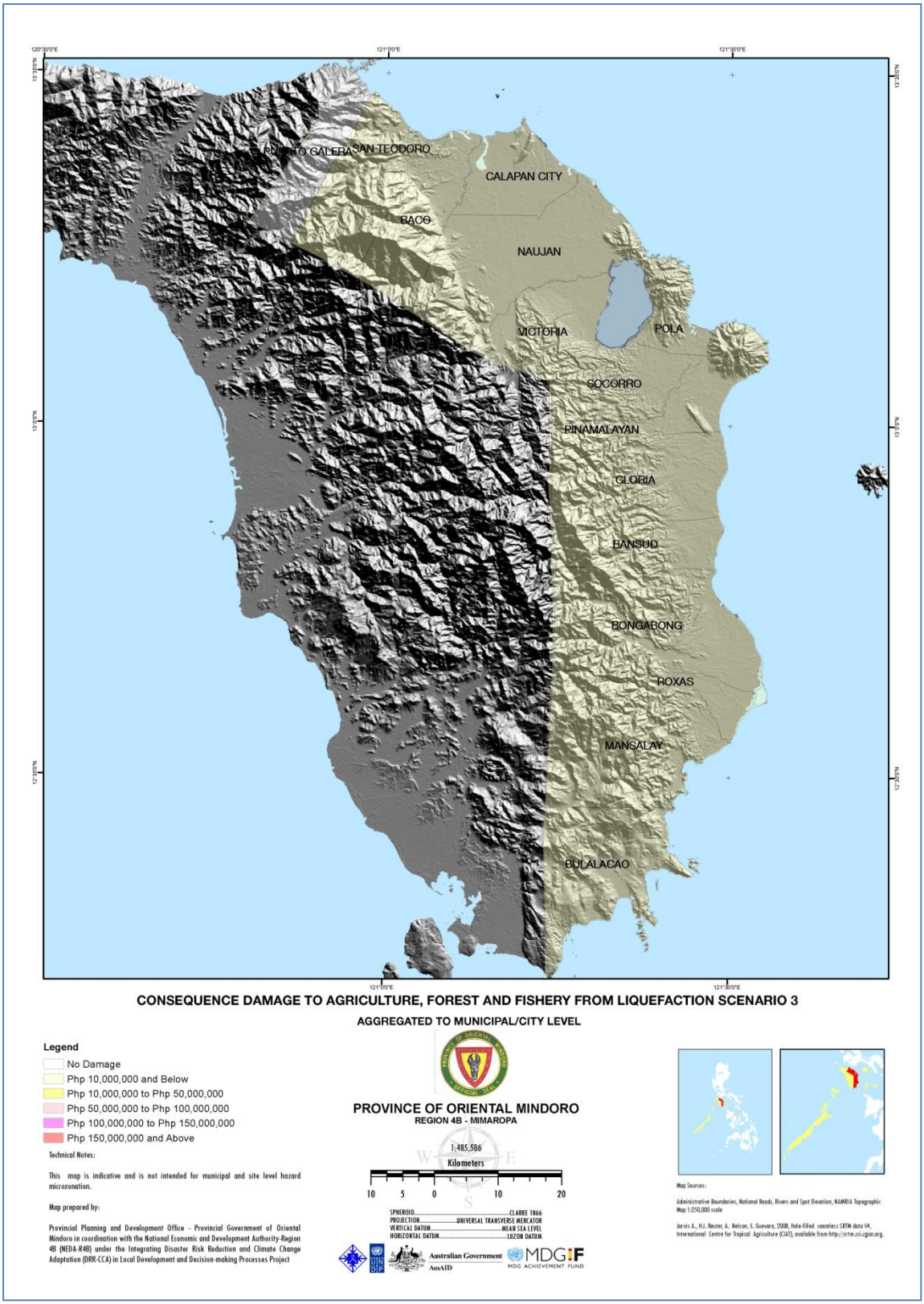



**Figure 37.** Map of consequence damage to agriculture, forest and fishery from liquefaction, scenario 3

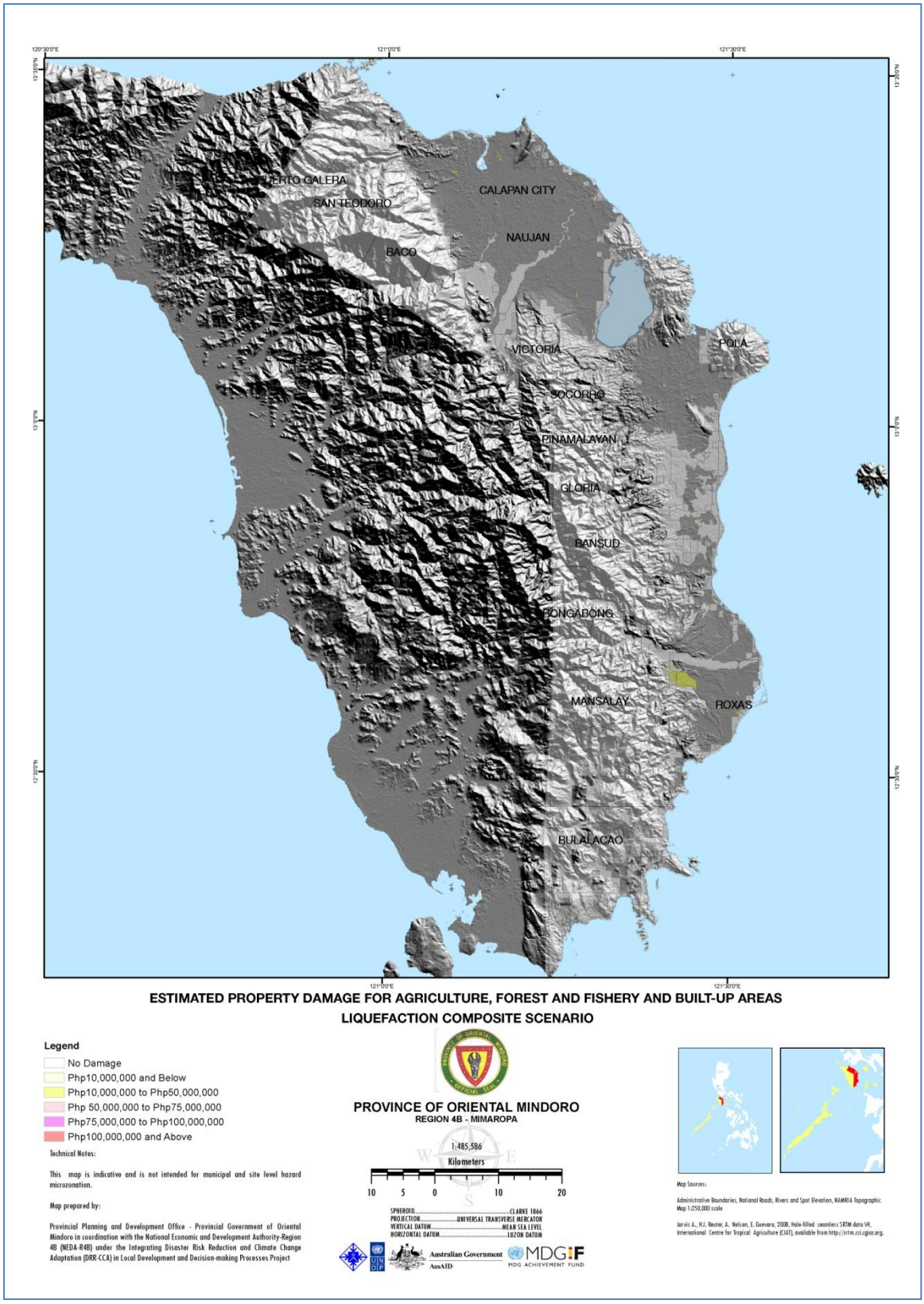



**Figure 38.** Map of estimated property damage for agriculture, forest and fishery and built-up areas from liquefaction, composite scenario

## 6. Tsunami

The estimated damages by tsunami to agriculture, forest and fishery (AFF) totalled PhP7,270,100,000.00 and PhP11,100,000.00 for built-up areas. Roxas has the highest estimated damage in AFF with PhP1,745,800,000.00 while Mansalay has the highest damage to built-up areas with PhP5,200,000.00.

**Table 40.** Estimated property damage to agriculture, forest and fishery (AFF) and built-up areas by tsunami

| CITY/ MUNICIPALITY | AFFECTED AREAS IN HECTARES | AFF CONSEQUENCE IN PHILIPPINE PESOS PER YEAR | BUILT-UP CONSEQUENCE IN PHILIPPINE PESOS PER YEAR | CONSEQUENCE IN PHILIPPINE PESOS PER YEAR |
|---|---|---|---|---|
| Baco | 560.68 | 712,000,000.00 | - | 712,000,000.00 |
| Bongabong | 526.38 | 668,500,000.00 | - | 668,500,000.00 |
| Calapan City | 934.16 | 1,183,000,000.00 | 3,400,000.00 | 1,186,400,000.00 |
| Mansalay | 1,043.21 | 1,319,700,000.00 | 5,200,000.00 | 1,324,900,000.00 |
| Puerto Galera | 941.00 | 1,193,200,000.00 | 1,800,000.00 | 1,195,000,000.00 |
| Roxas | 1,374.94 | 1,745,800,000.00 | 300,000.00 | 1,746,100,000.00 |
| San Teodoro | 353.05 | 447,900,000.00 | 400,000.00 | 448,300,000.00 |
| **Total** | **5,733.42** | **7,270,100,000.00** | **11,100,000.00** | **7,281,200,000.00** |

The total estimated damage to critical infrastructure was PhP3,261,931.50. Thirty seven percent or PhP1,208,341.50 of this is in Roxas where Dangay Port which is being used as entry and exit point to the Visayas via the Strong Republic Nautical Highway is located. In terms of property damage, Calapan City, the provincial capital and regional government center has the highest estimated cost with PhP291,465,127.25.

**Table 41.** Estimated damage to critical infrastructure and roads by tsunami

| CITY/ MUNICIPALITY | COST OF DAMAGE CRITICAL INFRASTRUCTURE | SUM OF AFFECTED ROAD | COST OF PROPERTY DAMAGE |
|---|---|---|---|
| Baco | 302,895.00 | 38.21 | 48,520,568.44 |
| Bongabong | 282,892.50 | - | - |
| Calapan City | 514,032.50 | 198.64 | 291,465,127.25 |
| Mansalay | 387,985.00 | 21.72 | 54,895,269.69 |
| Puerto Galera | 565,785.00 | 33.57 | 65,692,718.12 |
| Roxas | 1,208,341.50 | 14.86 | 43,417,034.20 |
| **Total** | **3,261,931.50** | **307.00** | **503,990,717.70** |

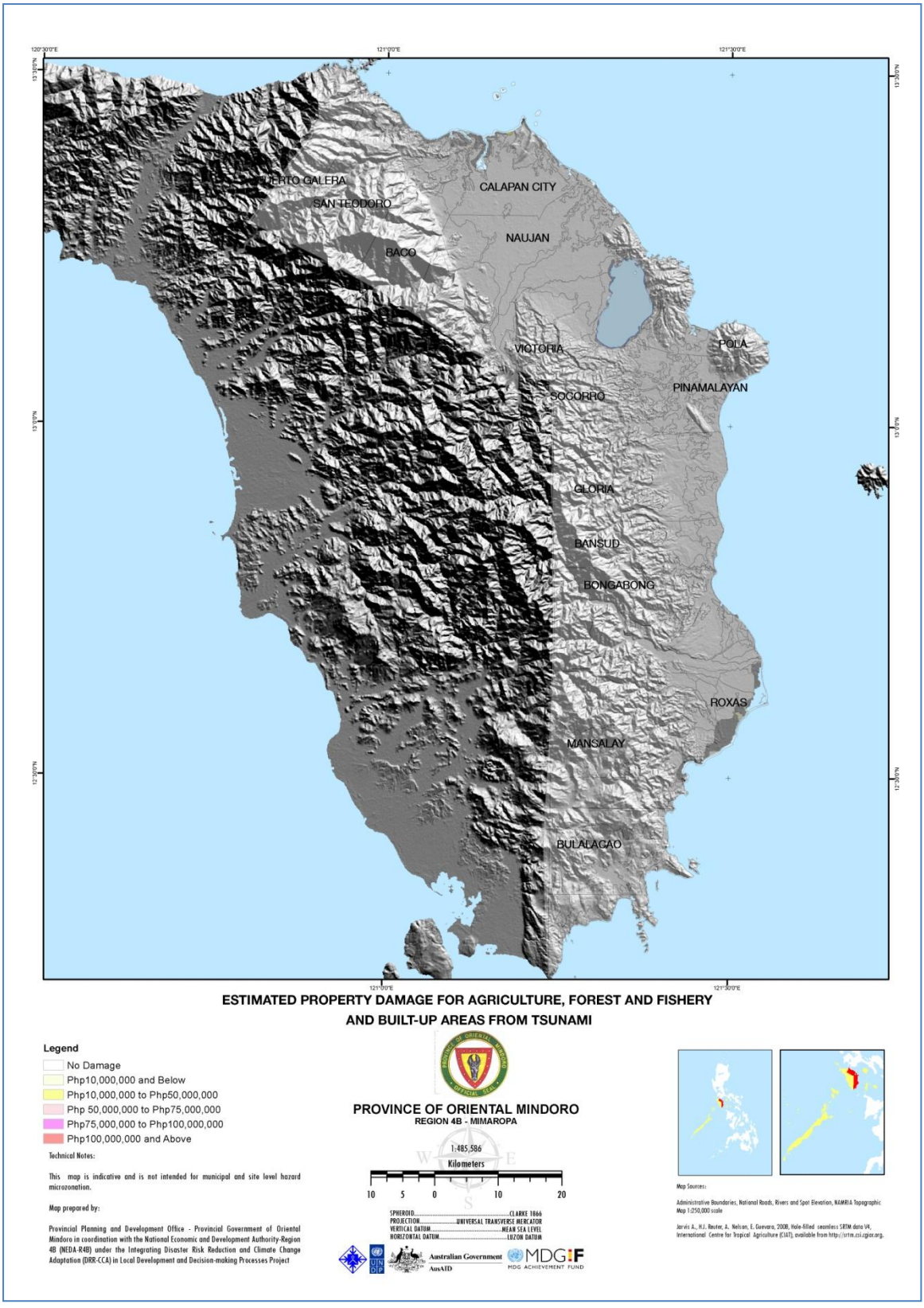



**Figure 39.** Map of estimated property damage for agriculture, forest and fishery and built-up areas from tsunami

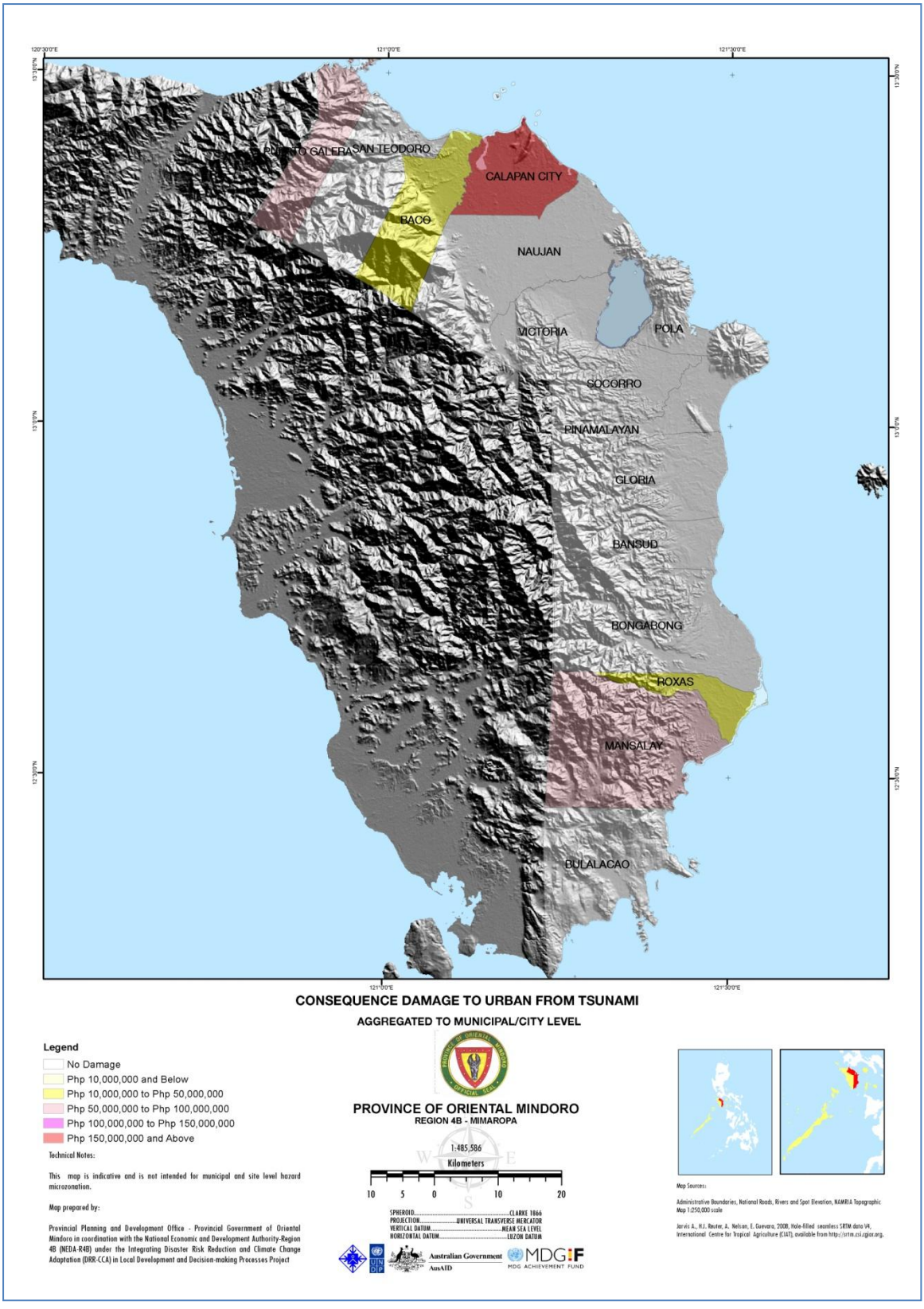



**Figure 40.** Map of consequence damage to urban from tsunami

## VULNERABILITY ASSESSMENT

Vulnerability is defined by Intergovernmental Panel on Climate Change (IPCC, 2007) as "*the degree to which a system is susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes.*" It is expressed as the function of the sensitivity, exposure and adaptive capacity of ecosystems and human communities therein.

According to Techopedia, vulnerability assessments are designed to yield a ranked or prioritized list of a system's vulnerabilities for various kinds of threats. Organizations that use these assessments are aware of security risks and understand they need help identifying and prioritizing potential issues. By understanding their vulnerabilities, an organization can formulate solutions and patches for those vulnerabilities for incorporation with their risk management system.

### Exposure of Vulnerable Sectors

### 1. Population

Results of the 2008 Community Based Monitoring System (CBMS) survey showed the potentially vulnerable segments of society. The municipality of Bulalacao has the highest proportion in eleven from a total of 15 indicators as shown in Table 10 where households with income below poverty threshold have the highest proportion of 86.5.

**Table 42.** Magnitude and proportion of households and male-female population by CBMS indicator, Bulalacao, 2008

| Indicator | Households | | Population | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | | | Proportion | | |
| | Magnitude | Proportion | Total | Male | Female | Total | Male | Female |
| Malnourished Children aged 0-5 years old | 582 | 18.2 | 754 | 391 | 363 | 15 | 15.4 | 14.7 |
| Children 0-5 years old who died | 38 | 1.2 | 40 | 14 | 26 | 0.8 | 0.5 | 1.1 |
| Households without access to sanitary toilet facilities | 3511 | 56.9 | 16386 | 8530 | 7856 | 56.8 | 57.4 | 56.1 |
| Households classified as squatters | 374 | 6.1 | 1847 | 958 | 889 | 6.4 | 6.4 | 6.3 |
| Children 6-12 years old not attending elementary | 1455 | 44.2 | 1891 | 1000 | 891 | 30.7 | 32.1 | 29.3 |
| Children 13-16 years old not attending high school | 1374 | 60.4 | 1694 | 954 | 740 | 54.1 | 59.3 | 48.6 |
| Children 6-16 years old not attending school | 1360 | 34.7 | 1947 | 1093 | 854 | 21 | 23.1 | 18.7 |
| Victims of Crime | 176 | 2.9 | 388 | 251 | 222 | 1.3 | 1.7 | 1.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Households with income below poverty threshold | 5337 | 86.5 | 25828 | 13352 | 12476 | 89.5 | 89.8 | 89.1 |
| Households with income below food threshold | 4865 | 78.9 | 23953 | 12391 | 11562 | 83 | 83.4 | 82.6 |
| Households that experienced food shortage | 1261 | 20.4 | 6190 | 3168 | 3022 | 21.4 | 21.3 | 21.6 |

*Source: CBMS, 2008*

The other municipalities with high magnitude and proportion of households and population per CBMS indicator are presented in Annex 15.

Pinamalayan has the highest magnitude and proportion of households without access to safe drinking water and households living in makeshift housing. Bongabong has the highest magnitude of households with unemployed members of the labor force at 322 but Victoria has the highest proportion with 3.5.

**Flooding**

Oriental Mindoro, being an island province with numerous rivers and creeks, has high exposure to flooding in terms of population, built-up area, agriculture, and roads. Table 43 shows that population is most exposed to groundshaking with most of the municipalities having over 90 percent exposure.

**Table 43.** Exposure percentage of population per hazard

| CITY/ MUNICIPALITY | FLOOD | | | LIQUE FACTION | TSUNAMI | GROUND SHAKING | EIL |
|---|---|---|---|---|---|---|---|
| | HSA | MSA | LSA | | | | |
| Baco | 58% | 15% | 9% | 80% | 7% | 98% | 10% |
| Bansud | 21% | 46% | 13% | 72% | | 90% | 9% |
| Bongabong | 51% | 16% | 6% | 65% | 6% | 92% | 10% |
| Bulalacao | 9% | 8% | 6% | 16% | | 74% | 7% |
| Calapan city | 51% | 37% | 6% | 87% | 10% | 89% | |
| Gloria | 30% | 41% | 7% | 84% | | 93% | 3% |
| Mansalay | 10% | 22% | 18% | 48% | 17% | 92% | 22% |
| Naujan | 28% | 41% | 15% | 76% | | 97% | 6% |
| Pinamalayan | 17% | 24% | 8% | 46% | | 87% | 3% |
| Pola | 18% | 12% | 5% | 38% | | 95% | 27% |
| Puerto galera | 8% | 7% | 2% | 1% | 32% | 62% | 34% |
| Roxas | 72% | 8% | 11% | 63% | 40% | 84% | 2% |
| San teodoro | 4% | 5% | 1% | 23% | 6% | 92% | 42% |
| Socorro | 6% | 34% | 16% | 82% | | 99% | 14% |
| Victoria | 21% | 42% | 17% | 70% | | 94% | 13% |

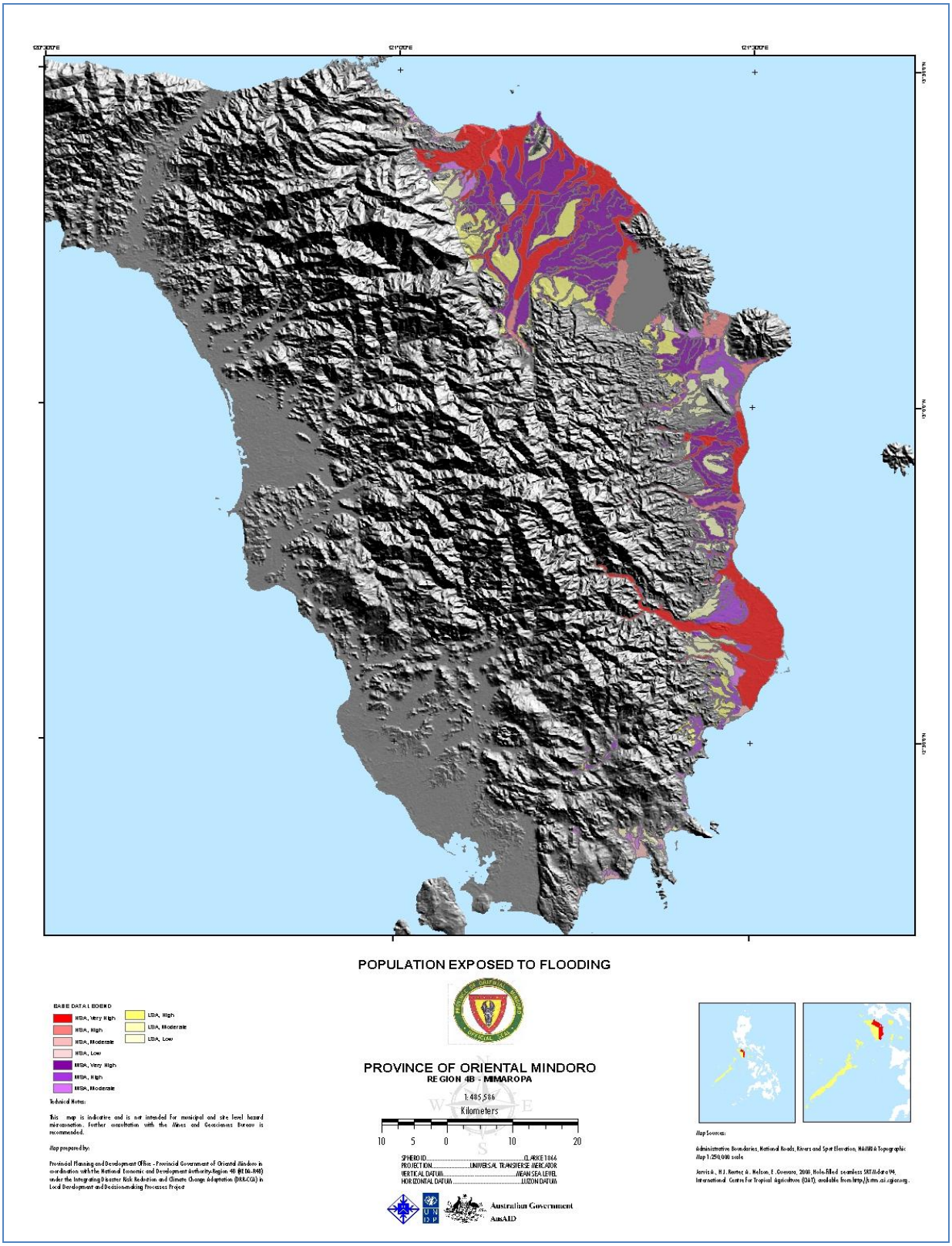



**Figure 41.** Population exposed to flooding

Of the fifteen municipalities in the province, Roxas which is a growth area has the highest percentage of population exposed to flooding with 72 percent (Annex 16). As per official result of the 2010 Census of Population conducted by the National Statistics Office, this would mean a total of 35,895 people in areas that are highly susceptible to flood. Given the municipality's annual population growth rate of 1.91, the projected population exposed to flooding in highly susceptible areas (HSA) will be 31,199 for the year 2011; 31,795 in 2012 and 32,403 in 2013 (Annex 17).

As per results of the CBMS survey conducted in 2008, there are 5,712 households with income below poverty threshold accounting for 60 percent of the total number of households in Roxas. On the other hand, 4,154 households or 43.7 percent have income below food threshold. These sectors should be prioritized in the implementation of development projects to build their resilience and adaptive capacity in the event that flooding occurs.

Calapan City, which is the province's entry point from mainland Luzon is likewise exposed to flooding where 93 percent of built-up areas are within HSA (Annex 18). Further, 51 percent of its population are within HSA, and 37 percent are residing in moderately susceptible areas (MSA). These are important considerations given the new role of Calapan City as MIMAROPA's Regional Government Center which is expected to encourage population influx and enhance local trade and industry.

**Table 44.** Exposure percentage of built-up areas per hazard

| CITY/ MUNICIPALITY | FLOOD | | | LIQUE FACTION | TSUNAMI | GROUND SHAKING | EIL |
|---|---|---|---|---|---|---|---|
| | HSA | MSA | LSA | | | | |
| Baco | 100% | 0% | 0% | 100% | | 100% | |
| Bansud | 6% | 94% | 0% | 100% | | 100% | |
| Bongabong | 29% | 17% | 49% | 88% | | 94% | |
| Bulalacao | 21% | 27% | 17% | 27% | | 82% | 0.05% |
| Calapan city | 93% | 6% | 1% | 98% | 10% | 100% | |
| Gloria | 0% | 100% | 0% | 100% | | 100% | |
| Mansalay | 4% | 85% | 7% | 100% | 28% | 95% | |
| Naujan | 48% | 52% | 0% | 97% | | 97% | |
| Pinamalayan | 16% | 77% | 0% | 49% | | 73% | |
| Pola | 25% | 0% | 0% | | | 37% | |
| Puerto galera | 47% | 10% | 0% | | 98% | 15% | |
| Roxas | 21% | 17% | 56% | 81% | 11% | 96% | |
| San teodoro | 0% | 100% | 0% | | 43% | 19% | |
| Socorro | 0% | 100% | 0% | 100% | | 100% | |
| Victoria | 40% | 29% | 28% | 68% | | 100% | 0.32% |

**Lliquefaction**

Calapan City has the highest percentage of population exposure to liquefaction with 87 percent followed by Gloria with 84 percent while the least is Puerto Galera with one percent. The map of population exposed to liquefaction is presented in Annex 19.

**Table 45.** Population exposure to liquefaction

| CITY/MUNICIPALITY | 2007 MUNICIPAL POPULATION | EXPOSED POPULATION IN PRONE AREAS | POPULATION EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Calapan city | 116976 | 102,197 | 87 |
| Gloria | 40561 | 34,248 | 84 |
| Socorro | 38052 | 31,188 | 82 |
| Baco | 34127 | 27,369 | 80 |
| Naujan | 90629 | 69,008 | 76 |
| Bansud | 35664 | 25,588 | 72 |
| Victoria | 44932 | 31,408 | 70 |
| Bongabong | 61127 | 39,710 | 65 |
| Roxas | 46711 | 29,524 | 63 |
| Mansalay | 43974 | 20,952 | 48 |
| Pinamalayan | 77119 | 35,276 | 46 |
| Pola | 32635 | 12,398 | 38 |
| San Teodoro | 15039 | 3,502 | 23 |
| Bulalacao | 30188 | 4,863 | 16 |
| Puerto Galera | 28035 | 352 | 1 |

All the built-up areas in the municipalities of Gloria, Bansud, Baco and Socorro are exposed to liquefaction (Annex 20). Calapan City has 98 percent exposure, Naujan - 97, Bongabong - 88, Roxas – 81 and Victoria – 68. These figures indicate that safety and security measures should be considered in the design and construction of structures in said municipalities.

**Tsunami**

Among the 15 municipalities of the province, Roxas has the highest population exposure to tsunami followed by Puerto Galera with 40 and 32 percent, respectively (Annex 21). These are the fisherfolk who earn income from fishing activities. Puerto Galera which is the primary tourist destination in the province has 98 percent of its built-up areas exposed to tsunami (Annex 22). Most of these are the beach resorts and hotels located near the coastline.

**Table 46.** Exposure of built-up areas to tsunami

| CITY/ MUNICIPALITY | MUNICIPAL BUILT-UP AREA | EXPOSED BUILT-UP AREA WITHIN PRONE AREAS | EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Puerto Galera | 22.42 | 21.89 | 98 |
| San Teodoro | 17.03 | 7.39 | 43 |
| Mansalay | 110.97 | 31.27 | 28 |
| Roxas | 1,204.40 | 136.29 | 11 |
| Calapan City | 367.47 | 36.45 | 10 |

**Ground shaking**

Population in all the 14 municipalities and Calapan City are highly exposed to ground shaking (Annex 23). Socorro has the highest exposure with 99 percent followed by Baco and Naujan with 98 and 97 percent, respectively. Puerto Galera has the least with 62 percent.

Results of the 2008 CBMS survey showed that Socorro has 5,629 households or 70.4 percent with income below poverty threshold and 4,427 households or 55.4 percent with income below food threshold. It also has a high proportion of children 13-16 years old not attending high school with 45.3 percent. Further, households without access to safe water and sanitary toilet facility are more than 20 percent of its total number of households.

**Table 47.** Population exposure to ground shaking

| CITY/ MUNICIPALITY | 2007 MUNICIPAL POPULATION | EXPOSED POPULATION IN PRONE AREAS | POPULATION EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Socorro | 38,052 | 37,491 | 99 |
| Baco | 34,127 | 33,603 | 98 |
| Naujan | 90,629 | 87,532 | 97 |
| Pola | 32,635 | 30,987 | 95 |
| Victoria | 44,932 | 42,196 | 94 |
| Gloria | 40,561 | 37,826 | 93 |
| Bongabong | 61,127 | 56,352 | 92 |
| Mansalay | 43,974 | 40,321 | 92 |
| San Teodoro | 15,039 | 13,764 | 92 |
| Bansud | 35,664 | 32,193 | 90 |
| Calapan City | 116,976 | 104,225 | 89 |
| Pinamalayan | 77,119 | 66,933 | 87 |
| Roxas | 46,711 | 39,202 | 84 |
| Bulalacao | 30,188 | 22,410 | 74 |
| Puerto Galera | 28,035 | 17,431 | 62 |

The province has a relatively high exposure of built-up areas to ground shaking with Calapan City and the municipalities of Gloria, Bansud, Socorro, Victoria and Baco having a hundred percent exposure (Annex 24). Only the municipalities of Pola, San Teodoro and Puerto Galera have low exposure with 37, 19 and 15 percent, respectively.

**Table 48.** Exposure of built-up areas to ground shaking

| CITY/MUNICIPALITY | MUNICIPAL BUILT-UP AREA | EXPOSED BUILT-UP AREA WITHIN PRONE AREAS | EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Gloria | 5.74 | 5.74 | 100 |
| Bansud | 97.29 | 97.29 | 100 |
| Socorro | 29.44 | 29.44 | 100 |
| Victoria | 39.75 | 39.75 | 100 |
| Baco | 26.92 | 26.92 | 100 |
| Calapan City | 367.47 | 367.47 | 100 |
| Naujan | 98.89 | 96.23 | 97 |
| Roxas | 1,204.40 | 1,151.61 | 96 |
| Mansalay | 110.97 | 104.89 | 95 |
| Bongabong | 426.76 | 399.04 | 94 |
| Bulalacao | 348.91 | 287.47 | 82 |
| Pinamalayan | 111.25 | 80.80 | 73 |
| Pola | 15.41 | 5.75 | 37 |
| San Teodoro | 17.03 | 3.27 | 19 |
| Puerto Galera | 22.42 | 3.32 | 15 |

**Earthquake induced landslide (EIL)**

Mansalay has the highest exposed population in EIL prone areas with 9,770 but the highest exposure percentage is in San Teodoro with 42 percent. Puerto Galera follows with 34 percent (Annex 25). These municipalities are located in areas with relatively high slope and are thus prone to landslides.

On the other hand, only the municipalities of Bulalacao and Victoria have built-up areas prone to earthquake-induced landslide. Victoria has a total built-up area of 39.75 hectares wherein 0.32 percent or 12.89 hectares are prone to EIL. Bulalacao which has larger built-up area of 348.91 hectares has only 0.05 percent exposure or 18.36 hectares.

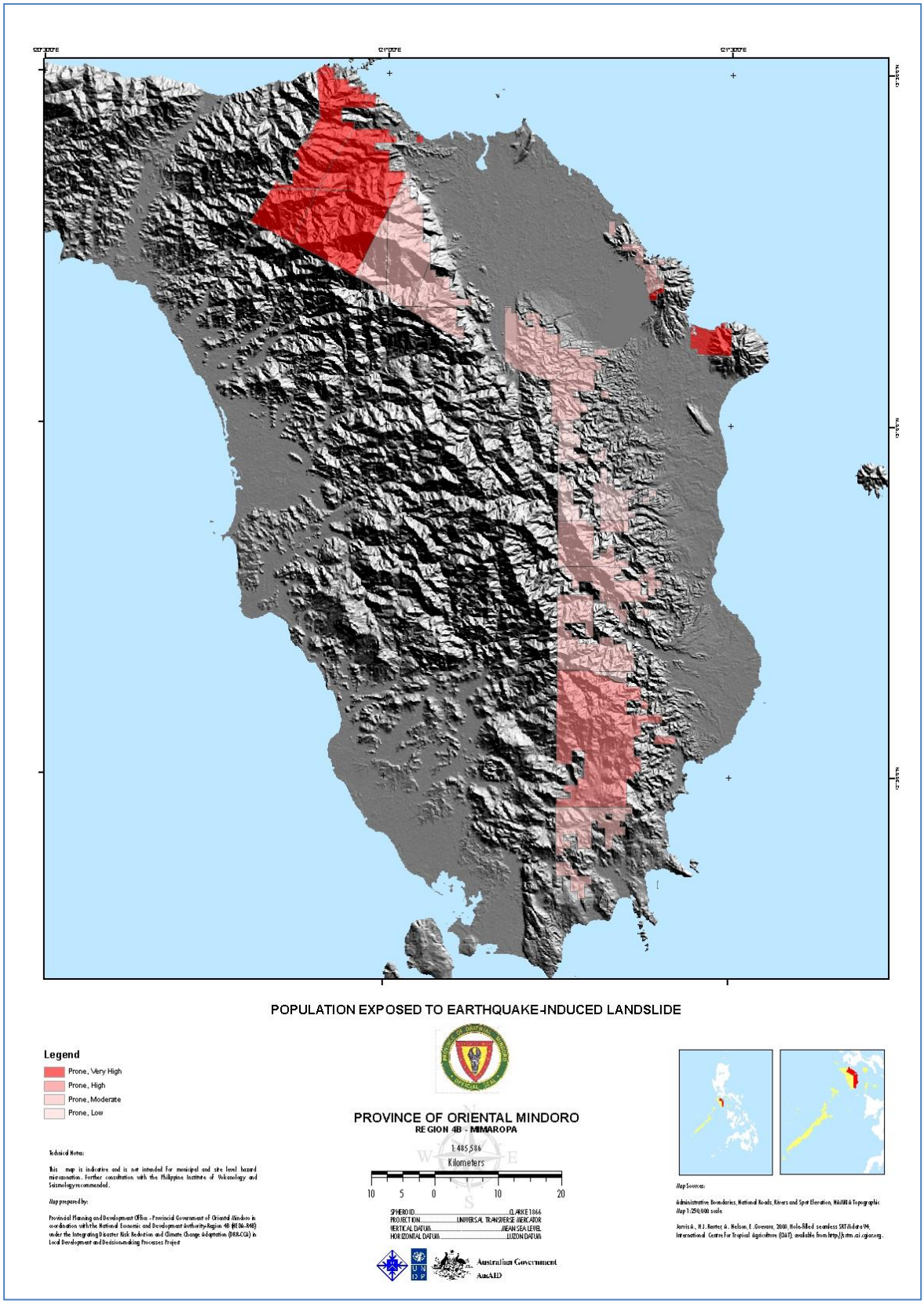



**Figure 42.** Population exposed to earthquake-induced landslide

**b. Economy**

The province of Oriental Mindoro is primarily agricultural. Of its 436,472 hectares total land area, 38.86% or 169,603.34 hectares are devoted to agriculture. According to the Bureau of Agricultural Statistics (BAS) data, area harvested to palay comprise an average of 48% of total agricultural area within the five-year period from 2006-2010 (Annex 26). Other major crops grown are coconut, banana and calamansi.

