CAVITE PROVINCE

PROVINCIAL DISASTER RISK REDUCTION AND MANAGEMENT PLAN 2011-2016

INTRODUCTION

Disasters or emergencies can happen suddenly, creating a situation in which the everyday, routinely and sometimes dreary existence of a community can become overwhelmed. During crises, the Province requires special procedures to address the needs of emergency response operations and recovery management. To address such emergencies, the Province of Cavite has established a Disaster Risk Reduction and Management Plan (DRRMP), which provides a guideline for the immediate action and operations required to respond to an emergency or disaster.

The Province of Cavite has one of the most dynamic and vibrant economy in the Philippines. This could be attributed to several innate and competitive advantages it has compared to other provinces in the country. The crucial question, however, is how the Province can sustain this performance to generate far more jobs and continue to become a destination of choice for investors and tourists alike.

The danger of climate change arguably presents a greater threat than what the government sees as its priorities such as education, health and poverty. If sustained growth is to take place, this challenge must be met. Specifically, we need to strengthen disaster resilience, care more for the urban environment, and confront climate change as part of the growth paradigm.

In other words, planners should include disaster resilience into its growth strategies and raise the priority of urban management as a strategic thrust. This would ensure that development plans that are viewed to facilitate economic growth are designed in such a way that would attain the desired level of prosperity without sacrificing the needed balance with the environment.

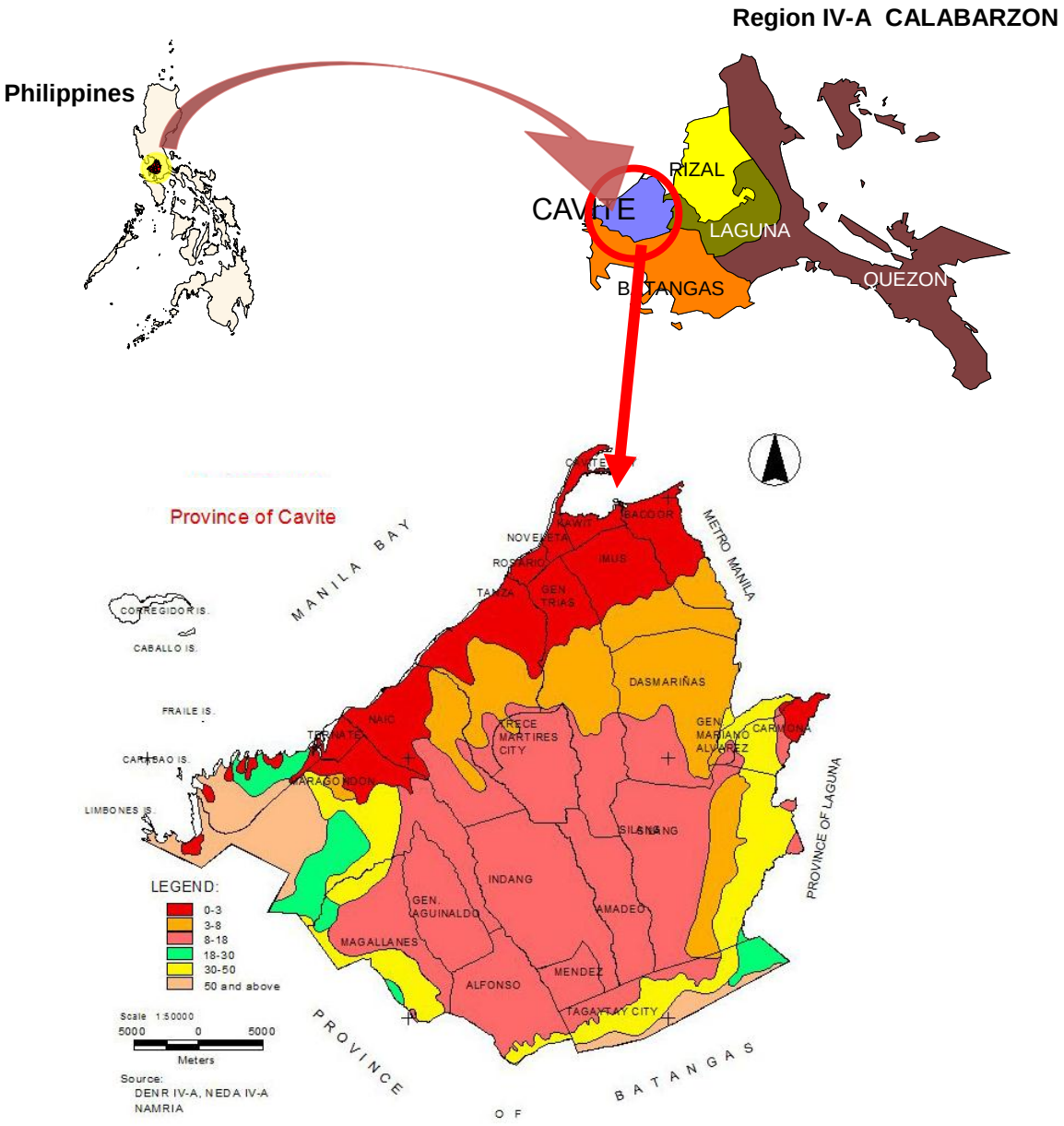
PURPOSE

The plan establishes policies and procedures that allow the Province to save lives, minimize injuries, protect property, preserve a functioning administration, and maintain activities essential to their survival and recovery from natural and man-made hazards. It establishes the guidelines for conducting efficient, effective, coordinated emergency operations involving the use of all resources belonging to the Province or available to it.

I. Provincial Profile

1.0 Location and Boundaries

Cavite province is situated south of Luzon, the most northerly of the large islands of the Republic of the Philippines. It is bounded by its neighboring provinces of Batangas in the south, Laguna on the east, Rizal on the northwest, Metro Manila and Manila Bay on the north, and China Sea on the west.



It is geographically located at latitude (14.2803 degrees) 14° 16' 49" North of the Equator and longitude (120.8664 degrees) 120° 51' 59" East of the Prime Meridian on the Map of the world.

2.0 Land Area and Landforms

2.1 Land Area

Cavite has a total land area of 142,706 hectares or 1,427.06 square kilometers representing approximately 8.72 percent of the CALABARZON's total land area and 0.48 percent of the total land area of the country.

2.2 Political Subdivision

The province is divided into seven legislative districts, composed of 19 municipalities and 4 cities having a total of 829 barangays. The four cities include the seat of the Provincial Government- Trece Martires City, the defense frontier- Cavite City, the provincial summer capital- Tagaytay City and the newly declared City of Dasmariñas under the Republic Act 9723 which was ratified last November 25, 2009. The City of Dasmariñas also happens to be a lone legislative jurisdiction of District IV.

By virtue of Presidential Decree 1163, Imus is the provincial capital but the seat of the provincial government is located at Trece Martires City.

2.3 Topography

Cavite is divided into four (4) physiographical areas, namely: the lowest lowland area, lowland area, the central hilly area and the upland mountainous area.

The lowest lowland area is the coastal plain in particular. These areas have extremely low ground level of 0 to 2 meters elevation compared to the high tide level of about 0.8 meter elevation from the Mean Sea Level (MSL). These are the municipalities of Bacoor, Kawit, Noveleta and Rosario.

The lowland area consists of the coastal and alluvial plains. These areas have flat ground slope of less than 0.5 percent and low ground elevation of 2 to 30 meters elevation. The alluvial plain can be found in the municipality of Imus and southern part of General Trias. Within these municipalities forms the transition area between the coastal plain and the central hilly area. It also covers some areas of Bacoor, Kawit, Noveleta, Rosario and Tanza.

The third topography type is the central hilly area, generally found on the mountain foot slope. It forms the rolling tuffaceous plateau. This topography includes steep hills, ridges and elevated inland valley. The plateau is characterized with ground elevation ranging from 30 meters to nearly 400 meters. Its ground slope ranges from 0.5 to 2 percent. The cities of Trece Martires and Dasmariñas and the municipalities of Indang and Silang have this kind of topography.

The last topography type is upland mountainous area, found in Amadeo and Tagaytay City. They are situated at a very high elevation above EL. 400m with slopes of more than 2%. The Tagaytay ridge has a peak elevation of 650m.

2.4 Climate

Cavite belongs to Type 1 climate based on the Climate Map of the Philippines by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). Being a Type 1, Cavite has two pronounced seasons: dry from November to April and wet during the rest of the year. In the year 2009, the average temperature of the province is at 28.4^{o}C. January, February and December are the coolest months with an average of 26.2^{o}C. The province has received a total of 2,001.2mm of rainfall in 2009. August and September are the rainiest months while minimal rainfall was experienced during the months of March and April.

2.5 Land Resources and Distribution

Cavite's land resources are categorized into two: forest lands and alienable and disposable lands. Forest lands are being maintained as they play a great role for the ecological balance of the Province aside from the fact that they are home to numerous flora and fauna that needs to be protected and preserved. Correspondingly, the alienable and disposable lands are the built-up areas as well as production areas. These lands are intended for urban, economic and demographic developments.

The Province is dominated with production area that accounts for 50.33% of its total land area. It is followed by built-up areas that cover 39.99% of Cavite. Lastly, 9.33% of the province is considered protection lands such as natural parks and forests.

3. 0 Other Features

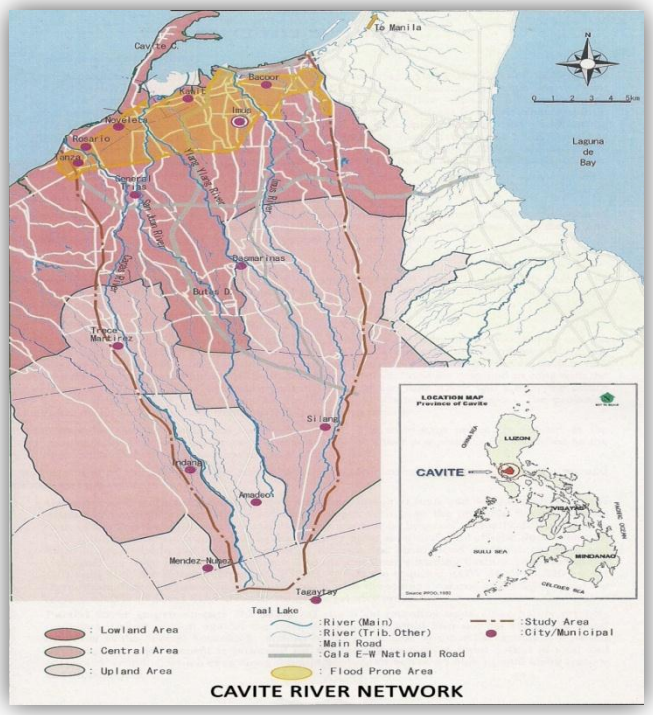
3.1 Water Resources

A. Major Rivers

Six major rivers are identified in Cavite, namely: Maragondon River, Labac River, Cañas River, San Juan River, Bacoor River and Imus River. These rivers are known to have various tributaries passing through the municipalities of the province.

Numerous springs, waterfalls and rivers found in the upland areas of the province are observed to be useful for domestic, tourism, and industrial users. These include Balite Spring (Amadeo), Saluysoy Spring (Alfonso), Matang Tubig Spring (Tagaytay City), Malakas Spring (General Aguinaldo), and Ulo Spring (Mendez).

The province is also endowed with waterfalls such as Palsajingin Falls (Indang), Balite Falls (Amadeo), Malibiclibic Falls (Gen. Aguinaldo), Talon-Butas Falls (Gen. Aguinaldo), Saluysoy Falls (Alfonso) and Tala River (Gen. Aguinaldo) which are conducive for recreational and leisure activities like picnics and gatherings.



B. Surface Freshwater Resources

The hydrological network of the province is composed of main rivers and tributaries. These rivers and tributaries generally have a flowing direction from the highlands of Tagaytay City going to Manila Bay with stretches from the Municipality of Bacoor up to Ternate.

a. Ground Water Resources

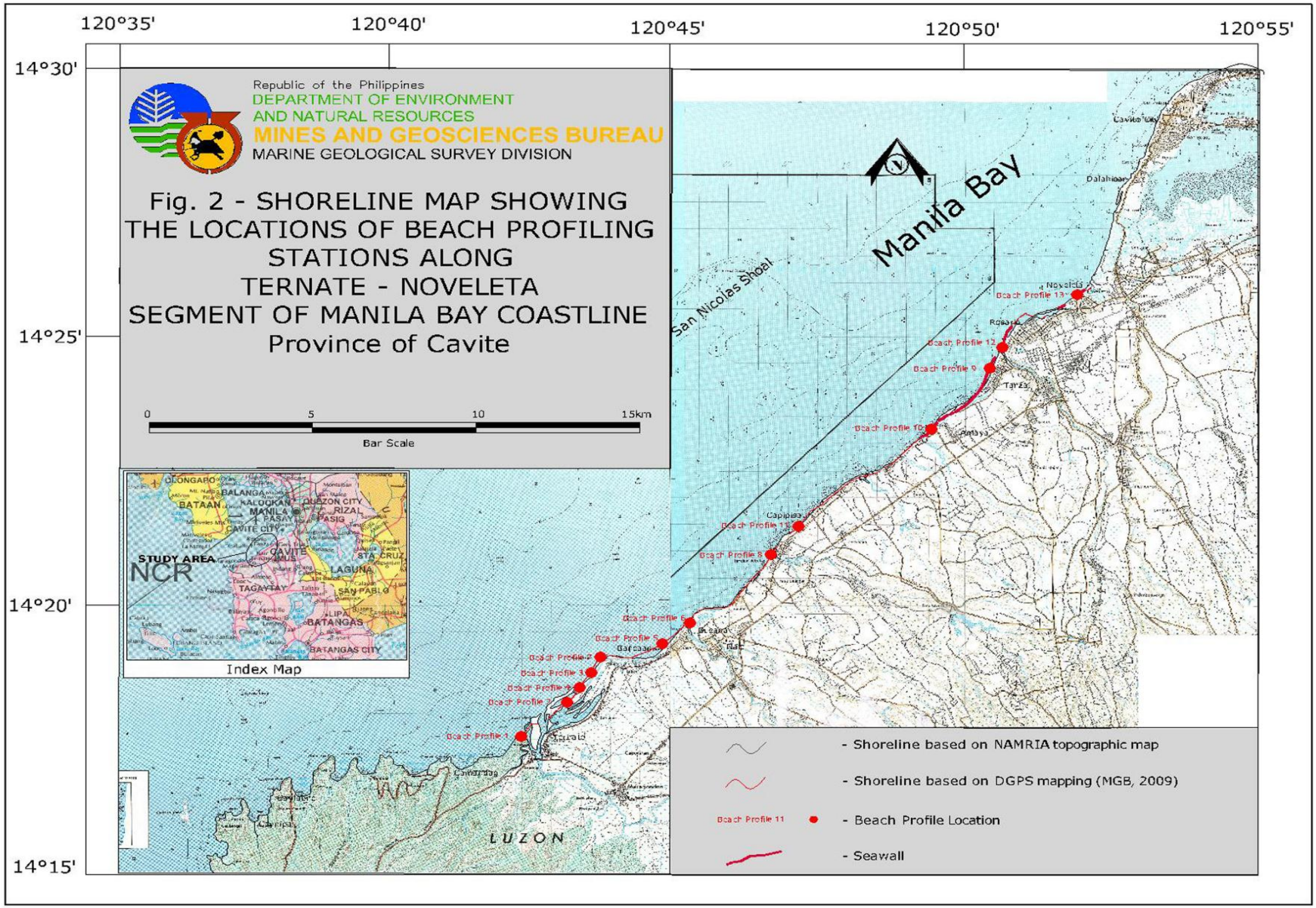
In the lowland areas covering the towns of Bacoor, Imus, General Trias, Dasmariñas, Naic, Tanza, Ternate, hundreds of artesian wells and deepwells provide water supply for both domestic and irrigation purposes. These have caused the salt water intrusion in the aquifers due to over extraction of water. According to a study made by the Japan International Cooperation Agency (JICA), the groundwater in Cavite is depleting at a rate of 1 meter water level decrease per year. In the upland areas of the province, groundwater is tapped mainly for domestic use through local water supply systems.

Based on the geological studies in Cavite, most of the ground water is stored in the pyroclastic rock reservoir and little in the volcano and clastic rock. Potable water is not reported in the near shore due to the presence of alluvium deposits which may be brackish and saline and are not safe for drinking and other domestic use. Another source of groundwater is called infiltrated rainfall which serves as the direct source of most near surface aquifers. Inflow from surface water reservoir and irrigation water also contributes to the ground water.

Freely-flowing wells occur in the 30-meter elevation of Southern Tanza and in the lower portions of near shore Naic and Ternate while in the municipality of Imus at elevation of about 15 meters.

b. Coastal Resources

Cavite boasts a stretch of about 123 kilometers of shoreline. These can be found along Cavite City, Bacoor, Kawit, Noveleta, Rosario, Tanza, Naic, Maragondon, and Ternate. The richness of Cavite's coastal resources paved the way for our recognition as major producer of oysters and mussels. The fisher folks are also active producers of sugpo/bangus. On the western coastlines lie the breath-taking beaches with pale gray sand. Thus, basically, coastal resource of the province contributes to the economic activities related to fishery and tourism.


120°35'
120°40'
120°45'
120°50'
120°55'
14°30'
14°25'
14°20'
14°15'
Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
MINES AND GEOSCIENCES BUREAU
MARINE GEOLOGICAL SURVEY DIVISION
Fig. 2 - SHORELINE MAP SHOWING THE LOCATIONS OF BEACH PROFILING STATIONS ALONG TERNATE - NOVELETA SEGMENT OF MANILA BAY COASTLINE
Province of Cavite
0
5
10
15km
Bar Scale
Index Map
STUDY AREA
NCR
Manila Bay
San Nicolas Shoal
LUZON
Beach Profile 1
Beach Profile 2
Beach Profile 3
Beach Profile 4
Beach Profile 5
Beach Profile 6
Beach Profile 7
Beach Profile 8
Beach Profile 9
Beach Profile 10
Beach Profile 11
Beach Profile 12
Beach Profile 13
- Shoreline based on NAMRIA topographic map
- Shoreline based on DGPS mapping (MGB, 2009)
- Beach Profile Location
- Seawall

3.2 Protected Area

The Mounts Palay-Palay and Mataas Na Gulod Protected Landscape

Cavite is very fortunate to have an area which is considered to be a biologically rich. In 1976, by virtue of Presidential Proclamation No. 1594, the Mounts Palay-Palay and Mataas na Gulod were declared to be national parks. The declaration aims to preserve the natural biodiversity of the area as part of the advocacy to preserve the country's natural heritage. The national park was later named as the Mounts Palay-Palay and Mataas na Gulod Protected Landscape.

The entire landscape is composed of more or less 4,000 hectares. The preservation of its natural biodiversity is a strategic move considering the rapid urbanization happening in the province of Cavite and the nearby Metro Manila. Known to be a good source of water, it is of utmost importance to preserve and rehabilitatethe damaged portions of the national park.

The national park is approximately located within the geographic coordinates of $14^{o}12'$ to $14^{o}17'$ north latitude and $120^{o}38'$ to $120^{o}42'$ east longitude. The park covers four (4) barangays (Sapang, Pinagsanhan, Patungan and Papaya) and seven (7) sitios (Malauyas, Caynipa, Caytako, Cacabay, Magabe, Murangdalig and Hamilo). Different portions of the park can be found in three municipalities (Ternate, Maragondon and Nasugbu) under two provinces (Cavite and Batangas).

3.3 Mineral Resources and Reserves

Non-Metallic Resources

The greater parts of Cavite are composed of volcanic materials, tuff, cinders, basalt, breccias, agglomerate and interbeddings of shales, and sandstones. The dormant and active volcanoes (Taal) are within these volcanic areas and have been the sources of volcanic materials which form the Tagaytay Cuesta. The drainage systems are deeply entrenched in the tuffs, eroding thin interbedded sandstones and conglomerate rocks which are the sources of little reserves of sand and gravel in the larger stream. Adobe stone quarries also flourish in the tuff areas.

Cavite coastal areas have marl and conglomerate sedimentary rocks and some igneous rocks which are prominent in the high, mountainous regions of western part of the province. Black sands are found in Kawit while Noveleta has its own salt products. Magallanes has gravel deposits while reserves of sand and gravel materials are found in Alfonso, Carmona, Gen. Aguinaldo, Naic, Ternate, Maragondon and Silang.

3.4 Structure of Economic Productivity

Agriculture

Cavite is predominantly an agriculture province. It has a total agricultural land of about 49.38% or 70,466.53 hectares. The Municipality of Maragondon has the biggest area intended for agriculture while Cavite City has no longer available lands for agriculture related activities and industries.

Agriculture industries include pineapple and coffee plantations, cutflower production, rice-farming, food crops such as corn and root crops, industrial/commercial crops such as coconut, banana, mango, papaya, peanut, sugarcane, black pepper and other fruit trees, vegetable farming, ornamentals, livestock production, aquaculture, feedmill productions, breeding and demonstration farms.

It also has a shoreline of 122,574 kilometers stretching along a city and 8 municipalities that are used for commercial and municipal fishing. The main fishing grounds are in Manila Bay, Bacoor Bay Canacao Bay. There are 10 municipal fish landing areas and a single commercial landing area in the Province.

Others also engaged in inland fisheries with a total area of 270.14 hectares of brackish water. Some of the produce are bangus, tilapias, oysters and mussels and sugpo. The province also actively engaged in the use of marine products as raw materials for highly acclaimed food products such as the tahong chips, fish sauce, crsipy shrimps, daing na bangus, smoked fish among others.

Commerce and Industries

The province has a total of 798 industrial establishments in 2009 distributed within the seven districts of the Province. The Municipality of Rosario houses the most number of these establishments at 259. A major number of these engage into electronics and electrical equipment, services, fabricated metal products, chemical and chemical products and textile or garments. These collectively account for 71.18% of al industrial locators in Cavite.

Cavite has a total of 46 economic zones/industrial estates, 27 are operating, 7 are proclaimed and 12 are still in the process of development. The highest numbers of investors in these industrial establishments are Flipinos accounting for 27.07% while the remaining 72.93% are the so-called foreign direct investments (Japanese, Korean, Taiwanese, Chinese, America Malaysian, others).

As with other areas in the country, the Province's economy has undergone developmental progression from a predominantly agriculture province into a service sector economy.

Based on available data, the province's economy is structured into three groups, the primary sector (agriculture), the secondary sector (manufacturing) and the tertiary sector. The tertiary sector accounts for the largest sectoral employment share at 84.87%, the secondary sector occupies 14.41% while agriculture garnered the remaining .72%. It is noteworthy to note that the wholesale and retail trade and hotels and restaurant corners the largest percentage with 38.21% and 13.50% respectively which is the main characteristic of this sector, provision of services to other businesses as well as final consumers.

Except for the negative structural shifts on Manufacturing (Secondary Sector), Financial Intermediation, Real Estate/Renting/Business Activities, Public Administration and Defense and Health and Social Work, the data shows increasing share of secondary and tertiary sector and a corresponding decrease in the share of the primary sector from 1.51% in 2005 down to .72% in 2009. This shift or change in

the sectoral share of employment could be attributed to the mushrooming of businesses and commercial establishments in the area as well as the proliferation of locators in the various economic zones in the province although the number of industrial establishments in 2009 is lower by .87% compared to 2008.