Despite the agricultural nature of the local economy, data on sectoral classification of new business names registered with DTI shows that agriculture has the least number of registered business establishments. This is because farmers are not required to have business names nor employment records. Only single proprietorship agri-businesses secure business name registrations. Within CYs 2006-2010, trading sector generated the highest number of new investments with 2,741 new establishments registered with DTI. The services sector followed as the 2nd most preferred investment having 2,567 new establishments.

**Table 49.** Number of New Business Names Registered by Sectoral Classification, Oriental Mindoro, 2006 to 2010.

| Sectoral Classification | 2006 | 2007 | 2008 | 2009 | 2010 | TOTAL |
|---|---|---|---|---|---|---|
| Agriculture | 24 | 9 | 2 | 6 | 3 | 44 |
| Manufacturing | 30 | 61 | 60 | 78 | 45 | 274 |
| Services | 391 | 498 | 509 | 569 | 600 | 2,567 |
| Tourism | 80 | 40 | 27 | 11 | 8 | 166 |
| Trading | 514 | 524 | 528 | 577 | 598 | 2,741 |
| Others | - | 2 | 7 | - | 1 | 10 |
| **Total** | **1,039** | **1,134** | **1,133** | **1,241** | **1,255** | **5,802** |

*Source: DTI*

With regard to business distribution by municipality, Calapan City appears to be the most preferred location for new investments followed by Puerto Galera, Pinamalayan and Roxas. New investments were practically attracted to these areas because of dynamic economic interchange, external accessibility-especially Roxas, and higher urbanity level.

**Table 50.** Number of new business names registered with DTI and employment by municipality, 2006-2010

| CITY/ MUNICIPALITY | NUMBER OF NEW BUSINESS NAME | | | | | EMPLOYMENT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2010 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Baco | 27 | 17 | 21 | 18 | 24 | 82 | 92 | 46 | 34 | 50 |
| Bansud | 17 | 38 | 48 | 38 | 54 | 36 | 67 | 110 | 90 | 122 |
| Bongabong | 65 | 51 | 64 | 53 | 57 | 98 | 108 | 162 | 78 | 103 |
| Bulalacao | 4 | 6 | 14 | 14 | 14 | 25 | 11 | 32 | 41 | 44 |
| Calapan City | 329 | 354 | 335 | 443 | 446 | 863 | 806 | 761 | 1074 | 953 |
| Gloria | 15 | 27 | 37 | 52 | 62 | 53 | 60 | 108 | 107 | 116 |
| Mansalay | 16 | 20 | 13 | 19 | 13 | 36 | 38 | 36 | 49 | 30 |
| Naujan | 49 | 77 | 56 | 69 | 71 | 93 | 114 | 103 | 120 | 160 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Pinamalayan | 116 | 154 | 168 | 182 | 172 | 248 | 309 | 339 | 337 | 359 |
| Pola | 9 | 12 | 12 | 4 | 14 | 12 | 30 | 35 | 5 | 30 |
| Puerto Galera | 206 | 152 | 145 | 109 | 120 | 513 | 437 | 611 | 284 | 337 |
| Roxas | 70 | 78 | 115 | 124 | 88 | 160 | 185 | 259 | 236 | 188 |
| San Teodoro | 8 | 10 | 11 | 6 | 7 | 23 | 15 | 19 | 9 | 12 |
| Socorro | 45 | 34 | 38 | 45 | 47 | 94 | 62 | 78 | 69 | 84 |
| Victoria | 50 | 87 | 60 | 65 | 66 | 88 | 144 | 110 | 138 | 102 |
| **TOTAL** | **1,026** | **1,117** | **1,137** | **1,241** | **1,255** | **2,424** | **2,478** | **2,809** | **2,671** | **2,690** |

*Source: DTI*

**Flooding**

As the main economic activity in the province, agriculture data were used in computing for the exposure percentage of municipalities to different hazards.

Based on the 2010 data from PAgO and PCA, rice, coconut, banana and citrus constitute the agricultural products of Roxas. Since seventy two percent of Roxas' agricultural area falls within HSA, the area and production of these crops would likely be affected in case flooding occurs. This scenario, together with the high magnitude and proportion of households with income below poverty and food threshold should be considered by the local government in the planning and implementation of development projects.

The other municipalities wherein agriculture area falls within HSA are Baco with 48 percent, Bongabong with 44 percent, Calapan City with 31 percent and Naujan with 23 percent (Annex 27).

**Table 51.** Agriculture exposure to flood

| CITY/ MUNICIPALITY | AGRICULTURAL AREA | EXPOSED AGRICULTURAL AREA | | | EXPOSURE PERCENTAGE | | |
|---|---|---|---|---|---|---|---|
| | | HSA | MSA | LSA | HSA | MSA | LSA |
| Baco | 9,498.94 | 4,598 | 1,756 | 1,548 | 48% | 18% | 16% |
| Bansud | 2,280.49 | 456 | 1,464 | 329 | 20% | 64% | 14% |
| Bongabong | 15,350.18 | 6,728 | 4,005 | 1,619 | 44% | 26% | 11% |
| Bulalacao | 11,682.13 | 902 | 1,203 | 760 | 8% | 10% | 7% |
| Calapan City | 16,913.20 | 5,325 | 9,583 | 1,197 | 31% | 57% | 7% |
| Gloria | 3,501.88 | 363 | 1,822 | 632 | 10% | 52% | 18% |
| Mansalay | 5,052.00 | 708 | 2,007 | 1,442 | 14% | 40% | 29% |
| Naujan | 28,890.24 | 6,733 | 15,465 | 5,278 | 23% | 54% | 18% |
| Pinamalayan | 12,136.01 | 1,264 | 3,290 | 2,558 | 10% | 27% | 21% |
| Pola | 9,735.98 | 856 | 751 | 456 | 9% | 8% | 5% |
| Puerto Galera | 2,399.21 | 206 | 214 | 88 | 9% | 9% | 4% |
| Roxas | 4,954.48 | 3,543 | 661 | 743 | 72% | 13% | 15% |
| San Teodoro | 4,459.51 | 473 | 853 | 317 | 11% | 19% | 7% |
| Socorro | 10,675.88 | 854 | 3,495 | 2,187 | 8% | 33% | 20% |
| Victoria | 11,543.20 | 1,644 | 4,508 | 2,938 | 14% | 39% | 25% |

**Liquefaction**

Naujan has the largest agricultural area exposed to liquefaction with 25,943.73 hectares (Annex 28). However, in terms of exposure percentage, Gloria is the most exposed with 98 percent followed by Calapan City with 97 percent. These figures indicate that almost all the agricultural areas in said municipalities are most likely to be affected by liquefaction.

With regard to rice, Naujan has the largest area harvested as of 2010 with 27,431 hectares and 99,757.14 metric tons of rice produced. Calapan City is next with 15,473 hectares harvested with 55,638.98 metric tons.

The other crops that will be affected are coconut and fruit crops like rambutan, banana, mango, citrus and lanzones.

**Table 52.** Agriculture assets exposed to liquefaction

| CITY/ MUNICIPALITY | MUNICIPAL AGRICULTURAL AREA | EXPOSED AGRICULTURAL AREA WITHIN PRONE AREAS | EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Gloria | 3,501.88 | 3,440.81 | 98 |
| Calapan City | 16,913.20 | 16,366.87 | 97 |
| Socorro | 10,675.88 | 10,094.91 | 95 |
| Bansud | 2,280.49 | 2,108.37 | 92 |
| Roxas | 4,954.48 | 4,567.15 | 92 |
| Naujan | 28,890.24 | 25,943.73 | 90 |
| Bongabong | 15,350.18 | 12,908.84 | 84 |
| Baco | 9,498.94 | 7,787.12 | 82 |
| Mansalay | 5,052.00 | 4,121.12 | 82 |
| Pinamalayan | 12,136.01 | 8,423.16 | 69 |
| Victoria | 11,543.20 | 7,719.58 | 67 |
| San Teodoro | 4,459.51 | 2,538.49 | 57 |
| Pola | 9,735.98 | 3,222.64 | 33 |
| Bulalacao | 11,682.13 | 2,556.85 | 22 |
| Puerto Galera | 2,399.21 | 37.88 | 2 |

**Tsunami**

Agricultural areas in Puerto Galera are more exposed to tsunami than the other coastal municipalities such as Roxas, Mansalay, San Teodoro, Calapan City, Baco and Bongabong. The exposure percentages of agriculture to tsunami are presented in Table 53.

**Table 53.** Agriculture assets exposure to tsunami

| CITY/MUNICIPALITY | MUNICIPAL AGRICULTURAL AREA | EXPOSED AGRICULTURAL AREA WITHIN PRONEAREAS | EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Puerto Galera | 2,399.21 | 1,187.43 | 49 |
| Roxas | 4,954.48 | 1,236.79 | 25 |
| Mansalay | 5,052.00 | 792.21 | 16 |
| San Teodoro | 4,459.51 | 296.66 | 7 |
| Calapan city | 16,913.20 | 870.76 | 5 |
| Baco | 9,498.94 | 432.49 | 5 |
| Bongabong | 15,350.18 | 469.14 | 3 |

Calapan City and Baco, which were heavily affected by the tsunami that occurred in 1994 both have an exposure percentage of only 5 percent of the total city/municipal agricultural area (Annex 29).

**Ground shaking**

The presence of active faults of Aglubang River and Central Mindoro and the earthquake generators near the province such as Lubang Fault, East Mindoro Trench and Manila Trench, contribute to the province's high exposure to ground shaking.

**Table 54.** Agriculture assets exposure to ground shaking

| CITY/MUNICIPALITY | MUNICIPAL AGRICULTURAL AREA | EXPOSED AGRICULTURAL AREA WITHIN PRONE AREAS | EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Gloria | 3,501.88 | 3,501.88 | 100 |
| Baco | 9,498.94 | 9,494.39 | 100 |
| Socorro | 10,675.88 | 10,645.05 | 100 |
| Naujan | 28,890.24 | 28,502.55 | 99 |
| Calapan City | 16,913.20 | 16,625.85 | 98 |
| San Teodoro | 4,459.51 | 4,371.12 | 98 |
| Bongabong | 15,350.18 | 14,991.49 | 98 |
| Roxas | 4,954.48 | 4,836.43 | 98 |
| Victoria | 11,543.20 | 11,248.95 | 97 |
| Pinamalayan | 12,136.01 | 11,769.55 | 97 |
| Pola | 9,735.98 | 9,355.97 | 96 |
| Bansud | 2,280.49 | 2,170.77 | 95 |
| Mansalay | 5,052.00 | 4,799.68 | 95 |
| Bulalacao | 11,682.13 | 10,973.28 | 94 |
| Puerto Galera | 2,399.21 | 1,777.37 | 74 |

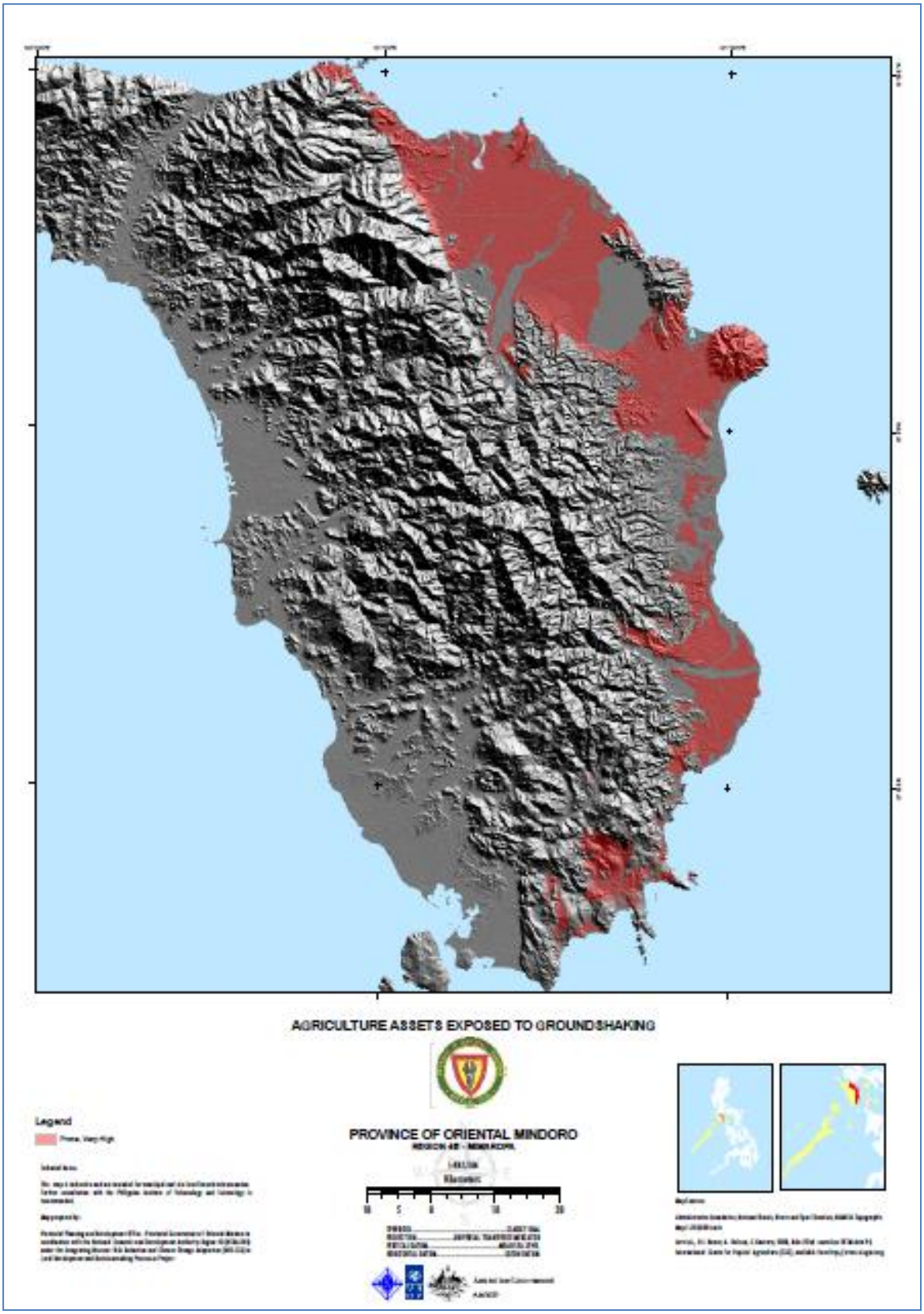



**Figure 43.** Agriculture assets exposed to ground shaking

Agricultural areas in the municipalities of Gloria, Baco, and Socorro have a hundred percent exposure to ground shaking. The exposure of other municipalities range from 94 to 99 percent. Only Puerto Galera has an exposure below 90 percent with 74 percent. These figures indicate a need for alternative sources of income for farmers who will be greatly affected by ground shaking.

**Earthquake Induced Landslide (EIL)**

Agricultural areas in the province has a relatively low exposure to EIL (Annex 30). The highest exposure is only 29 percent for Puerto Galera with its sloping agricultural area.

**Table 55.** Exposure of agriculture assets to earthquake-induced landslide

| CITY/MUNICIPALITY | MUNICIPAL AGRICULTURAL AREA | EXPOSED AGRICULTURAL AREA WITHIN PRONE AREAS | EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| Puerto Galera | 2,399.21 | 700.30 | 29 |
| Pola | 9,735.98 | 2,133.03 | 22 |
| Bulalacao | 11,682.13 | 1,643.62 | 14 |
| Victoria | 11,543.20 | 1,607.39 | 14 |
| San Teodoro | 4,459.51 | 464.30 | 10 |
| Socorro | 10,675.88 | 318.62 | 3 |
| Mansalay | 5,052.00 | 147.28 | 3 |
| Naujan | 28,890.24 | 389.57 | 1 |
| Baco | 9,498.94 | 97.92 | 1 |
| Bongabong | 15,350.18 | 135.62 | 1 |
| Pinamalayan | 12,136.01 | 100.51 | 1 |

A summary of the exposure percentage of agriculture to the different hazards are presented in Table 56.

**Table 56.** Exposure percentage of agriculture to various hazards

| CITY/ MUNICIPALITY | FLOOD | | | LIQUEFACTION | TSUNAMI | GROUND SHAKING | EIL |
|---|---|---|---|---|---|---|---|
| | HSA | MSA | LSA | | | | |
| Baco | 48 | 18 | 16 | 82 | 5 | 100 | 1 |
| Bansud | 20 | 64 | 14 | 92 | | 95 | |
| Bongabong | 44 | 26 | 11 | 84 | 3 | 98 | 1 |
| Bulalacao | 8 | 10 | 7 | 22 | | 94 | 14 |
| Calapan City | 31 | 57 | 7 | 97 | 5 | 98 | |
| Gloria | 10 | 52 | 18 | 98 | | 100 | |
| Mansalay | 14 | 40 | 29 | 82 | 16 | 95 | 3 |
| Naujan | 23 | 54 | 18 | 90 | | 99 | 1 |
| Pinamalayan | 10 | 27 | 21 | 69 | | 97 | 1 |
| Pola | 9 | 8 | 5 | 33 | | 96 | 22 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Puerto Galera | 9 | 9 | 4 | 2 | 49 | 74 | 29 |
| Roxas | 72 | 13 | 15 | 92 | 25 | 98 | |
| San Teodoro | 11 | 19 | 7 | 57 | 7 | 98 | 10 |
| Socorro | 8 | 33 | 20 | 95 | | 100 | 3 |
| Victoria | 14 | 39 | 25 | 67 | | 97 | 14 |

It can be noted that the agriculture areas in the municipality of Roxas have the most exposure to hazards particularly flood, liquefaction and ground shaking. This should be an important consideration in the local government's planning and implementation of development projects considering its role as one of the major growth centers in the province.

**c. Roads and critical point facilities**

Total road network in the province as of 2011 is composed of 313.499 kilometers provincial road and 897.285 kilometers national road. Forty-nine percent of these are concrete roads (594.0035 kms) while 44 percent are gravel (530.4662 kms). Asphalt and earth road surfaces constitute only six and one percent, respectively.

There are three airports in the province classified by Civil Aviation Authority of the Philippines (CAAP) – Calapan, Pinamalayan and Wasig Airports. However, all of these do not have any record of aviation/air transport related statistics.

The two major seaports in the province are located in Calapan City and Roxas. Other seaports are located in Pola, Bulalacao, Mansalay, Puerto Galera, Pinamalayan, Bansud and Bongabong.

A number of schools provide education to the school going population of Oriental Mindoro. During school year 2010-2011, there are a total of 1,013 registered government and private schools for all levels of education. Of the total, 351 are pre-schools, 521 were elementary schools; 118 secondary schools; and 28 are tertiary.

In terms of health services, there are nine government and fifteen private hospitals in the province as of 2010. Existing hospitals are Levels I, II and III only. It is noted that Level II and III hospital services are only available in Calapan City with a ratio of 1 bed for every 490 population. The total bed capacity is 462 of which, 277 are private and 185 are government. Using the standard ratio of 1:1,000 populations and the 2010 population of 882,602, these hospitals are still short of the present required number of hospital bed.

**Flooding**

Based on estimates, the province has approximately 1,093 critical point facilities consisting of barangay health stations, rural health units, schools, sea ports, airports and government facilities. Three hundred fifty four or 32% of these are located in areas with high susceptibility to flooding. The exposure table of critical facilities to flooding by municipality is presented in Annexes 31 to 34.

**Table 57.** Exposure table of critical facilities to flooding

| TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES SUSCEPTIBLE AREAS | | | EXPOSURE PERCENTAGE OF POINT FACILITIES (%) | | |
|---|---|---|---|---|---|---|---|
| | | HSA | MSA | LSA | HSA | MSA | LSA |
| Airport | 3 | 0 | 1 | 2 | 0 | 33 | 67 |
| BHS | 170 | 58 | 58 | 18 | 34 | 34 | 11 |
| RHU | 14 | 5 | 7 | 2 | 36 | 50 | 14 |
| School | 534 | 186 | 159 | 75 | 35 | 30 | 14 |
| Seaport | 5 | 3 | 2 | 0 | 60 | 40 | 0 |
| Government | 367 | 102 | 121 | 35 | 28 | 33 | 10 |
| **TOTAL** | **1093** | **354** | **348** | **132** | **32** | **32** | **12** |

The critical point facilities in the municipality of Roxas are highly exposed to flooding with all of its barangay health stations and rural health units within HSA. It also has the highest exposure percentage of schools and government facilities in HSA with 70 percent and 68 percent, respectively. Its national roads and seaport which connect the province to the Visayas are also within HSA.

**Table 58.** Exposure of national roads to flooding

| CITY/MUNICIPALITY | ROAD LENGTH | EXPOSED ROAD LENGTH | | | EXPOSURE PERCENTAGE (%) | | |
|---|---|---|---|---|---|---|---|
| | | HSA | MSA | LSA | HSA | MSA | LSA |
| Baco | 7.89 | 7.89 | - | - | 100 | 0 | 0 |
| Bansud | 8.52 | 1.52 | 7.00 | - | 18 | 82 | 0 |
| Bongabong | 23.44 | 12.02 | 11.42 | - | 51 | 49 | 0 |
| Bulalacao | 43.03 | 3.83 | 7.82 | 4.20 | 9 | 18 | 10 |
| Calapan City | 23.74 | 13.69 | 9.82 | 0.16 | 58 | 41 | 1 |
| Gloria | 14.74 | 1.81 | 10.91 | 2.01 | 12 | 74 | 14 |
| Mansalay | 16.55 | 3.08 | 8.75 | 1.27 | 19 | 53 | 8 |
| Naujan | 17.53 | 2.47 | 12.14 | 2.93 | 14 | 69 | 17 |
| Pinamalayan | 12.39 | 2.87 | 7.93 | 1.51 | 23 | 64 | 12 |
| Puerto Galera | 13.97 | 1.53 | 1.97 | 1.08 | 11 | 14 | 8 |
| Roxas | 14.86 | 13.05 | 1.81 | - | 88 | 12 | 0 |
| San Teodoro | 21.29 | 0.79 | 4.14 | 0.93 | 4 | 19 | 4 |
| Socorro | 16.77 | 0.29 | 6.79 | 0.31 | 2 | 40 | 2 |
| Victoria | 28.60 | 2.80 | 19.12 | 5.48 | 10 | 67 | 19 |

The national and provincial roads of Calapan City are also in highly susceptible areas with 58 percent and 30 percent exposure, respectively. Such concern needs to be addressed considering the city's primary role is Oriental Mindoro's government administration as the

regional government center and the site of the Provincial Capitol. It is also the primary entry and exit points for commerce and trade. The city also has the most number of higher education institutions, hospitals and commercial establishments. Other significant infrastructures such as port, electric cooperative, and local telephone system are likewise located in Calapan City.

**Liquefaction**

Rural health units (RHUs) are the critical point facilities in the province that have high exposure percentage to liquefaction particularly in the municipalities of Baco, Bongabong, Naujan, Pinamalayan, Pola, Roxas, San Teodoro, Socorro and Victoria. This should be a primary concern for Roxas where all RHUs are highly susceptible to flooding.

Schools and government facilities have relatively lower exposure percentage while Mansalay and Pinamalayan airports both have a hundred percent exposure. A fifty percent exposure was computed for Calapan City port. (Annexes 35- to 36)

**Table 59.** Exposure table of health facilities to liquefaction

| BHS | | | | RHU | | | |
|---|---|---|---|---|---|---|---|
| City/ Municipality | Total count of facilities | Exposed point facilities within prone areas | Exposure percentage of point facilities within prone areas (%) | City/ Municipality | Total count of facilities | Exposed point facilities within prone areas | Exposure percentage of point facilities within prone areas (%) |
| Baco | 7 | 1 | 14 | Baco | 1 | 1 | 100 |
| Bansud | 5 | 2 | 40 | Bongabong | 1 | 1 | 100 |
| Bongabong | 13 | 2 | 15 | Calapan City | 2 | 1 | 50 |
| Bulalacao | 5 | 1 | 20 | Gloria | 2 | 1 | 50 |
| Calapan City | 62 | 2 | 3 | Naujan | 1 | 1 | 100 |
| Gloria | 22 | 2 | 9 | Pinamalayan | 1 | 1 | 100 |
| Mansalay | 3 | 1 | 33 | Pola | 1 | 1 | 100 |
| Naujan | 11 | 1 | 9 | Roxas | 1 | 1 | 100 |
| Pinamalayan | 12 | 2 | 17 | San Teodoro | 1 | 1 | 100 |
| Pola | 7 | 1 | 14 | Socorro | 1 | 1 | 100 |
| Roxas | 6 | 1 | 17 | Victoria | 1 | 1 | 100 |
| San Teodoro | 6 | 1 | 17 | **Sub Total** | **13** | **11** | **85** |
| Socorro | 7 | 2 | 29 | | | | |
| Victoria | 4 | 2 | 50 | | | | |
| **Sub Total** | **170** | **21** | **12** | **GRAND TOTAL (BHS+RHU)** | **183** | **32** | **17** |

**Ground shaking**

Among the critical point facilities in the province, RHUs have the highest exposure percentage to ground shaking with 87 percent (Annex 37). The location of these facilities in the municipalities of Baco, Bongabong, Bulalacao, Mansalay, Naujan, Pinamalayan, Pola, Roxas, San Teodoro and Victoria should be evaluated considering the important function of these facilities in times of disasters. San Teodoro's schools and government facility are the most exposed with 50 and 100 percent, respectively. (Annex 38)

**Table 60.** Exposure table of schools to ground shaking

| CITY/MUNICIPALITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|
| Baco | 86 | 2 | 2 |
| Bansud | 30 | 2 | 7 |
| Bongabong | 39 | 1 | 3 |
| Bulalacao | 30 | 2 | 7 |
| Calapan City | 71 | 1 | 1 |
| Gloria | 38 | 1 | 3 |
| Mansalay | 30 | 1 | 3 |
| Naujan | 105 | 2 | 2 |
| Pinamalayan | 33 | 2 | 6 |
| Roxas | 24 | 1 | 4 |
| San Teodoro | 2 | 1 | 50 |
| Socorro | 19 | 1 | 5 |
| Victoria | 29 | 1 | 3 |

**Tsunami**

There is a total of nineteen exposed point facilities within areas prone to tsunami. The Calapan City airport which is a few kilometers away from the sea is highly exposed to tsunami. The seaports of Roxas and Mansalay are also located in areas prone to tsunami.

**Table 61.** Exposure table of critical point facilities to tsunami

| CITY/ MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|---|
| Calapan City | Airport | 1 | 1 | 100 |
| Bongabong | BHS | 13 | 1 | 8 |
| Calapan City | BHS | 62 | 1 | 2 |
| Puerto Galera | BHS | 6 | 2 | 33 |
| Roxas | BHS | 6 | 1 | 17 |
| Puerto Galera | RHU | 1 | 1 | 100 |
| Roxas | RHU | 1 | 1 | 100 |
| Baco | School | 86 | 1 | 1 |
| Calapan City | School | 71 | 1 | 1 |
| Mansalay | School | 30 | 1 | 3 |
| Roxas | School | 24 | 2 | 4 |
| Calapan City | Seaport | 2 | 1 | 50 |
| Mansalay | Seaport | 1 | 1 | 100 |
| Roxas | Seaport | 1 | 1 | 100 |
| Baco | Government | 31 | 1 | 3 |
| Mansalay | Government | 28 | 1 | 4 |
| Roxas | Government | 31 | 1 | 3 |

**Earthquake-induced landslide**

All airports and seaports in Oriental Mindoro are exposed to earthquake-induced landslide except for the seaport in Calapan City. As in the other hazards, majority of the rural health units are located in areas prone to EIL (see Annexes 39 to 42).

## 2. Vulnerability Indices (VI)

The determinants of vulnerability used to compute vulnerability indices for the agriculture, forestry, coastal and marine, biodiversity, water supply and health sectors were sensitivity, exposure and adaptive capacity. Sensitivity is a determinant of vulnerability referring to the degree to which a system will respond to a change in climatic conditions. Exposure is the extent of the ecosystem and/or human settlements as well as the types and value of assets that are at risk or most likely to be affected by climate change and its attendant hazards. Adaptive capacity refers to the general ability of institutions, systems and individuals to adjust to potential harms such as climate change.[14]

[14] Adapted from Kovats et al., 2003, as cited in the Philippines SNC project

In the case of Oriental Mindoro, local knowledge was used to determine the vulnerability weights of each determinant for identified climate change (CC) impact indicator.

**Agriculture Sector**

**Crop Production.** In Oriental Mindoro, crop production is most vulnerable to typhoon with 9.74 vulnerability index. Among the municipalities, Mansalay is most vulnerable with 0.83 VI. Mansalay's very high vulnerability to typhoon is due to its location which is along the typhoon path and facing northeast monsoon (*amihan*) and southwest monsoon (*habagat*). On the contrary, Bulalacao, its neighboring municipality, has low vulnerability owing to its proximity to Occidental Mindoro which has Type I climate and not usually affected by typhoons. During Typhoon Yolanda in 2013, Balatasan was the only barangay in Bulalacao that sustained heavy damage.

**Table 62.** Crop production vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Typhoon | | Flooding | | Drought/Heat Stress | | Pests and Diseases | | Erosion | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VI | VC | VI | VC | VI | VC | VI | VC | VI | VC |
| Calapan City | 0.67 | High | 0.83 | Very High | 0.52 | Moderate | 0.54 | Moderate | 0.41 | Moderate |
| Baco | 0.72 | High | 0.70 | High | 0.46 | Moderate | 0.52 | Moderate | 0.42 | Moderate |
| Bansud | 0.69 | High | 0.65 | High | 0.60 | Moderate | 0.54 | Moderate | 0.54 | Moderate |
| Bongabong | 0.69 | HIgh | 0.65 | High | 0.59 | Moderate | 0.62 | High | 0.49 | Moderate |
| Bulalacao | 0.36 | Low | 0.43 | Moderate | 0.62 | High | 0.49 | Moderate | 0.46 | Moderate |
| Gloria | 0.67 | High | 0.44 | Moderate | 0.58 | Moderate | 0.58 | Moderate | 0.60 | High |
| Mansalay | 0.83 | Very High | 0.71 | High | 0.77 | High | 0.51 | Moderate | 0.45 | Moderate |
| Naujan | 0.79 | High | 0.84 | Very High | 0.64 | High | 0.63 | High | 0.73 | High |
| Pinamalayan | 0.71 | High | 0.68 | High | 0.66 | High | 0.65 | High | 0.40 | Moderate |
| Pola | 0.57 | Moderate | 0.54 | Moderate | 0.67 | High | 0.53 | Moderate | 0.49 | Moderate |
| Puerto Galera | 0.45 | Moderate | 0.42 | Moderate | 0.38 | Low | 0.37 | Low | 0.40 | Moderate |
| Roxas | 0.60 | Moderate | 0.64 | High | 0.46 | Moderate | 0.62 | High | 0.52 | Moderate |
| San Teodoro | 0.63 | High | 0.53 | Moderate | 0.60 | Moderate | 0.61 | High | 0.51 | Moderate |
| Socorro | 0.64 | High | 0.58 | Moderate | 0.53 | Moderate | 0.43 | Moderate | 0.54 | Moderate |
| Victoria | 0.72 | High | 0.64 | High | 0.53 | Moderate | 0.43 | Moderate | 0.53 | Moderate |
| TOTAL | **9.74** | | **9.29** | | **8.59** | | **8.08** | | **7.48** | |

*Note: VI – Vulnerability Index; VC – Vulnerability Category*

Next to typhoon is flooding which has 9.29 VI wherein Calapan City and Naujan fall under the very high category. Other climate change impact indicators that affect crop production are drought/heat stress, pests and diseases and erosion.

Eighty seven percent of the municipalities are only moderately vulnerable to erosion since the province lies within the ecozone. On the other hand, Puerto Galera has low vulnerability to drought as well as pests and diseases since it has very small agricultural area compared with other municipalities. Puerto Galera is more focused on tourism-related projects and activities.

Among the province's adaptive capacity or the general ability to adjust to potential harms brought about by typhoon are access to typhoon forecasting information and early warning system and evacuation shelters for farm-based families. The other means of adaptation given bigger weights are flood control and drainage facilities for flooding and average expenditure for agricultural programs for erosion-affected areas. Annexes 43 to 47 show the vulnerability maps for each climate change impact.

**Fisheries.** Marine fisheries/mariculture is affected by sea level rise, tropical cyclones and storm surge, and sea surface temperature increase. Bongabong, Naujan and Pola have high vulnerability to sea level rise. The vulnerability maps for the fisheries sector are presented in Annexes 48 to 50.

**Table 63.** Fisheries vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Sea Level Rise | | Tropical Cyclones & Storm Surge | | Sea Surface Temperature Increase | |
|---|---|---|---|---|---|---|
| | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category |
| Calapan City | 0.54 | Moderate | 0.53 | Moderate | 0.54 | Moderate |
| Baco | 0.49 | Moderate | 0.61 | High | 0.45 | Moderate |
| Bansud | 0.51 | Moderate | 0.42 | Moderate | 0.40 | Low |
| Bongabong | 0.67 | High | 0.56 | Moderate | 0.50 | Moderate |
| Bulalacao | 0.53 | Moderate | 0.33 | Low | 0.46 | Moderate |
| Gloria | 0.37 | Low | 0.51 | Moderate | 0.26 | Low |
| Mansalay | 0.54 | Moderate | 0.58 | Moderate | 0.55 | Moderate |
| Naujan | 0.62 | High | 0.61 | High | 0.56 | Moderate |
| Pinamalayan | 0.53 | Moderate | 0.51 | Moderate | 0.42 | Moderate |
| Pola | 0.62 | High | 0.47 | Moderate | 0.48 | Moderate |
| Puerto Galera | 0.40 | Low | 0.44 | Moderate | 0.40 | Low |
| Roxas | 0.46 | Moderate | 0.52 | Moderate | 0.33 | Low |
| San Teodoro | 0.60 | Moderate | 0.50 | Moderate | 0.61 | High |
| Socorro | 0.36 | Low | 0.31 | Low | 0.26 | Low |
| Victoria | 0.40 | Low | 0.37 | Low | 0.26 | Low |
| **TOTAL** | **7.61** | | **7.27** | | **6.46** | |

**Coastal and Marine Sector**

The coastal and marine sector is most vulnerable to storm surge which is described as a rise above the usual water level along the shore that is the result of strong onshore winds and/or reduced atmospheric pressure. The actual surge height is the difference of the observed water level minus the predicted tide. It is followed by sea level rise then by sea surface temperature increases and by watershed runoff. (Annexes 51 to 54)

The municipality of Naujan has very high vulnerability to storm surge since it has eroded coastal areas in three barangays due to absence of mangrove/beach forest. Bansud is the only municipality with high vulnerability to sea level rise. Calapan City and the rest of the municipalities are moderately vulnerable.

**Table 64.** Coastal and marine sector vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Storm Surge | | Sea Level Rise | | Sea Surface Temperature | | Watershed Runoff | |
|---|---|---|---|---|---|---|---|---|
| | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category |
| Calapan City | 0.54 | Moderate | 0.58 | Moderate | 0.56 | Moderate | 0.53 | Moderate |
| Baco | 0.33 | Low | 0.56 | Moderate | 0.65 | High | 0.49 | Moderate |
| Bansud | 0.53 | Moderate | 0.66 | High | 0.60 | Moderate | 0.68 | High |
| Bongabong | 0.50 | Moderate | 0.60 | Moderate | 0.54 | Moderate | 0.50 | Moderate |
| Bulalacao | 0.39 | Low | 0.57 | Moderate | 0.38 | Low | 0.46 | Moderate |
| Gloria | 0.61 | High | 0.56 | Moderate | 0.51 | Moderate | 0.44 | Moderate |
| Mansalay | 0.63 | High | 0.60 | Moderate | 0.55 | Moderate | 0.53 | Moderate |
| Naujan | 0.87 | Very High | 0.51 | Moderate | 0.46 | Moderate | 0.41 | Moderate |
| Pinamalayan | 0.57 | Moderate | 0.55 | Moderate | 0.58 | Moderate | 0.47 | Moderate |
| Pola | 0.66 | High | 0.55 | Moderate | 0.49 | Moderate | 0.43 | Moderate |
| Puerto Galera | 0.41 | Moderate | 0.43 | Moderate | 0.46 | Moderate | 0.44 | Moderate |
| Roxas | 0.67 | High | 0.54 | Moderate | 0.40 | Low | 0.60 | High |
| San Teodoro | 0.55 | Moderate | 0.56 | Moderate | 0.59 | Moderate | 0.42 | Moderate |
| Socorro | 0.51 | Moderate | 0.31 | Low | 0.44 | Moderate | 0.46 | Moderate |
| Victoria | 0.38 | Low | 0.48 | Moderate | 0.31 | Low | 0.48 | Moderate |
| **TOTAL** | **8.15** | | **8.05** | | **7.52** | | **7.34** | |

Increases in sea surface temperature affect coral reef and seagrass which are the habitats of pelagic and demersal fishes, respectively. The establishment of more sanctuaries and marine protected areas (MPAs), together with fishery stock assessment in fishing grounds

and MPAs are important means of adapting to this climate change impact. Table 65 shows the established Marine Protected Areas (MPAs) in the province as of 2012.

**Table 65.** Established Marine Protected Areas by location, Oriental Mindoro, 2012

| Location/ Municipality | Barangay | Name of MPA | Area (has.) | Year Established |
|---|---|---|---|---|
| Calapan City | Lazareto | Harka Piloto Fish Sanctuary | 37.44 | 2003 |
| | Silonay | Silonay Mangrove Conservation Area | 41.00 | 2010 |
| San Teodoro | Ilag | Punta Ilag Fish Sanctuary | 23.10 | 2006 |
| | Tacligan | Tamauyan Reef Fish Sanctuary | 89.37 | 2006 |
| Puerto Galera | San Antonio | Pto. Galera Fish Sanctuary | 4,484.00 | 2006 |
| Naujan | Sitio Tujod, Herrera | Tujod Fish Sanctuary | 30.00 | 2006 |
| | Masaguing | Masaguing Fish Sanctuary | 16.39 | 2010 |
| Pola | Bacawan | Bacawan Fish Sanctuary | 23.44 | 2006 |
| | Puting Cacao | St. John the Baptist Fish Sanctuary | 49.38 | 2010 |
| | Tagumpay | St. Peter the Rock MPA | 25.11 | 2010 |
| Pinamalayan | Ranzo | Ranzo Fish Sanctuary | 16.39 | 2006 |
| | Sitio Simboryo, Banilad | Banilad-Simboryo MPA | 10.41 | 2010 |
| | Sitio Ginapangan, Banilad | Banilad-Ginapangan MPA | 10.28 | 2010 |
| | Sitio Bulaklak, Pili | Pili Marine Protected Area | 24.00 | 2010 |
| Gloria | Agsalin | Agsalin Fish Sanctuary | 80.13 | 2003 |
| Bansud | Proper Tiguisan | Bansud Fish Sanctuary | 45.07 | 2010 |
| Bongabong | Masaguisi | Masaguisi Fish Sanctuary | 21.68 | 2003 |
| Roxas | Paclasan | Roxas Fish Sanctuary | 29.00 | 2010 |
| Mansalay | Palaypay Cove & Balanga Point, B. Del Mundo | Palaypay Cove Fish Sanctuary | 82.79 | 2006 |
| | Sta. Brigida | Mansalay Marine Turtle Reserve | 934.61* | 2008 |
| Bulalacao | Balatasan | Balatasan Fish Sanctuary | 179.00 | 1993 |
| | Maujao | Maujao Fish Sanctuary | 40.00 | 2009 |

* shoreline, in meters

*Source: Provincial Agriculture Office, 2012*

### Biodiversity Sector

Biodiversity refers to the biological diversity in an environment as indicated by the number of different species of plants and animals. For the province, those municipalities with watershed protected areas are Baco, Bongabong, Bansud, Mansalay, Gloria, Naujan, Victoria, Socorro and Pola while all the 14 municipalities and 1 city have marine protected areas.

The biodiversity sector is vulnerable to forest fires and pests and diseases. (Annexes 55 and 56) The municipalities of Naujan and Victoria have high vulnerability to both hazards while Calapan City is the least vulnerable. While the presence of migratory birds within Naujan Lake area may be an added attraction for the tourism industry, they are also possible carriers of pests and diseases.

The adaptive capacity for forest fires are enforcement of laws within Protected Area (PA) management zones and relocation of informal settlers living inside PA. For pests and diseases, control and removal of alien species; prevention, control eradication of diseases and pests; and research and development of diseases cure and prevention were the identified adaptive measures.

**Table 66.** Biodiversity sector vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Forest Fires | | Diseases and Pests | |
|---|---|---|---|---|
| | Vulnerability Index | Vulnerability Category | Vulnerability Index | Vulnerability Category |
| Calapan City | 0.20 | Very Low | 0.22 | Very Low |
| Baco | 0.51 | Moderate | 0.36 | Low |
| Bansud | 0.66 | High | 0.46 | Moderate |
| Bongabong | 0.61 | High | 0.58 | Moderate |
| Bulalacao | 0.80 | HIgh | 0.57 | Moderate |
| Gloria | 0.70 | High | 0.36 | Low |
| Mansalay | 0.78 | HIgh | 0.50 | Moderate |
| Naujan | 0.66 | High | 0.64 | High |
| Pinamalayan | 0.44 | Moderate | 0.36 | Low |
| Pola | 0.46 | Moderate | 0.40 | Low |
| Puerto Galera | 0.39 | Low | 0.39 | Low |
| Roxas | 0.44 | Moderate | 0.46 | Moderate |
| San Teodoro | 0.54 | Moderate | 0.57 | Moderate |
| Socorro | 0.43 | Moderate | 0.42 | Moderate |
| Victoria | 0.63 | High | 0.64 | High |
| **TOTAL** | **8.25** | | **6.92** | |

**Forestry Sector**

The province's forestry sector is most vulnerable to landslides with 8.84 VI. Naujan has very high vulnerability with 0.88 VI while Calapan City has very low vulnerability at 0.20 VI considering forest area of only four hectares.

The forestry sector is also vulnerable to flooding (8.18 VI) and erosion (8.10 VI). Highly vulnerable to flooding are the forest areas of Bansud, Mansalay and Naujan. Six municipalities have high vulnerability to erosion – Bansud, Bulalacao, Mansalay, Naujan, Socorro and Victoria. For these two hazards, reforestation was the identified mitigating measure. Annexes 57 to 59 show the vulnerability maps of the forestry sector generated from local knowledge.

**Table 67.** Forestry sector vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Landslides | | Flooding | | Erosion | |
|---|---|---|---|---|---|---|
| | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category |
| Calapan City | 0.20 | Very Low | 0.19 | Very Low | 0.20 | Very Low |
| Baco | 0.38 | Low | 0.52 | Moderate | 0.38 | Low |
| Bansud | 0.63 | High | 0.62 | High | 0.76 | High |
| Bongabong | 0.68 | High | 0.56 | Moderate | 0.60 | Moderate |
| Bulalacao | 0.67 | High | 0.44 | Moderate | 0.67 | High |
| Gloria | 0.71 | High | 0.52 | Moderate | 0.54 | Moderate |
| Mansalay | 0.60 | Moderate | 0.66 | High | 0.70 | High |
| Naujan | 0.88 | Very High | 0.75 | High | 0.66 | High |
| Pinamalayan | 0.56 | Moderate | 0.57 | Moderate | 0.48 | Moderate |
| Pola | 0.62 | High | 0.58 | Moderate | 0.48 | Moderate |
| Puerto Galera | 0.50 | Moderate | 0.42 | Low | 0.34 | Low |
| Roxas | 0.58 | Moderate | 0.68 | Moderate | 0.53 | Moderate |
| San Teodoro | 0.54 | Moderate | 0.55 | Moderate | 0.54 | Moderate |
| Socorro | 0.60 | Moderate | 0.60 | Moderate | 0.61 | High |
| Victoria | 0.70 | High | 0.52 | Moderate | 0.61 | High |
| **TOTAL** | **8.84** | | **8.18** | | **8.10** | |

**Water Supply Sector**

The water supply sector in Oriental Mindoro is vulnerable to drought (8.33 VI), flooding (7.90 VI) and sea level rise (7.40 VI). (Annexes 60 to 62) Calapan City, Bansud, Mansalay, Socorro and Victoria have high vulnerability to drought.

Although the province has not experienced drought, it is important to reforest critical watershed areas to ensure continuous supply of water to the province.

**Table 68.** Water supply sector vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Drought | | Flooding | | Sea Level Rise | |
|---|---|---|---|---|---|---|
| | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category |
| Calapan City | 0.71 | High | 0.74 | High | 0.55 | Moderate |
| Baco | 0.53 | Moderate | 0.38 | Low | 0.36 | Low |
| Bansud | 0.61 | High | 0.50 | Moderate | 0.46 | Moderate |
| Bongabong | 0.46 | Moderate | 0.50 | Moderate | 0.54 | Moderate |
| Bulalacao | 0.54 | Moderate | 0.51 | Moderate | 0.64 | High |
| Gloria | 0.48 | Moderate | 0.62 | High | 0.46 | Moderate |
| Mansalay | 0.62 | High | 0.64 | High | 0.65 | High |
| Naujan | 0.39 | Low | 0.34 | Low | 0.39 | Low |
| Pinamalayan | 0.47 | Moderate | 0.48 | Moderate | 0.61 | High |
| Pola | 0.56 | Moderate | 0.60 | Moderate | 0.66 | High |
| Puerto Galera | 0.53 | Moderate | 0.48 | Moderate | 0.37 | Low |
| Roxas | 0.60 | Moderate | 0.38 | Low | 0.44 | Moderate |
| San Teodoro | 0.51 | Moderate | 0.56 | Moderate | 0.46 | Moderate |
| Socorro | 0.62 | High | 0.58 | Moderate | 0.39 | Low |
| Victoria | 0.68 | High | 0.60 | Moderate | 0.44 | Moderate |
| **TOTAL** | **8.33** | | **7.90** | | **7.40** | |

**Health Sector**

The province's health sector has equal vulnerability index of 7.85 to cholera, dengue and leptospirosis. Cholera is typically transmitted by either contaminated food or water. Bansud, Bongabong, Mansalay and Pinamalayan are highly vulnerable to cholera while Puerto Galera and Roxas are the least vulnerable.

On the other hand, malaria has a vulnerability index of only 5.61. The Provincial Health Office's records show that in 2010, there were 42 cases of malaria or a prevalence rate of 6.59 recorded. In partnership with Pilipinas Shell Foundation, Inc. thru the Global Fund, distribution of treated mosquito nets was undertaken in different municipalities of the province. There were only two cases recorded in 2011 or 0.31 prevalence rate and in the succeeding years, zero prevalence rate. The vulnerability maps for the health sector are shown in Annexes 63 to 66.

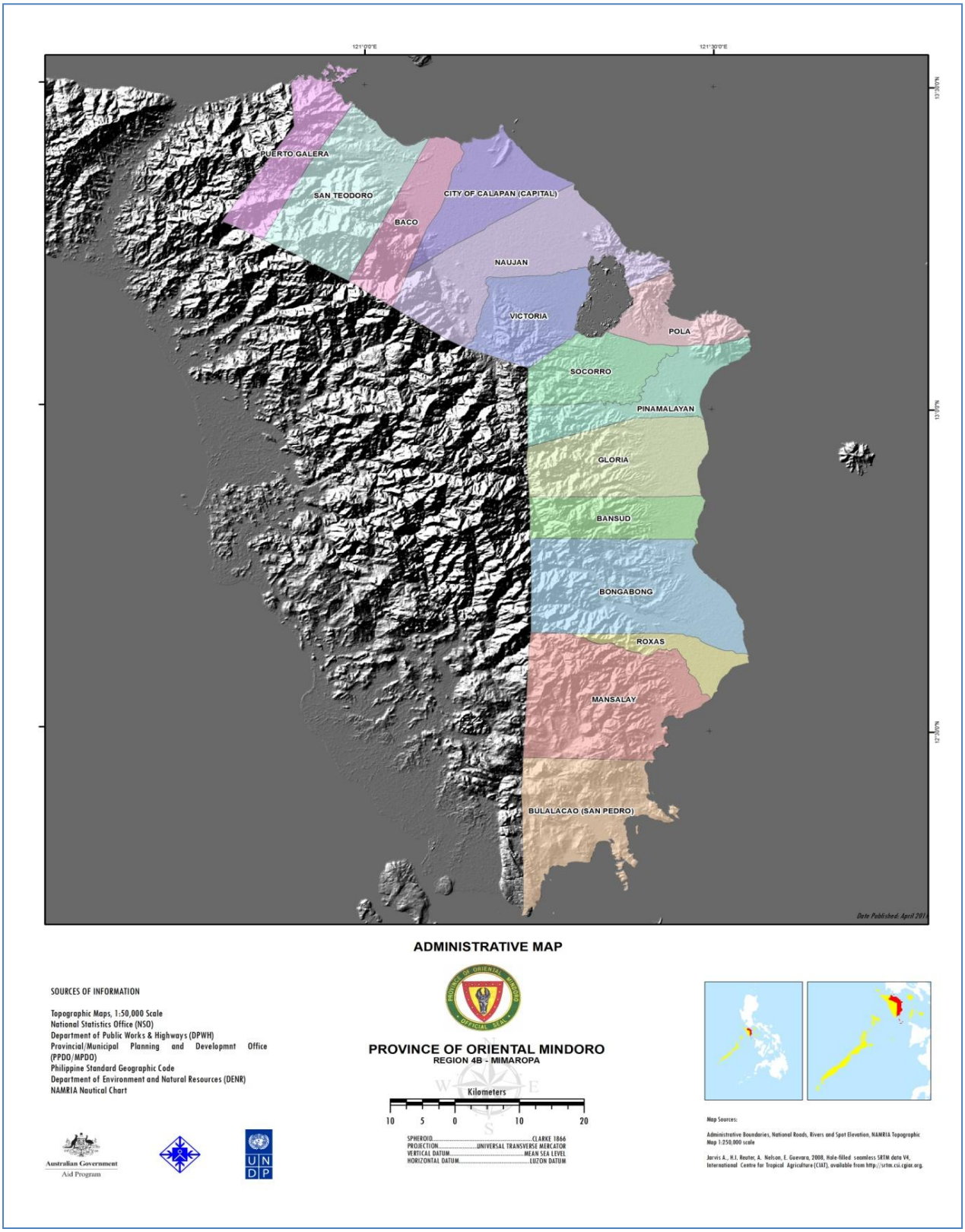
**Table 69.** Health sector vulnerability indices and categories by climate change impact indicator by municipality.

| CITY/ MUNICIPALITY | Cholera | | Dengue | | Leptospirosis | | Malaria | |
|---|---|---|---|---|---|---|---|---|
| | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category | VI | Vulnerability Category |
| Calapan City | 0.45 | Moderate | 0.45 | Low | 0.45 | Low | 0.20 | Very Low |
| Baco | 0.44 | Moderate | 0.44 | Low | 0.44 | Low | 0.30 | Low |
| Bansud | 0.61 | High | 0.61 | Moderate | 0.61 | Low | 0.37 | Low |
| Bongabong | 0.66 | High | 0.66 | Moderate | 0.66 | Low | 0.51 | Moderate |
| Bulalacao | 0.57 | Moderate | 0.57 | Low | 0.57 | Low | 0.44 | Moderate |
| Gloria | 0.45 | Moderate | 0.45 | Low | 0.45 | Moderate | 0.28 | Low |
| Mansalay | 0.68 | High | 0.68 | Moderate | 0.68 | Moderate | 0.37 | Low |
| Naujan | 0.58 | Moderate | 0.58 | High | 0.58 | Moderate | 0.73 | High |
| Pinamalayan | 0.66 | High | 0.66 | Low | 0.66 | Low | 0.33 | Low |
| Pola | 0.51 | Moderate | 0.51 | Moderate | 0.51 | Moderate | 0.52 | Moderate |
| Puerto Galera | 0.29 | Low | 0.29 | Low | 0.29 | Low | 0.20 | Very Low |
| Roxas | 0.39 | Low | 0.39 | Low | 0.39 | Low | 0.28 | Low |
| San Teodoro | 0.50 | Moderate | 0.50 | Moderate | 0.50 | Moderate | 0.52 | Moderate |
| Socorro | 0.51 | Moderate | 0.51 | Moderate | 0.51 | Moderate | 0.32 | Low |
| Victoria | 0.54 | Moderate | 0.54 | Moderate | 0.54 | Moderate | 0.24 | Low |
| **TOTAL** | **7.85** | | **7.85** | | **7.85** | | **5.61** | |

**Provincial Institutional Capacity for DRR/CCA**

The Provincial Government of Oriental Mindoro has been implementing programs, projects and activities in support of the national government's policy towards disaster risk reduction and climate change adaptation. It has taken specific actions to address the parameters enumerated in the Hyogo framework which is the global blueprint for disaster risk reduction efforts during the next decade (Annex 67). PGOM has also met the LGU mandates under RA 9729 or the Climate Change Act (Annex 68) and RA 10121 or the Disaster Risk Reduction and Management Act (Annex 69).

The Provincial Disaster Risk Reduction and Management Office (PDRRMO) was established in 2011 and has since then conducted activities to address DRR/CCA such as trainings, workshops, drills and simulations. The province also has a functional Provincial Disaster Preparedness and Response Team. Among the identified gaps and weaknesses regarding the PGOM's programs, projects and activities on disaster risk reduction and management are presented in Annex 70.



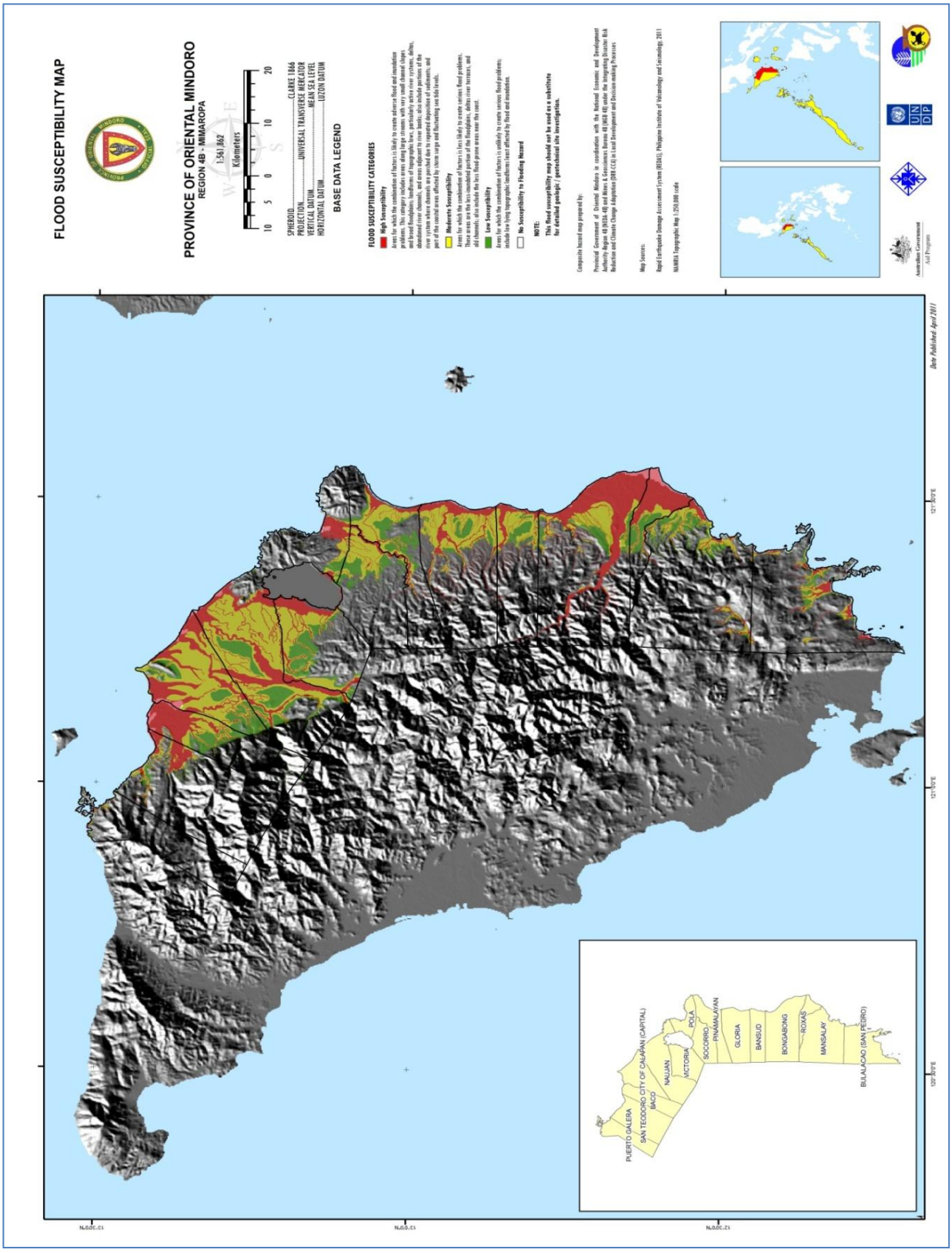

**Annex 1.** Administrative Map of Oriental Mindoro

**Annex 2.** Major disasters that occurred in Oriental Mindoro, 1981-2010.

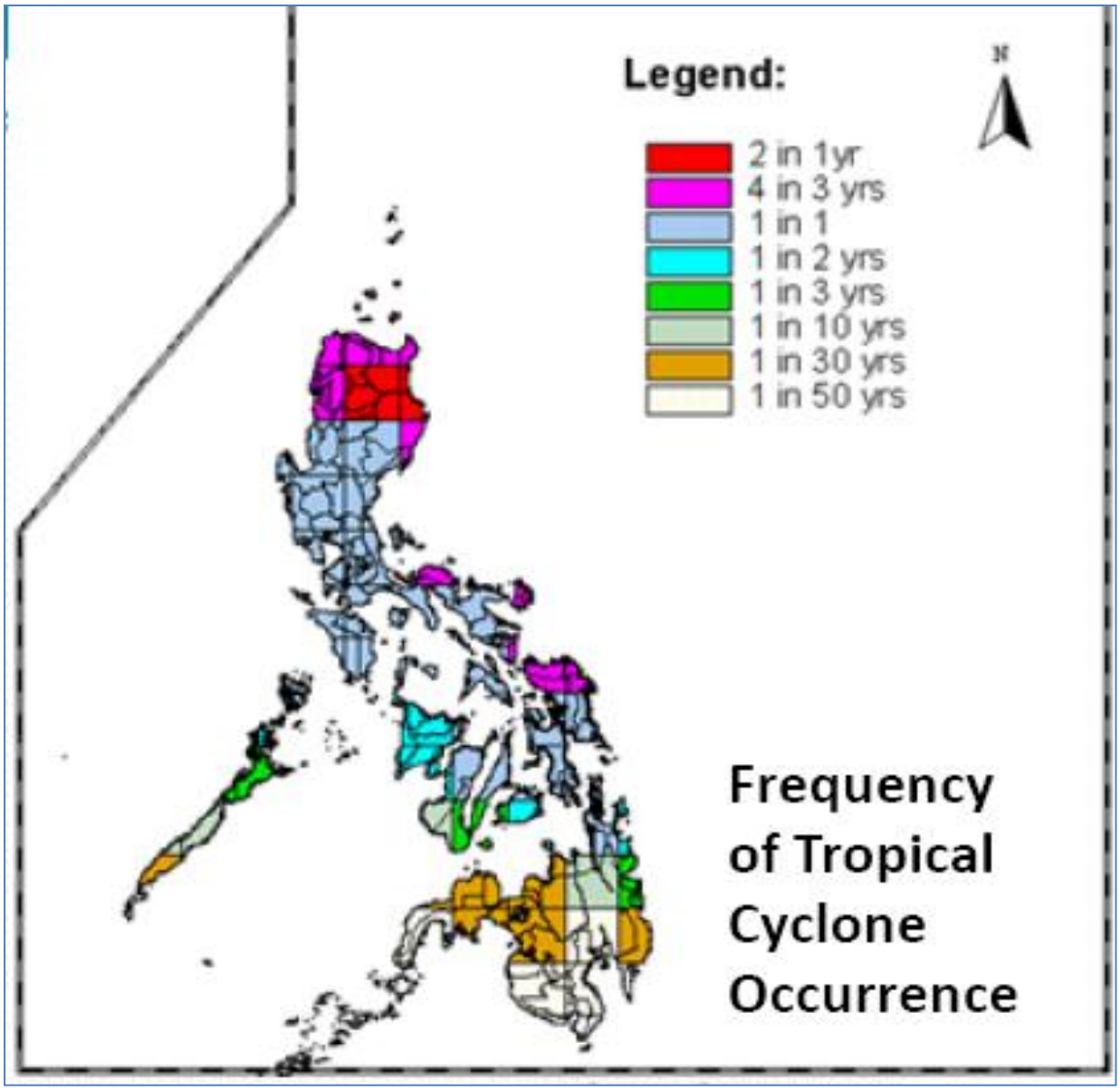
| Type of Disaster | Date Occurred | Location | No. of Dead/ Injured/Affected Persons/Families | Estimated Damages ('000 Pesos) |
|---|---|---|---|---|
| TYPHOONS | | | | |
| Typhoon Dinang | 1981 | | Dead - 250 | 1,040.00 |
| | | | Affected Persons - 180,000 | |
| Typhoons Naning and Puring | 1993 | 7 barangays (Calapan) | Dead - 311 | 1,080.00 |
| | | | Injured - 524 | |
| | | | Affected Persons - 994,478 | |
| Typhoon Goring | 1993 | | Dead - 2 | 17.68 |
| | | | Affected Persons - 29,413 | |
| Typhoon Katring | 1994 | | Dead - 14 | 2,696.00 |
| | | | Injured - 11 | |
| | | | Affected Persons - 90,000 | |
| Typhoon Gening | 1995 | | Dead -6 | |
| | | | Affected Persons - 195,886 | |
| Typhoon Eding | 2000 | | Dead - 55 | 104 |
| | | | Injured - 11 | |
| | | | Affected Persons - 23,375 | |
| Typhoon Utor (Feria) | 2001 | | Dead - 223 | 104 |
| | | | Injured - 180 | |
| | | | Affected Persons - 1,091,943 | |
| Typhoon Seniang | 2006 | | Affected Families - 186,346 | |
| Typhoon Caloy | May 12-13, 2006 | 379 brgys (all municipalities) | Dead -8 | 2,624.81 |
| | | | Injured - 30 | |
| | | | Affected Families - 81,860 | |
| | | | Affected Persons - 407,750 | |
| Typhoon Hagibis | Nov. 19-28, 2007 | 7 Municipalities | | |
| Typhoon Feria | 24-Jun-09 | 76 brgys (Calapan, Pinamalayan, Pola Bansud, Naujan & Socorro) | | 105,483.00 |

| Type of Disaster | Date Occurred | Location | No. of Dead/ Injured/Affected Persons/Families | Estimated Damages ('000 Pesos) |
|---|---|---|---|---|
| FLASHFLOODS | | | | |
| Flashflood | Dec. 6-7, 2005 | 163 brgys. (Calapan, Naujan, Victoria, Socorro, Pola, Pinamalayan & Baco) | Dead - 2 | 325,450.00 |
| | | | Affected Families - 30,420 | |
| | | | Affected Persons -155,274 | |
| Flashflood - Typhoon Quedan and continuous heavy rains | December 17 and 27, 2005 | 141 barangays (Baco, San Teodoro, Puerto Galera, Naujan, Victoria, Calapan City, Pinamalayan, Bansud, Bongabong, Roxas, Mansalay & Bulalacao) | Dead - 1 | |
| | | | Affected Families - 52,414 | |
| | | | Affected Persons - 133,190 | |
| Flashflood | Jan. 17-18, 2010 | 61 brgys. (Baco, Naujan, Calapan & Victoria) | Dead - 2 | 72,140.00 |
| | | | Injured - 346 | |
| | | | Affected Families - 5,876 | |
| Flashflood | Oct. 8, 2010 | 4 barangays in Pinamalayan | Dead - 1 | 6,940.00 |
| | | | Affected Families - 7 | |
| | | | Affected Persons - 35 | |
| EARTHQUAKE | | | | |
| Earthquake | Nov. 15, 1994 | All Municipalities | Dead - 83 | 513,021.00 |
| TSUNAMI | | | | |
| Tsunami Caused by Earthquake | | Coastal brgys. of Baco & Calapan | Injured - 430 | |
| | | | Affected Families - 22,452 | |
| | | | Affected Persons - 132,712 | |

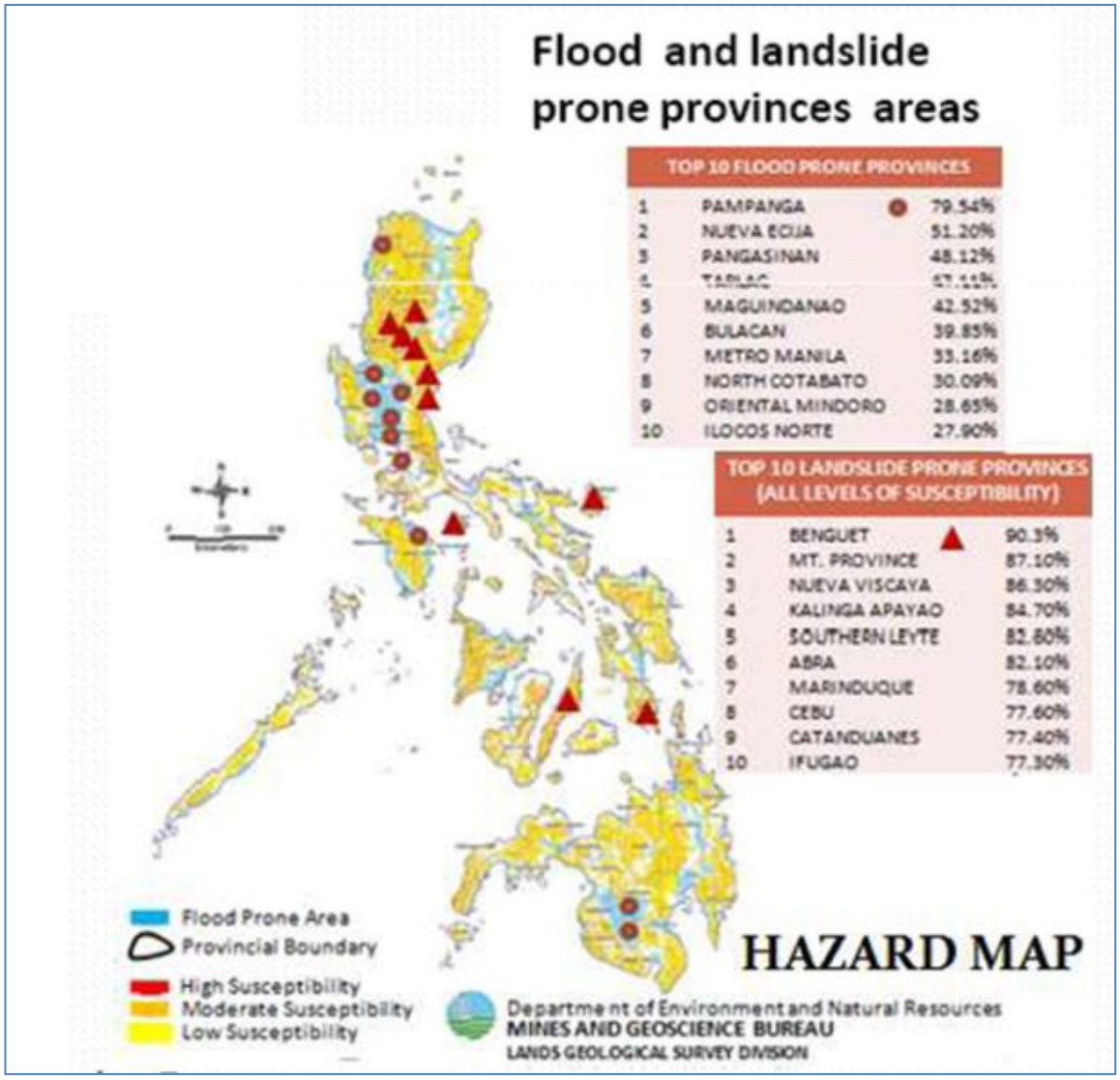
*Source: PPDO, PSWDO, OCD*



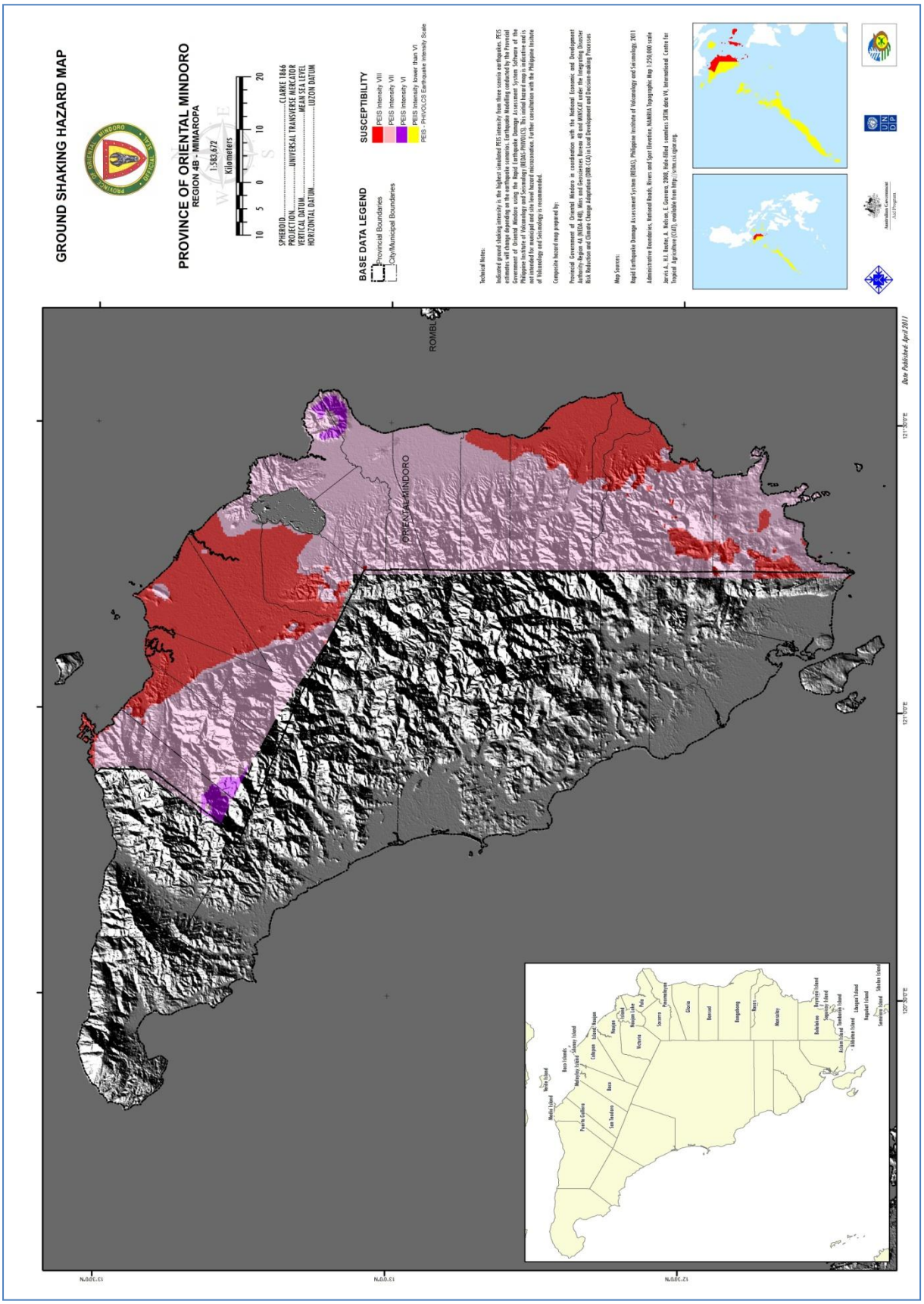

**Annex 3.** Flood Susceptibility Map



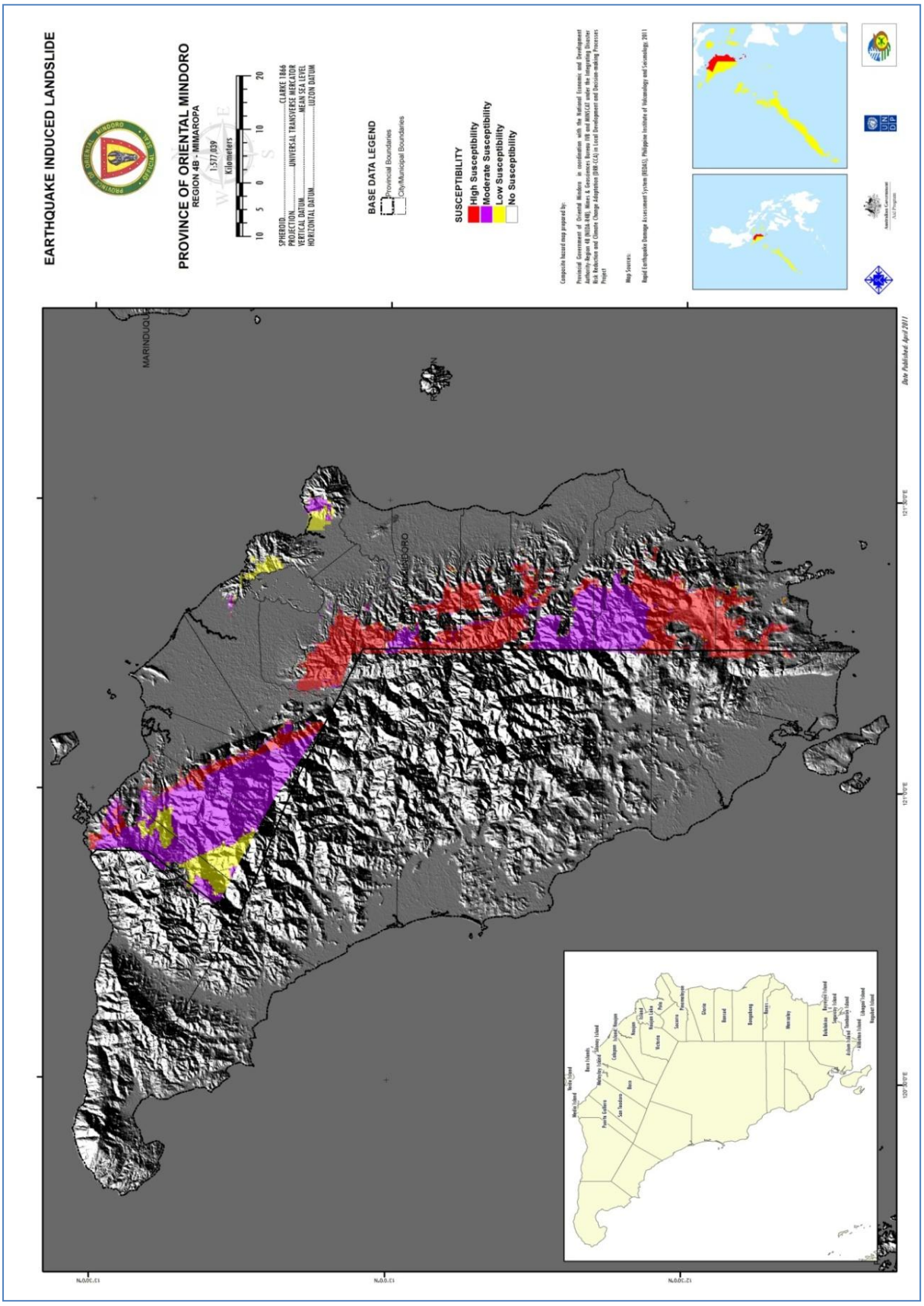

**Annex 4.** Frequency of tropical cyclone occurrence



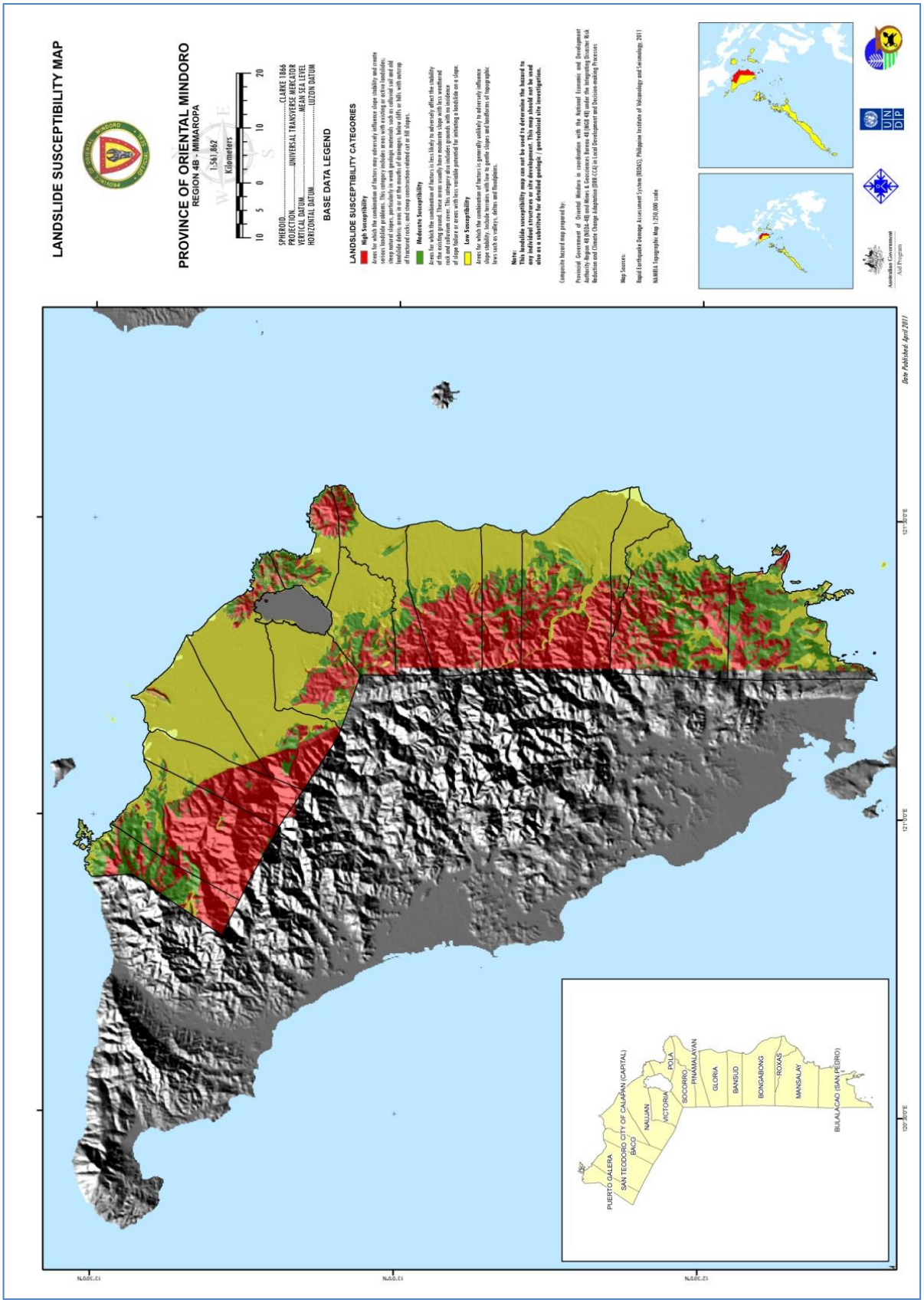

**Annex 5.** Flood and landslide prone provinces




**Annex 6.** Ground shaking hazard map




**Annex 7.** Earthquake-induced landslide hazard map




**Annex 8.** Landslide susceptibility map

**Annex 9.** Estimated fatality from earthquake-induced landslide, scenario 1

| CITY/MUNICIPALITY | ESTIMATED FATALITY | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 130.44 | 3,203.6 | 0.003 | 10 |
| Bansud | 61.51 | 3,299.2 | 0.003 | 10 |
| Bongabong | 150.26 | 6,119.8 | 0.003 | 18 |
| Bulalacao | 89.90 | 2,441.8 | 0.003 | 7 |
| Calapan City | - | - | 0.003 | - |
| Gloria | 67.60 | 1,349.0 | 0.003 | 4 |
| Mansalay | 258.97 | 10,457.0 | 0.003 | 31 |
| Naujan | 68.51 | 3,718.8 | 0.003 | 11 |
| Pinamalayan | 27.05 | 2,097.5 | 0.003 | 6 |
| Pola | 29.53 | 8,809.5 | 0.003 | 26 |
| Puerto Galera | 143.14 | 8,063.2 | 0.003 | 24 |
| Roxas | 5.85 | 894.8 | 0.003 | 3 |
| San Teodoro | 204.10 | 5,517.6 | 0.003 | 17 |
| Socorro | 53.13 | 5,015.9 | 0.003 | 15 |
| Victoria | 79.73 | 5,482.3 | 0.003 | 16 |