Human Resources

The total labor force of the Province is around 64.40% of the population or around 2.02 million individuals. Employment Rate is around 90.50%

There are a total of 17 public tertiary schools and 50 private tertiary schools operating in the province. Dasmarinas City holds the most number with 18 tertiary schools. It is dubbed as the “University Town of Cavite”. As of 2009, there are 132 private schools and three (3) government schools providing technical and vocational courses. Only two (2) public institutions exclusively offer manpower development training, the Technical Education Skills Development Authority (TESDA) in Rosario and Paliparan, Dasmarinas City.

Using the 2000 Census data, about 13.73% are College Undergraduates, 4.71% are College Graduates and .42% have Post-Graduate degrees.

II. Hazard Profile

Hazards can be categorized into natural and anthropogenic hazards. Climate and weather related hazards such as typhoons and droughts as well as geophysical hazards like earthquakes volcanic eruptions are natural hazards.

A natural hazards is defined as a natural process or event that is potentially damaging in that, it may result in loss of life or injury, loss of property socio-economic destruction or environment degradation.

Climate and weather related hazards, in particular, refer to the direct and indirect conditions of observed changes and/or major projected deviation from present day conditions of natural climate events (such as increases and decreases in precipitation and temperature); and impacts of changes in the frequencies and occurrence of extreme weather/climate events (such as tropical cyclones, droughts, and El Nino and La Nina events).

Geophysical events are destructive phenomena. However, these are part of the normal functioning of our dynamic planet. These so called hazards are due to naturally occurring processes in the earth's interior.

Two main types of hazards were considered in this DRA report that may hamper the development of the Province if not monitored and attended to. These are the Hydrometeorologic Hazards brought about by typhoons such Flood, Rainfall Induced Land slide and Storm Surge and the Geologic Hazard triggered by earthquakes which includes Ground Shaking, Liquefaction, Tsunami, Ground Rupture, andEarthquake Induced Land Slide.

A. Hydrometeorologic Hazards

Typhoons

A typhoon is a violent cyclone that occurs in the northwest Pacific Ocean. Typhoons feature heavy rains and winds that maintain speeds equal to or greater than 74 miles (119 kilometers) per hour. Similar storms that occur in other parts of the world are called tropical cyclones or hurricanes. The word typhoon comes from the Chinese term tai-fung meaning great wind (worldbook.com)

Cavite as part of Luzon, which is significantly more at risk to typhoons than more southern areas in the country, is strongly affected by monsoon (rain-bearing) winds, which blow from the southwest from approximately May to October and from the northeast from November to February. From June to December typhoons often strike the Philippines. Most of these storms come from the southeast, with their frequency generally increasing from south to north.

Based on data culled from the Climate and Agromet Data Section Climatology and Agrometereology Division of PAGASA, DOST, a total of 22 Tropical Cyclones crossed or directly hit the Province of Cavite from 1948-2009. The frequency of these typhoons occurred in the months of September and October, wherein 4 and 9 typhoons have been recorded. The duration of these typhoons averaged about 4.6 days, the longest of which were Tropical Storm Karing in 1979 (May 10-16), Tropical Storm Ruping in 1982

(September 5-11) and Typhoon Reming in 2000 (October 25-31), who lingered for seven (7) days within the Philippines' area of responsibility.

HISTORICAL OCCURENCE

Description	Population/Areas Affected	Impact
Tropical Storm "Falcon" June 21, 2011	Affected municipality: Kawit – 23 barangays, 4,438 families, 8,870 individuals	No significant damages incurred
Tropical Storm "Dodong" June 9, 2011	The municipality of Noveleta was affected by flooding. 20 families and 40 individuals were affected	No significant damages incurred
Typhoon "Juan" (Megi) October 13-24, 2010 155kt	Affected municipalities: Tagaytay City – 1barangay, 15 families, 57 individuals Ternate – 1 barangay, 64 families, 315 Ind. Cavite City – 2 barangays 107 families, 428 Individuals	No significant damages incurred
Typhoon "Basyang" (Conson) July 11-18, 2010 75kt	All municipalities of Cavite were affected with 729 barangays, 49,678 families, 247,537 individuals	Dead – 14 Injured – 13 Missing 3 totally damaged houses - 2,558 partially damaged houses - 32,735 Cost of damages: Infrastructure – Php2,299,500.00 Crops (rice and corn)- Php11,822,730.00 Cost of assistance (LGUs) – Php 10,185,520.00
Typhoon "Santi" (Mirinae) Oct. 27-Nov. 3, 2009 90kt	A total of 16 municipalities, 126 barangays, 4,141 families, 18,954 individuals were affected	Dead – 1 person Injured – 13 persons Totally damaged houses - 155 Partially damaged houses 1,267 Cost of damages: Roads/Bridges/Other Structures – Php9,570,000.00 Crops (Rice and corn) – Php25,044,185.00 Livestock – Php3,000.00 HVCC – Php143,099,434.00 Cost of Assistance (DSWD) – Php472,740.00

Typhoon "Pepeng" Sept. 27-Oct. 14, 2009 130kt	A total of 5 municipalities, 470 families, 1,402 individuals were affected	No significant damages incurred
Tropical Storm "Ondoy" September 25-30, 2009 90kt	A total of 19 municipalities, 442 bgys., 113,817 families, 534,209 individuals were affected	Dead – 6 persons Injured – 5 persons Missing – 1 Totally damaged houses - 293 Partially damaged houses - 2,325 Cost of damages: Roads/Bridges/Other Structures – Php9,570,000.00 Schools – Php10,007,000.00 (33) Crops (Rice and corn) – Php14,815,500.00 HVCC – Php2,610,000.00 Fisheries – Php3,307,600 (364.9 hectares) Cost of Assistance – Php2,284,750.00
Flashflood – Pansol River September 21, 2009	Municipality of Dasmariñas, Barangay Paliparan and Sampaloc IV	Dead – 5 persons
Typhoon "Isang" July 15-19, 2009 65kt	Kawit, Rosario, Imus, Bacoor, Noveleta and Naic were affected with a total of 53 barangays, 16,993 families	Totally damaged houses - 11 Partially damaged houses – 120
Typhoon "Feria" June 22-27, 2009 45kt	A total of 3 municipalities, 8 barangays, 706 families, 3,484 individuals were affected.	Totally damaged houses - 84 Partially damaged houses - 5
Typhoon "Frank" June 18-26, 2008 95kt	A total of 12 municipalities, 166 barangays, 40,645 families, 206,827 individuals were affected.	Totally damaged houses - 43 Partially damaged houses – 227 Cost of Damages: Agriculture – Php36,547,905.00 (2,426has.) Fisheries – Php3,888,000.00
Typhoon "Hana" Sept. 30 - October 4, 2007 70kt	The municipality of Rosario and Noveleta were affected with a total of 639 families.	Totally damaged houses - 28 Partially damaged houses - 10
Typhoon "Egay" August 12-20, 2007 140kt	A total of 14 municipalities, 232 barangays, 53,090 families, 260,561 individuals were affected.	1 missing person
Typhoon "Chedeng"	A total of 11 municipalities,	Totally damaged houses - 2

August 5-9, 2007 65kt	122 barangays, 87,920 families, 438,701 individuals	Partially damaged houses - 13
Typhoon "Milenyo" (Xangsane) September 25, 2006 to October 2, 2006 Maximum sustained winds of 125kt	All municipalities of Cavite were affected with 463 barangays, 164,137 families, 794,339 individuals	Dead – 31 Injured – 64; Missing – 18 Totally damaged houses - 8,509 Partially damaged houses - 48,562 Cost of Damages: Infrastructure – Php76,288,000.00 Agriculture – Php728,648,333.00 Livestock and Poultry – Php30,312,400.00
Typhoon "Florita" June 13, 2006	A total of 7 municipalities, 45 barangays, 2,260 families, 1,111 individuals affected.	Totally damaged houses - 51 Partially damaged houses - 38
Typhoon "Inday" July 2002	The municipalities of Bacoor, Noveleta, Rosario, Imus, Kawit, etc. with a total of 168,025 individuals were affected.	Dead – 1
Typhoon "Gloria" July 2002	The municipalities of Bacoor, Noveleta, Rosario, Imus, Kawit, etc. with a total of 173,075 individuals were affected.	
Typhoon "Reming" October 2000	The municipalities of Bacoor, Noveleta, Rosario, Imus, Kawit, etc. with a total of 380,616 individuals were affected.	Dead – 10

Source: NDCC, PDCC, PSWDO

Moreover, a total of 58 Tropical Cyclones crossed the Province within 50 kilometers from its boundaries. The months from June-November accounted for 47 of the total typhoons; most of them came in the months of October and November with 26 and 17 typhoons respectively. These typhoons remained within the country's area of responsibility for a period of about 4.4 days.

Gustiness

Tropical cyclones or Typhoons constitute a hazard in several ways. First, the strong winds can cause considerable damage. PAGASA classified these tropical cyclones into four (4) categories, TD (Tropical Depression) with maximum sustained winds from 45-61 kilometers per hour (kph); TS (Tropical Storm) with maximum sustained winds of 62-117 kph; TY (Typhoon) with maximum sustained winds of 118-239 kph and STY (Super Typhoon) with maximum sustained winds of more than 240 kph. From the 22 tropical

cyclones that affected the Province from 1948-2009, 10 were classified as typhoons, 8 were tropical storm and the remaining four (4) were tropical depressions.

An important component of typhoon which needs utmost attention is its gustiness. It is a sudden, brief increase in the speed of winds. It is of a more transient character than a squall and is followed by a lull or slackening in the wind speed. Generally, winds are at least gusty over large water surfaces and most gusty over rough land and near high buildings.

Since a gust of 130 km/h can practice a pressure up to 400 kg per cubic meters, roofs are torn away via wind-born missiles, trees get uprooted and electric- and telephone lines can be destroyed. House-fires are frequent secondary-effects because candles are often used in time of a typhoon - not remembering that the winds are functioning like bellows.

A cursory look at the last five (5) destructive typhoons that hit the Province, Typhoon Basyang has a maximum sustained winds of 85 kph near the center and gustiness of up to 100 kph (July 14, 2010), it totally damaged 2,558 houses and partially destroyed an additional 32,735; Typhoon Santi has a maximum sustained winds of 140 km/hr and gustiness of up to 170 kph (October 29, 2009), it totally damaged 55 houses and partially destroyed an additional 791; Typhoon Ondoy has a maximum sustained winds of 85 kph near the center and gustiness of up to 100 kph (September 25, 2009); it totally damaged 226 houses and partially destroyed an additional 1,577; Typhoon Frank packed maximum sustained winds of 165 kph and gustiness of up to 150 kph (June 21, 2008), it totally damaged 43 houses and partially damaged 227 houses; and finally Typhoon Milenyo has a maximum sustained winds of 170 kph and gustiness of up to 140 kph (September 25-29, 2006), it totally damaged 8,509 houses and partially destroyed a total of 48,562.

Storm Surge

The second major problem is the storm surge produced by a typhoon where its eye comes onshore from the open sea. The low barometric pressure caused by these typhoons leads to the development of a dome of water several meters high and several kilometers long.

Cavite, being bounded by China Sea on the west and having an extremely low ground level elevation of 0m to 2m at lowest lowland area, is exposed to storm surge.One documented major storm surge which occurred at the peak of Typhoon *Sening* on October 10-15, 1970, had an actual height of 3-5 m (PAGASA, 2004).

FGD (Focus Group Discussions) results revealed that over the past 30 years, strong typhoons with accompanying storm surges had caused destruction to coastal settlements and infrastructure, resulting in either total or partial damage on these communities and structures. Frequent rains and flooding characterized the 1980's. During this decade, the rainy season appeared to be longer than usual and typhoons varied in frequency and intensity. The decades from the 1990's to the present had also witnessed strong typhoons with strong winds and heavy rains. This latter decade is believed by many to have unpredictable weather patterns (Sales 2006).

The coastal-lying barangays are susceptible to this kind of hazard and these are located in the municipalities along the shoreline of the Province, in this case, a total of 22 barangays in Bacoor, Kawit and Cavite City are classified as low susceptible while a total of 38 barangays in Noveleta, Naic, Rosario Tanza, Ternate and Cavite City are deemed moderately susceptible.

Storm Surge Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Bacoor			- 9 Barangays	
Kawit			- 9 Barangays	
Noveleta		- 5 Barangays		
Naic		- 3 Barangays		
Rosario		- 8 Barangays		
Tanza		- 9 Barangays		
Ternate		- 2 Barangays		
Cavite City		- 11 Barangays	- 4 Barangays	

Flood

The third problem is the heavy rainfall commonly associated with tropical cyclones, which causes inland flooding. Flooding damages buildings via inundations and, in fast moving waters, via velocity effects. Flooding can have significant long-term human effects due to contamination of drinking water as well as providing sites for disease vectors. Damage to infrastructure is similar to that of buildings although infrastructure is also often damaged by ground failure due to rain or flood saturated ground.

Floods are considered by many to be the hazard that affects more people and causes more damage to property than any other (UNDRO, 1976; Cuny, 1990;Gupta, 1990; Palm, 1990). They are surely the most pervasive and chronic. They are produced by a variety of factors in different parts of the world (White 1945; Ward, 1978; Miller, 1999). Most commonly these include: over bank flow on rivers and lakes due to heavy precipitation exacerbated in denuded watersheds by accelerated runoff; urbanization which complicates flooding events by increasing the area of impermeable surfaces by the encroachment of roads, housing and other land uses onto floodplains; the silting of canals and riverbeds or the obstruction of waterways due to improper construction activities.

During the height of Typhoon Ondoy, which is considerably weaker than Typhoon Milenyo, the 9-hour deluge of rains submerged houses, washed away shanties and turned roads into raging rivers, forcing terrified residents to seek refuge on top of houses and cars.

Generally, flooding in Cavite is only experienced on low lying towns of the Province based on the study conducted by the Japan International Cooperation Agency (JICA) in 2008,. There are major rivers of the Province that serves as catchment areas. They literally catch the water volume coming from the upland municipalities of the Province in the occurrences of heavy rains, typhoons and other environmental phenomenon.

Remedial measures were undertaken by the Provincial Government in view of the findings made by the JICA study. Relocation of informal settlers, demolition of illegal structures, dredging and rip rapping along the riverbanks were implemented to alleviate the occurrences of flooding within the identified flood prone areas.

The flooding in Cavite has two classifications: the River Overflow Flood and Inland Flood.

The river overflow flood is defined as the flood caused by the overflow from the river. This flood type is usually associated with typhoons. On the other hand, inland flood is defined as inundation caused by the stagnant of the storm rainfall and/or the overflow from the local drainage channel. Intrusion of seawater during high tide would also cause this kind of flooding.

River Overflow Flood

This kind of flood in Cavite is due to inadequate flow capacity of various rivers and tributaries in the province. The floods usually occurs at the low dike section, narrow or bottleneck sections and the bridge sections. This is because those areas are usually clogged with debris. This kind of flooding can also be attributed to intensive land conversion and development for industrial and residential uses. In the year 2000-2006, there are four major river overflow floods recorded. These were brought by Typhoons Reming, Gloria, Inday and Milenyo.

Typhoon Milenyo and Reming both caused damages to properties as well as public infrastructures such as bridges, dams and ripraps of flood ways. TY Milenyo alone had caused damages on infrastructures, agriculture and livestock and poultry amounting to PhP 835,248,733.00.

In the advent of typhoons and heavy rains, the lowland part of the province is very much prone in the occurrences of inundations. The water volume coming from the upland part of the province also contributes to the volume of water in the lowland rivers and tributaries.

The upland municipalities of Indang, Amadeo and Silang also experience overflow flooding but at a minimal circumstances. Likewise, it affects minimal numbers of households, only the illegal settlers along the river channels.

Inland Flood

According to the study of Japan International Cooperation Agency JICA, the inland flooding in the province, particularly in the municipalities of Kawit, Noveleta, Rosario and Tanza is due to complex factors such as:

1. Low elevated ground level below the tidal level
2. Inadequate capacities of the existing drainage facilities
3. Clogging of the drainage channels due to solid wastes
4. Illegal encroachment of the structures in the drainage channels
5. Reclamation of the existing natural retarding basins and drainage channels

It is also observable that the advent of inland flooding in the province is not generally caused by adverse weather conditions. Even a no-to-light rainfall and natural tidal level changes can cause this kind of inundations. Also, according to the study, land development and land conversions causes inland flooding in Cavite. Such land developments decreases the basin retarding capacity of inland floodwater which resulting to increase of flood damages. Land developers are also doing inappropriate land developments and construction of structures that adds to the hazards of inland flooding.

As per maps provided by the REDAS Projects, areas were identified in the Province that is susceptible to occurrence of floods. Cavite's coastline stretches around 123 kilometers and could be found along Cavite City, Bacoor, Kawit, Noveleta, Rosario, Tanza and Naic. Most barangays that are highly susceptible to flooding belongs to the aforesaid municipalities although there are areas that are not along the shorelines that experiences flooding.

A total of 298 barangays are considered highly susceptible to flooding or a total of 10,461.24 hectares (7.3% of the total land area of the province), 231 of these are from the coastline municipalities, while 98 barangays are deemed low in terms of susceptibility, or a total of 8,821.85 hectares (6.17 of the total land area of the Province). Out of the total 829 barangays in the Province, around 48% are more or less prone to flooding.

It is interesting to note that some municipalities that are not considered flood-prone suffer or experience some cases of flooding. This may be attributed to blockages of channels arising from deposition of sediments, debris and the like and the narrowing or sections along waterways like canals, bridges, and culverts and siltation of major rivers and their tributaries.

The pilot areas used by the JICA study, three (3) barangays in Kawit, Cavite, are considered in the flood hazard map since all of the barangays in Kawit are vulnerable to flooding.

Flood Hazard Characterization Table

Municipality	Susceptibility Levels			Total Affected Area
	High	Moderate	Low	
Bacoor	- 55 Barangays Affected Area : 1,505.30 has.		- 9 Barangays Affected Area: 1,078.98 has.	2,584.28 has.
Carmona	- Cabilang Baybay Affected Area: 240.47 has.		- 11 Barangays Affected Area: 915.21 has.	1,155.68 has.
Gen. Trias	- 7 Barangays Affected Area: 909.37 has.		- 12 Barangays Affected Area: 882.62 has.	1,791.99 has.
Imus	- 38 Barangays Affected Area: 1,043.97 has.		- 23 Barangays Affected Area: 3.25 has.	1,047.21 has.

Kawit	- All barangays Affected Area: 1,340 has.			1,340 has.
Maragondon	- 3 Barangays Affected Area: 457.18 has.		- 13 Barangays Affected Area: 1,174.41 has.	1,631.59 has.
Noveleta	- All barangays Affected Area: 541 has.			541 has.
Naic	- 8 Barangays Affected Area: 536.64 has.		- 15 Barangays Affected Area: 2,427.49 has.	2,964.13 has.
Rosario	- All barangays Affected Area: 567 has.			567 has.
Tanza	- 26 Barangays Affected Area: 1,776.80 has.		- 7 Barangays Affected Area: 2,078.40 has.	3,855.20 has.
Ternate	- 8 Barangays Affected Area: 911.91 has.		- 2 Barangays Affected Area: 2,078.40 has.	3,855.20 has.
Cavite City	- All barangays - Portion of Corregidor Island			
Dasmariñas	- 11 Barangays			

Rainfall Induced Landslide

In terms of rainfall, based on data provided by PAG-ASA, the observed baseline (1971-2000), for the months of December, January and February, the Province has a total rainfall of 124.9 mm (1.38 mm/day); for the months of March, April and May, a total of 242.8 mm (2.63 mm/day); for the months of June, July and August, a total of 985.7 mm (10.7 mm/day) and for the months of September, October and November, a total of 579.0 mm (6.3 mm/day) or cumulatively totaling to 1,932.4 mm or a daily average of 5.29 mm of rainfall.

Incessant rains not only affect coastal-lying areas but likewise in mountainous or high altitude areas within a municipality or Province. This has resulted into a number of rain-induced landslides in the past.

The movement of material down-slope under the influence of gravity is referred to as mass movement. Landslides are one category of mass movement involving falling, sliding and/or gravity sediment flow of rocks or weathered rock material, commonly with water, down and out of a slope. Movement is often along well-defined surface confined to a limited portion of a slope.

Landslides occur everywhere in the world, but the danger of rainfall-induced slides tends to be much greater in tropical mountainous regions like here in the Philippines. Steep terrain, combined with the heavy rains brought by monsoon seasonsand typhoons puts

dense populations at risk. Steep slopes and coarse soil types are more susceptible to landslides and, in terms of land cover, bare soil contributes more to landslides.

It is often triggered by heavy rains, typhoons, earthquakes, eroding force of rivers, mining activities, road construction, and inappropriate landuse and deforestation. Landslides destroy and bury structures, people, farmland and roads. Their effects are death, damage to structures, partial damage or loss to livelihood, disruption of economic activities and flow of supplies

One of Cavite's physiographical areas is the upland mountainous areas found in Amadeo and Tagaytay City. They are situated at a very high elevation above EL.400m with slopes of more than 2%. The Tagytay ridge has a peak elevation of 650m.

As per guidelines set by DENR-MGB in susceptibility levels to landslide, it is clear that all the 34 barangays in Tagaytay City are considered susceptible to landslide, 11 are highly susceptible, 5 are moderately susceptible while the remaining 18 are low susceptible. On the other hand, all of Amadeo's barangays are classified under low susceptibility level.

A total of 22 barangays from six (6) municipalities, Alfonso, Magallanes, Maragondon, Silang, Ternate and Tagaytay are considered highly susceptible, totaling to 9,933.11 has or 6.95% of the total land area of the Province; 38 moderately susceptible (20,780.33 has or 14.55%) and 261 are low susceptible barangays (71,290.30 has or 49.93%) in the Province or about 39% of the total barangays are susceptible to varying degrees of rain induced landslides or around 71.45% of the total land area of the Province.

Rain Induced Landslides Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso		- 2 barangays	- All the rest of the barangays	
Amadeo			- All barangays of Amadeo	
Bacoor			- 9 Barangays	
Carmona			- 2 Barangays	
Imus			- 32 Barangays	
Indang		- 2 Barangays	- 34 Barangays	
Magallanes		- 3 Barangays	- 13 Barangays	
Maragondon	- 4 Barangays	- 6 Barangays	- 4 Barangays	
Mendez			- All barangays	
Naic		- 3 Barangays	- 6 Barangays	
Silang	- 6 Barangays	- 3 Barangays	- 56 Barangays	

Tanza		- *Barangays*	- *5 Barangays*	
Ternate	- *Bucana*	- *1 Barangay*		
Tagaytay City	- *11 Barangays*	- *5 Barangays*	- *18*	
Trece Martires		- *10 Barangays*	- *3 Barangays*	

Based on available data gathered from records of the National Disaster Coordinating Council, the Provincial Disaster and Coordinating Council and the Provincial Social Welfare and Development Office, five (5) recent typhoons that have triggered rain-induced landslides were documented; Super-Typhoon Juan (maximum sustained winds of 225 kph and gustiness of 260 kph, October 2010), displacing 64 families and 315 individuals in Barangay Bucana, in Ternate, Cavite; Typhoon Basyang, wherein a lone casualty was recorded and affected Barangay Iruhin in Tagaytay City; Tropical Storm Ondoy wherein the Tagaytay-Talisay Road was left impassable and Typhoon Lando wherein 31 families and 61 individuals were affected in Barangay Anahaw I in Silang and left two (2) persons dead and three (3) others injured.

B. Geologic Hazards

Earthquake

Earthquakes result from sudden shifting of the earth's crust below or at the surface, causing ground vibrations and shocks. In the Philippines two kind of earthquakes are experienced: tectonic and volcanic. A tectonic earthquake is a sudden shift of the earth's crust along active faults. A volcanic earthquake happens near volcanoes when hot rocks or magma moves from deep within the earth. Every day, at least five earthquakes occur in the Philippines. Strong shocks cause structures to collapse, destruction of properties, life-lines, and disruption of livelihood, trauma and death.

One of the major tectonic features in the country is the Philippine Fault Zone (PFZ). It is a left-lateral strike-slip fault that transects the whole archipelago along a general strike of N 30 degrees-40 degrees from northwestern Luzon to southern Mindanao (Phivolcs 2000; Bainer, et.al, 1991). It is comparable to the San Andreas Fault (SAF) in the United States because of its young geomorphic features.

It has many subsidiary faults, one strand of which is the West Valley Fault.This strand is capable of magnitude 6-7 events occurring on average every 200-300 years, and has not ruptured in over 200 years (Nelson et al, n.d.). This fault runs from the Sierra Madre Mountain ranges to Sta. Rosa, Laguna through Bulacan, Rodriguez, Rizal, Quezon City, the eastern side of Metro Manila including Pasig, Taguig, Muntinlupa, San Pedro and Carmona, Cavite.

The Japan International Cooperation Agency (JICA), in its Metro Manila Earthquake Impact reduction Study (MMEIRS) said a 7.2 earthquake in Metro Manila would destroy 16,000 buildings and injure at least 150,000 people. This finding is significant to the Province considering its proximity to the area. Moreover, Manila and Cavite are underlain by similar soft, alluvium deposits resulting into a higher degree of vulnerability to effects of an earthquake.

Alluvium (from the Latin, *alluvius*, from *alluere*, "to wash against") is loose, unconsolidated (not cemented together into a solid rock) soil or sediments, eroded, deposited, and reshaped by water in some form in a non-marine setting.Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel. When this loose alluvial material is deposited or cemented into a lithological unit, or lithified, it would be called an alluvial deposit (Wikipedia).

As of September 12, 2011, there were 543 recorded seismic events in the country (Seismological Observation and Earthquake Prediction Division of Philvolcs, Website). A number of them were felt here in Cavite.

Recently, last July 26, 2011 at 1:15 a.m., a 6.2 magnitude earthquake was recorded with an epicenter 13 kilometers northwest of Iba, Zambales. The earthquake is tectonic in origin and has a depth of 30 kilometers. As per Philvolcs Earthquake Intensity Level, the Municipality of Bacoor experienced Intensity IV as an offshoot of this event.

On the other hand, two (2) successive earthquakes were recorded in March 21 (6:37 p.m.) and 25 (1:29 p.m.) of this year. The first one was a 5.7 earthquake with an epicenter 12 miles from Lubang Island in Occidental Mindoro, it is tectonic in origin and has a depth of 63 kilometers. An Intensity IV was felt in Bacoor and Tagaytay City and Intensity III in Dasmariñas City, while the second one is a 6.0 magnitude earthquake with an epicenter 27 kilometers northwest of Lubang Island in Occidental Mindoro, it is likewise tectonic in origin, this was felt in Tagaytay City, Rosario and Trece Martires City (Intensity III).

Earlier in the year, last February 22, 2011 at 10:10 a.m., a 4.7 earthquake was recorded with an epicenter 26 kilometers northwest of Nasugbu in Batangas. It has a depth of 103 kilometers and was felt as Intensity IV in Dasmariñas City.

It must be pointed out that due to the dearth of documents on disastrous earthquakes, its damages or related-injuries, within the Province, a historical account could not be made. Although, there were records from Philvolcs about recorded earthquakes during the Spanish times, access on newer records could not be extracted at the moment.

In addition to ground shaking, earthquakes cause damage in other ways, the most significant of which are liquefaction, earth-induced landslides, tsunami and ground ruptures.

Historical Occurrences

Description	Population/Areas Affected	Impacts
June 3, 1863 – 7:20 PM	Sangley Point Cavite City Bacoor and Maragondon	- A crater opened and emitted water and dirt. - A barracks collapsed, the telegraph tower fell, and nearby all walls cracked. - On the peninsula of Cañacao, fissures opened. - Damage to church structures.
August 20, 1937 – 7:59 PM	Cavite City Mendez Nuñez and Silang	- One person died due to fright when the quake struck. - Several old buildings in the town collapsed. - A building on Calle Colon collapsed. - Some piers in the Navy yard cracked. - One wall of a house in the Navy yard collapsed. - Some cracks appeared in the walls of the churches.
March 16, 1892 – 9:01 PM Great intensity, 50 seconds	Cavite City	
July 18, 1880 – 12:40 PM Oscillatory, strong, N-S, 55	Cavite City	- The government house, church, rectory and

seconds		telegraph office fell; in the shipyard the black sand rose around the piles.
March 4, 1862 – 5:30 PM Felt Strongly	Cavite City	- The new barracks, the telegraph, and the Royal House are the structures which suffered most, but there were no injuries to persons.
September 16, 1852 – 6:30 PM	Cavite City Old Cavite	- All the buildings in the town were damaged seriously, especially those of the arsenal and royal house. - One of the eight sides of the telegraph building is cracked horizontally and there are two vertical cracks extending to the 2nd floor. - In the infantry barracks, most of the posts have been dislodged. - Some Earthquake Historical Record of Cavite 39 stones have been slightly moved, and three tie-beams in two rooms show cracks. - The former church of the Jesuits was spared by the earthquake in spite of the fact that the bell tower, which leaned against the facade, was cracked from top to bottom. - The house occupied by the supervisor was of very poor construction; through it the earthquake swept swiftly in all its walls, posts and partitions; the whole second floor is left in a very bad state, chiefly because its frame had been weakened by termites. - One of the beams supporting the roof broke and this caused the last wall to break for a length of six varas (5 1/2 yards) and

	Indang San Roque Imus	the west wall for ten varas. (about 9 yards). - The town suffered much especially the town. - Part of the chapel and walls of the cemetery were demolished. - The parish house and church have sustained considerable damage.
December 7, 1677 – 7:30 PM	West Coast of Cavite	- Waves were raised

Source: SEASEE

Ground Shaking

One of the main hazards emanating from an earthquake is ground motion or ground shaking. It is caused by the passage of seismic waves; especially surface waves near the epicenter of the earthquake are responsible for the most damage during and after the earthquake. The intensity of ground shaking depends on local geologic conditions in the area (in general, loose unconsolidated sediment is subject to more intense shaking than solid bedrock); size of the earthquake, the larger the earthquake, the more intense is the shaking and the duration of the shaking and distance from the epicenter (shaking is most severe near the epicenter and drops off away from the epicenter). The distance factor depends on the type of material underlying the area.

As stated above, part of the West Valley Fault traverses part of the Cavite Province,along the Municipalities of Carmona and Silang, all of the Province's municipalities and cities are affected by ground shaking. Only around 86 barangays out of the total 829 are classified as moderately susceptible and these are located in the Municipalities of Alfonso, Gen. E. Aguinaldo, Magallanes, Maragondon, Naic and Tagaytay City. The rest are highly susceptible or about 90% of the Province's total barangays.

In terms of land area, 88% (125,756 hectares) of the Province's total land area is susceptible to ground shaking, 65.95% (94,152.74 hectares out of the total land area of 142,760 hectares) are considered highly susceptible while 22.13% or 31,603.257 hectares are moderately susceptible.

Ground Shaking Hazard Characterization Table

Municipality	***Susceptibility Levels***			***Total land area***
	High	*Moderate*	*Low*	
Alfonso	*30 Barangays*	*9 Barangays*		
Amadeo	*All barangays*			
Bacoor	*All barangays*			
Carmona	*All barangays*			
Gen. E. Aguinaldo	*5 Barangays*	*12 Barangays*		
Gen. M. Alvarez	*All barangays*			

Gen. Trias	*All barangays*			
Imus	*All barangays*			
Indang	*All barangays*			
Kawit	*All barangays*			
Magallanes		*All barangays*		
Maragondon	*13 Barangays*	*15 Barangays*		
Mendez	*All barangays*			
Noveleta	*All barangays*			
Naic	*3 Barangays*	*29 Barangays*		
Rosario	*All barangays*			
Silang	*All barangays*			
Tanza	*All barangays*			
Ternate	*9 Barangays*	*2 Barangays*		
Cavite City	*All barangays*			
Dasmariñas City	*All barangays*			
Tagaytay City	*31 Barangays*	*B6 Barangays*		
Trece Martires City	*All barangays*			

Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. It occurs in saturated soils, that is, soils in which the space between individual particles is completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other.

Earthquake shaking often triggers this increase in water pressure, but construction related activities such as blasting could also cause an increase in water pressure. When liquefaction occurs, the strength of the soil decreases and the ability of a soil deposit to support foundations for buildings and bridges is reduced.

As per the READY Maps, a total of 371 barangays are susceptible to this phenomenon. Of the total susceptible barangays, 179 (3,875.749 hectares) are considered high,118 (6,555.093 hectares) are moderate and 74 (7231.338 hectares) are low or a total of 17,665.18 hectares, about 12.37% of the Province's land area. Most of the barangays considered as highly susceptible are located in the coastal municipalities.

Liquefaction Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Bacoor	32 Barangays	22 Barangays	8 Barangays	
Carmona		Maduya	10 Barangays	
Gen. Trias		8 Barangays	10 Barangays	
Imus	2 Barangays	45 Barangays	25 Barangays	
Kawit	17 Barangays	6 Barangays		
Maragondon			9 Barangays	
Noveleta	9 Barangays	7 Barangays		
Naic	5 Barangays	7 Barangays	3 Barangays	
Rosario	18 Barangays	2 Barangays		
Tanza	10 BARANGAYS	16 BARANGAYS	7 BARANGAYS	
Ternate	4 Barangay	4 Barangays	San Juan I	
Cavite City	All barangays of Cavite City except Corregidor Island			

Earthquake-Induced Landslides

Occurrence of **earthquake-induced landslides** is determined largely by local conditions. Many factors, including geologic and hydrologic conditions, topography, climate, weathering and land use, influence the stability of slopes and the characteristics of landslides.

Mapping the areas that are vulnerable or susceptible to earthquake-induced landslides induced the following results: a total of 444.4985 hectares are considered highly susceptible to earthquake-induced landslides, majority of the area located in Tagaytay City, Silang and Carmona; 1,476.2928 hectares are moderately susceptible with Tagaytay, Silang, Maragondon and Carmona owning bulk of this land area and finally low susceptible areas totaling to 3,585.392723 hectares or an overall land area of 5,506.184023 hectares or 3.85% of the total land area of the Province.

Ground Rupture

Ground rupture only occurs along the fault zone that moves during the earthquake. Thus structures that are built across fault zones may collapse, whereas structures built adjacent to, but not crossing the fault may survive.

As indicated above, three (3) barangays in Carmona, namely Cabilang Baybay, Mabuhay and Lantic with a total land area of 1,374.46 has and four (4) in Silang, Kaong, Tibig, Ichicam and Carmen, with a total land area of 2,086.31, are highly susceptible to the effects of said geological hazards.

Tsunami

When the earthquake occurs under the sea, the term 'tsunami' is used, which is Japanese for an ocean wave caused by submarine earthquakes and volcanic eruptions.

Since Tsunamis operate near coastal municipalities, mostly coastal barangays of the province totaling to 157 barangays or about 2,355.503 hectares are classified as highly susceptible, most of which are located in Bacoor, Kawit, Noveleta, Naic, Rosario, Tanza, all of the barangays in Cavite City and a portion of Barangay Medicion II-D in Imus, Cavite.

Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Bacoor	- 21 Barangays			
Kawit	- 16 Barangays			
Noveleta	- 5 Barangays			
Naic	- 7 Barangays			
Rosario	- 10 Barangays			
Tanza	- All Coastal barangays			
Cavite City	- All barangays of Cavite City			

Another form of geologic hazard is those that arise from a **volcanic eruption**. A volcano can be simply defined as a rupture or an opening on the crust of a planet like earth. This opening allows hot ash, molten rock and gases to blow off from the underground spaces. Volcanoes generally acquire shape of a mountain. These are usually found at places where tectonic plates get converged or diverged.

There are 37 volcanoes in the Philippines, of which 18 are still active volcanoes, the closest of which in the Province is the Taal Volcano, about 12.67 kilometers (7.872 miles) away from Tagaytay City. Active volcanoes are those that erupted within historical times (within the last 600 years) such that, accounts of these eruptions were documented by man.

Taal Volcano has been called the smallest active volcano in the world. It is located about 70-km south of Manila on an island inside a lake called Taal Lake. What makes Taal Volcano more unique is the fact that the volcano itself has a lake of its own inside its crater which is called the "Crater Lake." One can even swim inside the Crater Lake but don't stay too long because the lake's water is a much diluted form of sulfuric acid with high concentration of boron, magnesium, aluminum and sodium in salt form.

Thirty three eruptions have been recorded since 1572 at Taal, mostly on Volcano Island. The impacts of these eruptions were largely confined to the intracaldera area. Occasional violent activity, however, such as the 1754 plinian eruption, affected the entire region, including what is now the Metro Manila area with fallout. Some activity, such as the 1749 eruption, were accompanied by crustal disturbance and strong earthquakes, which generated ground fissures and pronounced subsidence that extended across Taal lake.

The caldera has a long, but little known history of catastrophic explosive volcanism affecting much larger areas, including the Metro Manila area. The eruptions, one to two orders of magnitude larger and more devastating than those of Mount Pinatubo, have deposited massive ignimbrites, including the deposits of turbulent pyroclastic flows, and widespread tephra fall units in recent geologic time. Accompanying this volcanism has been extensive volcaniclastic sedimentation, dominated by deposition of hyperconcentrated streamflows and lahars in low-lying subaerial and shallow marine environments.

The Philippine Institute of Volcanology and Seismology's (PHIVOLCS) choice of a Decade Volcano from among the 200 volcanoes in the Philippines rests on Taal's obvious and dangerous attributes:

- **frequent activity**
- greatest number of elements at risk,
- **high population density** of the region
- complicated and **little understood volcanology**
- excellent accessibility.

Taal caldera is envisaged as being composed of two adjacent calderas in a SW-NE striking graben setting largely controlled by the intersection of regional structures. Gravity profiles exhibit a high plateau-shaped anomaly, modeled as a graben structure underlain by a thick dense igneous intrusion (Yokoyama et al., 1975). Fault bounded caldera walls are more pronounced on the north rim, forming the Tagaytay Ridge with 600 m relief.

Taal is not a strato-cone, but has a low profile, pre-caldera construction topography, now blanketed by ignimbrite sheets. Taal lake has been the site of major eruptions of an unusual type of ignimbrite of andesitic composition, previously referred to as base surges (Geronimo, 1988).

The whole region surrounding Taal is at considerable volcanic risk. Taal Volcano is situated in a highly populated and rapidly growing agricultural and industrial region. Five towns are located around the lakeshore and 2 cities and 8 more towns are lined up along the caldera rim. Two large power stations are located 15 km and 17 km, respectively, from Taal Lake.

The geologic setting of Taal, and the variability of eruption sites and magnitudes, generates a diverse range of volcanic hazards, such as base surges, lava flows, ballistic fallout, ash and scoria fallout, toxic gases, acidic flashes from crater lake, lake tsunamis and seiches, lakeshore flooding, earthquakes, ground fissuring and subsidence, landslides and sectoral collapse, turbulent ashflows, and lahars.

Base surges were first documented during an eruption at Taal in 1965 (Moore et al., 1966). This particular hazard is the notorious cause of deaths and destructions both on Volcano Island and in lakeshore areas as surges can propagate over the lake without significant reduction in force.

Base surge eruptions in 1911 and 1965 blasted the villages to the west of the vent at Volcano Island, travelling 3 km across Lake Taal. In contrast, the aa lava flows erupted in 1968 and 1969 were confined within the embayment created by the 1965 eruption in the SW flank of Volcano Island and, apparently, did not pose a significant threat at that time. However, lava flows could be a serious hazard at Taal if erupted from a lakeshore vent and accompanied by violent hydrovolcanic explosions resulting from lava-lakewater interaction. The presence of a scoria cone at Boot, located east of Volcano Island, also suggests that eruptions along lakeshore areas are highly probable, although without historical precedence.

Since Philvocs have designated a standard 4 kilometer permanent danger zone within the area, the possibility of the Province being affected by a seismic activity is minimal. However, ash falls could become a potential threat due to its proximity to the area.

An example of the status report being maintained by Philvocs on Taal Volcano as of September 13, 2011, to wit:

Alert Level 1 remains in effect over Taal Volcano. This means that hazardous eruption is not imminent. The public, however, is reminded that the Main Crater should be strictly off-limits because sudden steam explosions may occur and high concentrations of toxic gases may accumulate. The northern portion of the Main Crater rim, in the vicinity of Daang Kastila Trail, may also become hazardous when steam emission along existing fissures suddenly increases. Furthermore, the public is also reminded that the entire Volcano Island is a Permanent Danger Zone (PDZ), and permanent settlement in the island is strongly not recommended