**Annex 10.** Estimated fatality from earthquake-induced landslide, scenario 2

| CITY/MUNICIPALITY | ESTIMATED FATALITY | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 130.96 | 3,192 | 0.003 | 10 |
| Bansud | 61.71 | 3,316 | 0.003 | 10 |
| Bongabong | 151.18 | 6,161 | 0.003 | 18 |
| Bulalacao | 90.26 | 2,453 | 0.003 | 7 |
| Calapan City | - | - | 0.003 | - |
| Gloria | 68.16 | 1,364 | 0.003 | 4 |
| Mansalay | 259.35 | 10,447 | 0.003 | 31 |
| Naujan | 73.92 | 5,221 | 0.003 | 16 |
| Pinamalayan | 27.37 | 1,995 | 0.003 | 6 |
| Pola | 28.99 | 8,704 | 0.003 | 26 |
| Puerto Galera | 160.49 | 9,694 | 0.003 | 29 |
| Roxas | 5.72 | 874 | 0.003 | 3 |
| San Teodoro | 229.96 | 6,352 | 0.003 | 19 |
| Socorro | 54.09 | 5,113 | 0.003 | 15 |
| Victoria | 81.35 | 5,724 | 0.003 | 17 |

**Annex 11.** Estimated fatality from earthquake-induced landslide, scenario 3

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM EARTHQUAKE-INDUCED LANDSLIDE SCENARIO 3 | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 96.26 | 2,246 | 0.003 | 7 |
| Bansud | 61.71 | 3,316 | 0.003 | 10 |
| Bongabong | 149.90 | 6,130 | 0.003 | 18 |
| Bulalacao | 90.31 | 2,423 | 0.003 | 7 |
| Calapan City | - | - | 0.003 | - |
| Gloria | 63.78 | 1,273 | 0.003 | 4 |
| Mansalay | 260.60 | 10,480 | 0.003 | 31 |
| Naujan | 52.57 | 2,044 | 0.003 | 6 |
| Pinamalayan | 24.86 | 1,768 | 0.003 | 5 |
| Pola | 26.86 | 8,434 | 0.003 | 25 |
| Puerto Galera | 37.45 | 1,585 | 0.003 | 5 |
| Roxas | 5.72 | 874 | 0.003 | 3 |
| San Teodoro | 67.18 | 1,777 | 0.003 | 5 |
| Socorro | 50.05 | 4,044 | 0.003 | 12 |
| Victoria | 76.05 | 5,309 | 0.003 | 16 |

**Annex 12.** Estimated fatality from liquefaction, scenario 1

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM LIQUEFACTION | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 77.47 | 26,105 | 0.003 | 78 |
| Bansud | 75.26 | 24,347 | 0.003 | 73 |
| Bongabong | 188.79 | 36,440 | 0.003 | 109 |
| Bulalacao | 1.22 | 120 | 0.003 | 0 |
| Calapan City | 165.45 | 84,314 | 0.003 | 253 |
| Gloria | 192.72 | 32,728 | 0.003 | 98 |
| Mansalay | 41.04 | 10,598 | 0.003 | 32 |
| Naujan | 324.72 | 65,595 | 0.003 | 197 |
| Pinamalayan | 101.24 | 32,311 | 0.003 | 97 |
| Pola | 37.71 | 11,959 | 0.003 | 36 |
| Puerto Galera | - | - | - | - |
| Roxas | 57.04 | 27,849 | 0.003 | 84 |
| San Teodoro | 15.54 | 1,637 | 0.003 | 5 |
| Socorro | 126.14 | 29,583 | 0.003 | 89 |
| Victoria | 76.82 | 27,514 | 0.003 | 83 |

**Annex 13.** Estimated fatality from liquefaction, scenario 2

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM LIQUEFACTION SCENARIO 2 | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 10.01 | 2,283 | 0.003 | 7 |
| Bansud | 31.34 | 2,277 | 0.003 | 7 |
| Bongabong | 104.47 | 14,225 | 0.003 | 43 |
| Bulalacao | 2.45 | 284 | 0.003 | 1 |
| Calapan City | 18.52 | 33,651 | 0.003 | 101 |
| Gloria | 73.88 | 8,007 | 0.003 | 24 |
| Mansalay | 54.47 | 13,869 | 0.003 | 42 |
| Naujan | 65.55 | 11,093 | 0.003 | 33 |
| Pinamalayan | 66.73 | 21,029 | 0.003 | 63 |
| Pola | 26.49 | 6,753 | 0.003 | 20 |
| Puerto Galera | 0.39 | 622 | 0.003 | 2 |
| Roxas | 29.00 | 15,254 | 0.003 | 46 |
| San Teodoro | 19.19 | 2,411 | 0.003 | 7 |
| Socorro | 66.25 | 8,975 | 0.003 | 27 |
| Victoria | 49.34 | 12,467 | 0.003 | 37 |

**Annex 14.** Estimated fatality from liquefaction, scenario 3

| CITY/MUNICIPALITY | ESTIMATED FATALITY FROM LIQUEFACTION | | | |
|---|---|---|---|---|
| | AFFECTED AREA | AFFECTED POPULATION | FACTOR OF FATALITY | NUMBER OF FATALITY |
| Baco | 58.07 | 20,919 | 0.003 | 63 |
| Bansud | 64.08 | 23,377 | 0.003 | 70 |
| Bongabong | 161.35 | 28,710 | 0.003 | 86 |
| Bulalacao | 43.81 | 4,870 | 0.003 | 15 |
| Calapan City | 145.64 | 52,354 | 0.003 | 157 |
| Gloria | 138.38 | 29,827 | 0.003 | 89 |
| Mansalay | 97.92 | 18,498 | 0.003 | 55 |
| Naujan | 265.62 | 57,067 | 0.003 | 171 |
| Pinamalayan | 59.42 | 21,149 | 0.003 | 63 |
| Pola | 18.16 | 7,437 | 0.003 | 22 |
| Puerto Galera | - | - | - | - |
| Roxas | 57.14 | 27,547 | 0.003 | 83 |
| San Teodoro | 0.28 | 29 | 0.003 | 0 |
| Socorro | 78.72 | 23,071 | 0.003 | 69 |
| Victoria | 38.08 | 16,447 | 0.003 | 49 |

**Annex 15.** Municipalities with high magnitude and proportion of households and population by CBMS indicator

| Indicator | Households | | Population | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Magnitude | Proportion | Magnitude | | | Proportion | | |
| | | | Total | Male | Female | Total | Male | Female |
| **Malnourished Children aged 0-5 years old** | | | | | | | | |
| **Bulalacao** | 582 | 18.2 | 754 | 391 | 363 | 15.0 | 15.4 | 14.7 |
| **Victoria** | 542 | 12.6 | 731 | 403 | 328 | 11.6 | 12.1 | 11.0 |
| **Baco** | 380 | 11.7 | 504 | 254 | 250 | 10.5 | 10.3 | 10.7 |
| **Children 0-5 years old who died** | | | | | | | | |
| **Bulalacao** | 38 | 1.2 | 40 | 14 | 26 | 0.8 | 0.5 | 1.1 |
| **Gloria** | 40 | 1 | 42 | 29 | 13 | 0.7 | 1.0 | 0.5 |
| **Households without access to safe drinking water** | | | | | | | | |
| **Pinamalayan** | 11026 | 65.7 | 47999 | 24234 | 23765 | 65.7 | 65.3 | 66.0 |
| **San Teodoro** | 1567 | 45.5 | 6704 | 3506 | 3198 | 44.7 | 45.5 | 43.8 |
| **Pola** | 2118 | 30.1 | 9137 | 4771 | 4366 | 30.7 | 31.3 | 30.0 |
| **Households without access to sanitary toilet facilities** | | | | | | | | |
| **Bulalacao** | 3511 | 56.9 | 16386 | 8530 | 7856 | 56.8 | 57.4 | 56.1 |
| **Mansalay** | 3312 | 40.8 | 15249 | 7878 | 7371 | 41.4 | 42.0 | 40.8 |
| **Pola** | 2234 | 31.7 | 9815 | 5083 | 4732 | 33.0 | 33.4 | 32.5 |
| **Households living in makeshift housing** | | | | | | | | |
| **Pinamalayan** | 1686 | 10.1 | 7422 | 3867 | 3555 | 10.2 | 10.4 | 9.9 |
| **Baco** | 532 | 7.7 | 2356 | 1256 | 1100 | 7.6 | 7.9 | 7.3 |
| **San Teodoro** | 161 | 4.7 | 747 | 383 | 364 | 5.0 | 5.0 | 5.0 |
| **Households classified as squatters** | | | | | | | | |
| **Bulalacao** | 374 | 6.1 | 1847 | 958 | 889 | 6.4 | 6.4 | 6.3 |
| **Calapan City** | 1036 | 4.3 | 4545 | 2376 | 2169 | 4.3 | 4.5 | 4.1 |
| **Bansud** | 313 | 4.2 | 1318 | 672 | 646 | 4.0 | 3.9 | 4.0 |
| **Children 6-12 years old not attending elementary** | | | | | | | | |
| **Bulalacao** | 1455 | 44.2 | 1891 | 1000 | 891 | 30.7 | 32.1 | 29.3 |
| **Mansalay** | 1778 | 42.5 | 2324 | 1197 | 1127 | 29.8 | 30.2 | 29.5 |
| **San Teodoro** | 643 | 40.4 | 871 | 485 | 386 | 32.4 | 34.2 | 30.5 |
| **Children 13-16 years old not attending high school** | | | | | | | | |
| **Bulalacao** | 1374 | 60.4 | 1694 | 954 | 740 | 54.1 | 59.3 | 48.6 |
| **San Teodoro** | 600 | 55.5 | 761 | 430 | 331 | 50.4 | 55.4 | 45.0 |
| **Mansalay** | 1473 | 52.8 | 1830 | 1045 | 785 | 47.3 | 52.3 | 41.9 |

| Indicator | Households | | Population | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Magnitude | Proportion | Magnitude | | | Proportion | | |
| | | | Total | Male | Female | Total | Male | Female |
| **Children 6-16 years old not attending school** | | | | | | | | |
| **Bulalacao** | 1360 | 34.7 | 1947 | 1093 | 854 | 21.0 | 23.1 | 18.7 |
| **San Teodoro** | 664 | 34.1 | 1111 | 635 | 476 | 26.5 | 28.9 | 23.8 |
| **Puerto Galera** | 845 | 30.5 | 1189 | 653 | 536 | 20.8 | 21.9 | 19.5 |
| **Victims of Crime** | | | | | | | | |
| **Bulalacao** | 176 | 2.9 | 388 | 251 | 222 | 1.3 | 1.7 | 1.6 |
| **Bansud** | 217 | 2.9 | 532 | 281 | 251 | 1.6 | 1.7 | 1.5 |
| **Roxas** | 239 | 2.5 | 697 | 392 | 305 | 1.6 | 1.8 | 1.4 |
| **Household members in the labor force** | | | | | | | | |
| **Gloria** | 7995 | 91 | 11759 | 8275 | 3484 | 31.1 | 43.0 | 18.7 |
| **Pinamalayan** | 15163 | 90.4 | 23420 | 15634 | 7786 | 32.0 | 42.2 | 21.6 |
| **San Teodoro** | 3021 | 87.6 | 4688 | 3183 | 1505 | 31.3 | 41.3 | 20.6 |
| **Unemployed members of the labor force** | | | | | | | | |
| **Victoria** | 301 | 3.5 | 374 | 229 | 145 | 3.0 | 2.5 | 4.3 |
| **San Teodoro** | 103 | 3.4 | 134 | 72 | 62 | 2.9 | 2.3 | 4.1 |
| **Bongabong** | 322 | 2.8 | 377 | 240 | 137 | 2.3 | 2.1 | 3.1 |
| **Households with income below poverty threshold** | | | | | | | | |
| **Bulalacao** | 5337 | 86.5 | 25828 | 13352 | 12476 | 89.5 | 89.8 | 89.1 |
| **Mansalay** | 6447 | 79.5 | 30938 | 15810 | 15128 | 84.0 | 84.3 | 83.7 |
| **Bongabong** | 9428 | 71.7 | 43960 | 22610 | 21350 | 77.4 | 78.0 | 76.8 |
| **Households with income below food threshold** | | | | | | | | |
| **Bulalacao** | 4865 | 78.9 | 23953 | 12391 | 11562 | 83.0 | 83.4 | 82.6 |
| **Mansalay** | 5589 | 68.9 | 27401 | 14010 | 13391 | 74.4 | 74.7 | 74.1 |
| **Bongabong** | 7642 | 58.1 | 36776 | 18986 | 17790 | 64.8 | 65.5 | 64.0 |
| **Households that experienced food shortage** | | | | | | | | |
| **Bulalacao** | 1261 | 20.4 | 6190 | 3168 | 3022 | 21.4 | 21.3 | 21.6 |
| **Mansalay** | 1559 | 19.2 | 7561 | 3850 | 3711 | 20.5 | 20.5 | 20.5 |
| **Bongabong** | 1943 | 14.8 | 9274 | 4794 | 4480 | 16.3 | 16.5 | 16.1 |

*Source: CBMS, 2008*

**Annex 16.** Population exposed to flooding by municipality

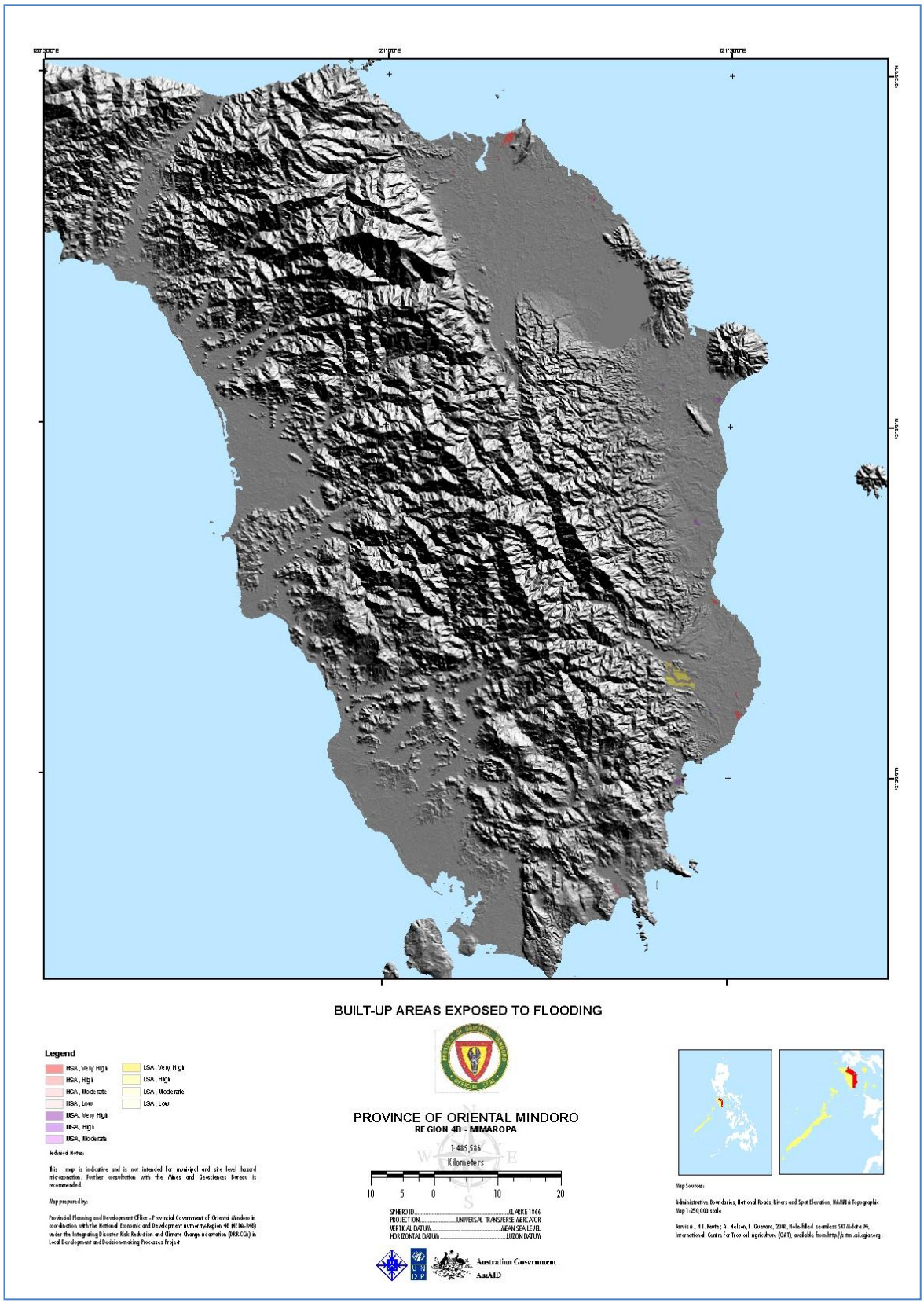
| Municipality | Municipal Area | Municipal Population | Exposed Population | | | Population Exposure Percentage | | |
|---|---|---|---|---|---|---|---|---|
| | | | HSA | MSA | LSA | HSA | MSA | LSA |
| **BACO** | 26,180.443 | 34,127 | 19,801 | 4,950 | 2,993 | 58% | 15% | 9% |
| **BANSUD** | 19,700.5132 | 35,664 | 7,391 | 16,452 | 4,472 | 21% | 46% | 13% |
| **BONGABONG** | 49,373.8764 | 61,127 | 31,307 | 9,576 | 3,406 | 51% | 16% | 6% |
| **BULALACAO** | 36,562.8211 | 30,188 | 2,727 | 2,339 | 1,757 | 9% | 8% | 6% |
| **CALAPAN CITY** | 18,823.0492 | 11,6976 | 59,800 | 43,124 | 7,288 | 51% | 37% | 6% |
| **GLORIA** | 32,727.9619 | 40,561 | 12,140 | 16,553 | 2,991 | 30% | 41% | 7% |
| **MANSALAY** | 47,719.9188 | 43,974 | 4,473 | 9,699 | 8,113 | 10% | 22% | 18% |
| **NAUJAN** | 51,164.7799 | 90,629 | 25,531 | 36,834 | 13,633 | 28% | 41% | 15% |
| **PINAMALAYAN** | 20,686.3462 | 77,119 | 13,176 | 18,699 | 6,462 | 17% | 24% | 8% |
| **POLA** | 12,703.5575 | 32,635 | 5,804 | 3,834 | 1,713 | 18% | 12% | 5% |
| **PUERTO GALERA** | 23,196.6371 | 28,035 | 2,358 | 1,928 | 462 | 8% | 7% | 2% |
| **ROXAS** | 9,014.3702 | 46,711 | 33,788 | 3,789 | 5,352 | 72% | 8% | 11% |
| **SAN TEODORO** | 33,190.613 | 15,039 | 570 | 815 | 157 | 4% | 5% | 1% |
| **SOCORRO** | 20,756.1953 | 38,052 | 2,285 | 12,947 | 6,161 | 6% | 34% | 16% |
| **VICTORIA** | 21,969.6975 | 44,932 | 9,509 | 18,869 | 7,509 | 21% | 42% | 17% |

*Note: uses 2007 CPH*

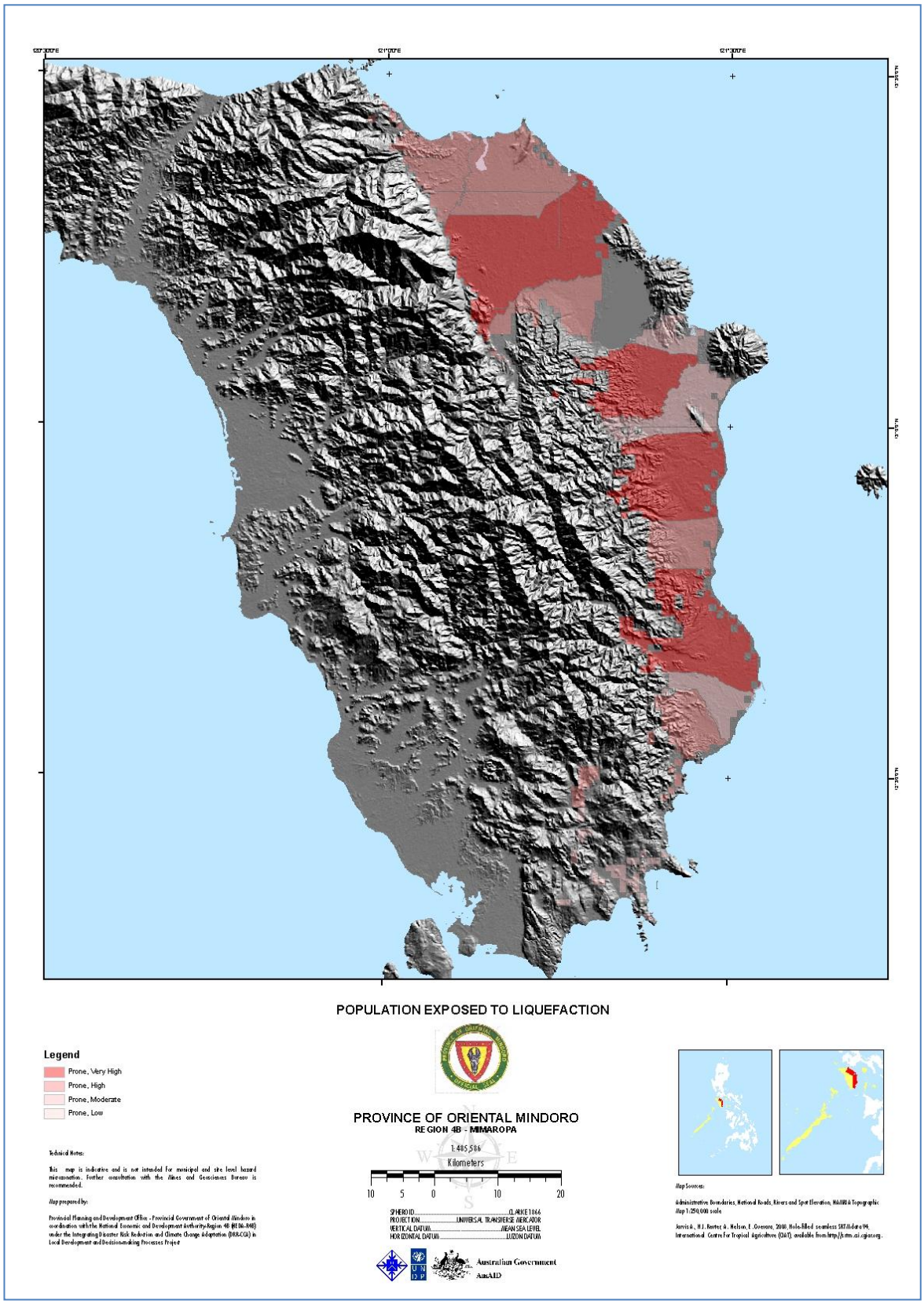
**Annex 17.** Projected population exposure to flooding, 2011-2014

| Province/ Municipality | ACTUAL POPULATION | PROJECTED POPULATION EXPOSURE TO FLOOD | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2011 | | | 2012 | | | 2013 | | | 2014 | | |
| | 2010 | HSA | MSA | LSA | HSA | MSA | LSA | HSA | MSA | LSA | HSA | MSA | LSA |
| BACO | 35,060 | 21,599 | 5,400 | 3,265 | 21,925 | 5,482 | 3,314 | 22,256 | 5,564 | 3,364 | 22,592 | 5,648 | 3,415 |
| BANSUD | 38,341 | 23,066 | 5,767 | 3,486 | 23,276 | 5,819 | 3,518 | 23,488 | 5,872 | 3,550 | 23,702 | 5,926 | 3,583 |
| BONGABONG | 66,569 | 40,399 | 10,100 | 6,106 | 40,856 | 10,214 | 6,175 | 41,317 | 10,330 | 6,245 | 41,784 | 10,447 | 6,316 |
| BULALACAO | 33,754 | 21,199 | 5,300 | 3,204 | 21,623 | 5,406 | 3,268 | 22,055 | 5,514 | 3,334 | 22,496 | 5,624 | 3,400 |
| CALAPAN CITY | 124,173 | 76,768 | 19,193 | 11,604 | 77,997 | 19,500 | 11,789 | 79,245 | 19,812 | 11,978 | 80,513 | 20,129 | 12,169 |
| GLORIA | 42,012 | 25,195 | 6,299 | 3,808 | 25,404 | 6,351 | 3,840 | 25,615 | 6,404 | 3,872 | 25,827 | 6,457 | 3,904 |
| MANSALAY | 51,705 | 33,568 | 8,393 | 5,074 | 34,525 | 8,632 | 5,218 | 35,509 | 8,878 | 5,367 | 36,521 | 9,131 | 5,520 |
| NAUJAN | 94,497 | 57,507 | 14,378 | 8,692 | 58,197 | 14,550 | 8,796 | 58,895 | 14,725 | 8,902 | 59,602 | 14,901 | 9,009 |
| PINAMALAYAN | 81,666 | 49,561 | 12,391 | 7,491 | 50,121 | 12,531 | 7,576 | 50,688 | 12,673 | 7,661 | 51,260 | 12,816 | 7,748 |
| POLA | 32,984 | 19,384 | 4,846 | 2,930 | 19,446 | 4,862 | 2,939 | 19,508 | 4,877 | 2,949 | 19,570 | 4,893 | 2,958 |
| PUERTO GALERA | 32,521 | 22,091 | 5,523 | 3,339 | 22,979 | 5,745 | 3,473 | 23,903 | 5,976 | 3,613 | 24,863 | 6,216 | 3,758 |
| ROXAS | 49,854 | 31,199 | 7,800 | 4,716 | 31,795 | 7,949 | 4,806 | 32,403 | 8,101 | 4,898 | 33,022 | 8,256 | 4,991 |
| SAN TEODORO | 15,810 | 9,682 | 2,421 | 1,463 | 9,814 | 2,454 | 1,483 | 9,947 | 2,487 | 1,504 | 10,083 | 2,521 | 1,524 |
| SOCORRO | 38,348 | 22,527 | 5,632 | 3,405 | 22,597 | 5,649 | 3,415 | 22,667 | 5,667 | 3,426 | 22,737 | 5,685 | 3,437 |
| VICTORIA | 48,308 | 29,398 | 7,350 | 4,444 | 29,751 | 7,438 | 4,497 | 30,108 | 7,527 | 4,551 | 30,469 | 7,618 | 4,605 |

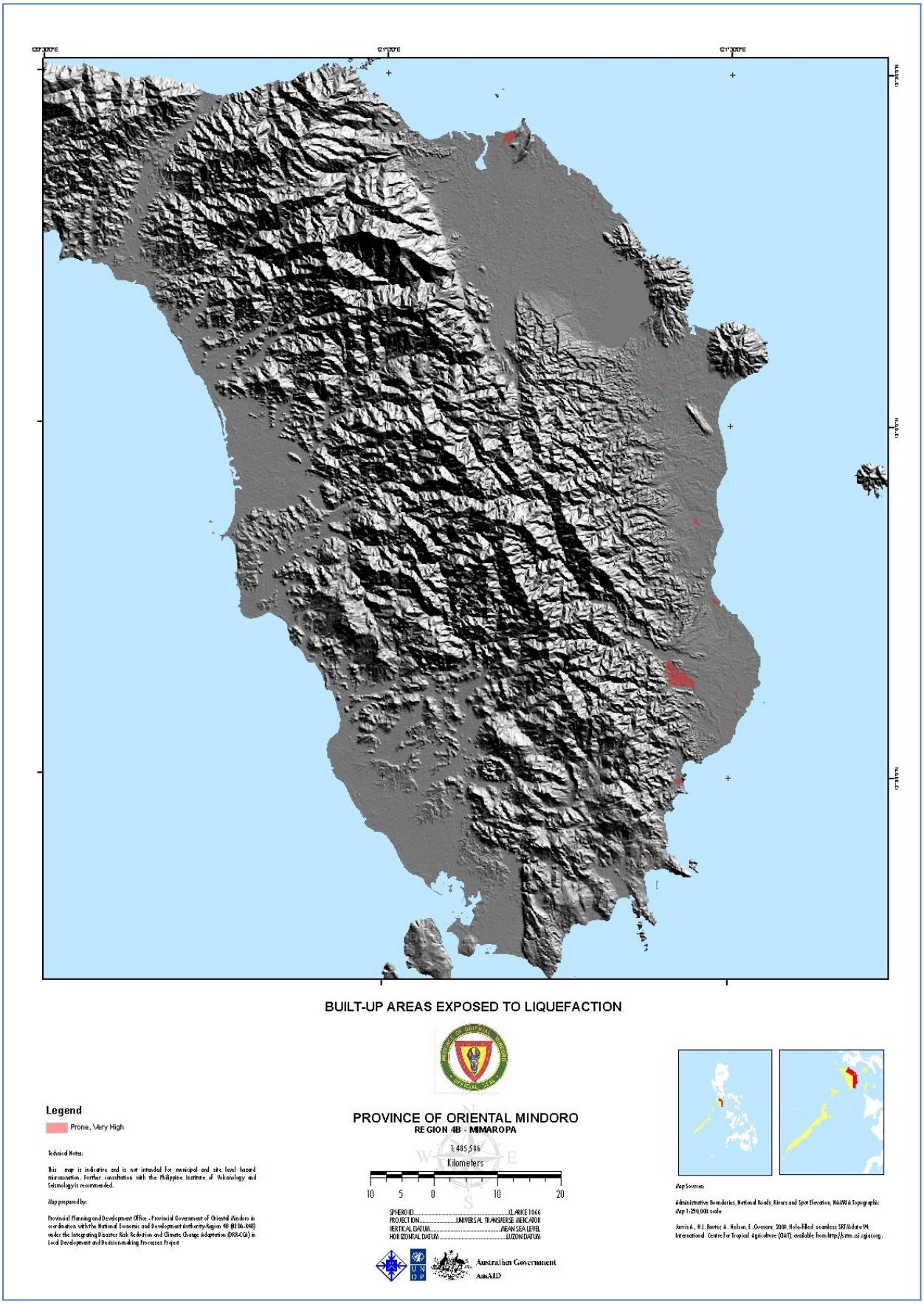
Note: 2010 - actual NSO Census of Population