Figure 2.1 Flood Hazard Map, Province of Cavite

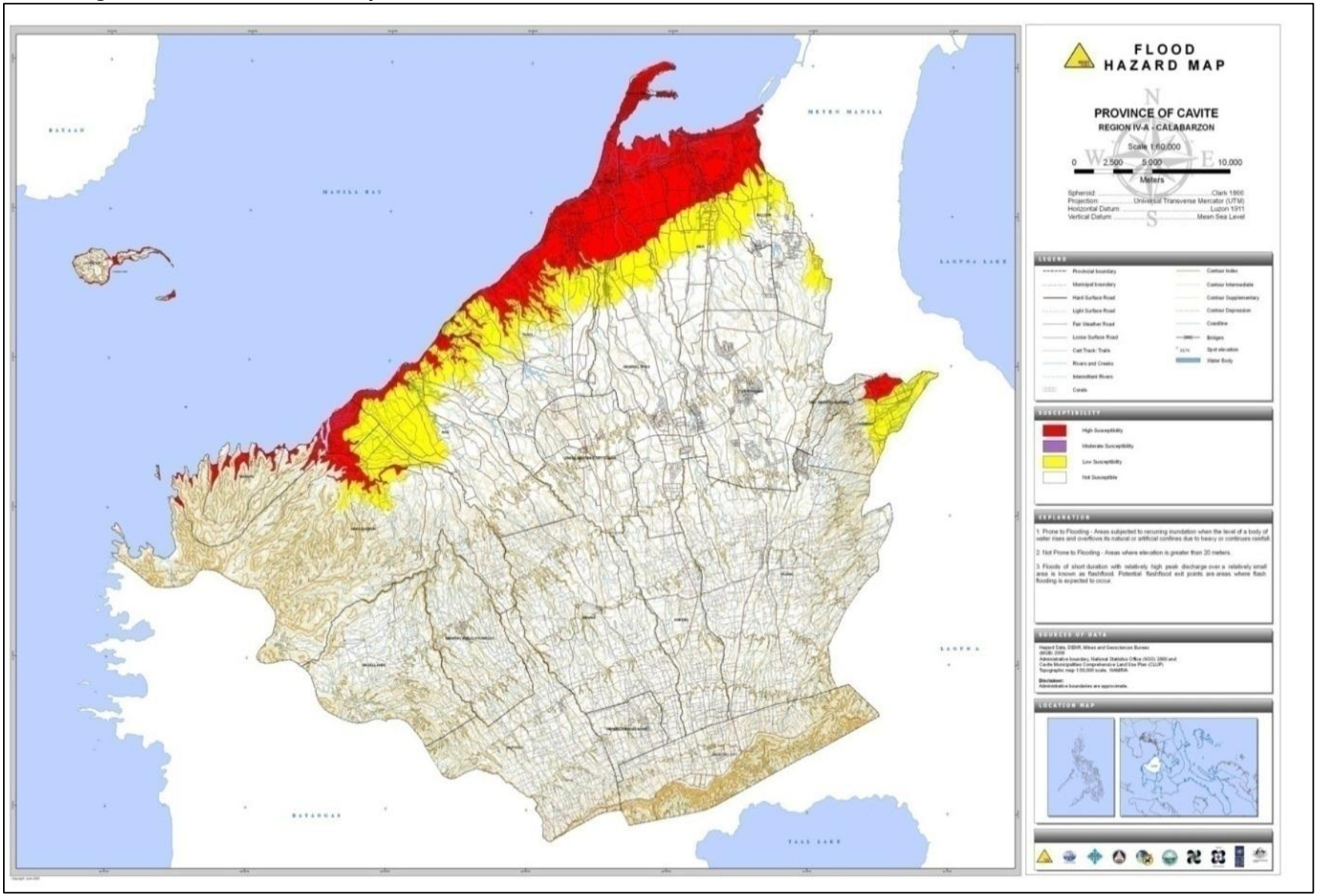


Figure 2.2 Rain-Induced Landslide Hazard Map, Province of Cavite

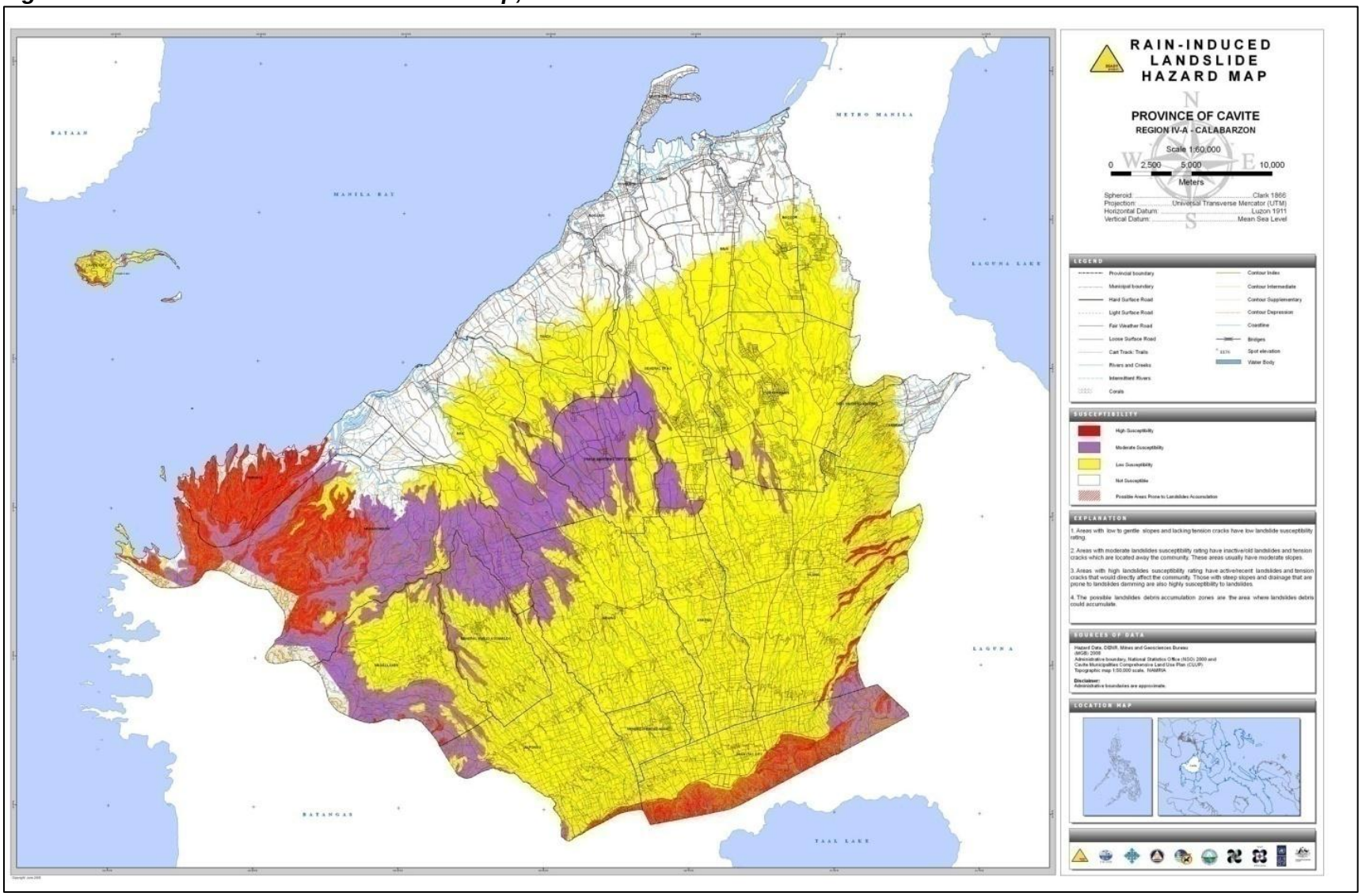


Figure 2.3 Storm Surge Hazard Map, Province of Cavite

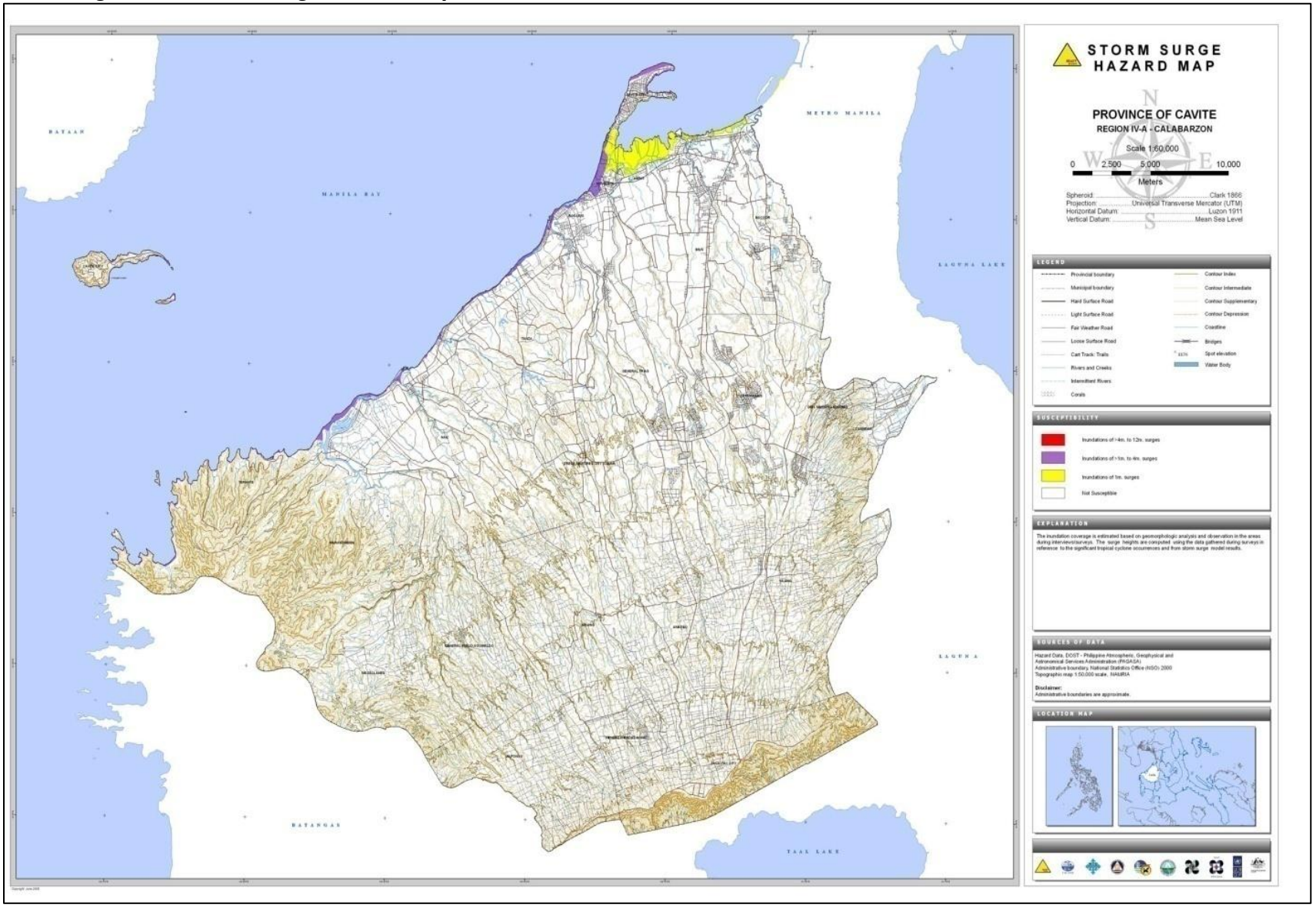


Figure 2.4 Ground Shaking Hazard Map, Province of Cavite

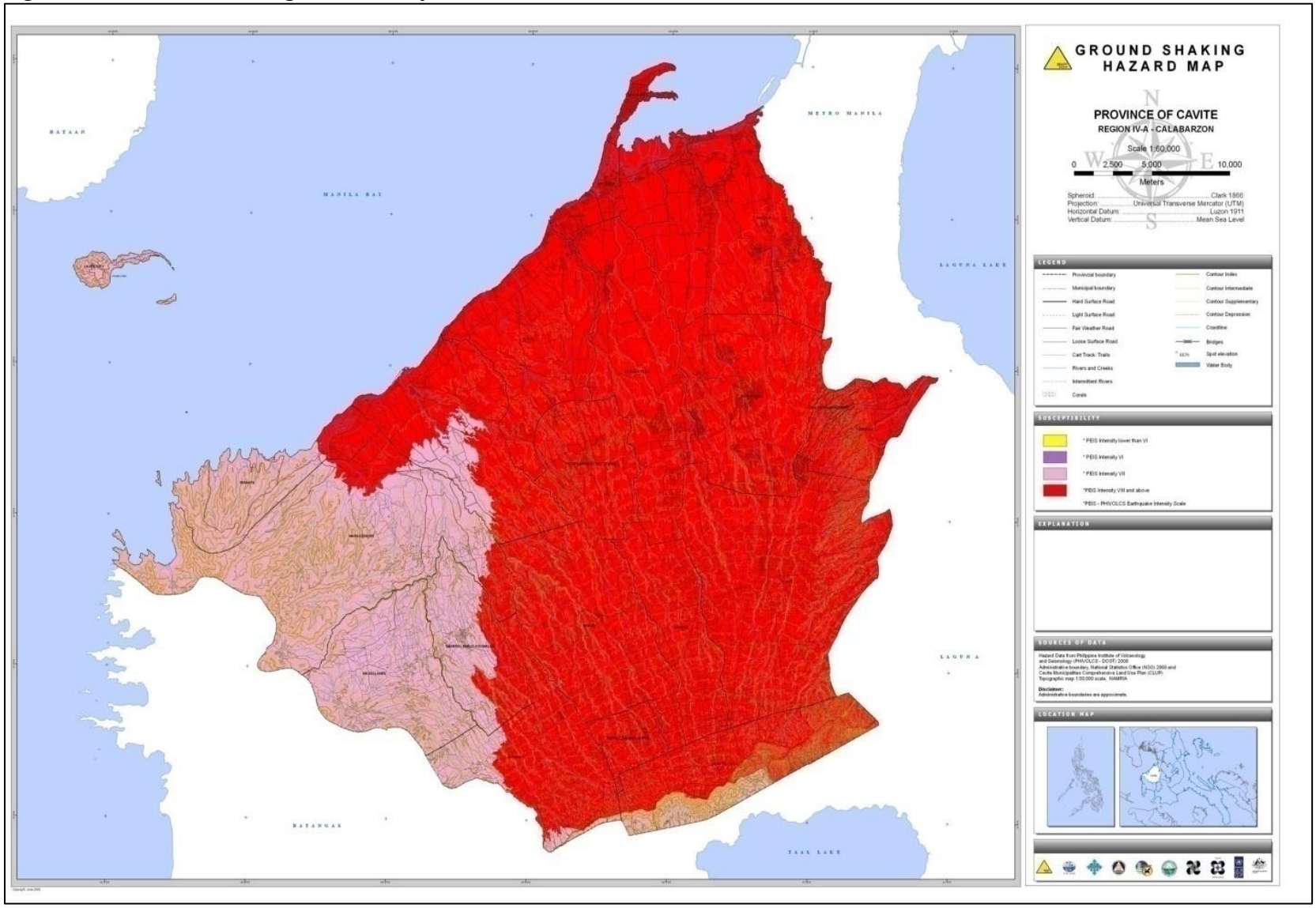


Figure 2.5 Liquefaction Hazard Map, Province of Cavite

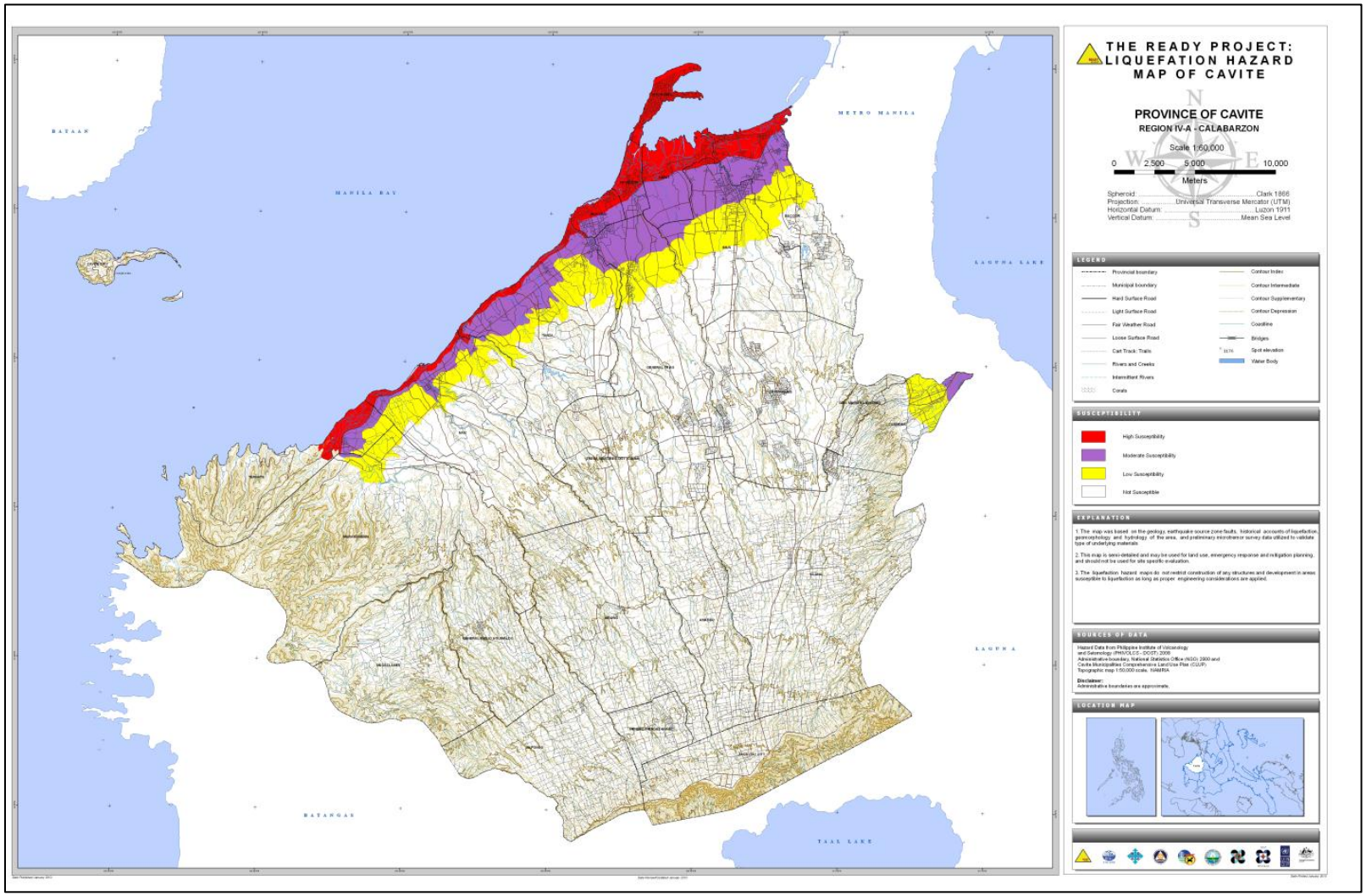


Figure 2.6 Tsunami Hazard Map, Province of Cavite

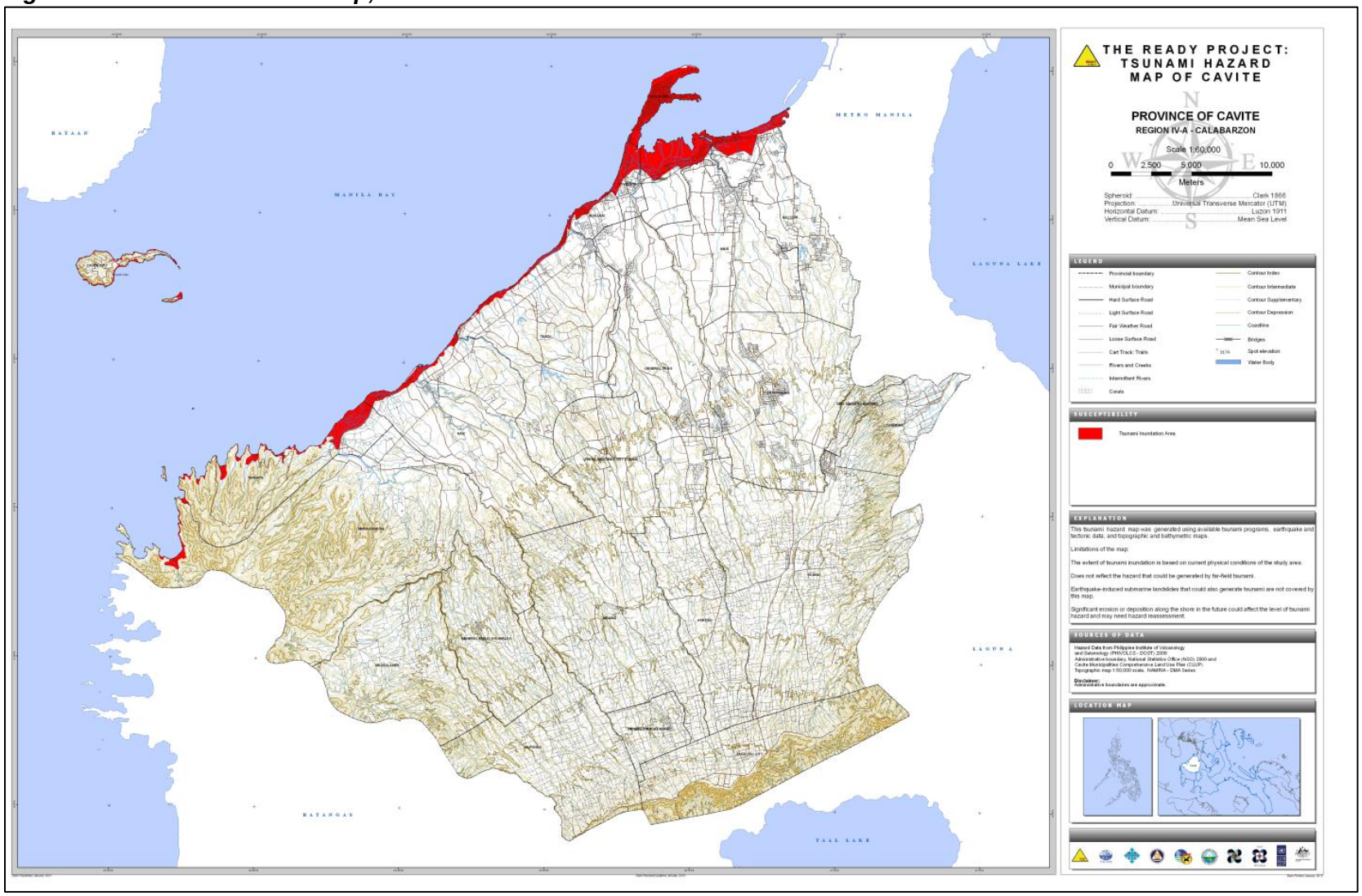


Figure 2.7 Tsunami Hazard Map, Province of Cavite

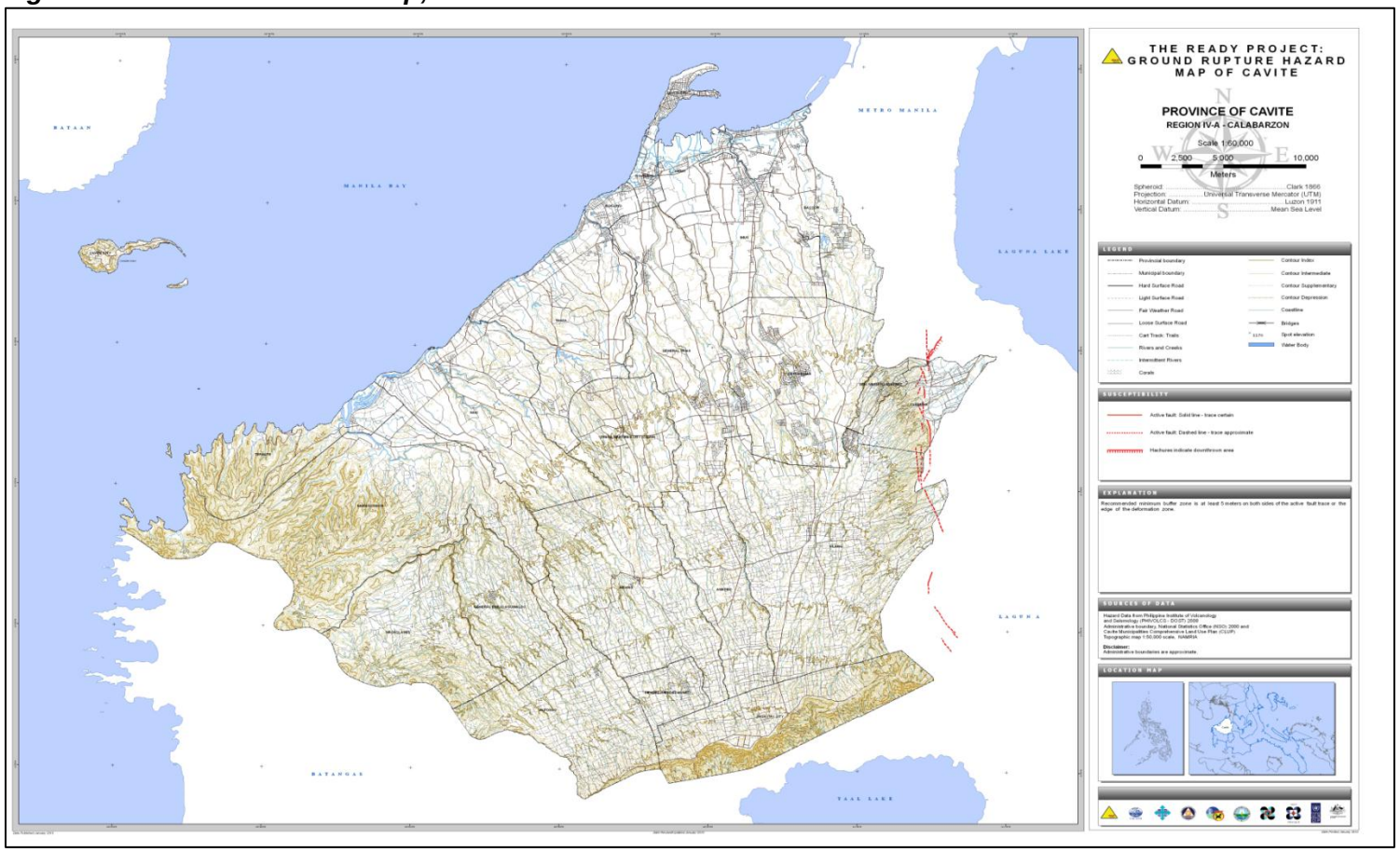
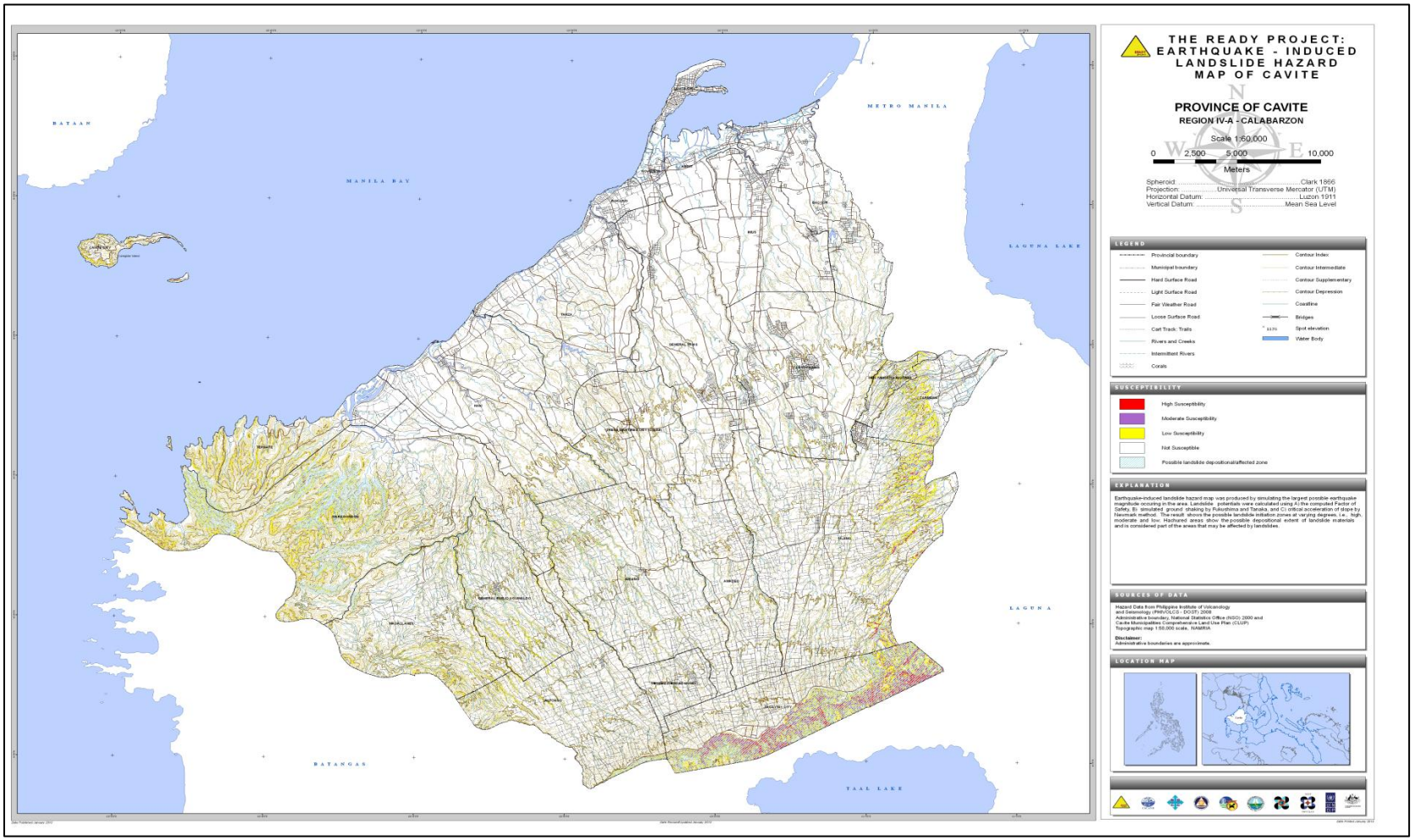


Figure 2.8 Earthquake-Induced Landslide Hazard Map, Province of Cavite



Summary

Municipality	Flood	Rainfall Induced Landslide	Storm Surge	Ground Shaking	Lique-faction	Tsunami	Ground Rupture	Earthquake Induced Lanslide
Alfonso		✓		✓				✓
Amadeo		✓		✓				✓
Bacoor	✓	✓	✓	✓	✓	✓		
Carmona	✓	✓		✓	✓		✓	✓
Gen. E. Aguinaldo		✓		✓				✓
Gen. M. Alvarez		✓		✓	✓			✓
Gen. Trias	✓	✓		✓	✓			✓
Imus	✓	✓		✓	✓			
Indang		✓		✓				✓
Kawit	✓		✓	✓	✓	✓		
Magallanes		✓		✓				✓
Maragondon	✓	✓	✓	✓	✓	✓		✓
Mendez		✓		✓				✓
Naic	✓	✓	✓	✓	✓	✓		✓
Noveleta	✓		✓	✓	✓	✓		
Rosario	✓		✓	✓	✓	✓		
Silang		✓		✓			✓	✓
Tanza	✓	✓	✓	✓	✓	✓		✓
Ternate	✓	✓	✓	✓	✓	✓		✓
Cavite City	✓	✓	✓	✓	✓	✓		✓
Dasmariñas City		✓		✓				✓
Tagaytay City		✓		✓				✓
Trece Martires City		✓		✓				✓

III. Consequence and Vulnerability Analysis

The rapid urbanization of the Province over the last several years has brought about extensive increase in the population, especially in areas where in commercial establishments and industrial estates continue to grow or mushroom.