**Annex 18.** Map of Built-up areas exposed to flooding



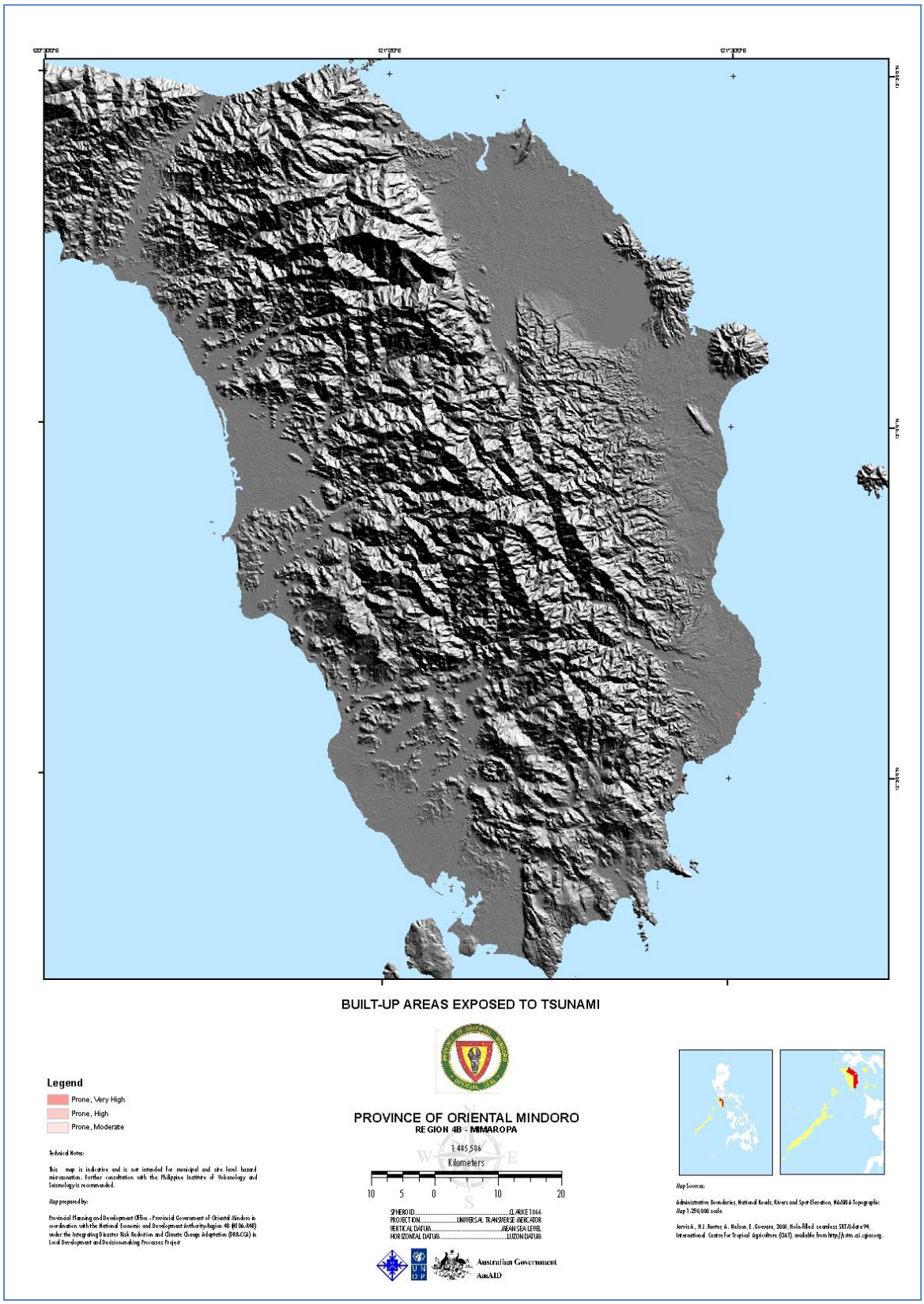

**Annex 19.** Map of population exposed to liquefaction



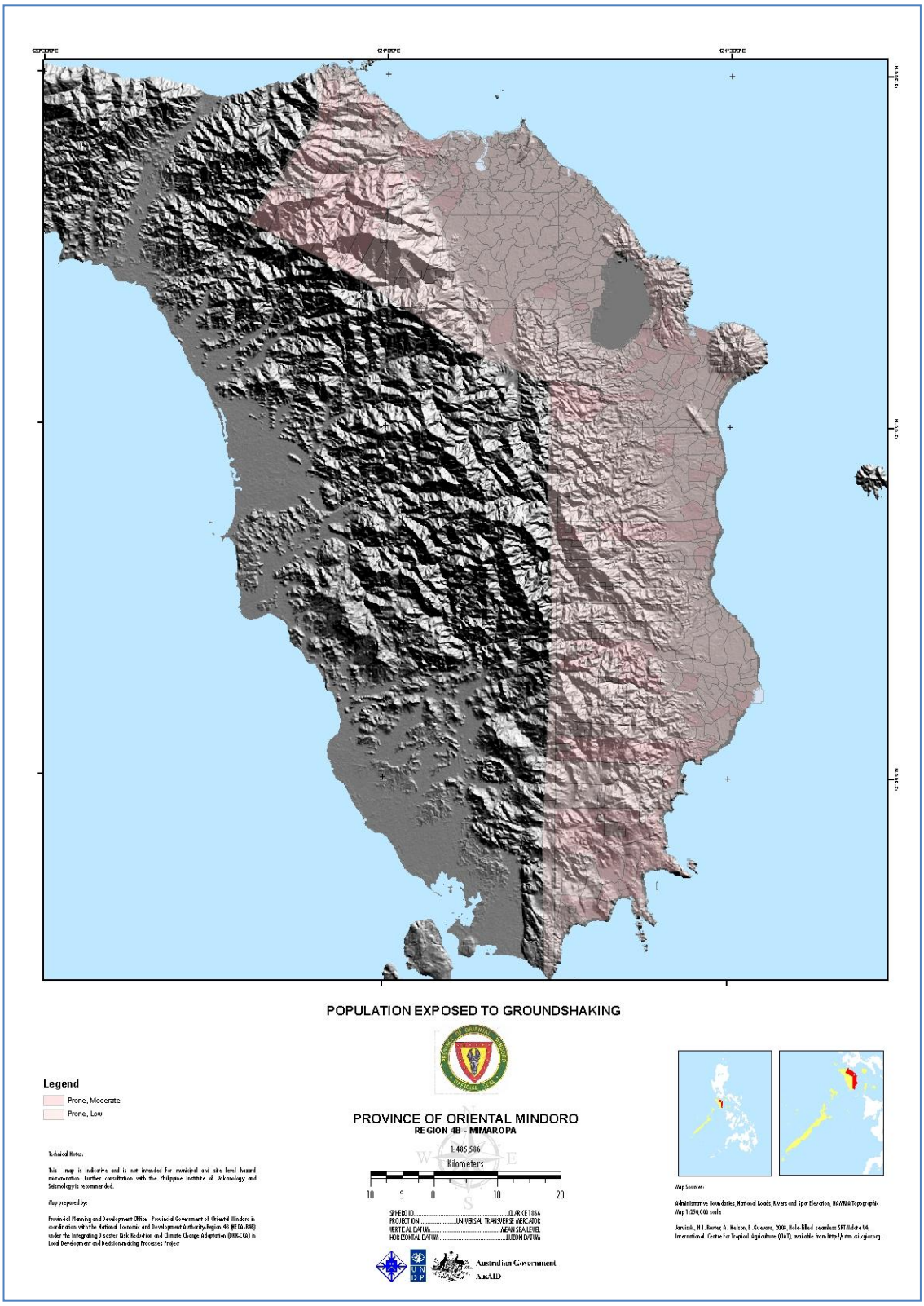

**Annex 20.** Map of built-up areas exposed to liquefaction

**Annex 21.** Population exposure to tsunami

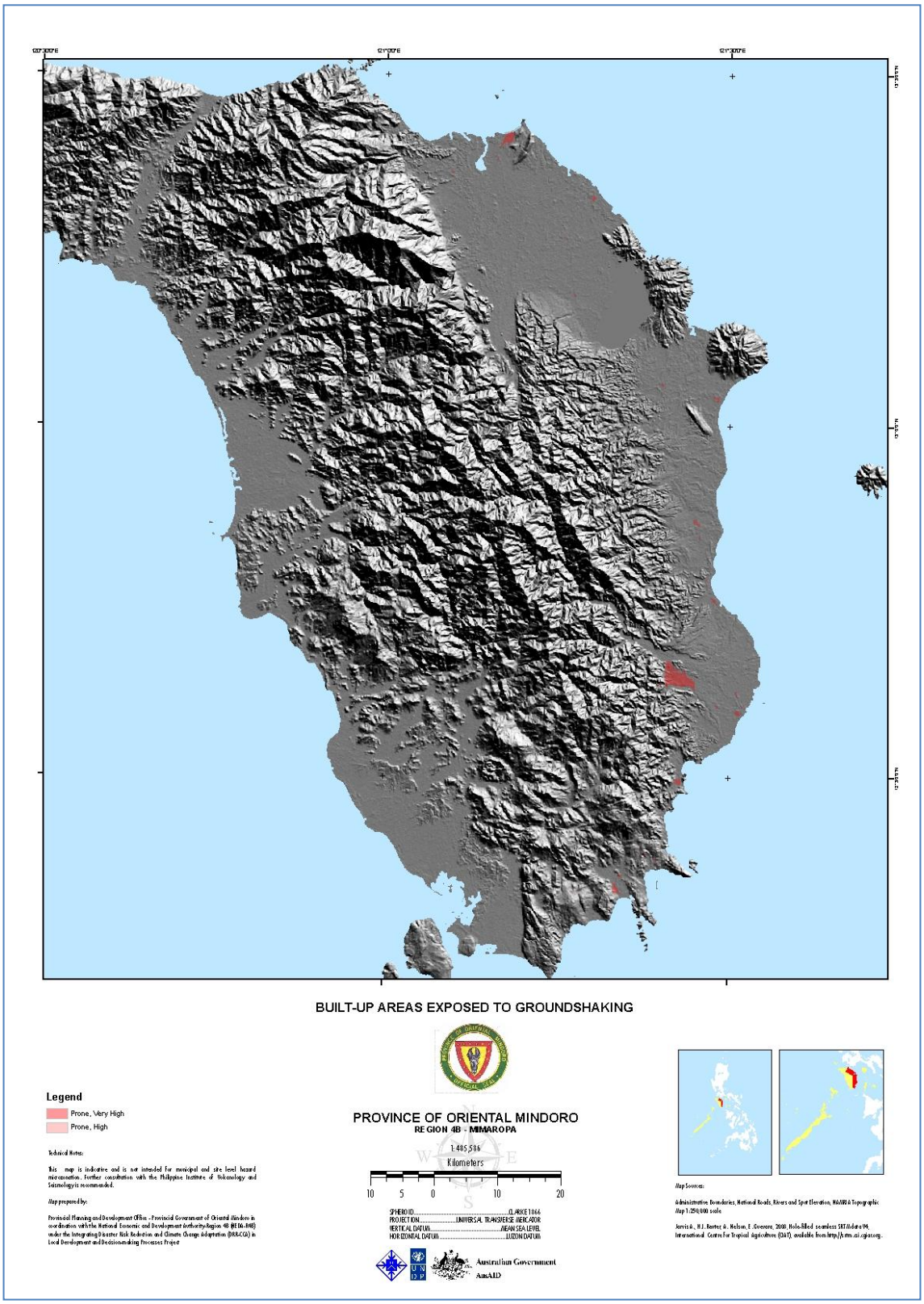
| CITY/MUNICIPALITY | 2007 MUNICIPAL POPULATION | EXPOSED POPULATION IN PRONE AREAS | POPULATION EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| **BACO** | 34,127 | 2,369 | 7 |
| **BONGABONG** | 61,127 | 3,756 | 6 |
| **CALAPAN CITY** | 116,976 | 11,927 | 10 |
| **MANSALAY** | 43,974 | 7,593 | 17 |
| **PUERTO GALERA** | 28,035 | 8,873 | 32 |
| **ROXAS** | 46,711 | 18,844 | 40 |
| **SAN TEODORO** | 15,039 | 974 | 6 |




**Annex 22.** Map of built-up areas exposed to tsunami




**Annex 23**. Map of population exposed to groundshaking




**Annex 24.** Map of built-up areas exposed to ground shaking

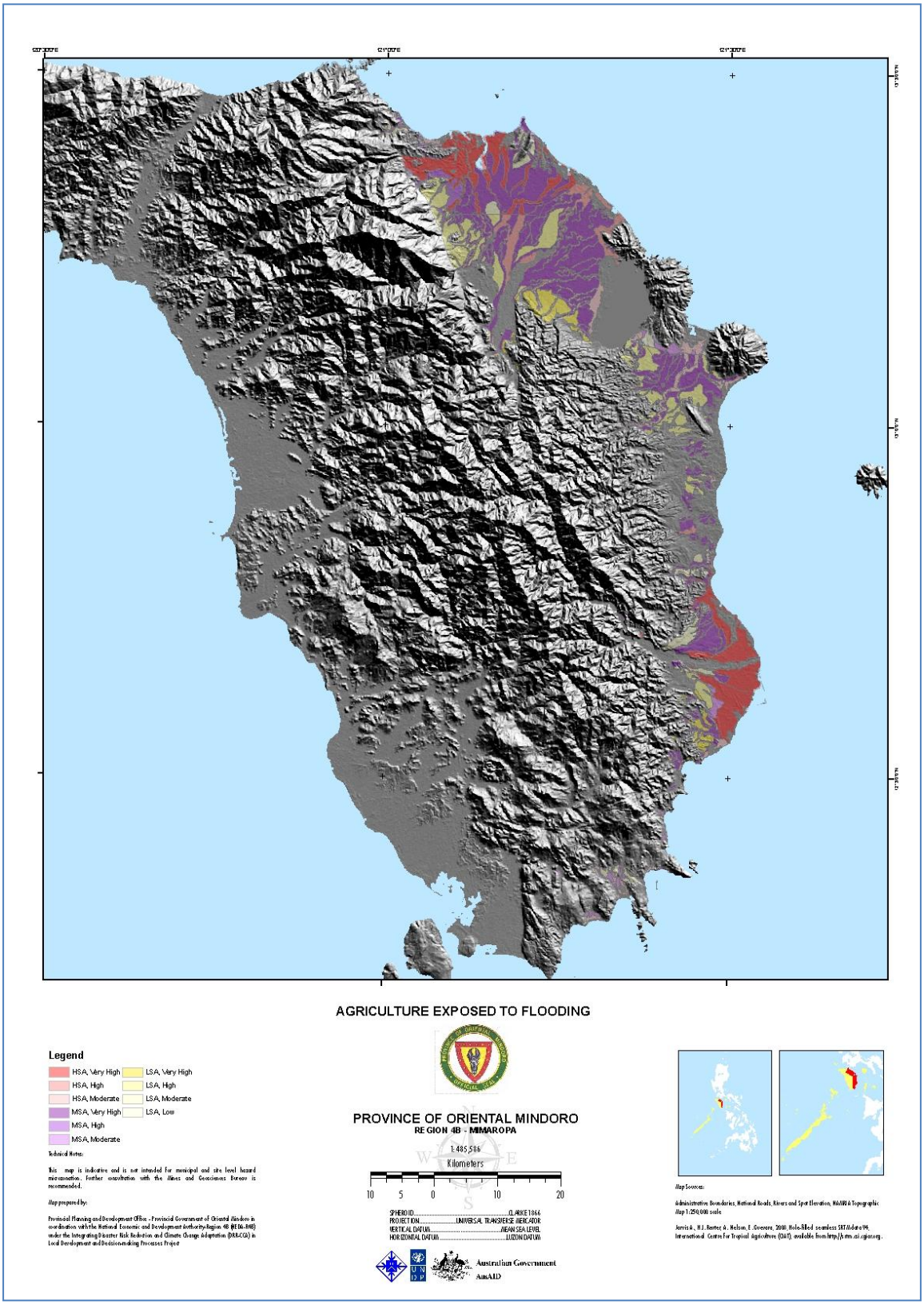
**Annex 25.** Population exposure to earthquake induced landslide

| CITY/MUNICIPALITY | 2007 MUNICIPAL POPULATION | EXPOSED POPULATION IN PRONE AREAS | POPULATION EXPOSURE PERCENTAGE IN PRONE AREAS (%) |
|---|---|---|---|
| **SAN TEODORO** | 15039 | 6,377 | 42 |
| **PUERTO GALERA** | 28035 | 9,535 | 34 |
| **POLA** | 32635 | 8,765 | 27 |
| **MANSALAY** | 43974 | 9,770 | 22 |
| **SOCORRO** | 38052 | 5,301 | 14 |
| **VICTORIA** | 44932 | 5,858 | 13 |
| **BONGABONG** | 61127 | 5,903 | 10 |
| **BACO** | 34127 | 3,266 | 10 |
| **BANSUD** | 35664 | 3,146 | 9 |
| **BULALACAO** | 30188 | 2,008 | 7 |
| **NAUJAN** | 90629 | 5,333 | 6 |
| **GLORIA** | 40561 | 1,200 | 3 |
| **PINAMALAYAN** | 77119 | 2,042 | 3 |
| **ROXAS** | 46711 | 895 | 2 |

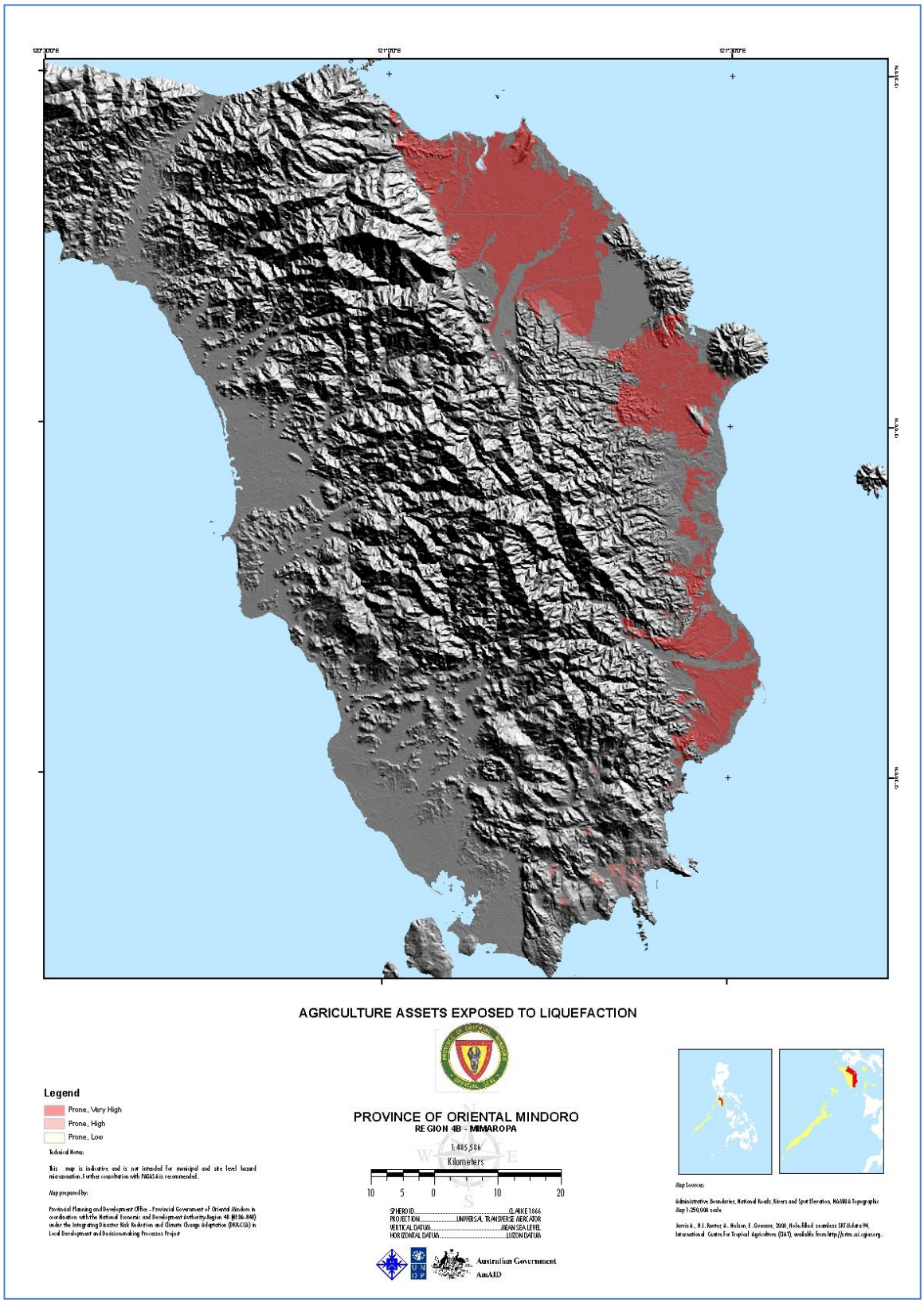
**Annex 26.** Rice Production by Municipality, 2010

| City/ Municipality | Farmers (No.) | Area Harvested (ha.) | Production (MT) | Average Yield (MT/ha) |
|---|---|---|---|---|
| Baco | 3,582 | 5,124.00 | 18,609.90 | 3.63 |
| Bansud | 3,326 | 5,856.50 | 23,623.03 | 4.03 |
| Bongabong | 5,176 | 10,211.50 | 36,814.70 | 3.6 |
| Bulalacao | 646 | 1,804.00 | 7,169.44 | 3.97 |
| Calapan City | 6,968 | 15,473.00 | 55,638.98 | 3.59 |
| Gloria | 3,660 | 4,954.00 | 17,881.87 | 3.6 |
| Mansalay | 3,254 | 5,059.00 | 20,459.82 | 4.04 |
| Naujan | 17,780 | 27,431.00 | 99,757.14 | 3.63 |
| Pinamalayan | 4,592 | 7,072.50 | 34,539.43 | 4.88 |
| Pola | 1,548 | 2,535.00 | 9,510.35 | 3.75 |
| Roxas | 2,676 | 5,143.50 | 25,791.60 | 5.01 |
| San Teodoro | 640 | 781 | 2,573.75 | 3.29 |
| Socorro | 2,592 | 4,667.00 | 19,426.76 | 4.16 |
| Victoria | 4,932 | 12,089.00 | 43,078.93 | 3.56 |
| **Total** | **61,372** | **108,201.00** | **414,875.70** | **3.83** |

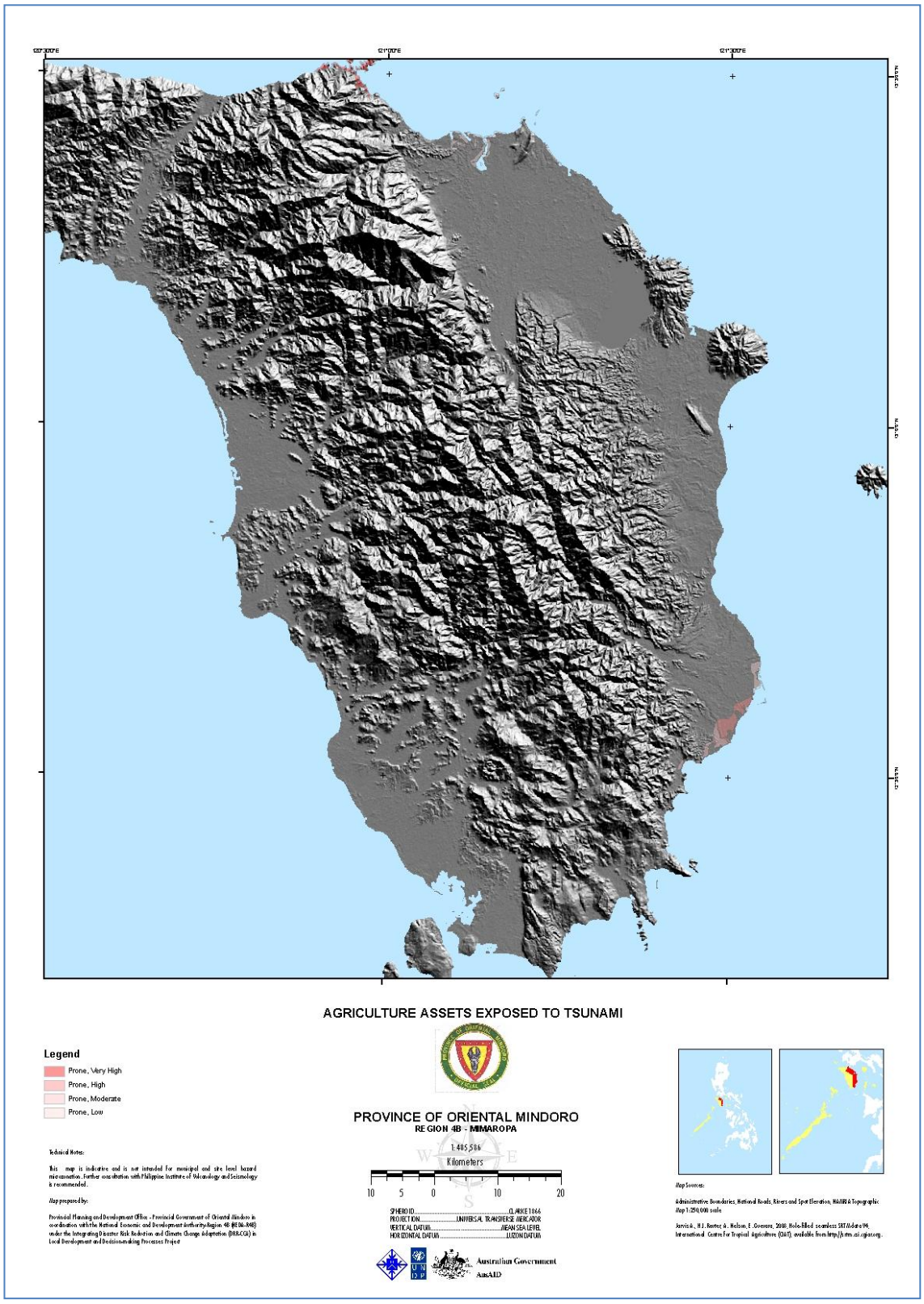
*Source: PAgO*



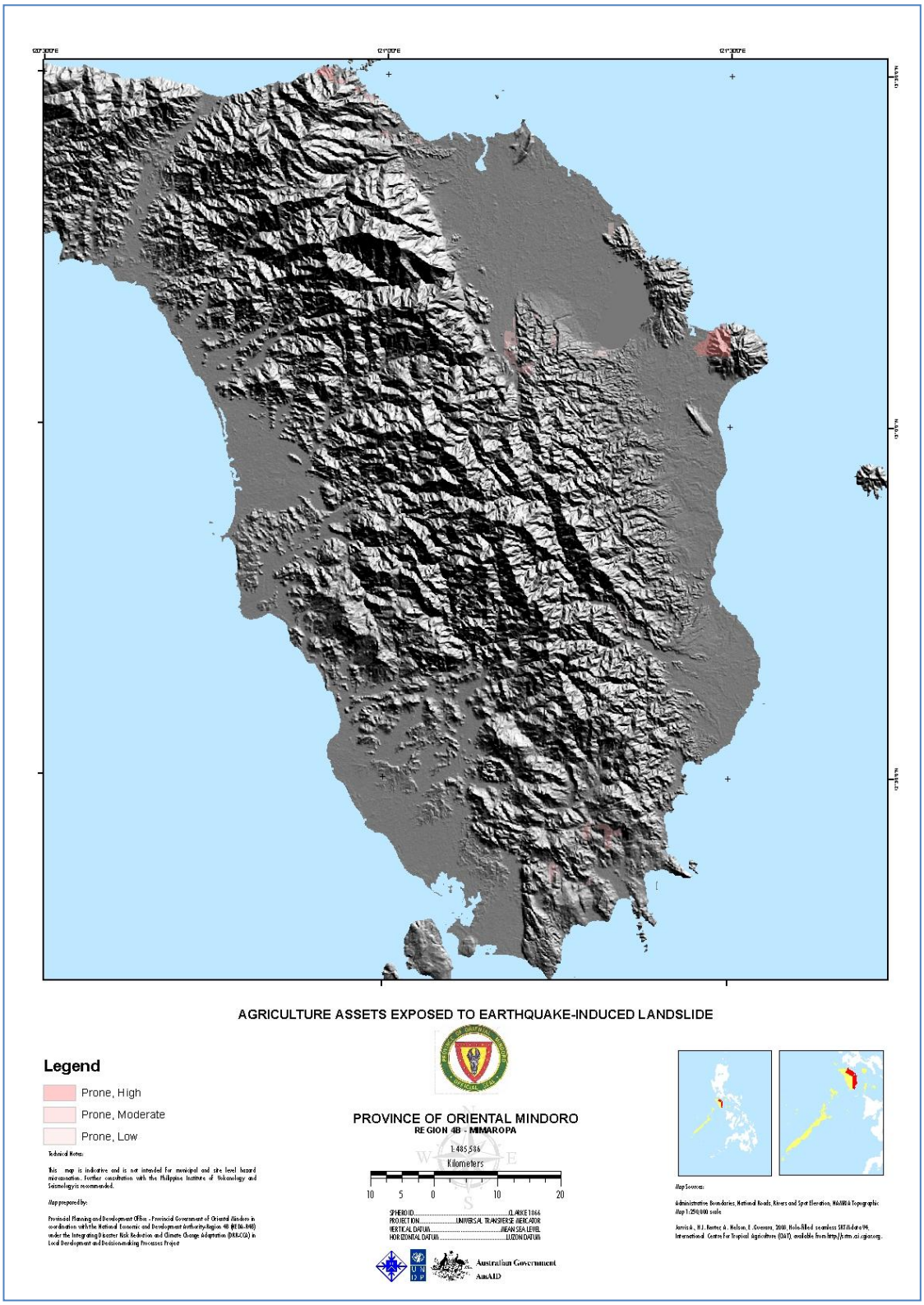

**Annex 27.** Map of agriculture exposed to flooding




**Annex 28.** Map of agriculture assets exposed to liquefaction




**Annex 29.** Map of agriculture assets exposed to tsunami




**Annex 30.** Map of agriculture assets exposed to earthquake-induced landslide

**Annex 31.** Exposure table of airport and seaport to flooding by specific location

| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN SUSCEPTIBLE AREAS | | | EXPOSURE PERCENTAGE OF POINT FACILITIES (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | | HSA | MSA | LSA | HSA | MSA | LSA |
| **CALAPAN CITY** | Airport | 1 | - | 1 | - | 0 | 100 | 0 |
| **MANSALAY** | Airport | 1 | - | - | 1 | 0 | 0 | 100 |
| **PINAMALAYAN** | Airport | 1 | - | - | 1 | 0 | 0 | 100 |
| **BANSUD** | Seaport | 1 | 1 | - | - | 100 | 0 | 0 |
| **BONGABONG** | Seaport | 1 | 1 | - | - | 100 | 0 | 0 |
| **CALAPAN CITY** | Seaport | 2 | - | 2 | - | 0 | 100 | 0 |
| **ROXAS** | Seaport | 1 | 1 | - | - | 100 | 0 | 0 |

**Annex 32.** Exposure table of health facilities to flooding

| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN SUSCEPTIBLE AREAS | | | EXPOSURE PERCENTAGE OF POINT FACILITIES (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | | HSA | MSA | LSA | HSA | MSA | LSA |
| Baco | BHS | 7 | 2 | 1 | 1 | 29 | 14 | 14 |
| Bansud | BHS | 5 | 1 | 2 | 1 | 20 | 40 | 20 |
| Bongabong | BHS | 13 | 8 | 4 | - | 62 | 31 | 0 |
| Bulalacao | BHS | 5 | - | - | 1 | 0 | 0 | 20 |
| Calapan City | BHS | 62 | 33 | 25 | 3 | 53 | 40 | 5 |
| Gloria | BHS | 22 | 5 | 12 | 2 | 23 | 55 | 9 |
| Mansalay | BHS | 3 | - | - | 1 | 0 | 0 | 33 |
| Naujan | BHS | 11 | 2 | 3 | 3 | 18 | 27 | 27 |
| Pinamalayan | BHS | 12 | - | 5 | 2 | 0 | 42 | 17 |
| Pola | BHS | 7 | 1 | 1 | 1 | 14 | 14 | 14 |
| Puerto Galera | BHS | 6 | - | 2 | 1 | 0 | 33 | 17 |
| Roxas | BHS | 6 | 6 | - | - | 100 | 0 | 0 |
| Socorro | BHS | 7 | - | 2 | - | 0 | 29 | 0 |
| Victoria | BHS | 4 | - | 1 | 2 | 0 | 25 | 50 |
| **Sub-Total** | | **170** | **58** | **58** | **18** | **34** | **34** | **11** |
| Baco | RHU | 1 | 1 | - | - | 100 | 0 | 0 |
| Bongabong | RHU | 1 | 1 | - | - | 100 | 0 | 0 |
| Calapan City | RHU | 2 | 1 | - | 1 | 50 | 0 | 50 |
| Gloria | RHU | 2 | - | 2 | - | 0 | 100 | 0 |
| Mansalay | RHU | 1 | - | 1 | - | 0 | 100 | 0 |
| Naujan | RHU | 1 | - | 1 | - | 0 | 100 | 0 |
| Pinamalayan | RHU | 1 | - | 1 | - | 0 | 100 | 0 |
| Pola | RHU | 1 | 1 | - | - | 100 | 0 | 0 |
| Roxas | RHU | 1 | 1 | - | - | 100 | 0 | 0 |
| San Teodoro | RHU | 1 | - | - | 1 | 0 | 0 | 100 |
| Socorro | RHU | 1 | - | 1 | - | 0 | 100 | 0 |
| Victoria | RHU | 1 | - | 1 | - | 0 | 100 | 0 |
| **Sub-Total** | | **14** | **5** | **7** | **2** | **36** | **50** | **14** |
| **Grand Total** | | **184** | **63** | **65** | **20** | **34** | **35** | **11** |

**Annex 33.** Exposure table of education facilities to flooding

| CITY/MUNICIPALITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN SUSCEPTIBLE AREAS | | | EXPOSURE PERCENTAGE OF POINT FACILITIES (%) | | |
|---|---|---|---|---|---|---|---|
| | | HSA | MSA | LSA | HSA | MSA | LSA |
| Baco | 86 | 57 | 11 | 10 | 66 | 13 | 12 |
| Bansud | 30 | 1 | 14 | 2 | 3 | 47 | 7 |
| Bongabong | 39 | 22 | 4 | 3 | 56 | 10 | 8 |
| Bulalacao | 30 | 2 | - | 1 | 7 | 0 | 3 |
| Calapan City | 71 | 30 | 35 | 6 | 42 | 49 | 8 |
| Gloria | 38 | 12 | 15 | 3 | 32 | 39 | 8 |
| Mansalay | 30 | 5 | 4 | 6 | 17 | 13 | 20 |
| Naujan | 105 | 27 | 44 | 25 | 26 | 42 | 24 |
| Pinamalayan | 33 | 9 | 10 | 5 | 27 | 30 | 15 |
| Roxas | 24 | 17 | - | 6 | 70 | 0 | 26 |
| Socorro | 19 | - | 3 | 4 | 0 | 16 | 21 |
| Victoria | 29 | 4 | 19 | 4 | 14 | 66 | 14 |
| **TOTAL** | **534** | **186** | **159** | **75** | **35** | **30** | **14** |

**Annex 34.** Exposure table of government facilities to flooding

| CITY/MUNICIPALITY | TOTAL COUNT OF FACILITIES | EXPOSED POINT FACILITIES WITHIN SUSCEPTIBLE AREAS | | | EXPOSURE PERCENTAGE OF POINT FACILITIES (%) | | |
|---|---|---|---|---|---|---|---|
| | | HSA | MSA | LSA | HSA | MSA | LSA |
| Baco | 31 | 12 | 6 | 6 | 39 | 19 | 19 |
| Bansud | 24 | 3 | 14 | 1 | 13 | 58 | 4 |
| Bongabong | 38 | 23 | 7 | - | 61 | 18 | 0 |
| Bulalacao | 30 | 5 | - | - | 17 | 0 | 0 |
| Calapan City | 14 | 7 | 7 | - | 50 | 50 | 0 |
| Gloria | 45 | 11 | 25 | 1 | 24 | 56 | 2 |
| Mansalay | 28 | 4 | 5 | 5 | 14 | 18 | 18 |
| Naujan | 27 | 7 | 14 | 3 | 26 | 52 | 11 |
| Pinamalayan | 66 | 8 | 35 | 7 | 12 | 53 | 11 |
| Roxas | 31 | 21 | 1 | 7 | 68 | 3 | 23 |
| Socorro | 33 | 1 | 7 | 5 | 3 | 21 | 15 |
| **TOTAL** | **367** | **102** | **121** | **35** | **28** | **33** | **10** |

**Annex 35.** Exposure table of schools to liquefaction

| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|---|
| Baco | School | 86 | 1 | 1 |
| Bansud | School | 30 | 2 | 7 |
| Bongabong | School | 39 | 2 | 5 |
| Bulalacao | School | 30 | 1 | 3 |
| Calapan City | School | 71 | 2 | 3 |
| Gloria | School | 38 | 2 | 5 |
| Mansalay | School | 30 | 2 | 7 |
| Naujan | School | 105 | 2 | 2 |
| Pinamalayan | School | 33 | 2 | 6 |
| Roxas | School | 23 | 1 | 4 |
| Socorro | School | 19 | 2 | 11 |
| Victoria | School | 29 | 1 | 3 |

**Annex 36.** Exposure table of government facilities to liquefaction

| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|---|
| Baco | Government | 31 | 1 | 3 |
| Bansud | Government | 24 | 2 | 8 |
| Bongabong | Government | 38 | 2 | 5 |
| Bulalacao | Government | 30 | 1 | 3 |
| Calapan City | Government | 14 | 1 | 7 |
| Gloria | Government | 45 | 2 | 4 |
| Mansalay | Government | 28 | 2 | 7 |
| Naujan | Government | 27 | 1 | 4 |
| Pinamalayan | Government | 66 | 2 | 3 |
| Roxas | Government | 31 | 2 | 6 |
| Socorro | Government | 33 | 2 | 6 |

**Annex 37.** Exposure table of health facilities to ground shaking

| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|---|
| Baco | BHS | 7 | 2 | 29 |
| Bansud | BHS | 5 | 1 | 20 |
| Bongabong | BHS | 13 | 1 | 8 |
| Bulalacao | BHS | 5 | 1 | 20 |
| Calapan City | BHS | 62 | 1 | 2 |
| Gloria | BHS | 22 | 1 | 5 |
| Mansalay | BHS | 3 | 1 | 33 |
| Naujan | BHS | 11 | 1 | 9 |
| Pinamalayan | BHS | 12 | 2 | 17 |
| Pola | BHS | 7 | 2 | 29 |
| Puerto Galera | BHS | 6 | 1 | 17 |
| Roxas | BHS | 6 | 1 | 17 |
| San Teodoro | BHS | 6 | 2 | 33 |
| Socorro | BHS | 7 | 1 | 14 |
| Victoria | BHS | 4 | 1 | 25 |
| **Sub Total** | | **176** | **19** | **11** |
| Baco | RHU | 1 | 1 | 100 |
| Bongabong | RHU | 1 | 1 | 100 |
| Bulalacao | RHU | 1 | 1 | 100 |
| Calapan City | RHU | 2 | 1 | 50 |
| Gloria | RHU | 2 | 1 | 50 |
| Mansalay | RHU | 1 | 1 | 100 |
| Naujan | RHU | 1 | 1 | 100 |
| Pinamalayan | RHU | 1 | 1 | 100 |
| Pola | RHU | 1 | 1 | 100 |
| Roxas | RHU | 1 | 1 | 100 |
| San Teodoro | RHU | 1 | 1 | 100 |
| Socorro | RHU | 1 | 1 | 100 |
| Victoria | RHU | 1 | 1 | 100 |
| **Sub Total** | | **15** | **13** | **87** |
| **Grand Total** | | **191** | **32** | **17** |

**Annex 38.** Exposure table of government facilities to ground shaking

| CITY/MUNICIPALITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|
| Baco | 31 | 1 | 3 |
| Bansud | 24 | 1 | 4 |
| Bongabong | 38 | 1 | 3 |
| Bulalacao | 30 | 2 | 7 |
| Calapan City | 14 | 1 | 7 |
| Gloria | 45 | 1 | 2 |
| Mansalay | 28 | 1 | 4 |
| Naujan | 27 | 2 | 7 |
| Pinamalayan | 66 | 2 | 3 |
| Roxas | 31 | 1 | 3 |
| San Teodoro | 1 | 1 | 100 |
| Socorro | 33 | 1 | 3 |
| Victoria | 1 | 1 | 100 |