However, due to the extreme weather conditions and the alarming frequency of natural calamity occurrences these past few years, this poses a significant danger in terms of safety concerns for the people, probability of lost employment opportunities and destruction of vital infrastructures.

To effectively illustrate the possible scenarios and extent of its potential harm to the populace and to the Province as a whole, a vulnerability assessment process was undertaken.

The Province only has three identified three (3) hydro meteorological hazards while the geological hazards such as earthquake and volcanic eruptions, the Province has limited data to undertake a full blown assessment or analysis.

In terms of flooding, the Province secured the rainfall value utilizing the Gumbel Matrix from the Philippine Athmospheric Geophysical and Astronomical Service Administration (PAG-ASA). To be able to plan for the worst case scenario, the Province secured the recorded rainfall value under the 500 year return period. The value for the Province was 374 mm, which has a likelihood score of 1. But an assigned score of 2 was instead used to provide a leeway for planning in extreme likelihood of hazard occurrences.

GIS Technology was then employed to map out the different hazards in the Province, their risk and exposure areas.

Parameters were established per hazards to better reflect the degree of vulnerability of each municipality. Scores are assigned from 1 to 4, wherein 1 means very low; 2 is low; 3 is high and 4 very high.

a. Population to Flooding

Since the Province has an extensive shoreline of about 122.574 kilometers that traverses The Cavite City and 8 municipalities namely Bacoor, Kawit, Noveleta, Rosario, Tanza, Naic, Maragondon, and Ternate, the occurrence of storms directly affects it in various ways, one of which is the pervasiveness of flooding.

Utilizing GIS technology, about 16.93% of the Province's land area is affected by flooding or about 21,215.28 hectares. Translated into total population, about 738,310 are highly susceptible while 358,495 are low-susceptible.

Table 3.1 . Hazard Susceptibility Areas and Potentially Affected Population (Flooding)

Municipality	Total Land Area	Hazard Susceptibility Areas (Has.)			Total Affected Land Area	Total Population	Estimated Affected Population			Total Affected Population
		HSA	MSA	LSA			HSA	MSA	LSA	
Alfonso	6733	-	-	-	-	47973	-	-	-	-
Amadeo	4420	-	-	-	-	31705	-	-	-	-
Bacoor	4550	1505	-	1079	2584	441197	219039	-	89296	308325
Carmona	2543	240	-	915	1155	68135	3301	-	47911	51212
Cavite City	1170	632	-	-	632	104581	94091	-	-	94901
Dasmarinas	8244	-	-	-	-	556330	-	-	-	
Gen. M. Alvarez	759	10	-	-	10	136613	710	-	-	710
Gen. E. 2lAguinaldo	4300	-	-	-	-	17818		-	-	
General Trias	8241	909	-	883	1792	218387	23743	-	31471	55214
Imus	5428	1044	-	1476	2520	153158	67506	-	89433	156939
Indang	8944	-	-	-	-	60755	-	-	-	
Kawit	1650	1649	-	-	1649	76405	76377	-	-	76377
Magallanes	6385	-	-	-	-	18890	-	-	-	
Maragondon	15078	457	-	1174	1631	33604	2591	-	15333	16507
Mendez	1502	-	-	-	-	18890	-	-	-	
Naic	7601	537	-	2427	2964	87058	18584	-	46913	49340
Noveleta	653	652	-	-	652	39294	39285	-	-	39285
Rosario	596	596	-	-	596	94228	93994	-	-	93994
Silang	14044	-	-	-	-	199825	-	-	-	
Tagaytay City	6506	-	-	-	-	61623	-	-	-	
Tanza	7400	1777	-	2078	3855	171795	88114	-	34196	122310
Ternate	4231	912	-	261	1173	20457	10974	-	3942	14916
Trece Martires City	4330	-	-	-	-	90177	-	-	-	
		10920		**10293**	**21213**		**738309**		**358495**	**1096804**

Aside from the coastline municipalities of the Province mentioned above, the Municipality of Gen. Trias and Imus were likewise included in the most at risk areas, although they are inland municipalities.

As per hazard characterization, a total of 19 barangays in Gen. Trias are affected, 7 of which are deemed highly susceptible while 12 are low susceptible areas or a total of 1,791 hectares. Imus, on the other hand has 61 barangays that are susceptible, 38 of which are highly susceptible areas or a total of 1,047.21 hectares.

Moreover, their proximity to typhoon prone municipalities such as Bacoor, Kawit in the case of Imus and Noveleta; Rosario in the case of Gen. Trias, have contributed to their vulnerability. In fact, during the height of Typhoon Milenyo (2006), Gen. Trias was one of the gravely affected by the unprecedented flooding and Imus was one of the affected areas during Typhoons Isang (2009), Inday (2002), Gloria (2002) and Reming (2000).

Three (3) parameters were used to gauge the municipalities existing conditions and these are ranked according their preparedness in terms of Building Condition; their Poverty Incidence and the presence or access to Early Warning Systems or EWS.

The Municipalities of Rosario, Kawit, Noveleta, Cavite City and Bacoor were the top five (5) areas in the Province whose population are most at risk during flooding.

These suggest that these areas (Rosario, Kawit, Noveleta, Cavite City and Bacoor) have to be prioritized when it comes to drafting contingency plans; provision of assistance, investment programming and instant actions in cases of prolonged rainfall brought by unrelenting typhoons.

Settlement Area

Moreover, Bacoor, Cavite City and Rosario belong to the top 10 largest settlement areas in the Province (Ranked 2nd, 9th and 10th with a total population of 713,589 about 23% of the total population, of the Province. Including Kawit and Noveleta, this would into more than 26% of the whole population of the Province. (2010, Census).

As of 2010 Census, the largest settlements in the Province, Dasmarinas City, Bacoor, Imus, Gen. Trias and Silang, continue to hold fort. However, in terms of population growth, Trece Martires City, Tanza and Carmona posted higher growth rates (1st, 3rd and 5th).

Based on the 2000-2007 data on urban population, the City of Trece Martires and the municipality of Gen. Trias experienced high annual urban population growth rate of 11.24 percent and 10.24 percent, respectively. The substantial increase in urban population in these areas may be attributed to expansion of residential areas and mass housing projects as well as the influx of commercial establishments, services and facilities.

Except for Cavite City which posted the lowest growth rate at .17%, all the vulnerable areas belonged to the top 13 areas in the province with high growth rates with Bacoor registering 5.46%, 4th overall.

Hierarchy of Settlements

In terms of hierarchy of settlements, 5 out of the ten municipalities with the highest growth areas are considered large towns, 4 are small/medium city and one (1) small town. Large Towns belong to the province's Primary Urban Center B, having an urban population of more than 50,000 and its role as inter-regional center, giving provincial services for specialist medical facilities, offices of NGA and tourism facilities.

It is therefore safe to assume that the direction of urban growth have now shifted from the traditional settlement areas like the coastal municipalities and industrial centers to the Province's upland and central areas.

Economy

It should be pointed out, that the Municipality of Rosario hosts the Cavite Export Processing Zone (CEPZ), one of the industrial estates in the Province and the third largest EPZ in the country. It likewise houses the largest number of industrial establishments at 259 (as of 2009) with a total employment of 61,965 individuals.

Moreover, the Municipality has the highest population density in 2007 within the Province at 16,619 persons per square kilometres although its area is only .40% in the whole Province, the second smallest.

Since, the presence of these establishments attract people and other commercial establishments, the total population of the place, at any given time, would be greatly affected because Rosario, together with the other coastline municipalities are included in the lowest lowland physiographical category within the Province. These areas have extremely low ground level of 0 to 2 meters elevation compared to the high tide level of about 0.8 meter elevation from the Mean Sea Level (MSL). Moreover, these establishments and the rapid increment of the population creates problem in terms of solid waste disposal since their combine volume reduces the channel flow capacity of drainages and other waste outlets.

As these areas have no longer areas to expand, reclamation projects have been included as options for development. However, similar experiences resulted into natural flood retarding basins and a considerable part of the ground being covered with pavement. These decreases flood retention capacity of the river basins and increases and spills over the habitual flood inundation area to places that have historically not experience any flooding of said kind.

With the exclusion of Bacoor, all of the barangays in the aforesaid most at-risk municipalities are located in the First District of Cavite or a total of 143 barangays (17% of the total barangays in the Province) that are perennially in threat of displacement and exposure to threats such as water-borne diseases and the likes. This is also aggravated by the fact that these areas also has high incidence of informal settlers proliferation whose structures are built on waterways, along the coastlines or on the sea itself.

Affected School Population

In terms of affected sectors of the society, 3,547 (as of 2009-2010 enrolment) of children below 6 years old are affected by the disruption of classes during typhoons and floodings, about 24.9% of the total pre-school students in the whole Province; 23.12% or 75,288 of the total elementary student population; 21.43% or 33,801 of total secondary student population and 21% or 14, 800 of the total tertiary student population in the Province.

b. Population to Rain-Induced Landslides (RIL)

As the Province has a peak elevation of 640 m above sea level located at the Tagaytay Ridge, coupled with high incidence of typhoon occurrences, rain-induced landslides along and adjoining these areas are inevitable.

The total RIL affected area totals to 102,474.31 has. The affected population was grouped into high susceptibility (26,514.54); medium susceptibility (142,327.23) and low susceptibility (1,570,545.87).

Tagaytay City, the Municipalities of Magallanes, Maragondon, Alfonso, SIlang and Ternate were determined as the most at-risk areas for RIL as these areas features range flat to rolling topography with gently sloping surfaces moderate to rugged topography.

Table 3.2. Hazard Susceptibility Areas and Potentially Affected Population (RIL)

Municipality	Total Land Area	Hazard Susceptibility Areas (Has.)			Total Affected Land Area	Total Population	Estimated Affected Population			Total Affected Population
		HSA	MSA	LSA			HSA	MSA	LSA	
Alfonso	6733	108	640	5984	6732	47973	1333	2145	44495	47973
Amadeo	4420	-	-	4420	4420	31705	-	-	31705	31705
Bacoor	4550	-	-	1964	1964	441197	-	-	132822	132822
Carmona	2543	-	-	1368	1368	68135	-	-	16243	16243
Cavite City	1170	56	44	370	470	104581	441	345	2883	3669
Dasmarinas	8244	-	291	7899	8190	556330	-	15645	538425	554070
Gen. M. Alvarez	759	-	-	749	749	136613	-	-	131319	131319
Gen. E. Aguinaldo	4300	-	1361	2939	4300	17818	-	2396	15421	17817
General Trias	8241	-	1034	5414	6448	218387	-	16309	146864	163173
Imus	5428	-	-	2908	2906	153158	-	-	96219	96219
Indang	8944	-	1176	7768	8944	60755	-	6525	54230	60755
Kawit	1650	-	-	-	-	76405	-	-	-	-
Magallanes	6385	116	2524	3492	2640	18890	194	4781	13490	18465
Maragondon	15078	4079	6652	1571	12302	33604	3416	7314	4303	15033
Mendez	1502	-	-	1502	1502	18890	-	-	26757	26757
Naic	7601	-	1828	2802	4630	87058	-	5440	15403	20843
Noveleta	653	-	-	-	-	39294	-	-	-	-
Rosario	596	-	-	-	-	94228	-	-	-	-
Silang	14044	647	243	13144	14034	199825	5170	2750	191853	199773
Tagaytay City	6506	2354	1048	3103	6505	61623	15199	9784	36639	61622
Tanza	7400	-	488	3056	3544	171795	-	1595	47873	49468
Ternate	4231	2628	361	5	2994	20457	760	718	1	1479
Trece Martires City	4330	-	3131	1199	4330	90177	-	66578	23599	90177
		9988	20821	71657	102474		26513	142325	1570544	1739382

Long considered as an alternative summer destination for Baguio, Tagaytay City has invested substantially in hotels, convention centers, exclusive subdivisions, entertainment areas and other tourism amenities. The development strategy of the incumbent administration is to pursue the same thrust of development but at the same time engage the other municipalities in a parallel development direction.

Settlement Area

The total population of the affected municipalities totals to only 399,904 or 12.9% of the Provincial Population. Although their land areas are among the largest in the Province, their population density is among the lowest, with Maragondon having the lowest population density of about 203 persons per square kilometres.

With the exception of Tagaytay City and Silang which belongs to the top 10 largest population growth rate as per 2010 Census; Alfonso, Magallanes, Maragondon and Ternate are among the areas with the lowest growth rates, 16th, 20th, 21st and 22, respectively out of the 23 municipalities/cities.

Data gathered by the National Coordinating Council, the Provincial Disaster and Coordinating Council and the Provincial Social Welfare and Development Office, only

five (5) recent typhoons have triggered rain-induced landslides in the Province, these are Super-Typhoon Juan (maximum sustained winds of 225 kph and gustiness of 260 kph, October 2010), displacing 64 families and 315 individuals in Barangay Bucana, in Ternate, Cavite; Typhoon Basyang, wherein a lone casualty was recorded and affected Barangay Iruhin in Tagaytay City; Tropical Storm Ondoy wherein the Tagaytay-Talisay Road was left impassable and Typhoon Lando wherein 31 families and 61 individuals were affected in Barangay Anahaw I in Silang and left two (2) persons dead and three (3) others injured.

Commerce

About 1,596 commercial establishments are registered in the six (6) municipalities identified as most risk areas or 11.85% of the total business establishments in the Province. These provides a total of 3,391 workers and their respective families that could be affected financially if access to and from their place of work is hampered via debris fall-outs or re-routing of traffic.

School

A total of 93, 362 students from pre-elementary, elementary, secondary and tertiary levels would be affected, in various degrees, if landslides of rare probability would occur within the said municipalities.

c. Population to Storm Surges

A hazardous by-product of strong typhoons is the formation of storm surges and this should be taken into consideration in development planning especially in areas like the Province wherein almost a third of its municipalities and cities lie along its coastlines.

Utilizing the same procedure from computations made to flooding vis-a-vis population and assigning different weights for the parameters established, the most at risk areas in the Provinces for storm surges is identical to those for flooding. These are Rosario, Noveleta, Naic, Cavite City, Ternate and Tanza.

The figures generated from this statistical analysis revealed that a total of 1,511.28 has are affected by storm surges and unlike those of flooding, only two (2) susceptibility descriptors or modifiers have been identified, moderately susceptible population total to 49,760 and least susceptible population at around 46,303.

The combined population of the coastline municipalities in the Province totals to 1,068,619 or 37.4% of the entire provincial population (2007). The coastal population is about 317,569 distributed among 98 barangays within the aforesaid municipalities and with fisherfolks that numbers to 14,938.

As fishing is one of the foremost means of livelihood in the Province and provides income and food for its people, the possible occurrence of storm surges would destroy not only coastal settlements and infrastructure in the area but more importantly aggravate its already dwindling fish production.

There are a combined eight (8) municipal landing areas located in Cavite City (Barangays 10-B, 11, 30 & 48); Naic (Brgys. Munting Mapino, Labaac, Bucana Malaki, Fishport Bancaan) and one (1) Commercial Landing Area or Pandawan in Rosario, Cavite. As evidenced by unpredictable weather patterns and longer than usual typhoon seasons in recent years, the extent of probable damage or effects to fisher folks and fish dealers that depends on these wharfs or ports is extensive.

Likewise, the proliferation of informal settlers living in “houses on stilts” within the sea area adds to the number of potential victims of this storm hazard.

Table 3.3. Hazard Susceptibility Areas and Potentially Affected Population (SS)

Municipality	Total Land Area	Hazard Susceptibility Areas (Has.)			Total Affected Land Area	Total Population	Estimated Affected Population			Total Affected Population
		HSA	MSA	LSA			HSA	MSA	LSA	
Alfonso	6733	-	-	-	-	47973	-	-	-	-
Amadeo	4420	-	-	-	-	31705	-	-	-	-
Bacoor	4550	-	-	95.37	95.37	441197	-	-		
Carmona	2543	-	-	-	-	68135	-	-	-	
Cavite City	1170	-	170	62.61	233	104581	-			
Dasmarinas	8244	-	-	-	-	556330	-	-	-	-
Gen. M. Alvarez	759	-	-	-	-	136613	-	-	-	-
Gen. E. Aguinaldo	4300	-	-	-	-	17818	-	-	-	-
General Trias	8241	-	-	-	-	218387	-	-	-	-
Imus	5428	-	-	-	-	153158	-	-	-	-
Indang	8944	-	-	-	-	60755	-	-	--	-
Kawit	1650	-	-	485	485	76405	-	-	485	485
Magallanes	6385	-	-	-	-	18890	-	-	-	-
Maragondon	15078	-	54	-	54	33604	-	36	-	36
Mendez	1502	-	-	-	-	18890	-	-	-	-
Naic	7601	-	79	-	79	87058	-	3201	-	3201
Noveleta	653	-	133	123	256	39294	-	9723		
Rosario	596	-	54	-	54	94228	-	16986	-	16936
Silang	14044	-	-	-	-	199825	-	-	-	-
Tagaytay City	6506	-	-	-	-	61623	-	-	-	-
Tanza	7400	-	104	-	104	171795	-	8435	-	8435
Ternate	4231	-	139	-	139	20457	-	796	-	796
Trece Martires City	4330		-	-	-	90177	-	-	-	-
			733	766	1499			49760	46303	96063

d. Agriculture to Flooding

Cavite is predominantly an agriculture province. Cavite’s economy is largely dependent in agriculture. Despite urbanization and industrialization, still, a significant number of Caviteños are engaged into agribusinesses.

Several parameters were agreed upon prior to computing for this, first are the municipality's vulnerability to flood, second are access to climate change information (early warning system) and flood control and drainage facilities in agricultural area.

Based on the GIS extracted data, the total agricultural area of the Province is 65,063 hectares, about 6,974.05 of these are affected by flood, 2,399.652 is classified as highly susceptible and 4,574.53. low susceptible.

Despite having the least number of agricultural lands and is known as fishing grounds of the Province, the Municipality of Rosario, Noveleta, Kawit, and even Cavite City were identified as the most-at risk in terms of agriculture to flood. Their combined total agricultural area of 884.2 is only 8.61% of the total agricultural area of Maragondon, the largest in the Province, totalling to 10,265.93.

The composite scores of Rosario, Noveleta, Kawit, Naic and Tanza were identical although the latter two (2) municipalities placed at the lower half of the most-at risk areas. This could be explained by the topography and location of the municipalities, which is highly susceptible to flooding and due to the development of the areas which were previously the inundation area. It is therefore understandable that despite the little or even negligible total of the agricultural area that these municipalities have, they came out of the computation as the most at risk areas due to their inherent physical characteristics.

Table 3.4. Agri to Flood Susceptibility Areas (Agri to Flood)

Municipal Name	Municipal Area	Municipal Agricultural Area	Agri Area Susceptible to Flood	Level of Susceptibility		Municipal Weighted Risk	Rank
				LSA	H SA		
ALFONSO	6733	6087.9259					
AMADEO	4420	3650.3772					
BACOOR	4550	270.6005	52.8360		52.8360	6.55	10
CARMONA	2543	236.7376	176.6770	176.6770		15.12	6
CAVITE CITY	1170	17.1282	16.8060		16.8060	20.80	4
DASMARIÑAS	8244	1623.8177					
GEN. MARIANO ALVAREZ	759	65.2976					
GENERAL EMILIO AGUINALDO	4300	3981.0580					
GENERAL TRIAS	8241	3099.5793	1145.2959	365.7504	779.5455	9.56	8
IMUS	5428	819.6664	280.2004	167.7735	112.4269	11.89	7
INDANG	8944	7685.5213					
KAWIT	1650	172.2580	172.2580		172.2580	23.81	3
MAGALLANES	6385	5938.3456					
MARAGONDON	15078	10957.4470	1417.2305	1001.6514	415.5791	4.84	12
MENDEZ (MENDEZ-NUÑEZ)	1502	1138.1538					
NAIC	7601	5862.8012	1702.6191	1548.0413	154.5777	6.27	11
NOVELETA	653	54.3021	54.3021		54.3021	23.81	2
ROSARIO	596	3.1403	3.1403		3.1403	23.81	1

SILANG	14044	8175.1774					
TAGAYTAY CITY	6506	1858.7320					
TANZA	7400	2144.8343	1232.7694	1059.3407	173.4287	7.04	9
TERNATE	4231	889.5608	719.9395	255.3088	464.6307	16.30	5
TRECE MARTIRES CITY (Capital)	4330	1234.7138	0.0000				
	125,308.00	65,967.18	6,974.07	4,574.54	2,399.53		

This means that although the Province is prone to flooding, the major players in agriculture in the Province such as the Municipalities of Maragondon, Silang, Indang, Naic and Alfonso are considered low risk areas.

e. Agriculture to RIL

Despite the prevalence of commercial establishments and tourism facilities within the area, Tagaytay City still has an agricultural area totalling to 1,270 hectares. This is attributed to the so-called Tagaytay loam soil type in the area which contains fine sandy materials, moderately friable, and easy to work on when moist. In an undisturbed condition, it bakes and becomes hard when dry. About one-half of this soil type is devoted to upland rice and upland crops. On the other hand, Tagaytay sandy loam is friable and granular with considerable amount of volcanic sand and underlain by adobe clay.