**Annex 39.** Exposure table of ports and seaports to earthquake-induced landslide

| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|---|
| Calapan City | Airport | 1 | 1 | 100 |
| Mansalay | Airport | 1 | 1 | 100 |
| Pinamalayan | Airport | 1 | 1 | 100 |
| Bansud | Seaport | 1 | 1 | 100 |
| Bongabong | Seaport | 1 | 1 | 100 |
| Calapan City | Seaport | 2 | 1 | 50 |
| Mansalay | Seaport | 1 | 1 | 100 |
| Pinamalayan | Seaport | 1 | 1 | 100 |
| Puerto Galera | Seaport | 1 | 1 | 100 |
| Roxas | Seaport | 1 | 1 | 100 |

**Annex 40.** Exposure table of health facilities to earthquake-induced landslide

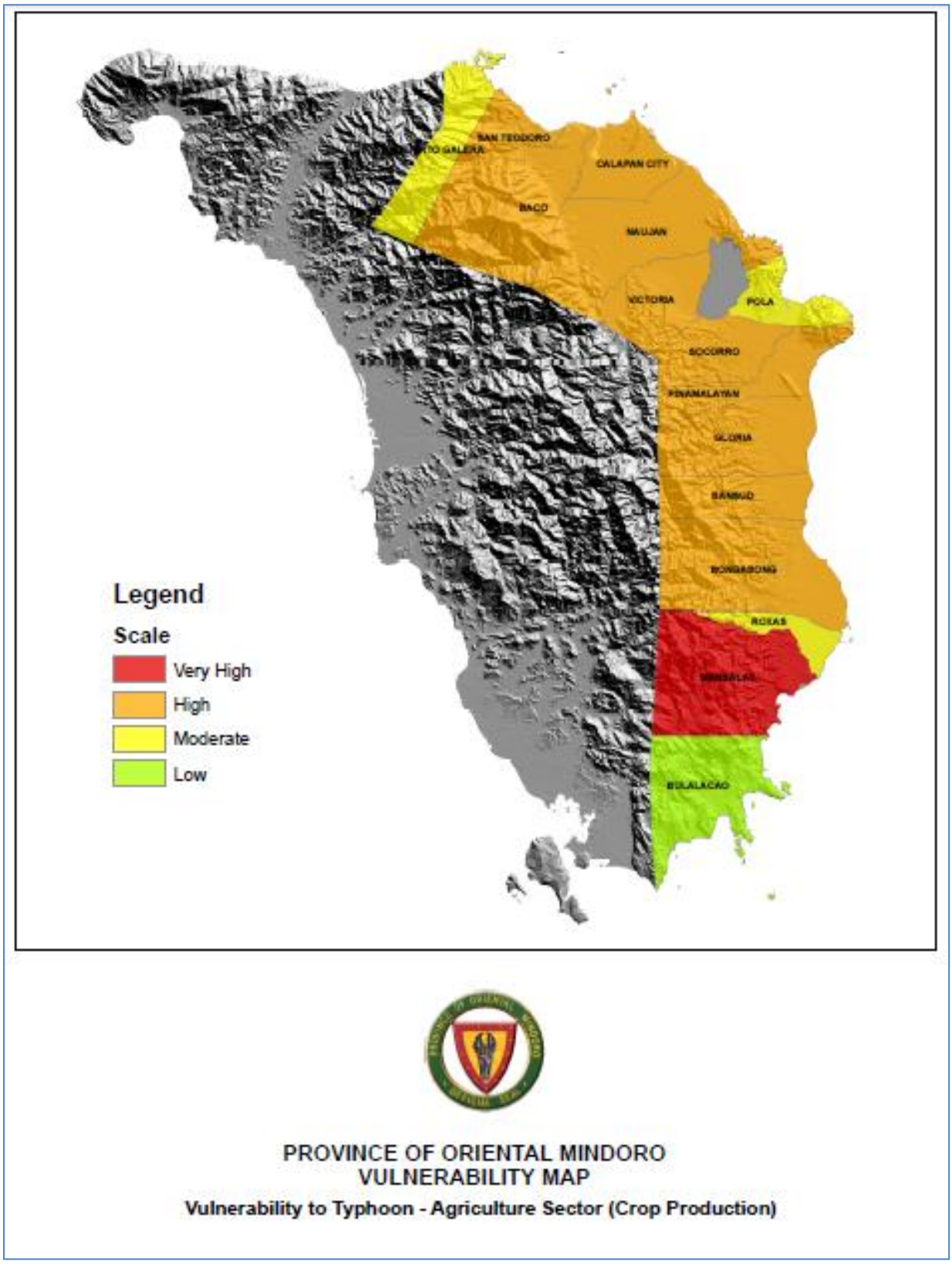
| CITY/MUNICIPALITY | TYPE OF CRITICAL POINT FACILITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|---|
| Baco | BHS | 7 | 3 | 43 |
| Bansud | BHS | 5 | 1 | 20 |
| Bongabong | BHS | 13 | 1 | 8 |
| Bulalacao | BHS | 5 | | 20 |
| Calapan City | BHS | 62 | 1 | 2 |
| Gloria | BHS | 22 | 1 | 5 |
| Mansalay | BHS | 3 | 1 | 33 |
| Naujan | BHS | 11 | 2 | 18 |
| Pinamalayan | BHS | 12 | 1 | 8 |
| Pola | BHS | 7 | 2 | 29 |
| Puerto Galera | BHS | 6 | 3 | 50 |
| Roxas | BHS | 6 | 1 | 17 |
| San Teodoro | BHS | 6 | 3 | 50 |
| Socorro | BHS | 7 | 1 | 14 |
| Victoria | BHS | 4 | 1 | 25 |
| **Sub Total** | | **176** | **23** | **13** |
| Baco | RHU | 1 | 1 | 100 |
| Bongabong | RHU | 1 | 1 | 100 |
| Bulalacao | RHU | 1 | 1 | 100 |
| Calapan City | RHU | 2 | 1 | 50 |
| Gloria | RHU | 2 | 1 | 50 |
| Mansalay | RHU | 1 | 1 | 100 |
| Naujan | RHU | 1 | 1 | 100 |
| Pinamalayan | RHU | 1 | 1 | 100 |
| Pola | RHU | 1 | 1 | 100 |
| Roxas | RHU | 1 | 1 | 100 |
| San Teodoro | RHU | 1 | 1 | 100 |
| Socorro | RHU | 1 | 1 | 100 |
| Victoria | RHU | 1 | 1 | 100 |
| **Sub Total** | | **15** | **13** | **87** |

**Annex 41**. Exposure table of schools to earthquake-induced landslide

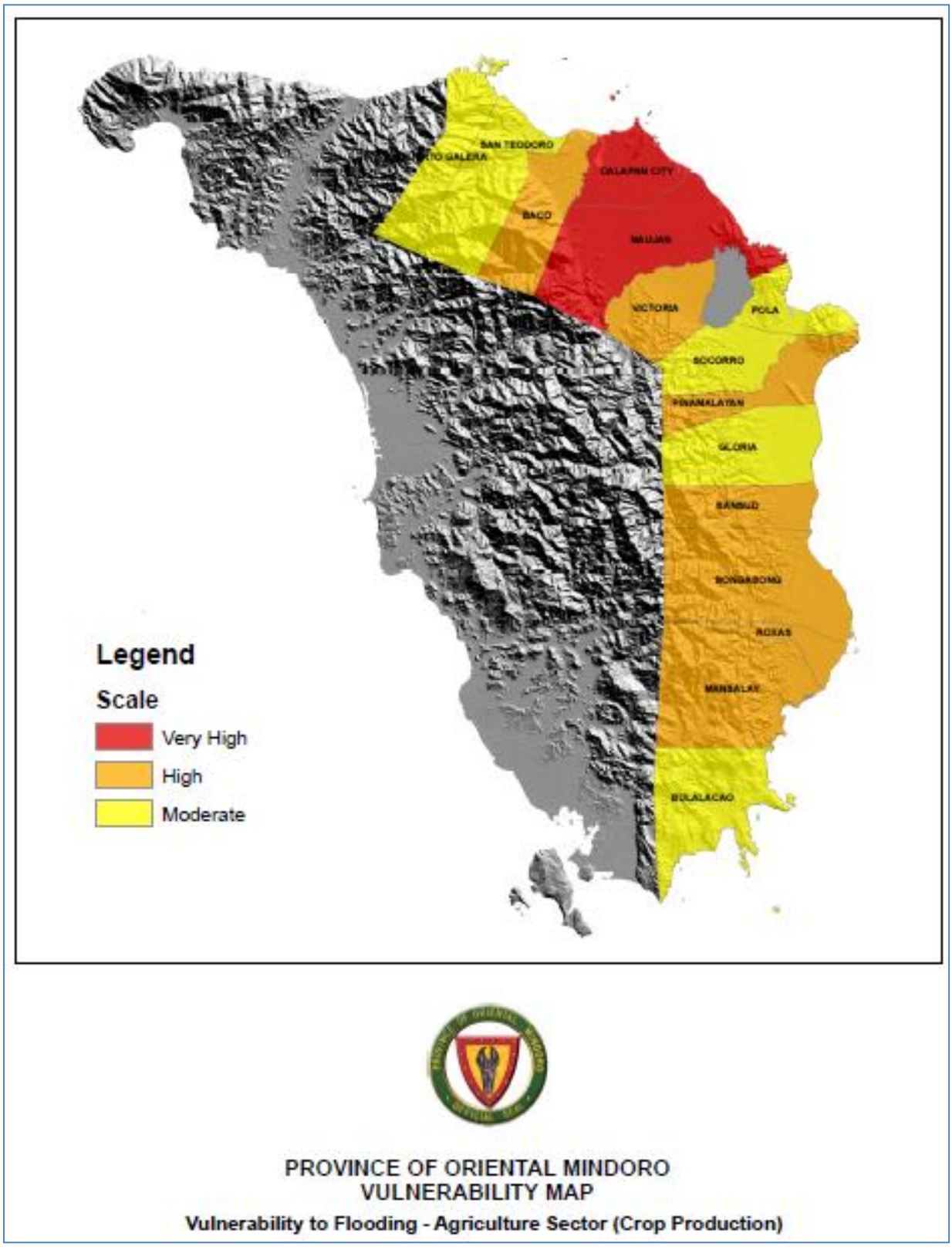
| CITY/MUNICIPALITY | TOTAL COUNT OF FACILITIES BY TYPE | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|
| Baco | 86 | 1 | 1 |
| Bansud | 30 | 3 | 10 |
| Bongabong | 39 | 2 | 5 |
| Bulalacao | 30 | 3 | 10 |
| Calapan City | 71 | 1 | 1 |
| Gloria | 38 | 4 | 11 |
| Mansalay | 30 | 5 | 17 |
| Naujan | 105 | 5 | 5 |
| Pinamalayan | 33 | 2 | 6 |
| Roxas | 24 | 1 | 4 |
| San Teodoro | 2 | 1 | 50 |
| Socorro | 19 | 4 | 21 |
| Victoria | 29 | 2 | 7 |

A**nnex 42**. Exposure table of government facilities to earthquake-induced landslide

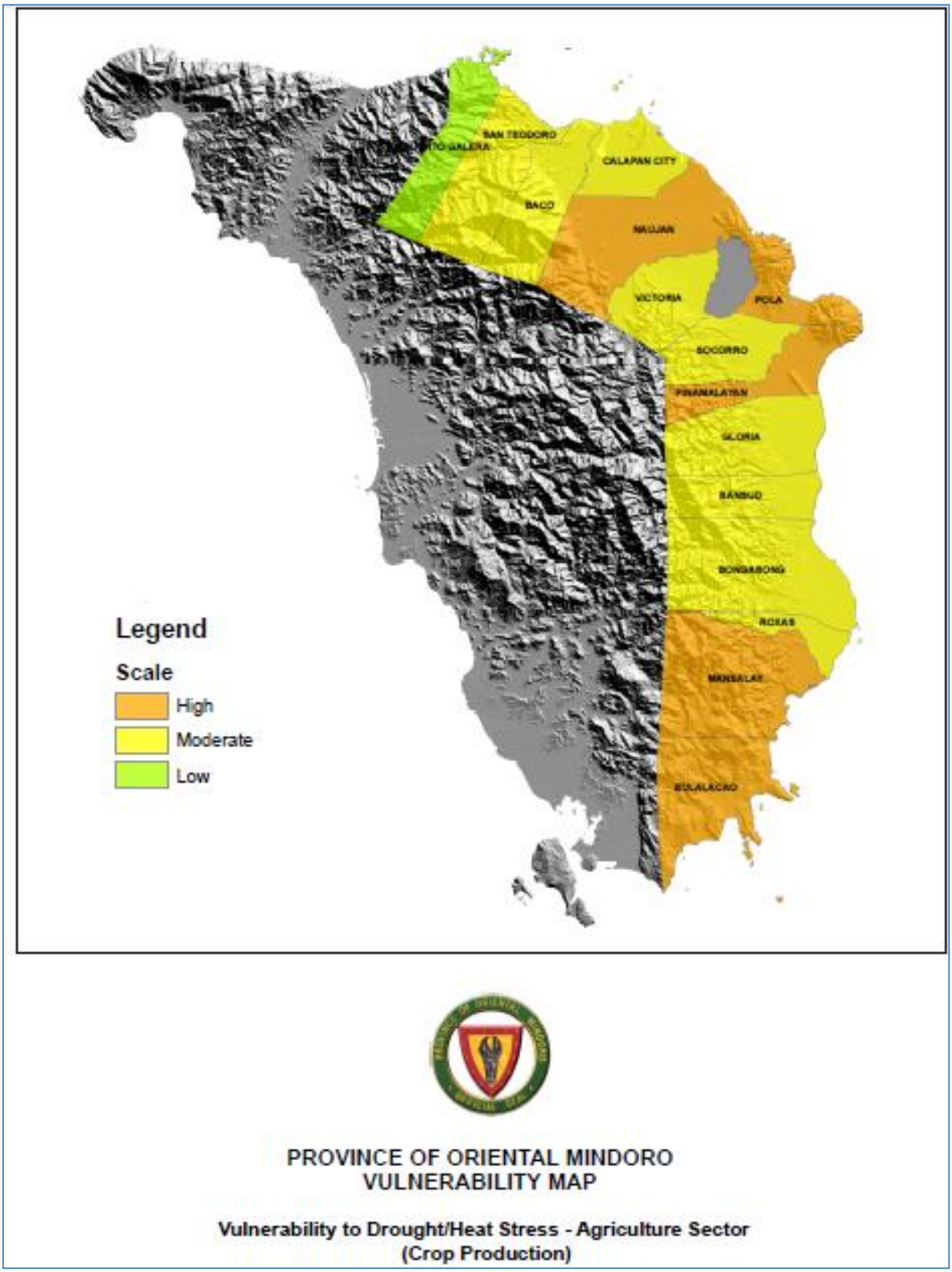
| CITY/MUNICIPALITY | TOTAL COUNT OF FACILITIES | EXPOSED POINT FACILITIES WITHIN PRONE AREAS | EXPOSURE PERCENTAGE OF POINT FACILITIES WITHIN PRONE AREAS (%) |
|---|---|---|---|
| Baco | 31 | 1 | 3 |
| Bansud | 24 | 1 | 4 |
| Bongabong | 38 | 3 | 8 |
| Bulalacao | 30 | 3 | 10 |
| Calapan City | 14 | 1 | 7 |
| Gloria | 45 | 1 | 2 |
| Mansalay | 28 | 3 | 11 |
| Naujan | 27 | 3 | 11 |
| Pinamalayan | 66 | 2 | 3 |
| Roxas | 31 | 1 | 3 |
| San Teodoro | 1 | 1 | 100 |
| Socorro | 33 | 4 | 12 |
| Victoria | 1 | 1 | 100 |



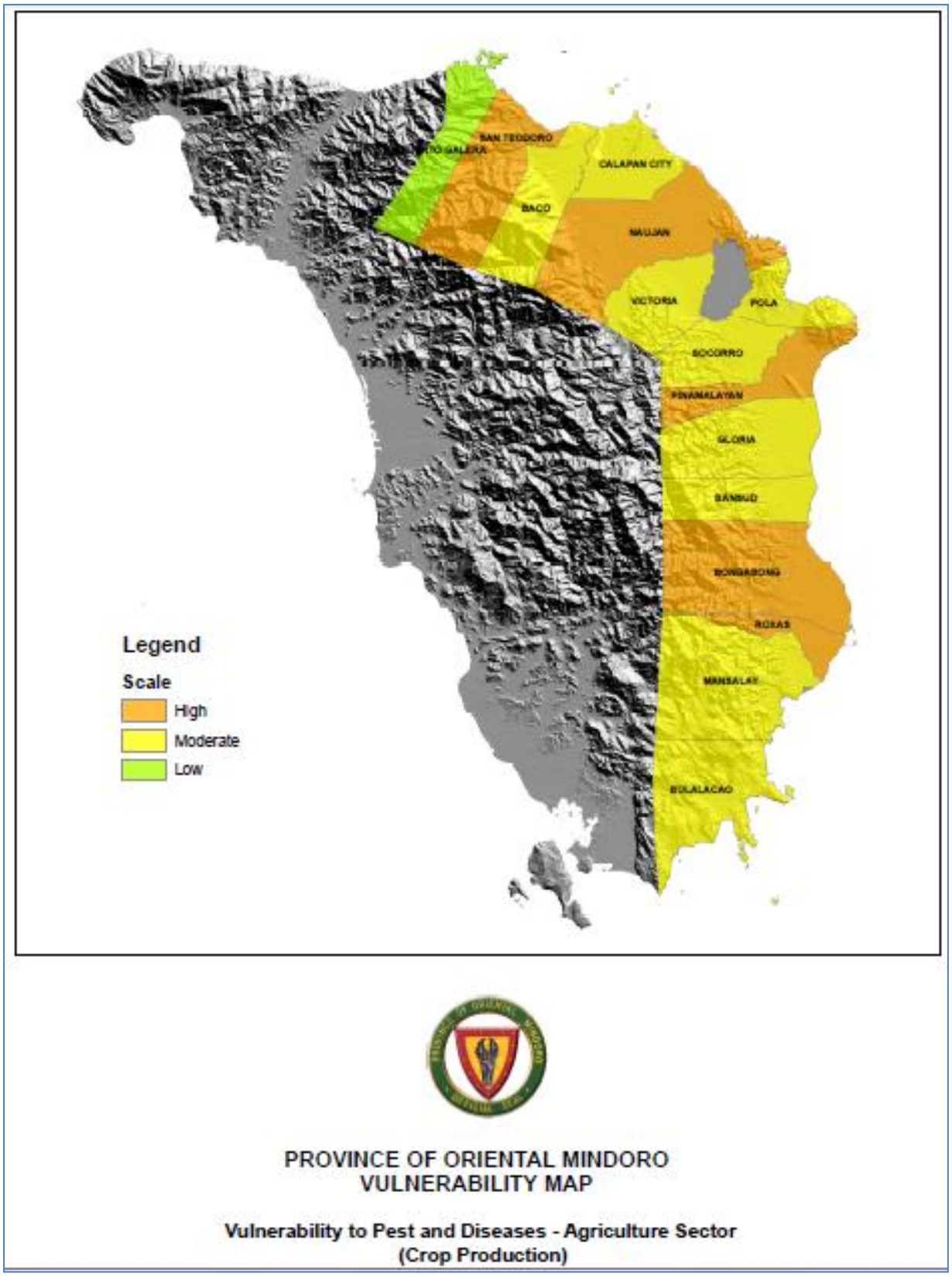

**Annex 43.** Map of Crop Production Vulnerability to Typhoon



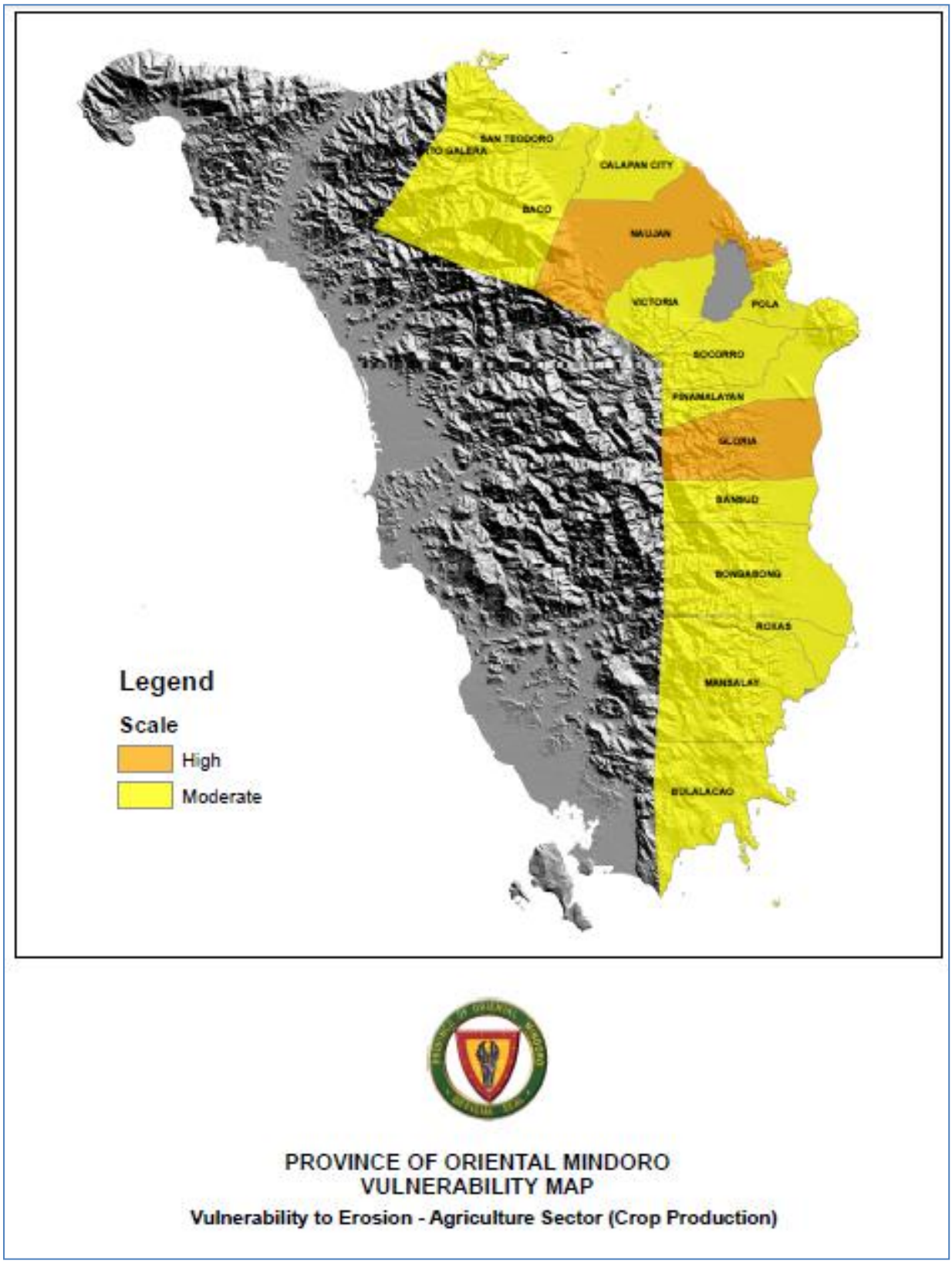

**Annex 44.** Map of Crop Production Vulnerability to Flooding



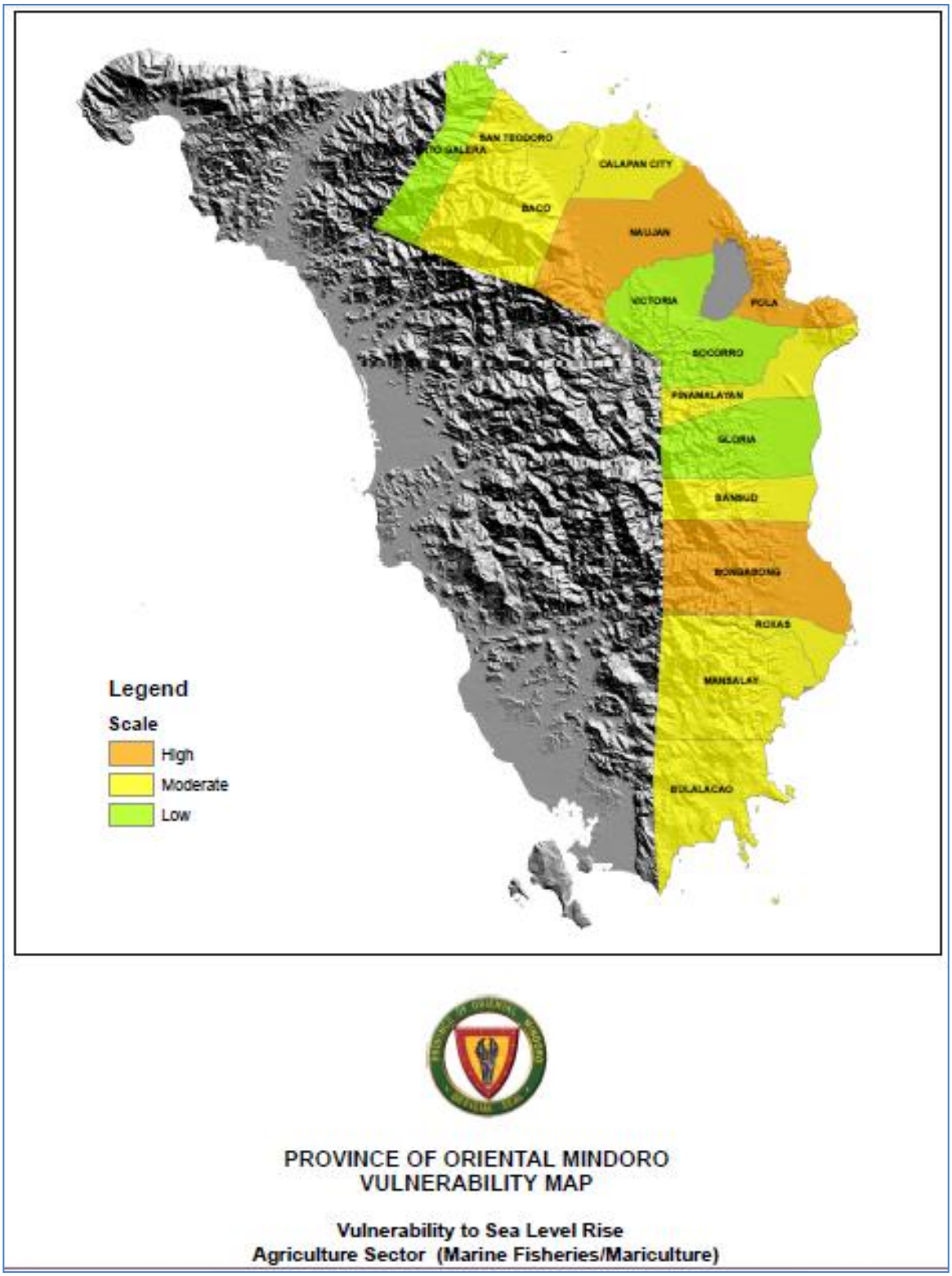

**Annex 45.** Map of Crop Production Vulnerability to Drought/Heat Stress



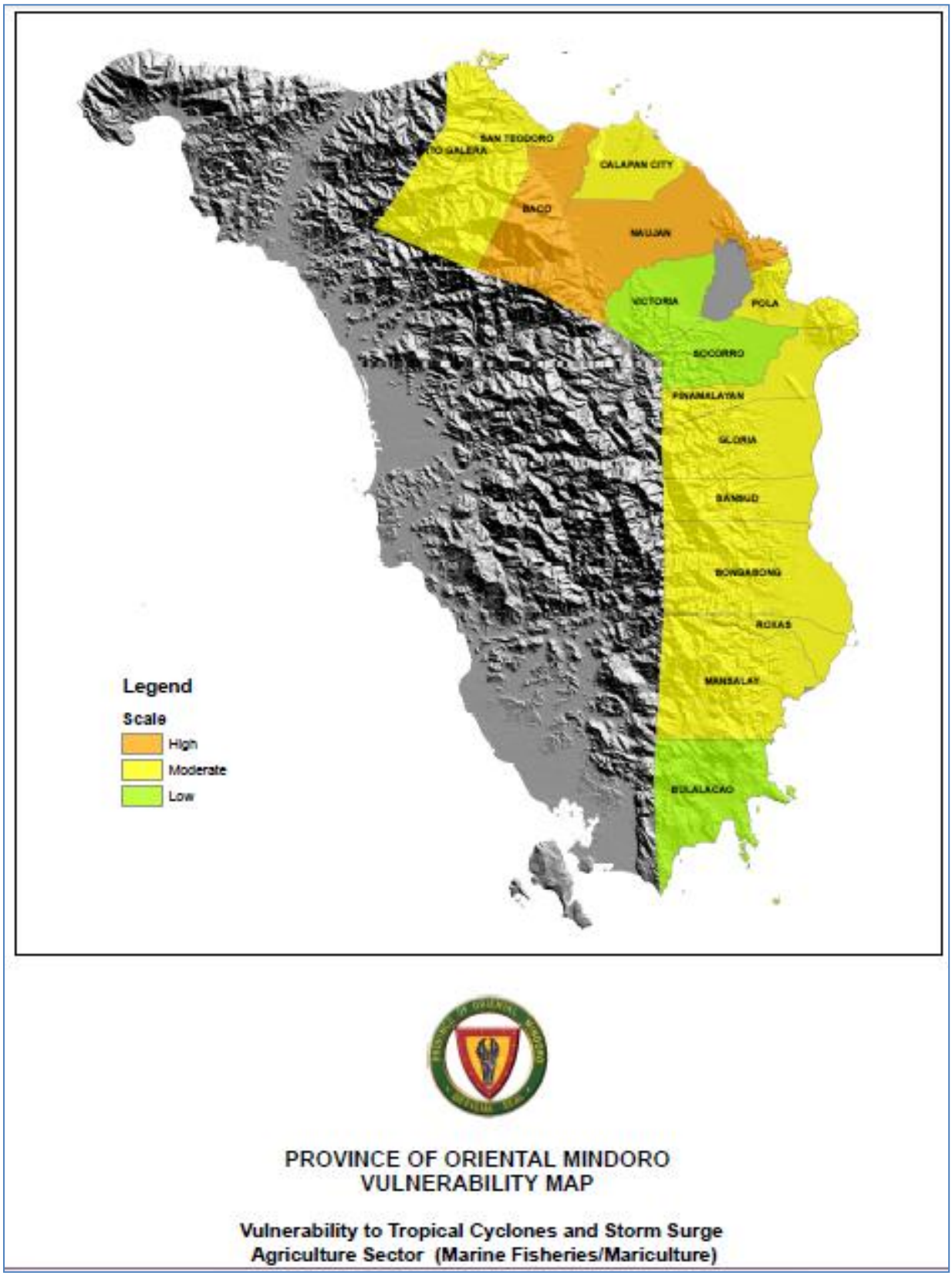

**Annex 46.** Map of Crop Production Vulnerability to Pests and Diseases



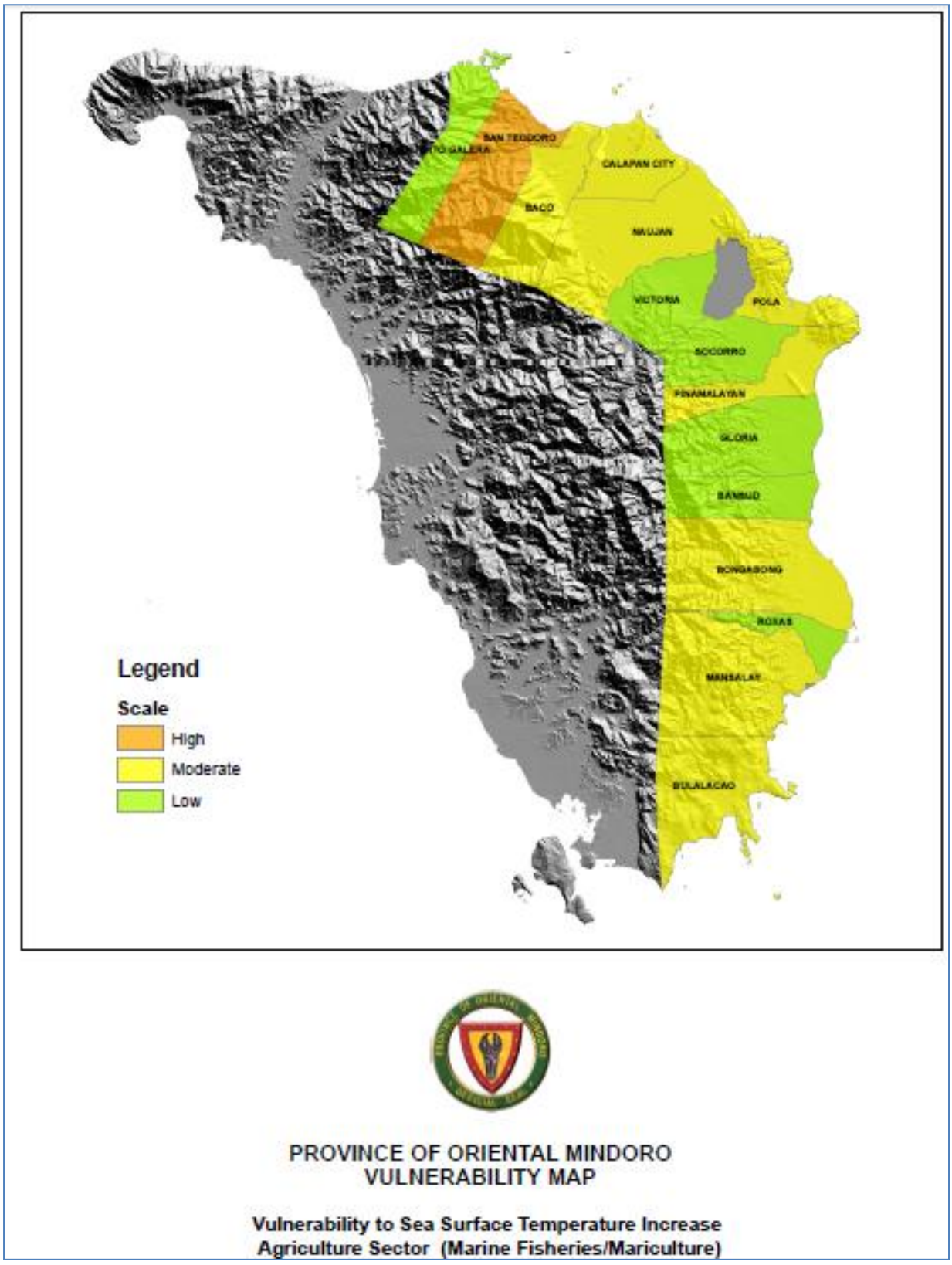

**Annex 47.** Map of Crop Production Vulnerability to Erosion



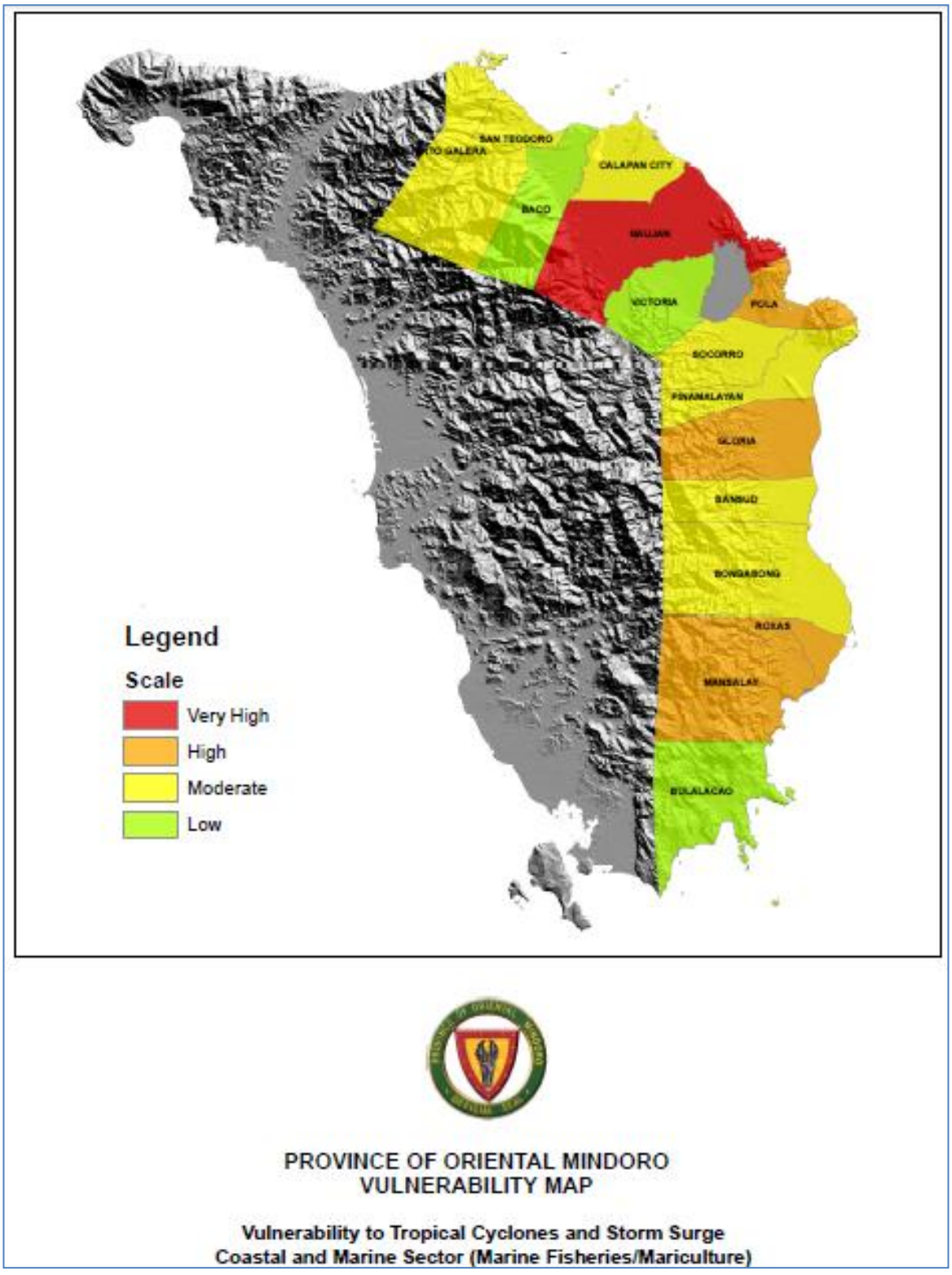

**Annex 48.** Map of Marine Fisheries/Mariculture Vulnerability to Sea Level Rise



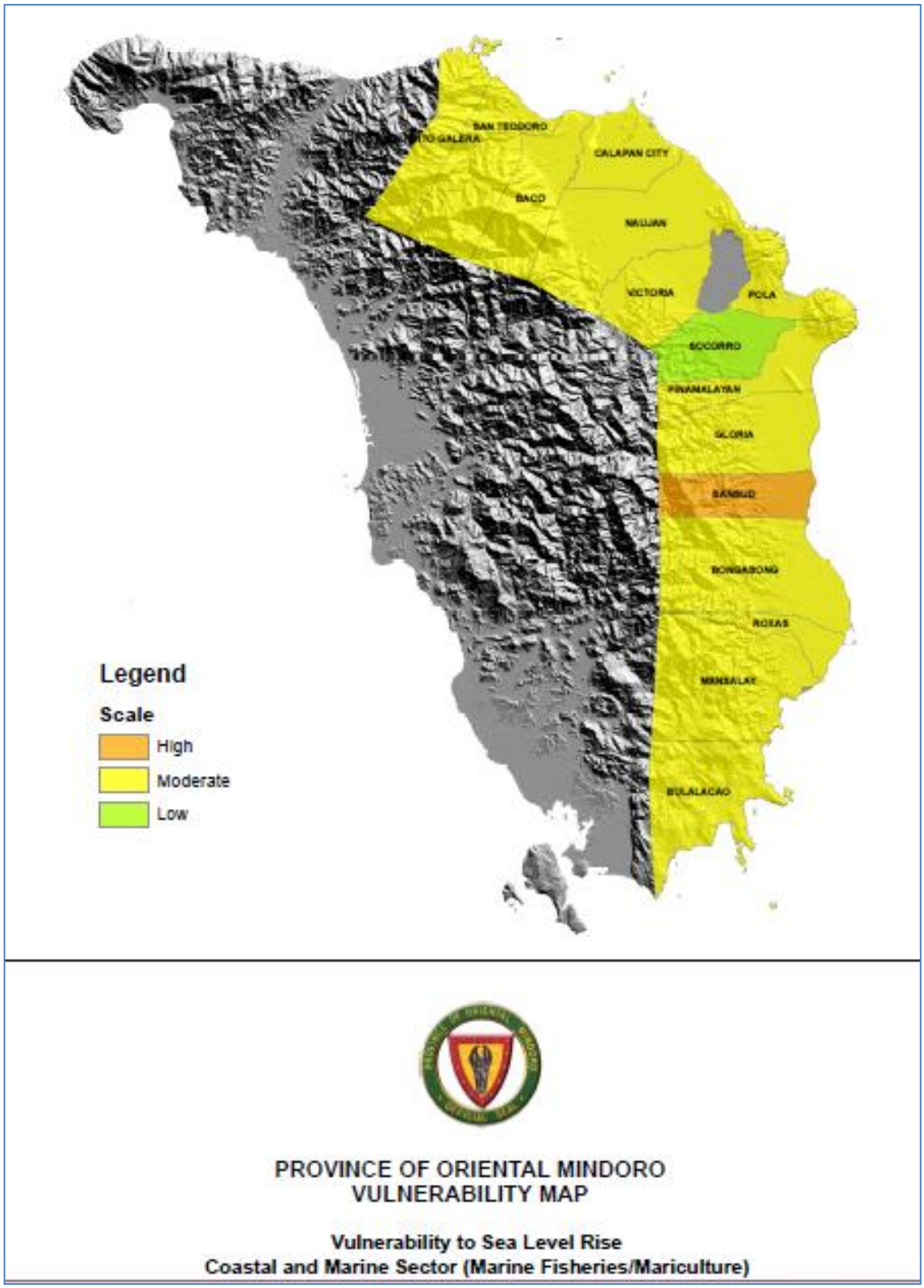

**Annex 49.** Map of Marine Fisheries/Mariculture Vulnerability to Tropical Cyclones and Storm Surge



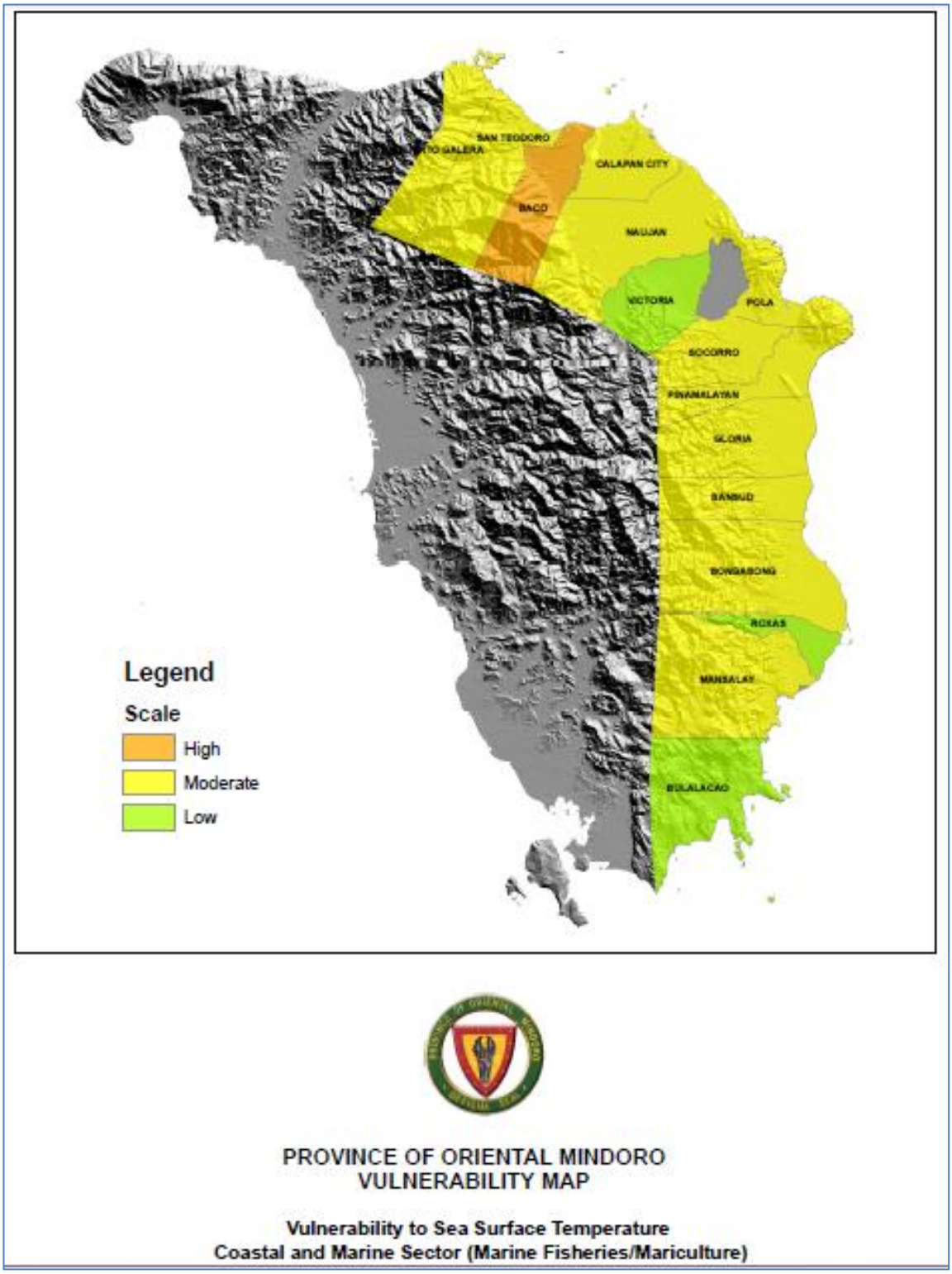

**Annex 50.** Map of Marine Fisheries/Mariculture Vulnerability to Sea Surface Temperature Increase



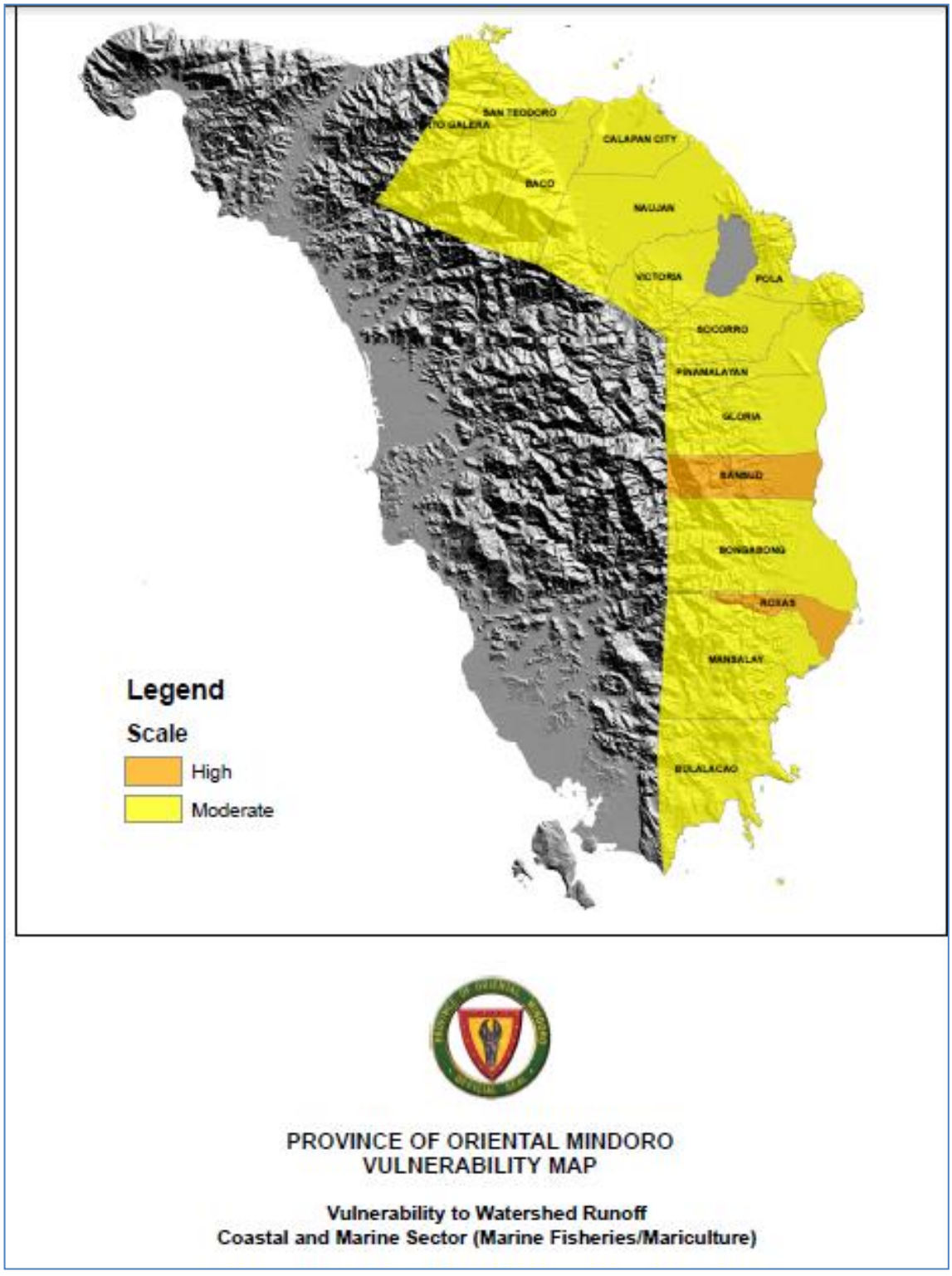

**Annex 51.** Map of Coastal and Marine Sector Vulnerability to Tropical Cyclones and Storm Surge



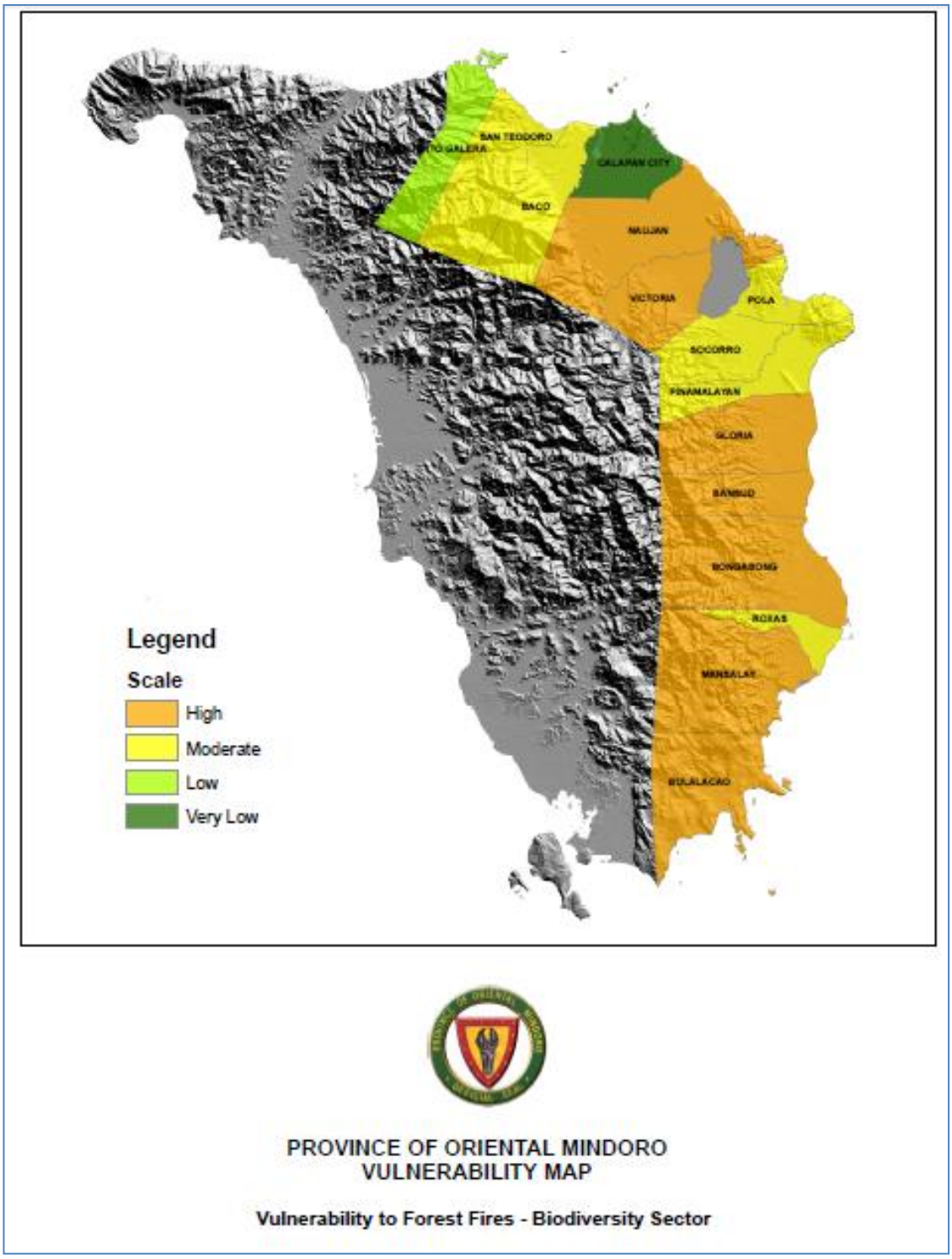

**Annex 52.** Map of Coastal and Marine Sector Vulnerability to Sea Level Rise



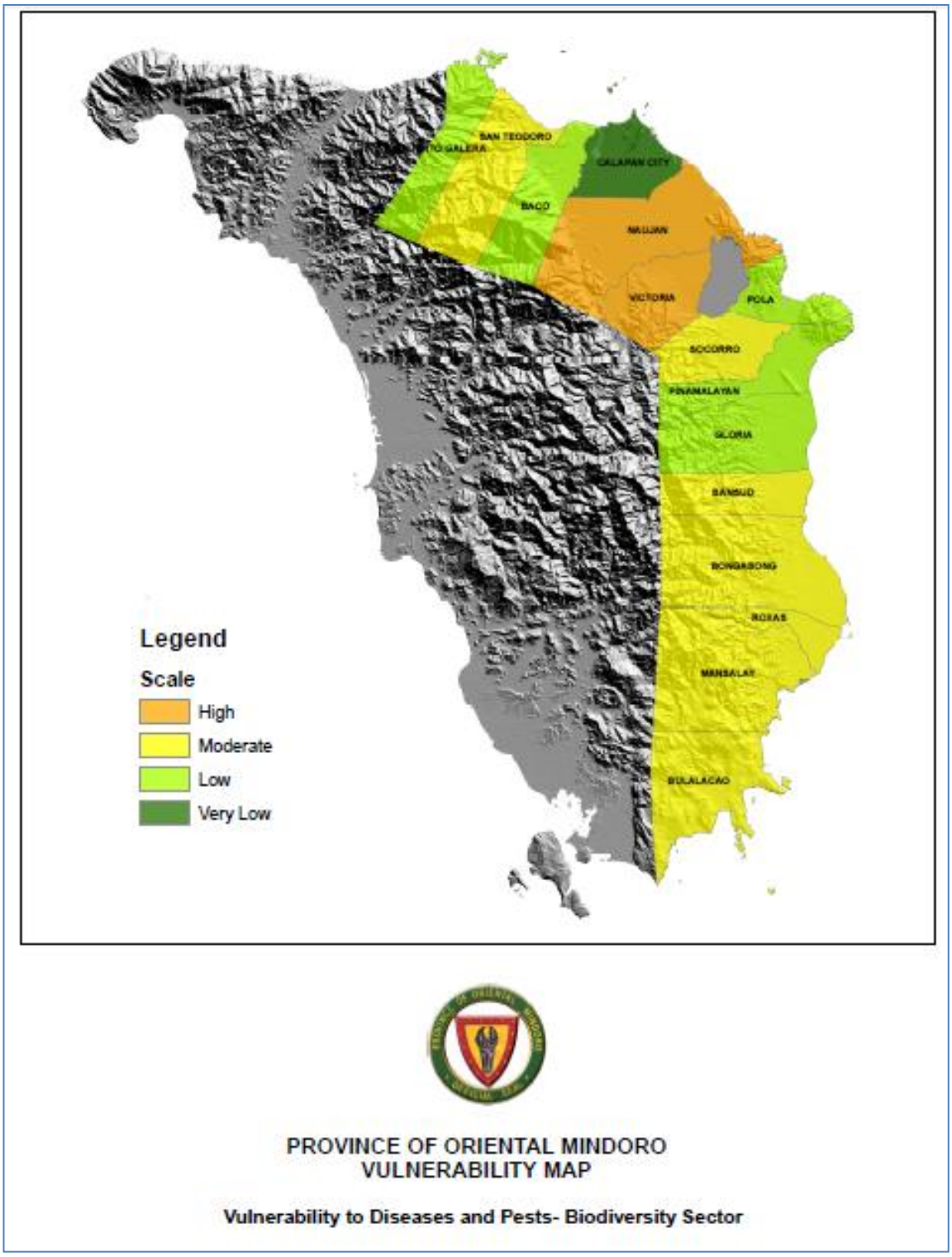

**Annex 53.** Map of Coastal and Marine Sector Vulnerability to Sea Surface Temperature



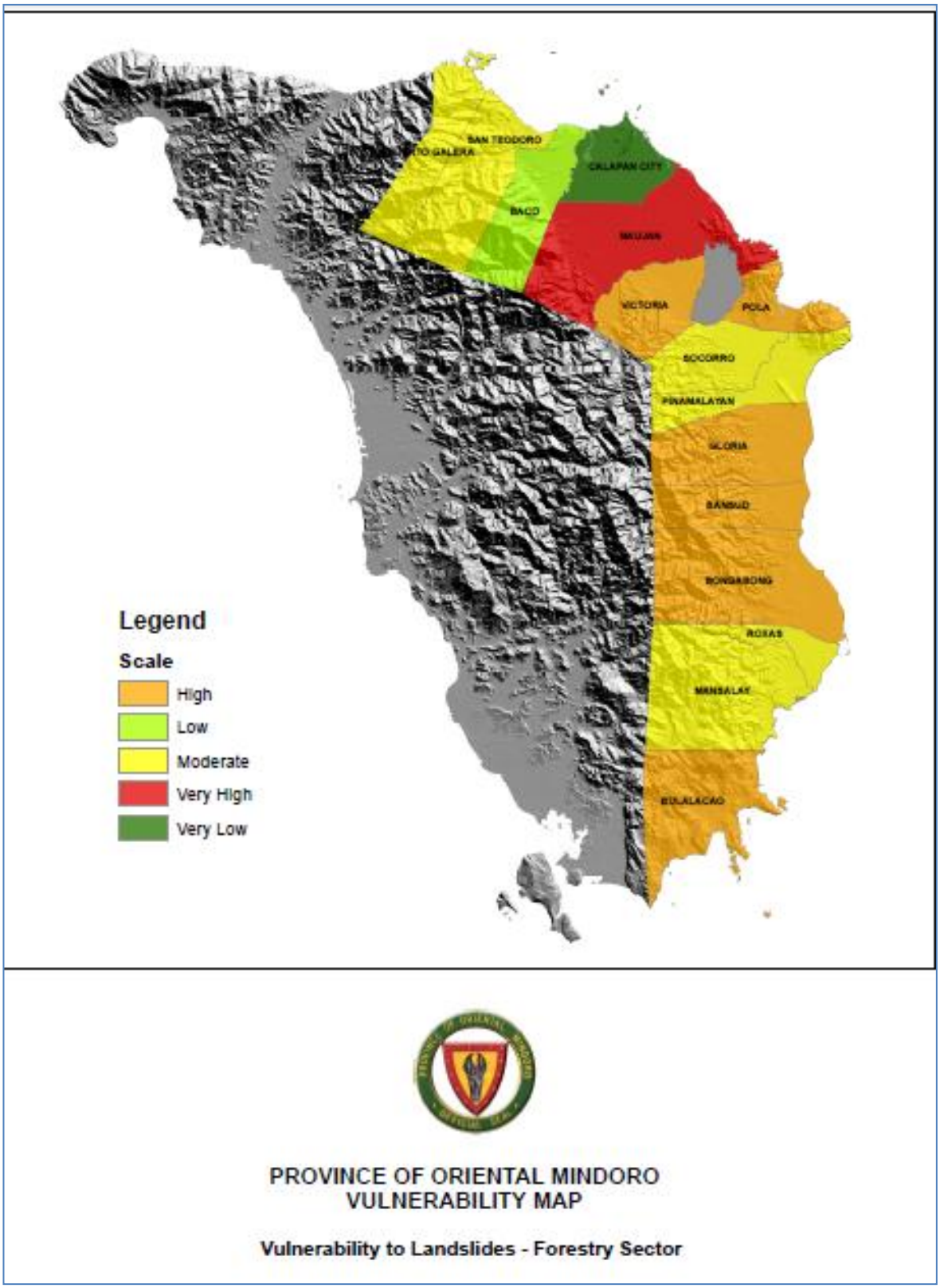

**Annex 54.** Map of Coastal and Marine Sector Vulnerability to Watershed Runoff



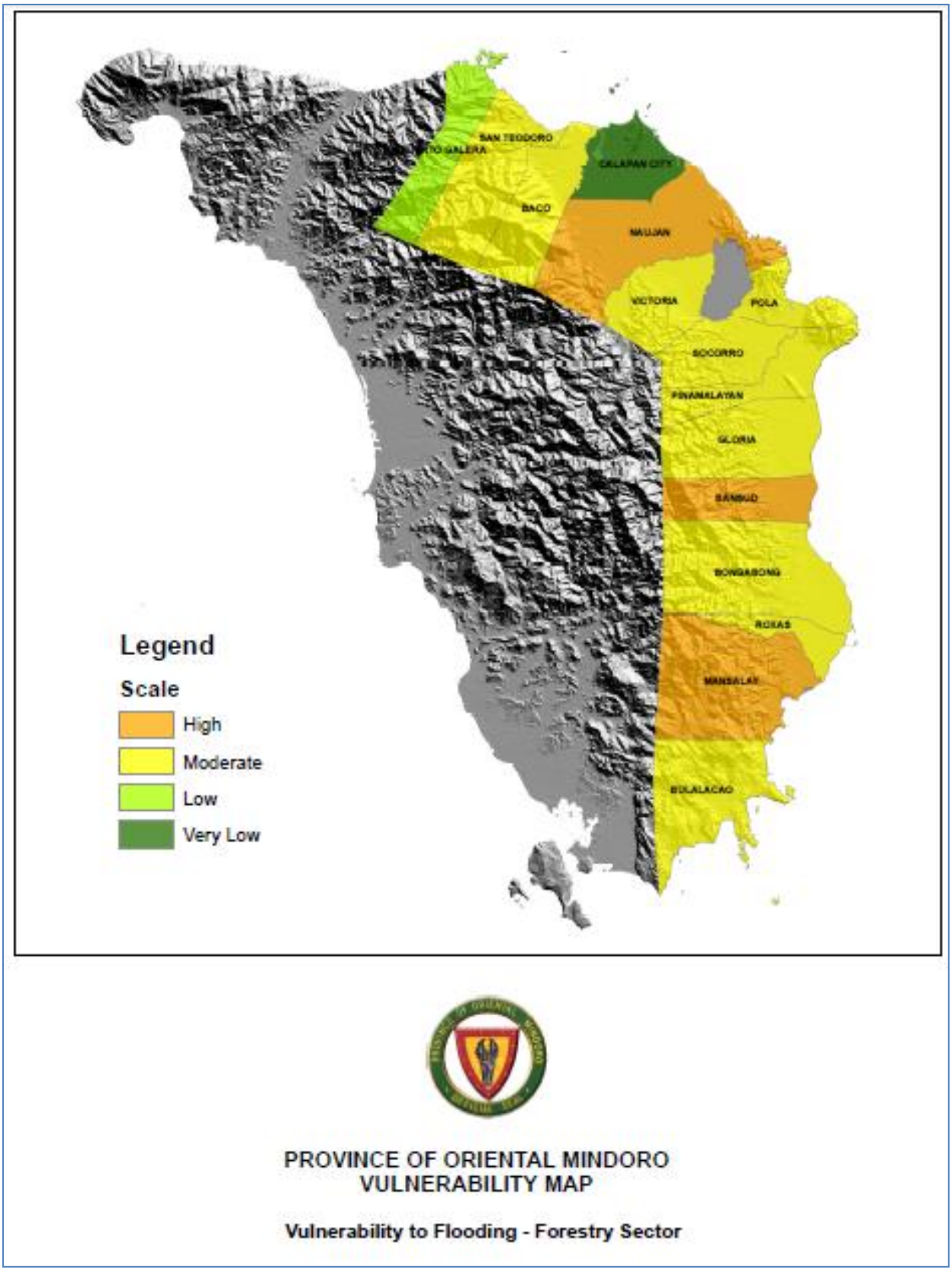

**Annex 55.** Map of Biodiversity Sector Vulnerability to Forest Fires



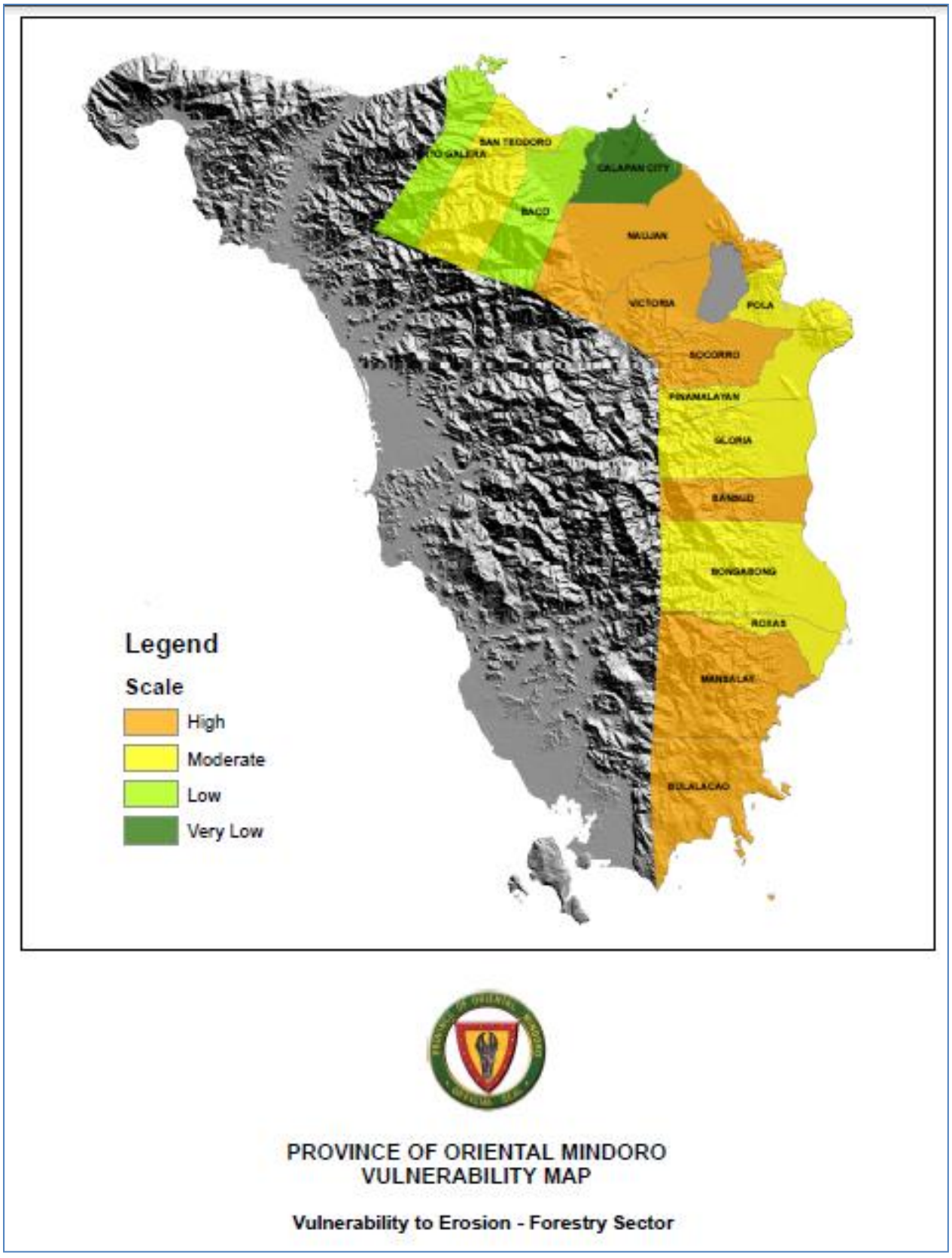

**Annex 56.** Map of Biodiversity Sector Vulnerability to Diseases and Pests



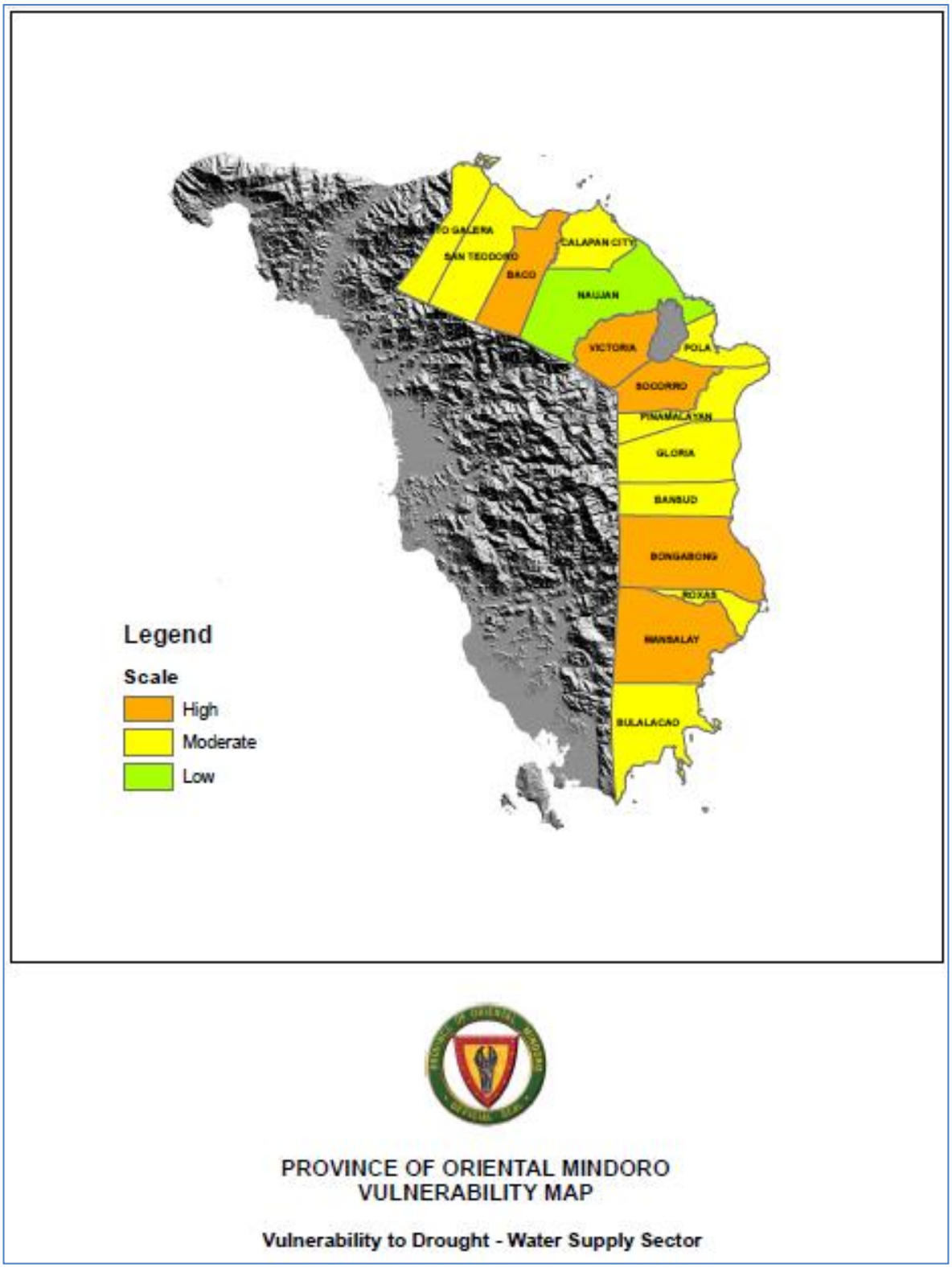

**Annex 57.** Map of Forestry Sector Vulnerability to Landslides



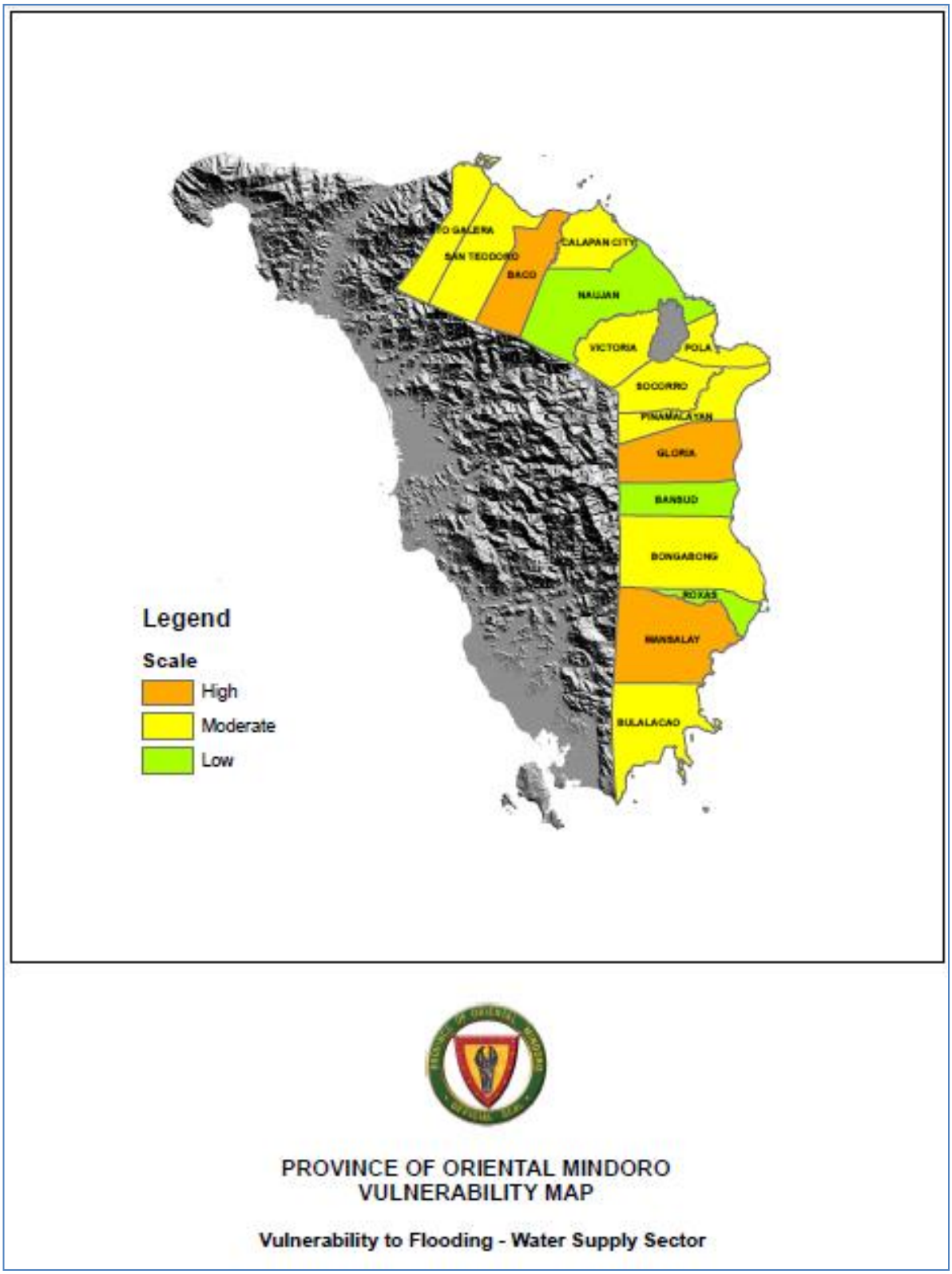

**Annex 58.** Map of Forestry Sector Vulnerability to Flooding



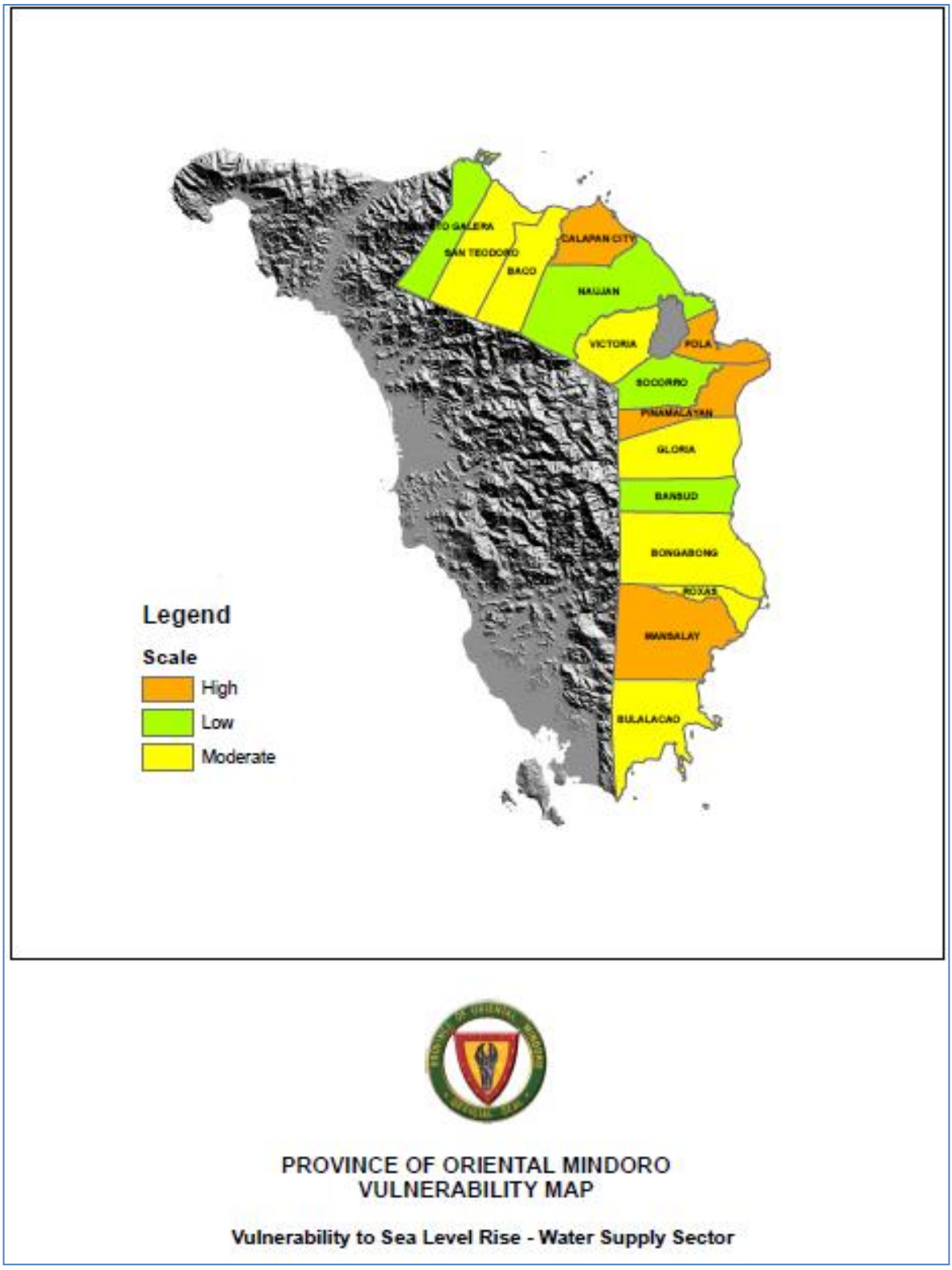

**Annex 59.** Map of Forestry Sector Vulnerability to Erosion



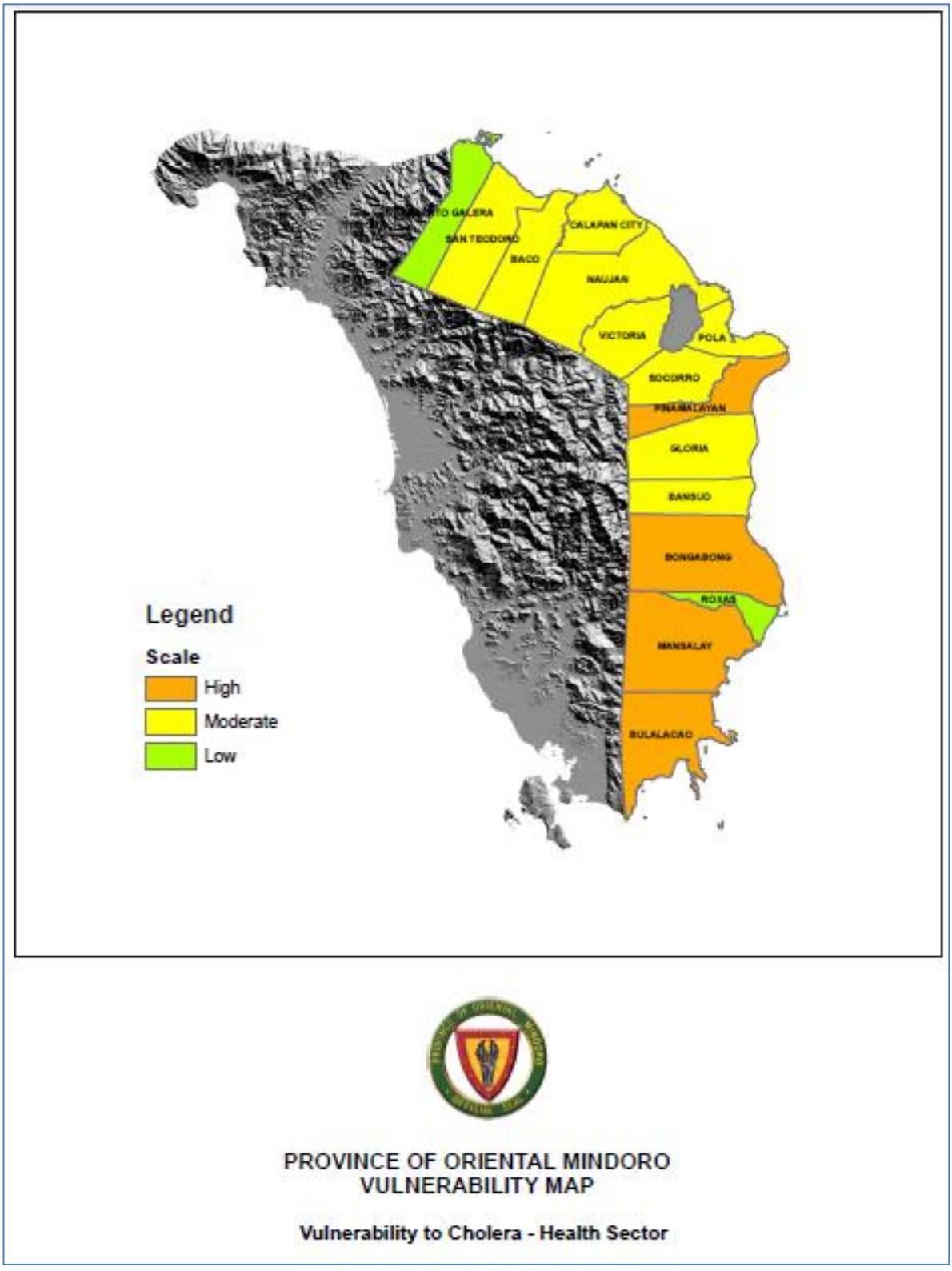

**Annex 60.** Map of Water Supply Sector Vulnerability to Drought



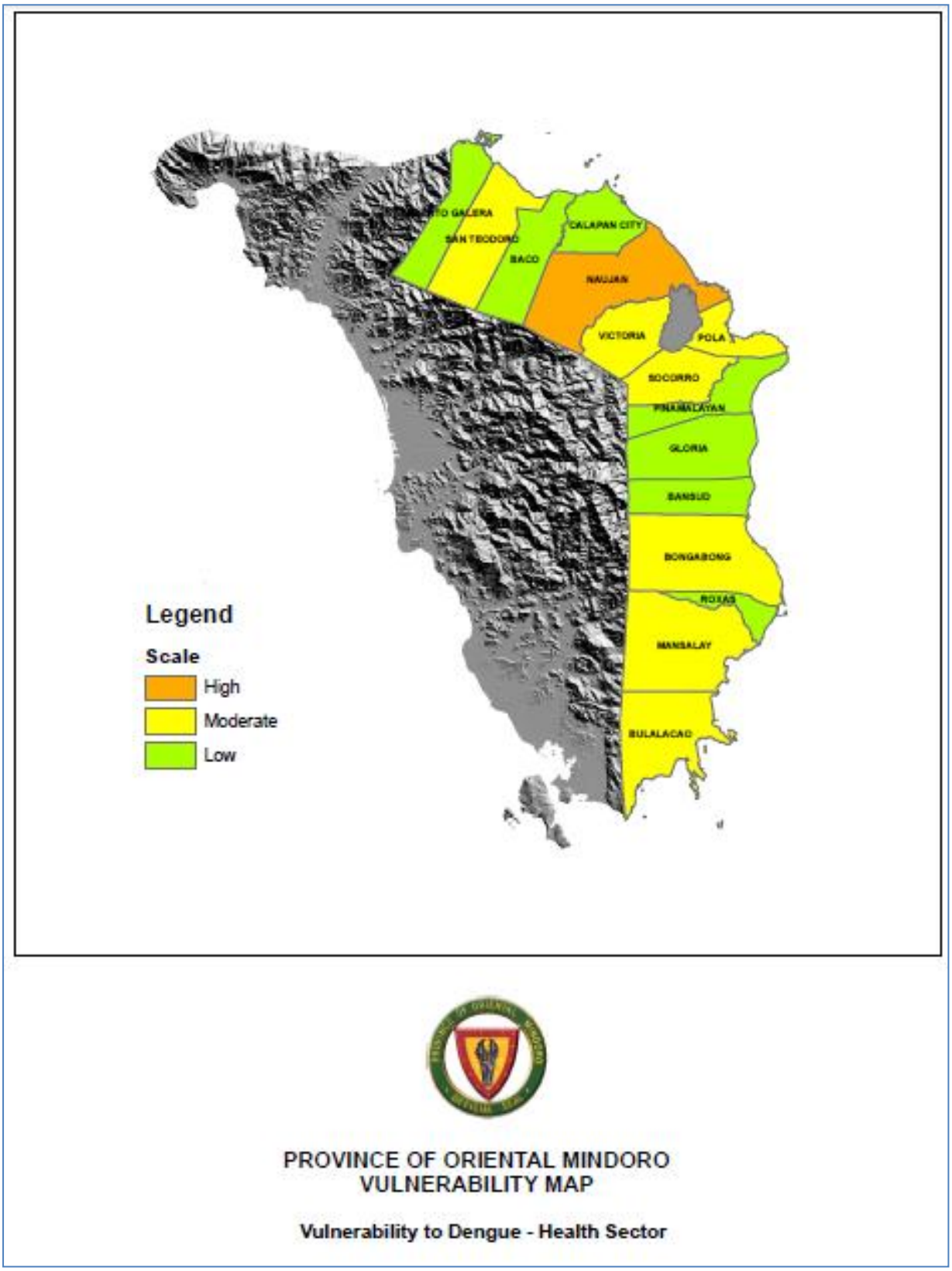

**Annex 61.** Map of Water Supply Sector Vulnerability to Flooding



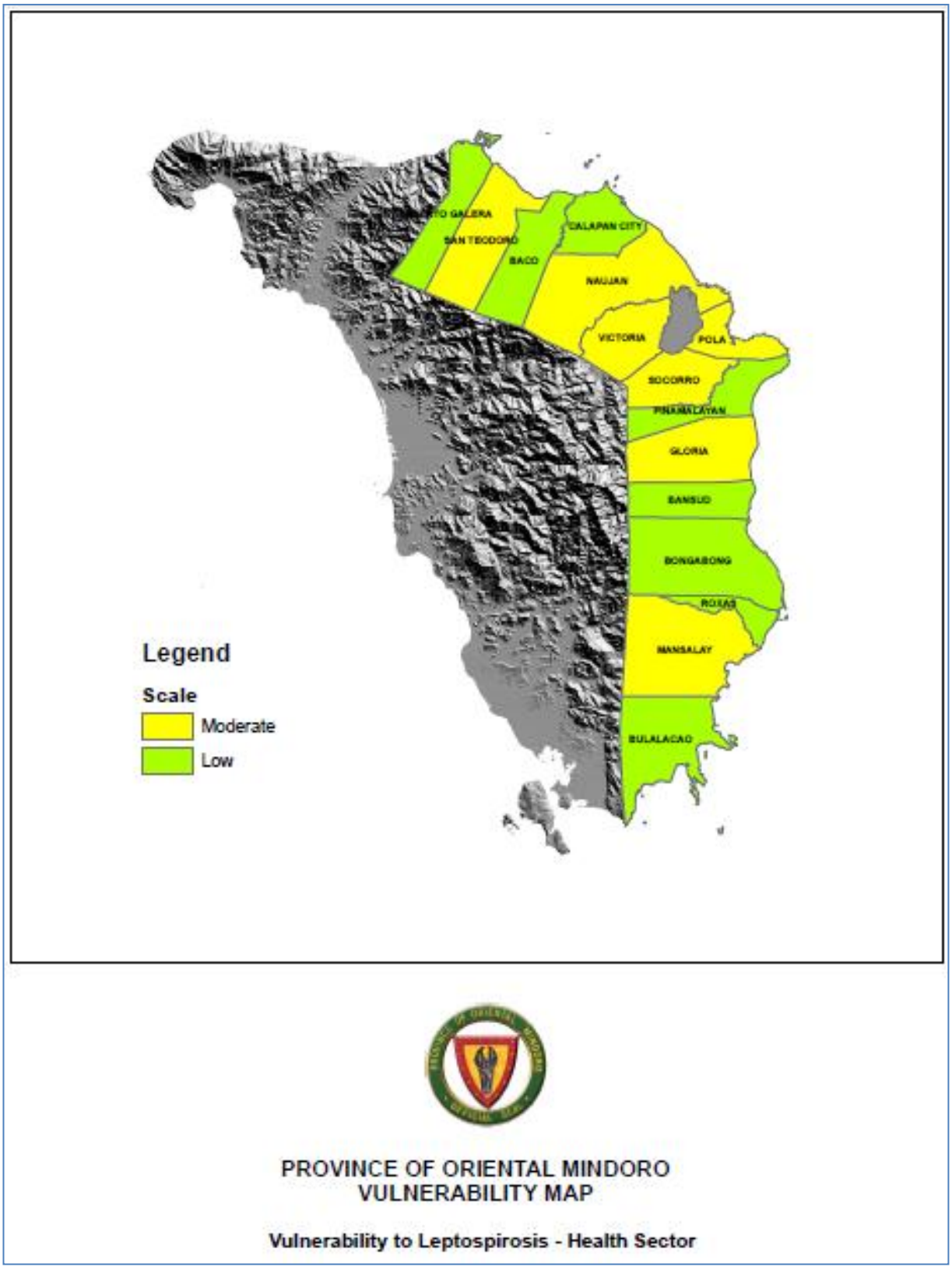

**Annex 62.** Map of Water Supply Sector Vulnerability to Sea Level Rise



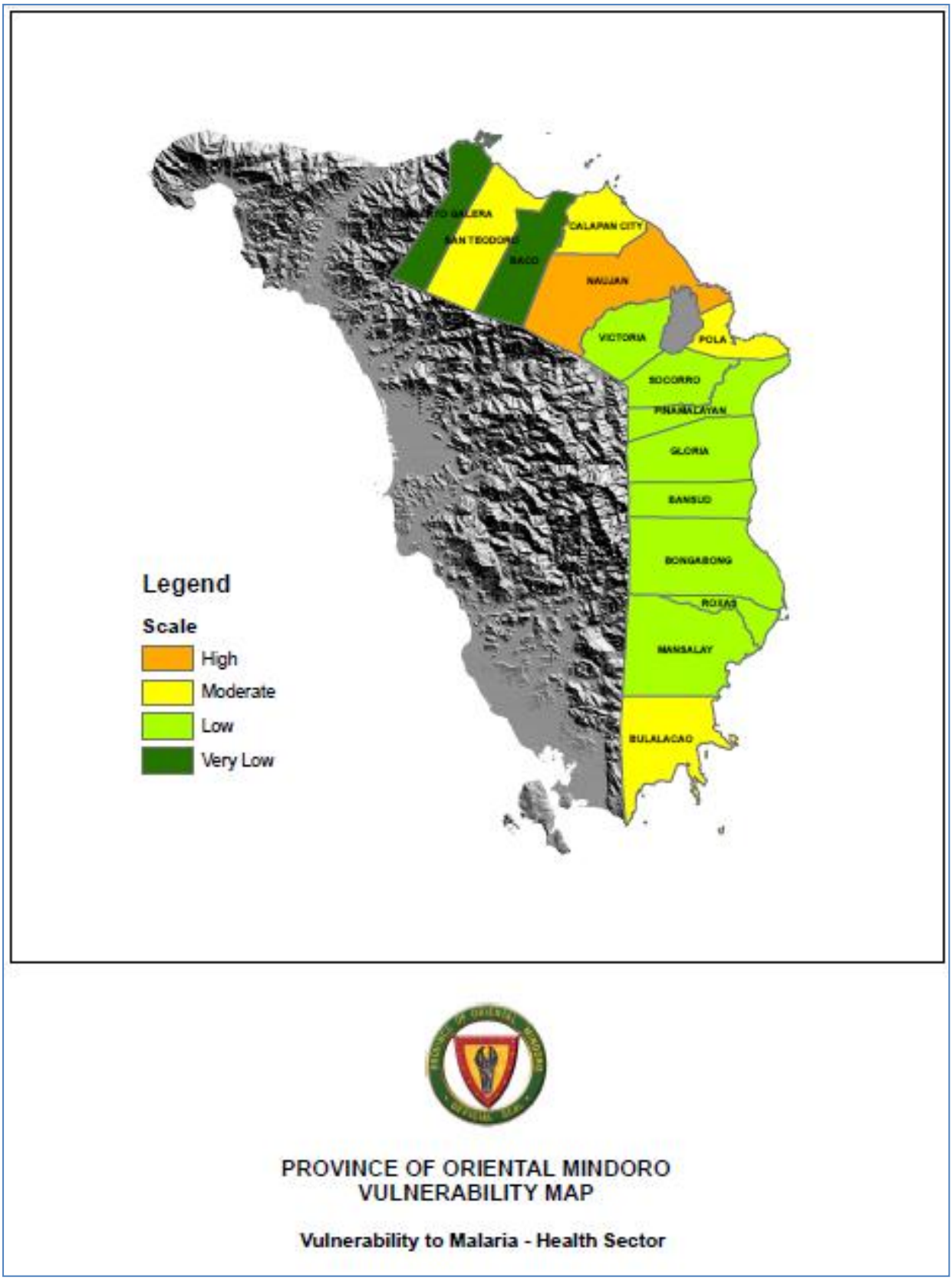

**Annex 63.** Map of Health Sector Vulnerability to Cholera




**Annex 64.** Map of Health Sector Vulnerability to Dengue




**Annex 65.** Map of Health Sector Vulnerability to Leptospirosis




**Annex 66.** Map of Health Sector Vulnerability to Malaria

**Annex 67.** Self-assessment of Disaster Risk Resiliency of the Province Using the Hyogo Framework

| Parameters/Questions | Briefly describe the specific actions taken or presently being undertaken with regards to the question being asked | Rating* (Mode) |
|---|---|---|
| 1. a) Does the provincial government have an organization and coordination in place to understand and reduce disaster risk, based on participation of citizen groups and civil society? | Yes. The Provincial Disaster Risk Reduction Management Council is functional and the PDRRM Office has been established. | 4 |
| b) Has the provincial government been able to build local alliances in DRRM? | Yes. There is a network of local volunteers established by PDRRMO. | 5 |
| c) Do all the departments in the provincial government understand their role to disaster risk reduction and preparedness? | Yes. Most departments are members of the PDRRM Council. | 4 |
| 2. a) Does the provincial government have a budget for disaster risk reduction? | Yes. Five percent of the Annual Budget was allocated as DRRM Fund. | 5 |
| b) Does it provide incentives for homeowners, low-income families, communities, businesses and public sector to invest in reducing the risks they face? | Not yet implemented | |
| 3. a) Does the provincial government maintain up-to-date data on hazards and vulnerabilities, prepare risk assessments and use these as the basis for urban development plans and decisions? | Yes. Database is maintained. | 4 |
| b) Are these information and plans for the province's resilience readily available to the public and fully discussed with them? | Yes. Information and education campaign are being done in communities and schools. | 5 |
| 4. Has the provincial government invested in and maintained critical infrastructure that reduces risk, such as flood drainage, adjusted where needed to cope with climate change? | Yes. Since 2011, PGOM allocates PhP 20 Million to prevent and mitigate disasters in the province. | 5 |
| 5. Does the provincial government conduct an assessment of the safety of all schools and health facilities and upgrade these as necessary? | Yes. It is being tackled during the conduct of Fire/Earthquake/Flood drills and simulation. | 5 |
| 6. a) Does the provincial government apply and enforce realistic, risk-compliant building regulations and land use planning principles? | Yes. PGOM orders LGUs to update their CLUPs and integrate DRRM into it. | 4 |

| Parameters/Questions | Briefly describe the specific actions taken or presently being undertaken with regards to the question being asked | Rating* (Mode) |
|---|---|---|
| b) Has the provincial government identified safe land for low-income citizens and develop upgrading of informal settlements, wherever feasible? | Yes. LGUs are the ones tasked to identify this and he PGOM can augment technically and financially. | 4 |
| 7. Does the provincial government have in place education programs and training on disaster risk reduction in schools and local communities? | Yes. It is included in the Annual Program Implementation Plan/Annual Investment Plan. | 5 |
| 8. a) Does the provincial government protect its ecosystems and natural buffers to mitigate floods, storm surges and other hazards to which it may be vulnerable? | Yes. Tree/Mangrove planting is being implemented. | 5 |
| b) Does the provincial government adapt to climate change by building on good risk reduction practices? | Yes. A Climate Change Adaptation and Mitigation Plan (CCHAMP) is being implemented. | 5 |
| 9. Does the provincial government have early warning systems and emergency management capacities installed and hold regular public preparedness drills? | Yes. Local Flood Early Warning System (LFEWS) is installed in San Andres and Mulawin, Naujan and Alcate, Victoria. | 4 |
| 10. a) Does the provincial government undertake reconstruction after any disaster? | Yes. Rehabilitation and recovery are implemented. | 4 |
| b) Does it ensure that the needs of the survivors are placed at the centre of reconstruction with support also coming from their community organizations to design and help implement responses, including rebuilding homes and livelihoods? | Yes. People are empowered by identifying their needs by themselves. | 4 |

Rating: 5 – Highly satisfactory; 4 – Moderately satisfactory; 3 –Fairly satisfactory; 2 – Poorly satisfactory; and 1 – Unsatisfactory

The Checklist builds on the priorities identified in the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* -www.unisdr.org/hfa

**Annex 68.** Assessment of Provincial Institutional Capacity to Implement LGU Mandates under the Climate Change Act (RA 9729)

| Mandates for Provincial LGUs | Briefly describe the actions taken or being undertaken with regards to the mandate | Compliance Rating |
|---|---|---|
| **Provide technical assistance, enforcement and information management in support of municipal and city climate change action plans.** | Yes. Capacity-building activities and IEC are being implemented in communities and schools. | 4 |
| **Conduct Inter-local government unit collaboration in the conduct of climate- related activities.** | Yes. LGUs are enjoined to conduct activities to adapt and mitigate climate change and provide funds thereto. | 3 |
| **Allocate from their annual appropriations adequate funds for the formulation, development and implementation, including training, capacity building and direct intervention, of their respective climate change programs and plans.** | Yes. Funds for CCA are allocated from the PDRRM fund. | 5 |
| **Conduct public awareness campaigns on the effects of climate change and energy-saving solutions to mitigate these effects, and initiatives, through educational and training programs and micro-credit schemes, especially for women in rural areas.** | Yes. As PGOM's DRRM and CCA programs are gender sensitive, women in communities are empowered. | 5 |

Rating: 5 – Fully met; 4 – Moderately met; 3 – Fairly met; 2 – Poorly met; and 1 – Not yet met

**Annex 69.** Assessment of Provincial Institutional Capacity to Implement LGU Mandates under the Disaster Risk Reduction and Management Act (RA 10121)

| Mandates for Provincial LGUs | Briefly describe the actions taken or being undertaken with regards to the mandate | Compliance Rating |
|---|---|---|
| **Establish an LDRRMO which shall be responsible for setting the direction, development, implementation and coordination of disaster risk management programs** | Yes. PDRRMO was established on 2011. | 5 |
| **Organize, train and directly supervise the local emergency response teams** | Yes. PDRT is functional. | 5 |
| **Design, program, and coordinate disaster risk reduction and management activities consistent with the National Council's standards and guidelines** | Yes. All activities and fund utilization are based on guidelines by NDRRMC and other national agencies. | 4 |
| **Facilitate and support risk assessments and contingency planning activities at the local level** | Yes. PDRRMO assists the communities in risk/hazard mapping and in revisiting their plans. | 4 |
| **Consolidate local disaster risk information which includes natural hazards, vulnerabilities, and climate change risks, and maintain a local risk map** | Yes. Hard and soft data of Participatory Capacities and Vulnerabilities Assessment (PCVA) are consolidated. | 4 |
| **Organize and conduct training, orientation, and knowledge management activities on disaster risk reduction and management at the local level** | Yes. IEC is an integral part of the PDRRMO's program. | 5 |
| **Operate a multi-hazard early warning system, linked to disaster risk reduction to provide accurate and timely advice** to national or local emergency response organizations and to **the general public, through diverse mass media, particularly radio, landline communications, and technologies for** communication within rural communities | Yes. Community-based and technology-based early warning system (EWS) are used. | 4 |
| **Formulate and implement a comprehensive and -integrated LDRRMP in accordance with the national, regional and provincial framework, and policies on disaster risk reduction in close coordination with the local development councils (LDCs)** | Yes. The National DRRM Framework is the basis of the PDRRM Plan. | 4 |
| **Prepare and submit to the local Sanggunian through the LDRRMC and the LDC the annual LDRRMO Plan and budget, the proposed programming of the LDRRMF, other dedicated disaster risk reduction and management resources, and other regular funding *source/s* and budgetary support of the *LDRRMO /BDRRMC*** | Yes. Annual PDRRM Plan, Annual Investment Plan and other pertinent documents are accomplished for the approval of LDC, LDRRMC and SP. | 4 |

| Mandates for Provincial LGUs | Briefly describe the actions taken or being undertaken with regards to the mandate | Compliance Rating |
|---|---|---|
| **Conduct continuous disaster monitoring and mobilize instrumentalities and entities of the LGUs, CSOs, private groups and organized volunteers, to utilize their facilities and resources for the protection and preservation of life and properties during emergencies in accordance with existing policies and procedures** | Yes. Daily monitoring of weather updates are done. Continuous monitoring are carried out after the occurrence of a weather disturbance. Volunteers are tapped and mobilized. | 5 |
| **Identify, assess and manage the hazards. vulnerabilities and risks that may occur in their locality** | Yes. This is part of the IEC and implementation of disaster mitigation projects. | 4 |