The total RIL affected area totals to 57,991 has, out of this 2,590.80 are highly susceptible, 14,494.56 are medium susceptible while 40,905.75 are low susceptible.

Upon subjecting the municipalities that are susceptible to RIL using the different parameters, the Municipality of Mendez, Amadeo, Magallanes, Naic and Maragondon were determined to be the most at risk areas.

Table 3.5. Agri to RIL Susceptibility Areas (Agri to RIL)

Municipal Name	Municipal Area	Municipal Agricultural Area	Agri Area Susceptible to RIL	Level of Susceptibility			Municipal Weighted Risk	Rank
				LSA	MSA	H SA		
ALFONSO	6733	6087.9259	6087.9259	5445.7941	639.9351	2.1967	11.397539	8
AMADEO	4420	3650.3772	3650.3772	3650.3772			25.398416	2
BACOOR	4550	270.6005	217.7526	217.7526			7.268482	12
CARMONA	2543	236.7376	58.2879	58.2879			6.349604	18
CAVITE CITY	1170	17.1282						
DASMARIÑAS	8244	1623.8177	1584.0905	1373.8525	210.2380		6.918756	14
GEN. MARIANO ALVAREZ	759	65.2976	65.2976	65.2976			5.768998	19
GENERAL EMILIO AGUINALDO	4300	3981.0580	3981.0580	2653.9308	1327.1272		18.994426	3
GENERAL TRIAS	8241	3099.5793	1954.2834	1744.3430	209.9405		6.47323	17
IMUS	5428	819.6664	539.4660	539.4660			6.603854	15
INDANG	8944	7685.5213	7685.5213	6580.2108	1105.3105		12.605764	7

KAWIT	1650	172.2580						
MAGALLANES	6385	5938.3456	5687.0199	3102.6408	2468.0841	116.2951	15.048561	4
MARAGONDON	15078	10957.4470	9192.9336	1477.1123	5695.3615	2020.4598	13.287157	6
MENDEZ (MENDEZ-NUÑEZ)	1502	1138.1538	1138.1538	1138.1538			25.398416	1
NAIC	7601	5862.8012	4160.1821	2456.1035	1704.0786		13.523024	5
NOVELETA	653	54.3021						
ROSARIO	596	3.1403						
SILANG	14044	8175.1774	8175.1804	7704.6479	119.7734	350.7591	8.766379	10
TAGAYTAY CITY	6506	1858.7320	1858.7320	1674.2918	181.4858	2.9545	6.944964	13
TANZA	7400	2144.8343	912.0649	878.8674	33.1975		6.47323	16
TERNATE	4231	889.5608	162.5129		53.4698	109.0431	7.921131	11
TRECE MARTIRES CITY (Capital)	4330	1234.7138	1014.3595	1014.3595			10.692623	9
	125,308.00	65,967.18	58125.1996	41775.4894	13748.0019	2601.7083		

Mendez and Amadeo are adjacent to Tagaytay and since their slopes ranges from 8-18% compared to the more than 18%-to above 50% of the whole Tagaytay area, they are directly affected by strong down pour in these areas and its subsequent incident of landslides. They are likewise waterways or river tributaries within these areas that increases the possibility of landslides. Further, the landslide prone areas within Tagaytay are located at the Tagaytay Ridge whose soil integrity is strengthened with lush vegetations cultivated through the years.

The said municipalities' susceptibility is significant considering that both Amadeo and Mendez are contributors in the Province's agricultural production, with Amadeo a major production area of coffee, the Province's One Town One Product and considered as a cash crop, accounting to 45.7% of the Province's annual production.

Based on data from the Provincial Agriculture Office, the Province's sufficiency level for agricultural products, that is supply vis-a-vis consumption, posted a shortage or deficit. Except for coffee, products that are grown in both municipalities would add to the insufficiency of the Province, translating into loss of income to farmers and additional costs to consumers within the Province.

f. Agriculture to Storm Surge

The agricultural area affected by storm surge totals to 207.62 has, 117.22 has are classified as moderately susceptible while the remaining 90.40 has are low susceptible.

A different set of parameters were set in place for this particular category, the crop type in the particular area, the implementation of storm surge mitigation intervention and access to typhoon forecasting information and EWS.

Similar to the findings iIn Agriculture to Flood, the most at risk areas for agriculture to storm surge are likewise located in the coastal lying municipalities.

Cavite City, although scored high in the composite scores for the set parameters, was considered the most at risk areas, since its exposure score is 3, which means 75% of its agriculture area are exposed to storm surge.

The growing temperature in recent years have resulted into more intense tropical typhoon, increasing incidences of sea level rise in coastal communities that could gravely affect the vulnerability of these areas to storm surges.

Since Cavite City has one of the highest population in the Province (7th), its coastal population, about 50%, would also be vulnerable to diseases including mosquito-borne illnesses like malaria and dengue.

Table 3.6. Agri to Storm Surge Susceptibility Level/Municipality

Municipal Name	Municipal Area	Municipal Agricultural Area	Agri Area Susceptible to Storm Surge	Level of Susceptibility			Municipal Weighted Risk	Rank
				LSA	MSA	H SA		
ALFONSO	6733	6087.9259						
AMADEO	4420	3650.3772						
BACOOR	4550	270.6005	39.662189	39.662189			15.119052	4
CARMONA	2543	236.7376						
CAVITE CITY	1170	17.1282	7.637793		7.637793		37.614405	1
DASMARIÑAS	8244	1623.8177						
GEN. MARIANO ALVAREZ	759	65.2976						
GENERAL EMILIO AGUINALDO	4300	3981.0580						
GENERAL TRIAS	8241	3099.5793						
IMUS	5428	819.6664						
INDANG	8944	7685.5213						
KAWIT	1650	172.2580	47.061818	47.061818			27.473136	2
MAGALLANES	6385	5938.3456						
MARAGONDON	15078	10957.4470						
MENDEZ (MENDEZ-NUÑEZ)	1502	1138.1538						
NAIC	7601	5862.8012	27.097827		27.097827		13.8	5
NOVELETA	653	54.3021	3.677027	3.677027			13.736568	7
ROSARIO	596	3.1403						
SILANG	14044	8175.1774						
TAGAYTAY CITY	6506	1858.7320						
TANZA	7400	2144.8343	23.285499		23.285499		13.8	6
TERNATE	4231	889.5608	59.197721		59.197721		15.797053	3
TRECE MARTIRES CITY (Capital)	4330	1234.7138						
	125,308.00	65,967.18	207.62	90.40	117.22			

g. Built up to Flood

As per HLURB, built-up area is defined as an area with contiguous grouping of ten (10) or more structures on it. Hence, built-up area is not a defined political administrative area

but is a delineated built-up area usually derived from aerial photo and/or land use survey.

The total built-up area of the Province as generated by GIS is about 47,348.44 has, total affected area by flooding around 13,402.58, classified further into highly susceptible of about 7,679.69 has and low-susceptible at 5,722.89 has.

It should be noted that the third parameter, building condition, was limited only to two vulnerability scores because due to the susceptibility of these areas to flood, no structures are deemed very low resilient or very resilient at the other end due to the unpredictability of climate patters in recent years.
The risk score of Maragondon that is 19.04 from the range of 2-32, means that it is at risk to occasional hazards but with high severity. Its severity of consequence score of 10 is considered severe that an advocacy for emergency management is required.

The Municipality of Maragondon was considered the most at risk area since it has the highest exposure scores, that is 4 and 2, for its two modifiers, LSA and HSA, respectively. This means that more than 75% of its low susceptible built-up areas are concentrated in flood prone areas and and more than 35% of its HSA areas have similar situations.

However, the said affected area, 198.7 hectares is just 1.71% of its total municipal area, a small figure–compared to Naic, whose consequence scores are identical with Maragondon but its affected built-up areas accounts to 22.8% of its total built-up area. Its exposure score though is only 1, or less than 1% of its LSA and HSA.

Table 3.7. Built-Up to Flood (Susceptibility Levels/Municipality)

Municipal Name	Municipal Area	Municipal BuiltUp Area	BuiltUp Area Susceptible to Flood	Level of Susceptibility			Municipal Weighted Risk	Rank
				LSA	MSA	H SA		
ALFONSO	6733.00	523.1225						
AMADEO	4420.00	770.5145						
BACOOR	4550.00	4230.2226	2484.5389	1074.1690		1410.3699	18.114654	7
CARMONA	2543.00	2288.0179	976.7458	736.6407		240.1051	9.121828	11
CAVITE CITY	1170.00	500.5568	493.3878			493.3878	23.810051	5
DASMARIÑAS	8244.00	6577.7395						
GEN. MARIANO ALVAREZ	759.00	521.4196	10.4120			10.4120	7.8	12
GENERAL EMILIO AGUINALDO	4300.00	328.2320						
GENERAL TRIAS	8241.00	5140.7877	646.2134	516.8210		129.3924	5.40305	13
IMUS	5428.00	4607.1097	2240.5153	1309.2153		931.3001	11.355563	10
INDANG	8944.00	1285.9282						
KAWIT	1650.00	1228.8462	1228.8462			1228.8462	31.2	2
MAGALLANES	6385.00	449.7419						
MARAGONDON	15078.00	198.7306	198.7306	171.9892		26.7414	19.037693	6
MENDEZ (MENDEZ-NUÑEZ)	1502.00	356.5084						

NAIC	7601.00	1733.0922	1257.3946	882.3150		375.0797	13.009592	9
NOVELETA	653.00	591.6341	590.9131			590.9131	27.255706	3
ROSARIO	596.00	572.0222	572.0222			572.0222	34.340041	1
SILANG	14044.00	5982.0514						
TAGAYTAY CITY	6506.00	1130.0653						
TANZA	7400.00	5245.3479	2599.5350	1026.5977		1572.9373	16.350561	8
TERNATE	4231.00	103.989244	103.9416	5.7576		98.1840	23.953573	4
TRECE MARTIRES CITY	4330.00	3096.808116						
	125,308.00	47,462.49	13,403.20	5,723.51	-	7,679.69		

h. Built-up to RIL

A total of 12 municipalities are identified as risk areas, with Tagaytay City leading the pack with a risk score of 14.27 from the range of 2-32

The Province has an affected total area of 33,924.71 has, with three modifiers, HSA at 302.17 has, MSA at 3,890.58 and LSA at 29,731.96 has.

The risk score of Tagaytay that is 14.28, from the range of 2-32, is considered low to moderate risk. But since the range of 13 to 24, covers a range of events, one of which are very rare events with very high severity impacts (severity of consequence is 6 and up), Tagaytay City should advocate emergency management considering that its level of consequence is 7.

Based on the exposure maps for Built-Up to RIL, Dasmarinas City's affected built-up area is more than 75% exposed to RIL or about 79.77 of its total land area. However, most of these areas are classified as low-susceptible areas (LSA) or about 98.7percent of the total affected area. Since Dasmarinas City belongs to the central or transition area with slopes ranging to 3%-8%, which are suitable for irrigated rice if terraced or fishponds, their risk to RIL is zero. This is significant since most tertiary schools and technical schools are located in the area.

On the other hand, Tagaytay's exposure areas are located adjacent to the Tagaytay Ridge, the highest peak in the Province. These areas have a number of residential, commercial and tourism establishments. Although the affected areas that fall under highly-susceptible areas (HAS) totals to only about .5% of its total built-up area, its impact on the business enterprises therein and the tourism arrivals or visit would be greatly affected since most of the real estate along the ridge are prime properties and the view of the Taal Volcano is part of its attractiveness, its market value therefore would greatly decrease.

i. Built-up to Storm Surge

Coastal lying municipalities in the Province were identified as susceptible to storm surges and the total built-up area in the Province affected by storm surge is 747.65

hectares, of which 342 hectares are moderately susceptible and the remaining 404.50 hectares low susceptible.

Noveleta, Kawit and Cavite City are considered the top risk areas since their respective built-up area exposures are below 30% while the remaining 4 areas have exposures that is less than 10% of their built-up areas. Noveleta is bounded by Manila Bay and Bacoor Bay which explains its much higher risk scores than Kawit which is bounded only by Bacoor Bay. However, their proximity and locations contributed to their almost identical scores.

On the other hand, Cavite City's exposure area is located at the air-strip or runway inside the Sangley Naval Base, thus the potential damage is much less than that of the other two municipalities.

Moreover, the affected areas are the smallest municipalities in the Province, with Noveleta the smallest one. Its location has contributed significantly in having its affected built-up area total to 90% of its total built-up area; Kawit about 74% and finally, Cavite City with about 42.7% of its built-up areas affected.

These are severe events but are rare or unlikely to occur in a lifetime. All the municipalities affected should advocate emergency management by relocating affected structures outside the high hazard zone or appropriate design based solutions.

j. Lifeline to Flood/RIL/SS

The vitality of transport means and transportation networks are very important for any province, thus having an efficient and effective transport system, access roads and traffic circulation is a good indicator of a well-organized province and is an added factor for investment that will likely lead to development.

The province's transport infrastructure has kept on moving with the increasing industrial and commercial activities which sometimes results to quilts of urban sprawl, traffic congestion and increased road accidents. From this, more transportation facilities, better traffic control systems and road signages are provided by the provincial government.

Generally, the transportation system in the Province of Cavite is predominantly landbased, of which the main transport mode is road-based. The roads are classified into national, provincial, city/municipal, and barangay roads. The national roads form part of the trunkline systems and are connected by provincial roads from one city/municipality to another, and the city/municipal roads interlink barangays.

Cavite's total road network comprises roughly 2,222.0714 kilometers wherein 18.20 percent or 404.3580 kilometers are national roads while 370.6770 kilometers or 16.68 percent are provincial roads. Most of these roads are surfaced with concrete or asphalt. Moreover, 90.22 percent or 287.9257 kilometers of the city/municipal roads are paved with concrete while majority of the 1,127.9041 kilometers barangay roads are earthfill and concrete roads.

Cavite has six (6) major entrances and exits: the Aguinaldo Boulevard (Manila-Cavite Coastal Road), South Luzon Expressway (SLEX) in Carmona, the Aguinaldo Highway

(Batangas-Alfonso-Tagaytay Road), the Zapote-Las Piñas Road, the Sta. Rosa-Tagaytay Road, and the Alabang-Molino via Daang Hari Road.

There are 311 bridges which connect roads in different cities and municipalities of the province. These are also classified as national, provincial, city/municipal and barangay bridges wherein 255 or 89.99 percent of these have permanent structures having a total length of 4,917.94 linear meters while 56 or 18.01 percent are temporary structures registering a total length of 1,093.15 linear meters.

The national and provincial roads in only 12 municipalities are affected by flooding and these are the City of Cavite, Municipalities of Noveleta, Kawit, Rosario, Tanza, Naic, Bacoor, Gen. Trias, Carmona, Maragondon, Imus and Ternate. Except for Gen. Trias and Imus, these are coastline municipalities. Their total road length is 284.88 kms, of which 99.01 are classified as highly susceptible and 62.89 as low susceptible.

The total road length of Rosario, Kawit and Novelta are 100% affected while the least affected area is the Municipality of Carmona with 0% susceptibility.

Except for Cavite City, who only has one (1) ingress and egress, the other areas have alternate roads or arterial roads that are passable in cases of extreme flooding.

In terms of RIL, there are 19 municipalities identified as risk areas, wherein Mendez the most at risk municipality in which both its national and provincial road (9.85 kms.) are 100% affected and the least affected is Ternate.

It should be noted, however, that out of the total road length of 574.65 kms only 42.89 kms or 7.4% is highly susceptible to RIL.

Similar to the areas in flooding, the availability of alternate routes have greatly lessened the impact of RIL in terms of travel time or delivery of goods. In cases of debris clearing, the presence of equipment and the emergency response team of the Provincial Government as well as those of the municipalities ensure swift action.

Meanwhile, the effects of Storm Surge on the Province's life lines are likewise minimal. Three (3) areas are pinpointed as susceptible and these are Noveleta at 28% of its road length affected; Kawit at 14.27% of their road length affected and Cavite City with 10.37% of its lifeline affected.

Table 3.8. Summary Matrix, Estimated Affected Area (Lifeline)

Municipality	Road Class	Flood			Rain Induced Landslide			Storm Surge		
		HSA	MSA	LSA	HSA	MSA	LSA	HSA	MSA	LSA
Alfonso	National				3.534746		18.787125			
	Provincial				0.186698		21.423076			
Amadeo	National						12.81811			
	Provincial						`			
Bacoor	National	10.203513		2.813371			6.082511			
	Provincial	10.364757		2.774892						

Carmona	National			7.37536			5.300029			
	Provincial									
Cavite City	National	8.318303				0.199591	0.975926		0.869063	1.050902
	Provincial									
Dasmarinas	National					0.18456	33.093699			
	Provincial						10.49687			
General Emilio Aguinaldo	National									
	Provincial					4.669417	14.439005			
General Mariano Alvarez	National									
	Provincial									
General Trias	National	5.252029		3.283538		0.909112	18.99547			
	Provincial	3.349399		3.465307		2.026917	10.420245			
Imus	National	1.811854		3.185417			4.101891			
	Provincial	13.649312		8.68027			4.438358			
Indang	National					0.027986	29.024864			
	Provincial					1.414088	7.960243			
Kawit	National	11.570762								
	Provincial	1.365663								0.194851
Magallanes	National					1.763805	12.60232			
	Provincial					0	1.895158			
Maragondon	National	2.035884		4.663928		3.193534	6.997129			
	Provincial					8.63277	4.523709			
Mendez	National						3.839406			
	Provincial						6.011511			
Naic	National	0.932125		11.297733		2.050763	13.311637			
	Provincial	2.620331		6.821214		2.998119	5.069348			
Noveleta	National	6.511571								1.82604
	Provincial									
Rosario	National	3.635126								
	Provincial									
Silang	National				1.476779		28.494302			
	Provincial				2.725325		34.79			
Tagaytay City	National				23.129026	2.191068	17.689757			
	Provincial				0.220882		1.588371			
Tanza	National	8.354221		5.144083		0.96299	8.063897			
	Provincial	6.162985		3.319663			0.035811			
Ternate	National	2.880884			11.620228	3.185271				
	Provincial	0.082565		0.071394						
Trece Martires City	National					9.578839	6.995307			
	Provincial									

k. Critical Areas to Flooding/RIL/SS

These areas include public utilities such as hospitals, electricity installations; public institutions such as residential areas, government offices, schools and the likes.

A total of only 179 critical infrastructures were digitized, 91 are affected, 72 are considered highly susceptible and 19 low susceptible. These infrastructures were identified in only 20 municipalities within the Province, consisting of 44 schools, 6 churches, 27 bridges, 67 government buildings and 17 hospitals.

Flooding **(Table 3.9. Risk Score/Critical Infra)**

Municipal Name	Critical Infra Type	Risk Score
BACOOR	Bridge	20.80000000000
KAWIT	Bridge	9.15200000000
MARAGONDON	Bridge	2.64000000000
NAIC	Bridge	2.56000000000
NOVELETA	Bridge	41.60000000000
GENERAL TRIAS	Church	3.60000000000
MARAGONDON	Church	5.95800000000
ROSARIO	Church	3.74400000000
BACOOR	Government Building	15.60000000000
CAVITE CITY	Government Building	21.84000000000
GENERAL TRIAS	Government Building	7.84800000000
IMUS	Government Building	31.20000000000
KAWIT	Government Building	6.86400000000
MARAGONDON	Government Building	5.28000000000
NAIC	Government Building	3.06000000000
ROSARIO	Government Building	3.74400000000
TANZA	Government Building	9.36000000000
CAVITE CITY	Hospital	8.32000000000
GENERAL TRIAS	Hospital	10.81600000000
KAWIT	Hospital	23.29600000000
NAIC	Hospital	8.00000000000
ROSARIO	Hospital	8.32000000000
TANZA	Hospital	16.64000000000
CAVITE CITY	School	3.12000000000
GENERAL TRIAS	School	6.86400000000
MARAGONDON	School	6.61200000000
NAIC	School	8.40000000000
ROSARIO	School	17.47200000000
TANZA	School	9.36000000000

In terms of bridges, the most affected are the Ilang-Ilang Bridge and Soriano Bridge in

Noveleta. Soriano Bridge links Cavite City, the northernmost part of the Province with Noveleta to other municipalities, while Ilang-Ilang Bridge happens to be located adjacent to the Town Plaza and Commercial Area of Noveleta. This bridge also connects Noveleta to Kawit heading to Metro Manila.

The risk score of Noveleta for Bridges is 41.6, considered as moderate risk, but since its level of consequence is extremely high, action should be to prioritize risk.

The Imus Municipal Hall in Imus, Cavite was deemed as the most susceptible government building since its area, Poblacion IV-D, was considered a highly susceptible area for flooding. The risk score of the Imus Municipal Hall is 31, likewise considered as moderate risk, but action should be to prioritize risk and advocacy for designed or location based solution and emergency management should be initiated.

For hospitals, Kawit Maternity and General Hospital in Kawit, Cavite was found out ot be the most at risk facility, considering that it is located in Marulas, wherein extreme flooding was experienced during the height of Typhoon Milenyo. It is also situated in an area wherein a number of subdivisions are being developed. The risk score of this hospital is 23.9, considered low to moderate risk, advocacy for emergency management, appropriate special land use management option, should be explored.

The schools in Rosario, Cavite were the most at risk educational institution due to factors such as its susceptibility to flooding and site of the largest ecozone in the Province. The risk score of Rosario's schools is 17.4, considered low to moderate risk but its severeity consequence is extremely high. Risks should be addressed or advocated by exploring or addressing issues and concerns about its location or the need to retrofit it.

Rain-Induced Landslide (RIL)

There are a total of 66 affected critical infrastructures, one (1) is considered as highly susceptible, 19 are moderately susceptible and 46 low susceptible.

In terms of bridges, the most affected are those located in the City of Dasmarinas (Langkaan I, Pala-pala, Paredes, San Marcelino, Piela ad Aguinaldo Bridges) and Gen. Trias (Panaysayan, Manggahan, Langkaan III and Malabon Bridges). These are critical infrastructures since Gen. Trias is the site of many industrial establishments and an economic zone and Dasmarinas is home to the most number of educational institutions in the Province. They both have a risk score of 32, moderate risk, but with high severity of consequence, necessitating action to mitigate risk or advocacy for emergency management.