| **Disseminate information and raise public awareness about those hazards. vulnerabilities and risks, their nature,** effects, early warning signs and **counter-measures** | Yes. Communities are trained on DRRM implementation. | 4 |
| **Identify and implement cost-effective risk reduction** measures/strategies; | Yes. Disaster mitigation projects are implemented. | 4 |
| **Maintain a database of human resource, equipment, directories, and location of critical infrastructures and their capacities such as hospitals and evacuation centers** | Yes. List of PDRRMC members, local volunteers, MDRTs as well as their resources are maintained. | 5 |
| **Develop, strengthen and operationalize mechanisms for partnership or networking with the private sector, CSOs, and volunteer groups** | Yes. There is an existing partnership with volunteer groups and private sector and we continue to expand it. | 5 |
| **Take all necessary steps on a continuing basis to maintain, provide, or arrange the provision of, or to otherwise make available, suitably-trained and competent personnel for effective civil defense and disaster risk reduction and** management in its area | Yes. PDRRMO personnel attend trainings to enhance skills particularly BLS and first aid. | 4 |
| **Organize, train, equip and supervise the local emergency response teams and the ACDVs ensuring that humanitarian aid workers are equipped with basic skills to assist mothers to breastfeed** | Yes. PDRT/MDRTs are trained to implement gender-sensitive DRRM programs. | 4 |
| **Prepare and submit, through the LDRRMC and the LDC, the report on the utilization of the LDRRMF and other dedicated disaster risk reduction and management resources to the local Commission on Audit (COA), copy furnished the regional director of the OCD and the Local Government Operations Officer of the DILG** | Yes. Reports on the utilization of the PDRRMF are prepared and submitted to concerned agencies. | 4 |

| Mandates for Provincial LGUs | Briefly describe the actions taken or being undertaken with regards to the mandate | Compliance Rating |
|---|---|---|
| **Respond to and manage the adverse effects of emergencies and carry out recovery activities in the affected area, ensuring that there is an efficient mechanism for immediate delivery of food, shelter and medical supplies for women and children, endeavour to create a special place where internally-displaced mothers can find help with breastfeeding, feed and care for their babies and give support to each other** | Yes. Response mechanism is activated. | 5 |
| **Within its area, promote and raise public awareness of and compliance with the DRRM Act and legislative provisions relevant to the purpose of this Act** | Yes. RA 10121 is discussed in CBDRRM trainings and orientation. | 4 |
| **Serve as the secretariat and executive arm of the LDRRMC** | Yes. PDRRMO actively act as secretariat. | 5 |
| **Coordinate other disaster risk reduction and** management activities | Yes. PDRRMCs and other concerned groups are coordinated. | 4 |
| **Establish linkage/network with other LGUs for disaster risk reduction and emergency response purposes** | Yes. MDRRMOs are regularly coordinated as well as their MDRTs. | 5 |
| **Recommend through the LDRRMC the enactment of local ordinances consistent with the requirements of this Act** | Yes. Matters that need legislative actions are brought to local sanggunian. | 4 |
| **Implement policies, approved plans and programs of the LDRRMC consistent with the policies and guidelines laid down in this Act** | Yes. RA 10121 serves as guide in the implementation of DRRM. | 4 |
| **Establish a Provincial Disaster Risk Reduction and Management Operations Center** | Yes. OPCEN is functional. | 4 |
| **Prepare and submit, through the LDRRMC and the LDC, the report on the utilization of the LDRRMF and other dedicated disaster risk reduction and management resources to the local Commission on Audit (COA), copy furnished the regional director of the OCD and the Local Government Operations Officer of the DILG** | Yes. Reports on utilization of LDRRM Fund are submitted to LDC , LDRRMC and other concerned government agencies. | 4 |
| **Encourage community, specifically the youth, participation in disaster risk reduction and management activities, such as organizing quick response groups, particularly in identified disaster-prone areas, as well as the inclusion of disaster risk reduction and management programs as part of the SK programs and projects** | Yes. Youth groups are trained and oriented on DRRM to act as volunteers. | 4 |

| Mandates for Provincial LGUs | Briefly describe the actions taken or being undertaken with regards to the mandate | Compliance Rating |
|---|---|---|
| **Monitor and evaluate the use and disbursement of the LDRRMF based on the LDRRMP as incorporated in the local development plans and annual work and financial plan** | Yes. Funds are utilized based on LDRRMP, AIP and other annual plans. | 4 |

*Rating: 5 – Fully met; 4 – Moderately met; 3 – Fairly met; 2 – Poorly met; and 1 – Not yet met*

**Annex 70.** Checklist for Evaluating Gaps and Weaknesses in LGU's PPAs on DRRM

| DRRM Phase | Strategies and Measures Required | LGU Gaps and Weaknesses |
|---|---|---|
| *Pre-disaster* | | |
| **-Prevention or avoidance** | **Proper siting of human settlements**. New urban towns and new settlement areas should be located away from disaster prone areas | Funds for procurement of housing sites are limited. |
| | **Proper zoning of disaster prone areas**. Areas frequently devastated by floods, volcano eruption, landslides, mudslides, rockslides should be zoned as danger zones and their land uses should be strictly regulated; residents occupying highly vulnerable areas should be relocated and resettled. | Strict implementation of zoning and land use are not carried out. |
| | **Strict monitoring and prohibiting the occupation by informal settlers of hazard zones**. Danger zones should be closely guarded to prevent informal settlers from intruding and occupying these areas. | LGUs have efforts to do this. |
| | **Preserving or conserving natural defense**. Critical environment and natural resources should be protected and conserved because they are natural buffer zones against natural disasters. Degraded environments further trigger or aggravate disasters. | LGUs have opposing views on environmental protection and entries of business (eg. Mining) |
| | **Reducing trigger factors and sources contributing to climate change, landslides and flooding** (e.g., climate change – emission of GHGs; landslides – improper uses and denudation of unstable slopes; flooding – heavy siltation or obstruction of river channels and built-up of river flood plains; drought effects on wetlands and biotic components). | Strict implementation of laws and ordinances |
| | **Improving socio-economic status of vulnerable communities**. Poverty reduction programs should be established and greater opportunities for employment should be provided. Resilient, low cost and affordable housing projects for resettled or relocated communities should be made available | Offices/Agencies convergence are done to pool resources and carry out PPAs for poverty reduction. |

| DRRM Phase | Strategies and Measures Required | LGU Gaps and Weaknesses |
|---|---|---|
| **-Mitigation** | **Providing access to insurance or various forms of risk transfer mechanism**. Awareness and access of disaster-prone communities to insurance systems should be provided. | Not yet fully met although some LGUs provide funds for this. |
| | **Establishing emergency operation system.** Emergency action systems should be in place (e.g., SOPs) to safeguard populations from hazards brought about by physical events. | MDRTs are now formed to execute response mechanisms. |
| | **Properly enforcing building codes and fire codes**. Existing building regulations and requirements should be properly enforced. | Strict implementation of laws and ordinances. |
| | **Strictly enforcing environmental laws and regulations to minimize the adverse impacts of climate change**. Monitor compliance to environmental laws and regulations by developers and residents. | Strict implementation of laws and ordinances. |
| | **Issuing local ordinances on safety of communities**. Local ordinances establishing measures for communities to stay away from disaster risk areas and adopt prescribed safety measures should be issued and strictly enforced. | Strict implementation must be done. |
| | **Providing appropriate engineering interventions or structural measures**. Physical structures/infrastructures like dams, levees, flood control and drainage, river bank and road bank stabilization structures (e.g., rip raps) should be constructed and properly maintained. | PGOM provides funds for this annually. |
| | **Developing and building climate change resilient architecture designs** such as green buildings and water-proofed housing, and using climate change resistant construction materials in vulnerable areas. | Not yet met. |

| DRRM Phase | Strategies and Measures Required | LGU Gaps and Weaknesses |
|---|---|---|
| **-Preparedness** | **Forecasting and planning for disaster risk management**. Establishing local weather forecasting stations to support emergency planning and operations. Disaster risk management plan and contingency plan should be formulated and implemented. DRM plans and programs should be mainstreamed into local planning and decision-making processes (e.g., CLUPs and CDPs). | Contingency plans are available but not updated. |
| | **Community organizing**. Communities serving as planning and response teams during pre-disaster and disaster phases should be organized and mobilized during disaster events. | Community volunteers are organized and trained. |
| | **Training on disaster risk management**. Local DRM teams should be trained on planning, program implementation, monitoring, early warning and alert systems. | It is presently being done by LGUs. |
| | **Developing early warning system** involves mapping of routes and safe grounds for evacuation, installation of alarm systems in strategic locations. | |
| | **Conducting drills and exercises**. Simulation drills and exercises for safe evacuation due to fire, flooding, typhoon, earthquake, tsunami, storm surge, and volcanic eruption should be conducted periodically. | Schools are active in conducting drills but this should be done regularly at the community level. |
| | **Stockpiling of food and other emergency needs**. Food, medicines and other paraphernalia and equipment (e.g., inflatable boats, fire extinguisher, chainsaw, ropes, etc.) should be stockpiled for use during emergency situations. | Except for food, LGUs have stockpiles of non-food items. |
| | **Providing evacuation conveyance and protective shelters**. Transportation facilities during evacuation should be made available and evacuation centers with adequate facilities should be provided. | LGUs provide transportation facilities. |

| DRRM Phase | Strategies and Measures Required | LGU Gaps and Weaknesses |
|---|---|---|
| | **Conducting hazard assessment and mapping**. Hazard assessment and mapping of disaster-prone areas and proper dissemination of textual and spatial information for planning and action programming should be conducted. | Community-based hazard mapping and assessment are being done. |
| | **Conducting public information and awareness**. Public information and awareness on DRM should be conducted and participation of local communities in DRM programs and activities should be advocated. | LGUs undertake Information and Education Campaign. |
| | **Undertaking communications and early warning activities**. Monitoring, early warning and alert systems involving reliable and effective means of communications should be undertaken. | Community-based systems are utilized. |
| *Disaster* | Establishing and operating incident command system. | Not yet met |
| **Response** | Providing health services and temporary shelter with adequate facilities | Not yet met |
| | Providing relief goods (food, water, medicines and other material needs of affected families). | LGUs were provided augmentation from PGOM and other agencies. |
| | Undertaking search and rescue operations | Rescue operations were done with the assistance of PNP and Army/BFP/PCG. |
| | Assessing damages and analyzing needs of affected communities. | LGUs should be trained. |