The Candelaria Church in Silang, Cavite was the most at risk religious instituion in the Province with a risk score of 6.0. The church is one of the oldest existing Spanish Churches in the Province (built in 1595) and considered as a pilgrimage site or a tourism attraction due to its rococo altars. The risk score is considered very low risk and as per criteria this requires no action.

Table 3.10. Risk Score/Critical Area (RIL)

Municipal Name	Critical Infra Type	Risk Score
ALFONSO	Bridge	6.40
DASMARI╤AS	Bridge	32.00
GENERAL TRIAS	Bridge	32.00
INDANG	Bridge	12.80
MAGALLANES	Bridge	8.00
MARAGONDON	Bridge	6.00
SILANG	Bridge	8.00
TRECE MARTIRES CITY (Capital)	Bridge	9.10
SILANG	Church	6.00
TRECE MARTIRES CITY (Capital)	Church	1.38
GENERAL EMILIO AGUINALDO	Government Building	7.92
MENDEZ (MENDEZ-NU╤EZ)	Government Building	24.00
NAIC	Government Building	9.00
SILANG	Government Building	12.00
TAGAYTAY CITY	Government Building	9.60
TRECE MARTIRES CITY (Capital)	Government Building	11.00
TAGAYTAY CITY	Hospital	16.64
TRECE MARTIRES CITY (Capital)	Hospital	4.16
ALFONSO	School	19.20
GENERAL EMILIO AGUINALDO	School	16.08
INDANG	School	14.40
MAGALLANES	School	14.45
MARAGONDON	School	12.03
NAIC	School	6.00
TAGAYTAY CITY	School	4.80
TRECE MARTIRES CITY (Capital)	School	2.38

For hospitals, The Tagaytay Hospital System Medical Ceter in San Jose, Tagaytay City Cavite was found out tobe the most at risk facility, considering that it is located in a highly susceptible area. It is a tertiary level hospital facility, which means that all the needed medical services are provided. Its risk score of 16 is considered low to moderate risk but its severity of consequence is 8, which requires action and advocacy on emergency management.

The schools in Alfonso, Cavite were the most at risk educational institution since all barangays in the municipality are exposed ro RIL (MSA and LSA) The risk score of Alfonso's schools is 19.20, considered low to moderate risk but its severeity consequence is extremely high. Risks should be addressed or advocated by exploring or addressing issues and concerns about its location or the need to relocate it to safer grounds.

Table 3.11. Risk Score/CrticalArea (Storm Surge)

Municipal Name	Critical Infra Type	Risk Score
CAVITE CITY	Government Building	9.23400000000
CAVITE CITY	Hospital	6.24000000000
CAVITE CITY	School	9.36000000000
NOVELETA	Bridge	72.00000000000

A total of eight (8) infrastructures are affected, one (1) government building is highly susceptible while (7) are low susceptible (2 government building, 2 hospitals, 2 schools and 1 bridge).

Except for Noveleta, this is identified as the most at risk area in terms of bridges, Cavite City tops in Government Building, Hospital and Schools, due to the topography and location of the area. However, the risk scores of 9.23, 6.24 and 9.36, are considered very low risk to very low risk, which requires no action for Hospitals, and advocacy for emeregency management for Government Building and School.

Vulnerability Assessment

Vulnerability Assessment is the initial step in the emergency management process that leads to mitigation against, preparedness for, response to, and recovery from hazards. Hazards have the potential of becoming emergencies or disasters that can adversely affect the people, property, environment and economy of the province.

This assessment helps the Province rate the risk, determine vulnerability, and predict the adverse impact of emergencies and disasters. With this, the Province could effectively organize resources and develop comprehensive emergency management plans to minimize the impact of emergencies and disasters, and analyze sustainable development.

The Province of Cavite, due to its topography and location, experiences a number of hazards in a given year. Its coastline municipalities suffer from the effects of flooding due to severe typhoon occurrences and its upland areas to rain-induced landslides.

Due to the dearth of data, vulnerability assessment was undertaken only on two sectors, the health sector, effects from dengue and gastroenteritis, and the forest sector, effects from rain-induced landslides.

Furthermore, vulnerability levels per sector were determined using the three components: *sensitivity, exposure and adaptive capacity*.

Sensitivity is the degree to which a system would respond to a change in climactic conditions (UPLBFI, 2010). In other words, sensitivity means susceptibility.

Exposure, on the other hand, is the extent of the ecosystem and/or human settlements as well as the types ad value of assets that are at risk or most likely to be affected by climate change and its attendant hazards. Exposure is equal to the extent and/or number and cost of climate change and natural disaster impacts.

Adaptive Capacity refers to the general ability of institutions, systems and individuals to adjust to potential harms such as climate change (Adapted from Kovats et. Al., 2003, as cited in the Philippine SNC Project)

To calculate the Vulnerability Index, there is a need to derive the value for each sub-indicator of a gven Impact parameter; then compute total value of all sub-indicators of the Impact Parameters, then separately for the three (3) sub-indices (sensistivity, exposure, adaptive capacity and finally compute the total value of the three (3) sub-indices to get the V index for the impact parameter.

Table 3.12: Indicators and Weights per Sector

Sector	Indicators and Weight of Relevance					
	Sensitivity: 35%		Exposure: 35%		Adaptive Capacity: 30%	
Health	Increase in temperature	0.25	Extent of stagnant water	0.35	Access to sanitary facilities	0.4
	Water supply	0.30	Access to sanitation	0.35	Access to health facilities	0.3
	Waste disposal facility	0.20	Extent of informal settlements	0.30	Alternative health care	0.3
	Presence of stagnant water	0.25				
Forestry	Slope	0.40	Denuded areas	0.33	Reforestation efforts	0.50
	Vegetation	0.30	Upland farms	0.33	Soil erosion control measures	0.20
	Soil type	0.30	Kaingin areas	0.40	Soil conservation / agroforestry	0.30

The level of vulnerability of the sector to the given impact is expressed in five scales, namely: Very High, High, Moderate, Low and Very Low which are assigned values from 1.0 (very high) to 0.2 (very low impacts). The values of the indicators are weighted and summed. The final value derived is the level of vulnerability of the sector with respect to the specific impact of climate change also known as the vulnerability index. The figure shows the formula used in deriving the vulnerability index:

Vulnerability Index = weighted (sensitivity sub-index + exposure sub-index + adaptive capacity)

The result of the vulnerability index analysis will serve as reference for sectoral and local planners in making programs and projects to mitigate the impact of hazards. Likewise, this will be used in prioritizing geographic areas in the province.

Vulnerability Assessment Health Sector

The changes in climate patterns have taken its toll to areas such as the Province of Cavite whose extensive coastline has placed it in the frontline for water borne diseases and other health issues.

However, vital indices have indicated positive signs of the state of health in the Province as it tries to address these concerns. Based on records from the NSCB, the Province is in the top five provinces in the country that has the biggest expenditures on health, nutrition & population control in 2009 amounting to Php306,548,979.

As could be gleaned by the table below, all of the municipalities in the Province have registered low vulnerability index, with the Municipality of Bacoor scoring the "highest." This reflects the existing capacities of the different municipalities in the Province to implement various health programs and policies that would protect its constituency.

In addition to this, the Province has the lowest poverty incidence among Provinces in the country based in 2005, an important parameter in determining the level of "healthiness" of its people.

The list of morbidity and mortality incidences in the Province indicates that aside from diarrhea, no other case of water-borne and related diseases was recorded.

	35%	**35%**	**30%**		
Municipality	SI	EI	ACI	Vulnerability Index	
ALFONSO	0.34	0.27	0.26	0.2915	Low
AMADEO	0.34	0.27	0.26	0.2915	Low
BACOOR	0.44	0.4	0.26	0.372	Low
CARMONA	0.39	0.34	0.26	0.3335	Low
CAVITE CITY	0.39	0.33	0.26	0.33	Low
DASMARINAS	0.39	0.33	0.26	0.33	Low
GMA	0.34	0.33	0.26	0.3125	Low
GEN AGUINALDO	0.34	0.27	0.32	0.3095	Low
GEN. TRIAS	0.39	0.33	0.2	0.312	Low
IMUS	0.44	0.33	0.2	0.3295	Low
INDANG	0.39	0.27	0.2	0.291	Low
KAWIT	0.39	0.33	0.2	0.312	Low
MAGALLANES	0.39	0.27	0.26	0.309	Low
MARAGONDON	0.39	0.33	0.26	0.33	Low
MENDEZ	0.44	0.27	0.2	0.3085	Low
NAIC	0.39	0.33	0.2	0.312	Low
NOVELETA	0.39	0.33	0.2	0.312	Low
ROSARIO	0.44	0.33	0.2	0.3295	Low
SILANG	0.39	0.27	0.2	0.291	Low
TANZA	0.39	0.33	0.2	0.312	Low
TRECE	0.44	0.27	0.2	0.3085	Low
TERNATE	0.39	0.33	0.2	0.312	Low

TAGAYTAY	0.34	0.27	0.2	0.2735	Low

Vulnerability Assessment Forestry Sector

Cavite Province lies in the western monsoon forest zone. This location is very beneficial for the formation of tropical rain forests which are characteristically made through natural vegetation.

In 2007, the existing forest area within the province totalled to 8,624.956 hectares. These forest areas were categorized as Protected Landscape under R.A.7586 otherwise known as National Integrated Protected Area System (NIPAS) and the unclassified forest (Non-NIPAS).

	35%	35%	30%		
Municipality	SI	EI	ACI	Vulnerability Index	
LFONSO	0.66	0.464	0.62	0.5794	Moderate
AMADEO	0.66	0.464	0.5	0.5434	Low
BACOOR	0.26	0.398	0.3	0.3203	Very Low
CARMONA	0.4	0.398	0.44	0.4113	Low
CAVITE CITY	0.26	0.464	0.3	0.3434	Low
DASMARINAS	0.4	0.332	0.4	0.3762	Low
GMA	0.4	0.332	0.4	0.3762	Low
Gen. AGUI	0.66	0.464	0.5	0.5434	Low
GEN. TRIAS	0.46	0.398	0.44	0.4323	Low
IMUS	0.26	0.332	0.3	0.2972	Very Low
INDANG	0.6	0.398	0.4	0.4693	Low
KAWIT	0.42	0.596	0.3	0.4456	Low
MAGALLANES	0.74	0.464	0.5	0.5714	Moderate
MARAGONDON	0.74	0.398	0.4	0.5183	Low
MENDEZ	0.74	0.398	0.4	0.5183	Low
NAIC	0.26	0.398	0.3	0.3203	Very Low
NOVELETA	0.26	0.398	0.3	0.3203	Very Low
ROSARIO	0.26	0.398	0.3	0.3203	Very Low
SILANG	0.54	0.398	0.4	0.4483	Low
TANZA	0.26	0.398	0.3	0.3203	Very Low
TRECE	0.4	0.464	0.44	0.4344	Low
TERNATE	0.34	0.398	0.4	0.3783	Very Low
TAGAYTAY	0.68	0.398	0.44	0.5093	Low

By virtue of Proclamation Number 1594 on 26 October 1976, a total of 4,000 hectares located in Ternate and Maragondon, Cavite was proclaimed as national park, now known as the Mts. Palay-Palay and Mataas na Gulod Protected Landscape. The park lies in the border of Cavite and Batangas and has three peaks, Palay-Palay, Pico de Loro and Mataas na Gulod. Still, there were five (5) unclassified forests found along Tagaytay Ridge, Maragondon, Magallanes, Ternate and Alfonso.

The Municipalities of Alfonso and Magallanes scored the highest vulnerability index at .579 and .571 respectively. As they are the municipalities that are adjacent to Tagaytay City whose slope range is much higher, waters from precipitation would naturally flow directly to their forest and agricultural lands. Moreover, their soil type is clay which loses its integrity during excessive rainfall.

It is imperative therefore that the slopes or steep areas that has vegetation cover or structures should be strengthened or undertake measures that would mitigate effects of possible rain-induced landslides.

It should be noted that the municipalities with the largest forest areas, Maragondon (5,022.630 has.), Tagaytay (1,779.520 has) and Ternate (1,248.700 has.) have very low to low vulnerability although they have 50% and higher slopes, the highest in the Province.

Recommendations

The effects of hazards such as flooding and landslides coupled with the changes in our climate has made the Province realize the importance of integrating it in its plans and programs for a sustainable development.

Since 9 out of the 23 areas in the Province lies in its coastline areas, a combination of adaptive and mitigating measures should be in place. This includes relocation of coastal communities or retrofitting their settlements; planting of mangrove covers; flood control projects such as retarding basins; and rockwall projects.

On the other hand, forest lands are being maintained as they play a great role for the ecological balance of the Province aside from the fact that they are home to numerous flora and fauna that needs to be protected and preserved.

Although the forests in the Province have registered low vulnerability to landslides, it does not preclude it from continuing its reforestation and upland development programs especially in areas that are protected.

The municipalities identified that have moderate vulnerability such as Alfonso and Magallanes should put in place measures that would protect its forests from further degradation through various interventions such as sustainable forest management.

IV. Provincial Disaster Risk Reduction Management Plan

Strategies, Programs, Projects and Activities

DEVELOPMENT ISSUES/PROBLEMS	STRATEGIES	PROGRAMS/PROJECTS/ ACTIVITIES
Population & Settlements		
Inadequate flow capacity of various rivers and tributaries in the province	Implementation of storm surge mitigation intervention and access to typhoon forecasting information and EWS.	Water Resources Management
	Conduct of Capacity and Resiliency Need Assessment and Capacity Building Training	Protection & conservation of watershed
	Clearing out operations	Coastal clean-up
Inadequate capacities of the existing drainage facilities.	Construction of canals/ canal linings	Construction of canal lining, riverwalls, breakwater, groin, riprapping, river dredging, rehabilitation of flood control system, declogging/cleaning of canal
Clogging of the drainage channels due to solid wastes.	Declogging/clearing of canals/waterways	Integrated Coastal Management
	Enforcement of PD 1152 Sec. 43-45	Forest Resource Management
Illegal encroachment of the structures in the drainage channels.	Relocation of informal settlers along major river banks	Reforestation Project/ Treeplanting
Informal settlers living in “houses on stilts”	Demolition of illegal structures along the shore lies of Manila Bay, Canacao Bay and Bacor Bay	Establishment of greenhouse bldg.
In-Migration of informal settlers at the coastal barangays		Solid Waste Management
Scarcity of dwelling Units		Establishment of Sanitary Landfill
Reclamation of retarding basins and drainage channels	Construction of on-site flood regulation pond in the new subdivisions	Advocacy on Solid Waste Management
		Relocation of Illegal Settlers
Intensive land conversion and development for industrial and residential uses.	Urban-Rural Integrated Development	Prevention of Development in Waterways
		Tree planting along riverbanks
Physical Resources		
Severe erosion characterized by soil erosion, coastal erosion or riverbank erosion which needs to be protected and rehabilitated	Enactment of Comprehensive Flood and Drainage System	Construction of Canal Lining & Riprapping of Riverwalls
	Enactment of Local Ordinance for the Integrated Water Quality Management Plan	
	Enactment of Local Ordinance for	

Siltation and sedimentation of waterways, river banks	Integrated Coastal Management Plan or Sea Use Plan Implementation of the JICA study on the Comprehensive Flood Mitigation for Cavite Lowland Areas "Kawit, Imus, Bacoor, Noveleta" in 2007	Provision of Patrol Boats, Radio Communication Equipment and Other Logistical Support Operationalization of Bantay Kalikasan
Ground water depletion in most lowland areas of the province	Retarding basin in all subdivisions Dredging of Imus and Ilang-ilang River and rip rapping along the riverbanks	
Salt water Intrusion in the aquifers in the coastal areas	Construction of Break water along the shore line of Mania Bay	
Slope alteration along upland areas		
Encroachment & occupancy within NIPAS and non-NIPAS areas		
Incidence of Pollution (Air and water) generated by Industries and households		
Economy		
Declining volume of fish catch	Strict implementation of the provisions of AFMA especially in the preservation of SAFDZs complemented by a local comprehensive land use policy to protect agricultural zones Enforcement of Fishery Laws Establishment of Maniculture Park Establishment of Fish Sanctuary Mangrove Development Program	Establishment and propagation of tropical fisheries Establishment of Fish Sanctuaries Mangrove Development Project Red Tide Monitoring Coastal Clean-up
In adequate supply of crops and meat products	Introduction and adoption of new farming technology to intensify crop and livestock production Establishment of Cavite Central Trading Post, (Pasalubong Center and Trading Center) Establishment Mari-Culture Park at Bacoor and Canaca Bay	Livestock and Poultry Production and Productivity Enhancement Animal Production and Dispersal Program Establishment of additional slaughterhouses and auction market Cooperative formation of livestock and poultry farmers Installation of tubular poly-ethylene biogas

Closure of industrial establishments Increasing unemployment	Strict compliance, enforcement and implementation of Zoning Ordinance Establishment of new eco-zones in no hazard prone areas Trade and Investment Promotion Conduct Capacity Need Assessment for MSME Promotions of Business Entrepreneurial And Livelihood Development Program Provisions of micro-financing and Promotions of products of cooperatives and MSME	digester Establishment and maintenance of checkpoints Provision of micro financing Financial assistance from LGUs and other line agencies such as DOLE and OWWA Techno-demonstration of multiple cropping systems, integrated farming and balanced fertilization Intensified Farming System with organic application Establishment of demo farms Seminars/Trainings on agri-business development and upgrading technologies Revitalization of the Coffee Industry Rehabilitation of agricultural infrastructure and facilities Rehabilitation of irrigation system Construction of Bagsakan Center Business Entrepreneurial & Livelihood Development Agribusiness/Enterprise Development/Marketing
Displacement of Industrial workers Peace and Order situation	Strengthening Local Peace and Order Council and Formulation of Integrated Areas/Community Public Safety Plan Establishment of public safety monitoring and response management system using the latest technology and best practices in video surveillance (CCTV), geographic positioning system, environmental monitoring, in all strategic locations and main thoroughfares of the province Strengthening the Cavite Tripartite Industrial Peace Council	

Transportation, Access & Circulation		
Road network system Lack of transport facilities/traffic control systems/ traffic management support equipment	Construction of additional External and Internal Linkages Road Widening and Improvement Opening of new arterial roads Coastal Road Extension from Kawit to Cavite City.	Establishment of mass transport system Construction/ Completion of new entrances/exits Construction/ Improvement/ Widening of national/ provincial bridges Improvement/Concreting/ Asphalting of national roads Improvement of barangay/ farm-to-market roads Provision of transport facilities Traffic Control Management system Development of Sangley Point as an alternate to the seaport of Manila and Civil Aviation Port Development of an integrated fish port Development of an integrated cargo terminal
Income, Employment, Service Access, Poverty		
Schools are used as evacuation centers	Provision of basic needs/ commodities during calamities Rehabilitation of affected schools	Construction/Upgrading of School Facilities
Increasing unemployment	Conduct of Jobs Fair, seminars / conferences Preparation of flyers, leaflets and posters	Employment Promotion& Facilitation
Displacement of Industrial workers	Conduct skills training Link-up with financing institutions for start-up capital Control installation of deep wells	Alternative Livelihood for Displaced Workers
Salt water intrusion in coastal municipalities Rapid depletion of ground water	Improve environmental conditions along with the regulated ground water extraction	Water Sources Mapping Program Environmental Restoration Program Ground water level monitoring

Land Use and Physical Framework		
Diminishing areas for agriculture due to land use conversion	Designate SAFDZs as key production areas for food security	Sustainable Agri-based Rural Enterprise
Areas for mining/ quarrying are not properly delineated	Protect SAFDZ areas from conversion to other uses	Conduct of seminars/ trainings on mining rules, laws and regulations with mining operators
Lack of Material Recovery and Sanitary waste disposal facilities	Protection and Preservation of Coastal Environment and Habitat	MRF Operation Capability Building Program
	Restrict human encroachment into protection land	Orientation Seminars on RA 9003, Reading materials and seminars on the proper operation of MRF, contest on Best MRF Facility
	Establishment of Sanitary landfill	Establishment of Sanitary Landfill
	Restriction of establishment of new Industrial Estates and Economic Zones in low land Cavite	
	Concentration of Industrialization shall be in District IV (Tanza, Gen. Trias Trece Martires City) and portion of Naic where significant turn-about in economic activities is expected to occur	
	Histo-cultural sites and establishments shall be maintained, improved and restored to provide impetus to eco-tourism development and preserve the historical and cultural values of Cavite	Fund Sourcing for the development of potential
		Development of eco-tourism sites
		Green Sanctuary Project
		Agri-Tourism Program
		Massive Tourism Promotion and Information

Programs/Projects/Activities

Program/Project/Activity Description	Total Cost	Annual Cost		
		2011	2012	2013
	352,200,000.00	**104,900,000.00**	**119,600,000.00**	**127,700,000.00**
1. Pre-Disaster Preparedness	***199,200,000.00***	***59,400,000.00***	***66,900,000.00***	***72,900,000.00***
1.1 Integrated Coastal Management Program	26,000,000.00	10,000,000.00	10,000,000.00	6,000,000.00
1.2 Flood Mitigation and River Rehabilitation Program	7,000,000.00	2,000,000.00	2,500,000.00	2,500,000.00
1.3 Forest Rehabilitation Program	6,000,000.00	2,000,000.00	2,000,000.00	2,000,000.00
1.4 Peace, Security and Anti Insurgency Program	45,000,000.00	15,000,000.00	15,000,000.00	15,000,000.00
- Purchase of firearms				
- Purchase of disaster vehicles				
1.5 Food Security Program	11,000,000.00	3,000,000.00	3,000,000.00	5,000,000.00
1.6 Health, Sanitation and Epidemic Prevention & Control Program	14,000,000.00	4,000,000.00	5,000,000.00	5,000,000.00
1.7 Manpower Capacity Enhancement Program	16,000,000.00	4,000,000.00	6,000,000.00	6,000,000.00
1.8 IEC and Advocacy Program	5,000,000.00	1,000,000.00	2,000,000.00	2,000,000.00
1.9 Infrastructure, Utilities, Facilities and Equipment Program	47,400,000.00	15,000,000.00	15,000,000.00	17,400,000.00
1.10 Other Related Programs	21,800,000.00	3,400,000.00	6,400,000.00	12,000,000.00
- Purchase of heavy equipments, generator, etc.				
2. Quick Response	***105,700,000.00***	***31,500,000.00***	***35,900,000.00***	***38,300,000.00***
2.1 Search and Rescue Program	15,000,000.00	5,000,000.00	5,000,000.00	5,000,000.00
2.2 Evacuation and Emergency Shelter Program	13,000,000.00	3,000,000.00	5,000,000.00	5,000,000.00
2.3 Food Assistance Program	45,000,000.00	15,000,000.00	15,000,000.00	15,000,000.00
2.4 Medical Assistance Program	8,000,000.00	2,000,000.00	3,000,000.00	3,000,000.00
2.5 Other Related Programs	24,700,000.00	6,500,000.00	7,900,000.00	10,300,000.00
- Shelter assistance, food asistance, etc.				
3. Post Disaster	***47,300,000.00***	***14,000,000.00***	***16,800,000.00***	***16,500,000.00***
3.1 Relief and Rehabilitation Program	12,000,000.00	2,000,000.00	5,000,000.00	5,000,000.00
3.2 Financial Assistance Program	20,000,000.00	10,000,000.00	5,000,000.00	5,000,000.00
3.3 Other Related Programs	15,300,000.00	2,000,000.00	6,800,000.00	6,500,000.00

ANNEX - A

Flood Hazard Characterization

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso				
Amadeo				
Bacoor	- Alima - Aniban I - Aniban II - Aniban III - Aniban IV - Aniban V - Banalo - Bayanan - Campo Santo - Daan Bukid - Digman - Dulong Bayan - Habay I - Habay II - Kaingin - Ligas I - Ligas II - Ligas III - Mabolo I - Mabolo II - Mabolo III - Maliksi I - Maliksi II - Maliksi III - Niog I - Niog II - Niog III - Panapaan I - Panapaan II - Panapaan III - Panapaan IV - Panapaan V - Panapaan VI - Panapaan VII - Panapaan VIII - Real I - Real II - Salinas I - Salinas II - Salinas III - Salinas IV		- Mambog I - Mambog II - Mambog III - Mambog IV - Mambog V - Molino VII - San Nicolas I - San Nicolas II - San Nicolas III	

	- Sineguelasan - Tabing-Dagat - Talaba I - Talaba II - Talaba III - Talaba IV - Talaba V - Talaba VI - Talaba VII - Zapote I - Zapote II - Zapote III - Zapote IV - Zapote V			
Carmona	- Cabilang Baybay		- Maduya - Lantic - Poblacion 1 - Poblacion 2 - Poblacion 3 - Poblacion 4 - Poblacion 5 - Poblacion 6 - Poblacion 7 - Poblacion 8 - Milagrosa	
Gen. E. Aguinaldo				
Gen. M. Alvarez				
Gen. Trias	- San Juan I - San Juan II - Bacao I - Bacao II - Dulongbayan - Sampalucan - Tejero		- San Gabriel - Arnaldo - Corregidor - Vibora - Gov. Ferrer - Bagumbayan - 1896th - Sta. Clara - Navarro - Prinza - Pinagtipunan - Portion of Pasong Camachile I	
Imus	- Alapan I-A - Alapan I-B - Alapan II-A - Bayan Luma I - Carsadang Bago I - Carsadang Bago II		- Alapan I-C - Alapan I-A - Alapan II-B - Anabu I-A - Anabu I-B - Bagong	

	- Medicion I-A - Medicion I-B - Medicion I-C - Medicion I-D - Medicion II-A - Medicion II-B - Medicion II-C - Medicion II-D - Medicion II-E - Medicion II-F - Pag-asa I - Pag-asa II - Pag-asa III - Palico I - Palico II - Palico III - Poblacion I-A - Poblacion I-B - Poblacion I-C - Poblacion II-A - Poblacion II-B - Poblacion III-A - Poblacion III-B - Poblacion IV-A - Poblacion IV-B - Poblacion IV-C - Poblacion IV-D - Toclong I-A - Toclong I-B - Toclong I-C - Toclong II-A - Toclong II-B		Silang - Bayan Luma II - Bayan Luma III - Bayan Luma IV - Bayan Luma V - Bayan Luma VI - Bayan Luma VII - Bayan Luma VIII - Bayan Luma IX - Bucandala I - Bucandala II - Bucandala III - Bucandala IV - Bucandala V - Buhay na Tubig - Palico IV - Pinagbuklod - Tanzang Luma I - Tanzang Luma II - Tanzang Luma III - Tanzang Luma IV - Tanzang Luma V - Tanzang Luma VI	
Indang				
Kawit	- All barangays of Kawit			
Magallanes				
Maragondon	- Poblacion I-A - Poblacion I-B - Caingin		- Poblacion II-A - Poblacion II-B - Garita I-A - Garita I-B - Bucal I - Bucal II - Bucal III-A - Bucal III-B	

			- Bucal IV-A - San Miguel I-A - San Miguel I-B - Portion of Pinagsanhan I-B - Portion of Silangan II-A	
Mendez				
Noveleta	- All barangays of Noveleta			
Naic	- Mabulo - Timalan Balsahan - Timalan Concepcion - Munting Mapino - Bucana Sasahan - Bagong Kalsada - Bucana Malaki		- Sabang - Latoria - Ibayong Silangan - Gomez Zamora - Kanluran - Humbac - Capt. C. Nazareno - Makina - Santolan - Labac - Bancaan - Sapa - Malainen Bago - Muzon - Ibayo Estacion	
Rosario	- All barangays of Rosario			
Silang				
Tanza	- Halayhay - Sahud-Ulan - Amaya I - Amaya II - Amaya III - Amaya IV - Amaya V - Amaya VI - Amaya VII - Daang Amaya I - Daang Amaya II - Daang Amaya III		- Santol - Sanja Mayor - Mulawin - Biga - Calibuyo - Capipisa - Lambingan	

	- Julugan I - Julugan II - Julugan III - Julugan IV - Julugan V - Julugan VI - Julugan VII - Julugan VIII - Biwas - Bucal - Poblacion I - Poblacion II - Poblacion III - Poblacion IV			
Ternate	- San Juan II - Sapang I - Sapang II - Poblacion I-A - Poblacion I - Poblacion II - Poblacion III - Portion of Bucana		- San Juan I - San Jose	
Cavite City	- All barangays of Cavite City - Portion of Corregidor Island	-		
Dasmariñas City	- Sta. Lucia - H2 - San Manuel I - San Manuel II - Salitran II - San Fransciso (along the creek) - Paliparan II - Burol I - Burol II - San Juan			
Tagaytay City				
Trece Martires City				

Rain Induced Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso		- Kaysuyo - Amuyong	- All barangays of Alfonso except for Kaysuyo and Amuyong	
Amadeo			- All barangays of Amadeo	
Bacoor			- Molino IV - Queens Row Central - Queens Row East - Queens Row West - Molino I - Molino II - Molino III - Molino IV - Molino V	
Carmona			- Bancal - Mabuhay	
Gen. E. Aguinaldo				
Gen. M. Alvarez				
Gen. Trias				
Imus			- Malagasang I-A - Malagasang I-B - Malagasang I-C - Malagasang I-D - Malagasang I-E - Malagasang I-F - Malagasang I-G - Malagasang II-A - Malagasang II-B - Malagasang II-C - Malagasang II-D - Malagasang II-E - Malagasang II-F - Malagasang II-G - Anabu I-C - Anabu I-D - Anabu I-E - Anabu I-F - Anabu I-G - Anabu II-A - Anabu II-B	

			- Anabu II-C - Anabu II-D - Anabu II-E - Anabu II-F - Maharlika - M. Espeleta I - M. Espeleta II - M. Espeleta III - Pasong Buaya I - Pasong Buaya II - Magdalo	
Indang		- Banaba Lejos - Daine II	- Agus-os - Alulod - Banaba Cerca - Bancod - Buna Cerca - Buna Lejos I - Buna Lejos II - Calumpang Cerca - Calumpang Lejos - Carasuchi - Daine I - Guyam Malaki - Guyam Munti - Harasan - Kayquit I - Kayquit II - Kayquit III - Kaytambog - Kaytapos - Limbon - Lumampong Balagbag - Lumampong Halayhay - Mahabang Kahoy Cerca - Mahabang Kahoy Lejos - Mataas na Lupa - Poblacion I - Poblacion II - Poblacion III - Poblacion IV - Pulo - Tambo Balagbag	

			- Tambo Ilaya - Tambo Malaki - Tambo Munti Kulit	
Kawit				
Magallanes		- Urdaneta - Tua - Medina	- Barangay I-Poblacion - Barangay II-Poblacion - Barangay III-Poblacion - Barangay IV-Poblacion - Barangay V-Poblacion - Baliwag - Bendita I - Bendita II - Caluangan - Kabulusan - Pacheco - Ramirez - San Agustin	
Maragondon	- Pinagsanhan A - Pinagsanhan B - Patungan - Sta. Mercedes	- Talipusngo - Mabato - Pantihan II - Pantihan III - Layong Mabilog - Tulay Kanluran	- Pantihan IV - Tulay Silangan - Pantihan I - Bucal IV-A	
Mendez			- All barangays of Mendez	
Noveleta				
Naic		- Palangue Central - Palangue II - Palangue III	- Sabang - San Roque - Calubcob - Halang - Molino - Malainen Luma	
Rosario				
Silang	- Carmen - Munting Ilog - Hukay - Pooc II - Pasong Langka	- Adlas - Biga I - Biga II	- Barangay 1 - Barangay 2 - Barangay 3 - Barangay 4 - Barangay 5 - Acacia	

	- Cabangaan		- Anahaw 1 - Anahaw 2 - Balite 1 - Balite 2 - Balubad - Banaba - Batas - Biluso - Bucal - Buho - Bulihan - Hoyo - Iba - Inchican - Ipil I - Ipil II - Kalubkob - Kaong - Lalaan I - Lalaan II - Litlit - Lucsuhin - Lumil - Maguyam - Malabag - M. Tatyao - M. na Burol - Narra I - Narra II - Narra III - Paligawan - Pooc I - Pulong Bunga - Pulong Saging - Puting Kahoy - Sabutan - San Miguel I - San Miguel II - Santol - San Vicente I - San Vicente II - Tartaria - Tibig - Toledo - Tubuan 1 - Tubuan 2 - Tubuan 3 - Ulat	

			- Yakal	
Tanza		- Bunga - Punta I - Punta II	- Tanauan - Paradahan I - Paradahan II - Tres Cruses - Bagtas	
Ternate	- Bucana	- Sapang II		
Cavite City				
Dasmariñas City				
Tagaytay City	- Bagong Tubig - Sambong - Kaybagal South - Maharlika East - Maharlika West - Silang Crossing South - San Jose - Tolentino West - Sungay West - Sungay East - Calabuso	- Dapdap East - Dapdap West - Iruhin East - Iruhin West - Iruhin South	- Francisco - Tolentino East - Mag-asawang Ilat - Maitim II-East - Maitim II-Central - Maitim II-West - Kaybagal North - Silang Crossing North - Kaybagal Central - Patutong Malaki North - Patutong Malaki South - Mendez Crossing East - Mendez Crossing West - Asisan - Neogan - Zambal - Guinhawa North - Guinhawa South	
Trece Martires City		- De Ocampo - Gregorio - San Agustin - Cabuco - Lapidario - Luciano - Aguado - Inocencio - H. Perez - Osorio	- Conchu - Lallana - Cabezas	

Storm Surge Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso				
Amadeo				
Bacoor			- Sineguelasan - Alima - Tabing Dagat - Digman - Kaingin - Maliksi III - Maliksi I - Talaba I - Talaba II	
Carmona				
Gen. E. Aguinaldo				
Gen. M. Alvarez				
Gen. Trias				
Imus				
Indang				
Kawit			- Sta. Isabel - Wakas I - Wakas II - Panamitan - Poblacion - Marulas - Congbalay-Legaspi - Pulborista - Kaingen	
Magallanes				
Maragondon				
Mendez				
Noveleta		- San Rafael I - San Rafael II - San Rafael III - San Rafael IV - Salcedo II		
Naic		- Bucana Sasahan - Bucana Malaki - Bagong Kalsada		
Rosario		- Ligtong I - Ligtong IV - Muzon I - Muzon II		

		- Kanluran - Sapa II - Sapa III - Wawa II		
Silang				
Tanza		- Julugan I - Julugan II - Julugan III - Julugan IV - Julugan V - Julugan VI - Julugan VII - Amaya I - Amaya VII		
Ternate		- Portion of Sapang I - Portion of San Juan		
Cavite City		- Barangay 36 - Barangay 30 - Barangay 13 - Barangay 48-A - Barangay 37-A - Barangay 29 - Barangay 18 - Barangay 53 - Barangay 42-C - Barangay 42-B - Barangay 42-A	- Barangay 3 - Barangay 4 - Barangay 26 - Barangay 58	
Dasmariñas City				
Tagaytay City				
Trece Martires City				

Earthquake Ground Shaking Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso	- Poblacion I - Poblacion II - Pobalcion III - Poblacion IV - Poblacion V - Bilog - Portion of Buck Estate - Esperanza Ibaba - Esperanza Ilaya - Kaytitinga III - Portion of Luksuhin Ibaba - Luksuhin Ilaya - Mangas I - Mangas II - Marahan I - Marahan II - Matagbak I - Matagbak II - Pajo - Palumlum - Portion of Sikat - Sinaliw Malaki - Sinaliw Munti - Sulsugin - Taywanak Ibaba - Taywanak Ilaya - Portion of Upli - Portion of Kaytitinga I - Portion of Kaytitinga II - Portion of Sta. Theresa	- Kaysuyo - Amuyong - Portion of Buck Estate - Portion of Upli - Portion of Luksuhin Ibaba - Portion of Kaytitinga I - Portion of Kaytitinga II - Portion of Sta. Theresa - Portion of Sikat		

Amadeo	- All barangays of Amadeo			
Bacoor	- All barangays of Bacoor			
Carmona	- All barangays of Carmona			
Gen. E. Aguinaldo	- Castaños Lejos - Kaymisas - Portion of Batas-Dao - Portion of Kabulusan - Portion of Narvaez	- A. Dalusag - Lumipa - Tabora - Kaypaaba - Poblacion I - Poblacion II - Poblacion III - Poblacion IV - Castaños Cerca - Portion of Batas-Dao - Portion of Kabulusan - Portion of Narvaez		
Gen. M. Alvarez	- All barangays of GMA			
Gen. Trias	- All barangays of Gen. Trias			
Imus	- All barangays of Imus			
Indang	- All barangays of Indang			
Kawit	- All barangays of Kawit			
Magallanes		- All barangays of Magallanes		
Maragondon	- Bucal 1 - Bucal 2 - Bucal 3-B - Caingin - Garita A	- Bucal 3-A - Bucal 4-A - Bucal 4-B - Layong Mabilog		

	- Garita B - Poblacion 1-A - Poblacion 1-B - Poblacion 2-A - Poblacion 2-B - San Miguel I-A - San Miguel 1-B - Pantihan 4	- Mabato - Pantihan 1 - Pantihan 2 - Pantihan 3 - Pinagsanhan A - Pinagsanhan B - Patungan - Talipusngo - Tulay A - Tulay B		
Mendez	- All barangays of Mendez			
Noveleta	- All barangays of Noveleta			
Naic	- Calubcob - Molino - Malainen Luma	- Bagong Kalsada - Balsahan - Bancaan - Bucana Malaki - Bucana Sasahan - Capt. C. Nazareno - Gombalza - Halang - Humbac - Ibayo Estacion - Ibayo Silangan - Kanluran - Labac - Latoria - Mabulo - Makina - Malainen Bago - Munting Mapino - Muzon - Palangue Central		

		- Palangue 2 & 3 - Sabang - San Roque - Santulan - Sapa - Timalan Balsahan - Timalan Concepcion		
Rosario	- All barangays of Rosario			
Silang	- All barangays of Silang			
Tanza	- All barangays of Tanza			
Ternate	- Poblacion I-A - Poblacion I - Poblacion II - Poblacion III - Sapang I - Portion of Sapang II - San Juan I - San Juan II - San Jose	- Bucana - Portion of Sapang II		
Cavite City	- All barangays of Cavite City			
Dasmariñas City	- All barangays of Dasmariñas City			
Tagaytay City	- Asisan - Calabuso - Dapdap East - Dapdap West - Francisco - Guinhawa North - Guinhawa	- Bagong Tubig - Sambong - Portion of Kaybagal South - Maharlika East - Maharlika West		

	South - Iruhin East - Iruhin Central - Iruhin West - Kaybagal North - Kayabagal Central - Portion of Kaybagal South - Mag-asawang Ilat - Maitim II West - Maitim II Central - Maitim II East - Mendez Crossing East - Mendez Crossing West - Neogan - Patutong Malaki North - Patutong Malaki South - San Jose - Portion of Sillang Crossing East - Silang Crossing West - Sungay East - Sungay West - Tolentino East - Tolentino West - Zambal	- Portion of Silang Crossing East		

Trece Martires City	- All barangays of Trece			

Liquefaction Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso				
Amadeo				
Bacoor	- Alima - Campo Santo - Daan Bukid - Digman - Dulong Bayan - Habay 1 - Kaingin - Mabolo 1 - Mabolo 2 - Mabolo 3 - Maliksi I - Maliksi II - Maliksi III - Niog I - Panapaan I - Panapaan II - Panapaan III - Panapaan IV - Sineguelasan - Tabing Dagat - Talaba I - Talaba II - Talaba III - Talaba IV - Talaba V - Talaba VI - Talaba VII - Zapote I - Zapote II - Zapote III - Zapote V	- Panapaan V - Panapaan VI - Panapaan VII - Panapaan VIII - Real I - Real II - Zapote IV - Aniban I - Aniban II - Aniban III - Aniban IV - Aniban V - Ligas I - Ligas II - Ligas III - Niog III - Niog II - Habay II - Salinas I - Salinas II - Salinas III - Salinas IV	- San Nicolas I - San Nicolas II - Mambog I - Mambog II - Mambog III - Mambog IV - Mambog V - Bayanan	
Carmona		- Maduya	- Poblacion 1 - Poblacion 2 - Poblacion 3 - Poblacion 4 - Poblacion 5 - Poblacion 6	

			- Poblacion 7 - Poblacion 8 - Cabilang Baybay - Milagrosa	
Gen. E. Aguinaldo				
Gen. M. Alvarez				
Gen. Trias		- Corregidor - Sampalucan - San Juan I - San Juan II - Dulong bayan - Bacao I - Bacao II - Tejero	- Navarro - Pinagtipunan - Prinza - 1896TH - Gov. Ferrer - Vibora - Bagumbayan - San Gabriel - Arnaldo - Sta. Clara	
Imus	- Medicion II-F - Medicion II-D	- Alapan I-A - Alapan I-B - Alapan II-A - Bayan Luma I - Carsadang Bago I - Carsadang Bago I - Carsadang Bago II - M. Espeleta I - M. Espeleta II - M. Espeleta III - Magdalo - Maharlika - Medicion I-A - Medicion I-B - Medicion I-C - Medicion I-D - Medicion II-A - Medicion II-B - Medicion II-C - Medicion II-E - Pag-asa I - Pag-asa II - Pag-asa III - Palico I - Palico II - Palico III	- Bucandala I - Bucandala II - Bucandala III - Bucandala IV - Bucandala V - Alapan II-B - Alapan I-C - Anabu I-A - Anabu I-B - Bayan Luma II - Bayan Luma III - Bayan Luma IV - Bayan Luma V - Bayan Luma VI - Bayan Luma VII - Bayan LumaVIII - Bayan Luma IX - Bagong Silang - Pinagbuklod - Tanzang Luma II - Tanzang	

		- Pasong Buaya I - Pasong Buaya II - Poblacion I-A - Poblacion I-B - Poblacion I-C - Poblacion II-A - Poblacion Poblacion II-B - Poblacion III-A - Poblacion III-B - Poblacion IV-A - Poblacion IV-B - Poblacion IV-C - Poblacion IV-D - Tanzang Luma I - Toclong I-A - Toclong I-B - Toclong I-C - Toclong II-A - Toclong II-B	Luma III - Tanzang Luma IV - Tanzang Luma V - Buhay na Tubig - Palico IV	
Indang				
Kawit	- Aplaya - Gahak - Kanluran-Lola Neneng - Manggahan-Lawin - Panamitan - Pulvorista - Tabon III - Tramo Bantayan - Wakas I - Wakas II - Congbalay Legaspi - Kaingen - Marulas - Poblacion - Samala Marquez - Sta. Isabel	- Batong Dalig - San Sebastian - Tabon I - Tabon II - Magdalo (Putol) - Toclong		
Magallanes				

Maragondon			- San Miguel I-A - San Miguel I-B - Garita I-A - Garita I-B - Poblacion I-A - Poblacion I-B - Poblacion II-A - Poblacion II-B - Caingin	
Mendez				
Noveleta	- Magdiwang - Salcedo I - Salcedo II - San Juan I - San Juan II - San Rafael I - San Rafael II - San Rafael III - San Rafael IV	- Sta. Rosa I - Sta. Rosa II - San Antonio I - San Antonio II - Poblacion - San Jose I - San Jose II		
Naic	- Bucana Malaki - Bucana Sasahan - Munting Mapino - Timalan Concepcion - Timalan Balsahan	- Capt. C. Nazareno - Kanluran - Humbac - Gombalza - Balsahan - Latoria - Ibayo Estacion	- Santulan - Makina - Ibayong Silangan	
Rosario	- Bagbag I - Bagbag II - Kanluran - Ligtong I - Ligtong II - Ligtong IV - Poblacion - Muzon I - Muzon II - Sapa I - Sapa II - Sapa III - Sapa IV - Silangan I - Silangan II - Wawa I - Wawa II - Wawa III	- Tejeros Convention - Ligtong III		

Silang				
Tanza	- Halayhay - Amaya I - Amaya II - Julugan I - Julugan II - Julugan III - Julugan IV - Julugan V - Julugan VI - Julugan VII	- Capipisa - Lambingan - Calibuyo - Sahud-Ulan - Amaya III - Amaya VI - Amaya VII - Julugan VIII - Biwas - Daana Amaya II - Daang Amaya III - Bucal - Poblacion I - Poblacion II - Poblacion III - Poblacion IV	- Biga - Sanja Mayor - Santol - Mulawin - Amaya IV - Amaya V - Daang Amaya I	
Ternate	- Sapang I - Sapang II - San Juan II - Poblacion I-A	- Poblacion I - Poblacion II - Poblacion III - San Jose	- San Juan I	
Cavite City	- All barangays of Cavite City except Corregidor Island			
Dasmariñas City				
Tagaytay City				
Trece Martires City				

Tsunami Hazard Characterization Table

Municipality	Susceptibility Levels			Total land area
	High	Moderate	Low	
Alfonso				
Amadeo				
Bacoor	- Sineguelasan - Banalo - Mabolo II - Alima - Tabing Dagat - Digman - Camposanto - Daang Bukid - Maliksi I - Maliksi II - Maliksi III - Panapaan II - Panapaan III - Panapaan IV - Talaba I - Talaba II - Talaba III - Talaba IV - Zapote II - Zapote III - Zapote IV			
Carmona				
Gen. E. Aguinaldo				
Gen. M. Alvarez				
Gen. Trias				
Imus				
Indang				
Kawit	- Aplaya - Balsahan-Bisita - Congbalay-Legaspi - Kaingen - Kanluran - Manggahan-Lawin - Marulas - Panamitan - Poblacion - Pulvorista - Samala-Marquez - Sta. Isabel - Tabon III			

	- Tramo Bantayan - Wakas I - Wakas II			
Magallanes				
Maragondon				
Mendez				
Noveleta	- Salcedo V - San Rafael I - San Rafael II - San Rafael III - San Rafael IV			
Naic	- Mabulo - Bagong Kalsada - Bucana Sasahan - Munting Mapino - Timalan Balsahan - Timalan Concepcion			
Rosario	- Wawa II - Sapa II - Sapa III - Sapa IV - Kanluran - Muzon I - Muzon II - Poblacion - Ligtong I - Ligtong IV			
Silang				
Tanza	- Coastal barangays of Tanza			
Ternate				
Cavite City	- All barangays of Cavite City			
Dasmariñas City				
Tagaytay City				
Trece Martires City				