Chapter 2: Geophysical Environment

Geographical Location

The Province of Cavite is situated in Luzon's southern part, the largest island in the Philippines. It belongs to Region IV-A or the CALABARZON region. It is bounded by the provinces of Batangas in the south, Laguna on the east, Metro Manila and Manila Bay on the north, and the West Philippine Sea on the west.

It is geographically located at latitude (14.2803°) 14° 16' 49" north of the equator and longitude (120.8664°) 120° 51' 59" east of the prime meridian.

Political Subdivision

The passage of Republic Act 11069 in 2018, divided the province into eight legislative districts, the most in the country. The 1st District is composed of Cavite City, Kawit, Noveleta and Rosario while the 2nd, 3rd, 4th and 6th Districts belong to the lone districts of cities of Bacoor, Imus, Dasmariñas and Gen. Trias, respectively. In the 5th district are Carmona, Silang and Gen. Mariano Alvarez; Amadeo, Indang, Tanza and Trece Martires City are in the 7th district; and in the 8th district are the towns of Alfonso, Gen. Emilio Aguinaldo, Magallanes, Maragondon, Mendez-Nuñez, Naic, Ternate and Tagaytay City.

The province is further divided into seven cities and 16 municipalities with 829 barangays. The seven cities include the seat of the Provincial Government – Trece Martires City, the defense frontier – Cavite City, the provincial summer capital – Tagaytay City, the City of Dasmariñas under RA 9723, the City of Bacoor under RA 10160, the City of Imus by RA 10161, and the City of Gen. Trias through RA 10675.

Presidential Decree 1163 declared the City of Imus as the de jure (according to law) provincial capital and Trece Martires City as the provincial government's de facto seat.

On December 03, 1909, during the American regime, Governor-General William Cameron Forbes issued Executive Order No. 124 that annexed Corregidor and the Islands of Caballo (Fort Hughes), La Monja, El Fraile (Fort Drum), Sta. Amalia, Carabao (Fort Frank), and Limbones and all waters and detached rocks surrounding them to Cavite City. These are now major tourist attractions of the province. Moreover, the adjacent Balut island is under the jurisdiction of the municipality of Ternate.

Land Area

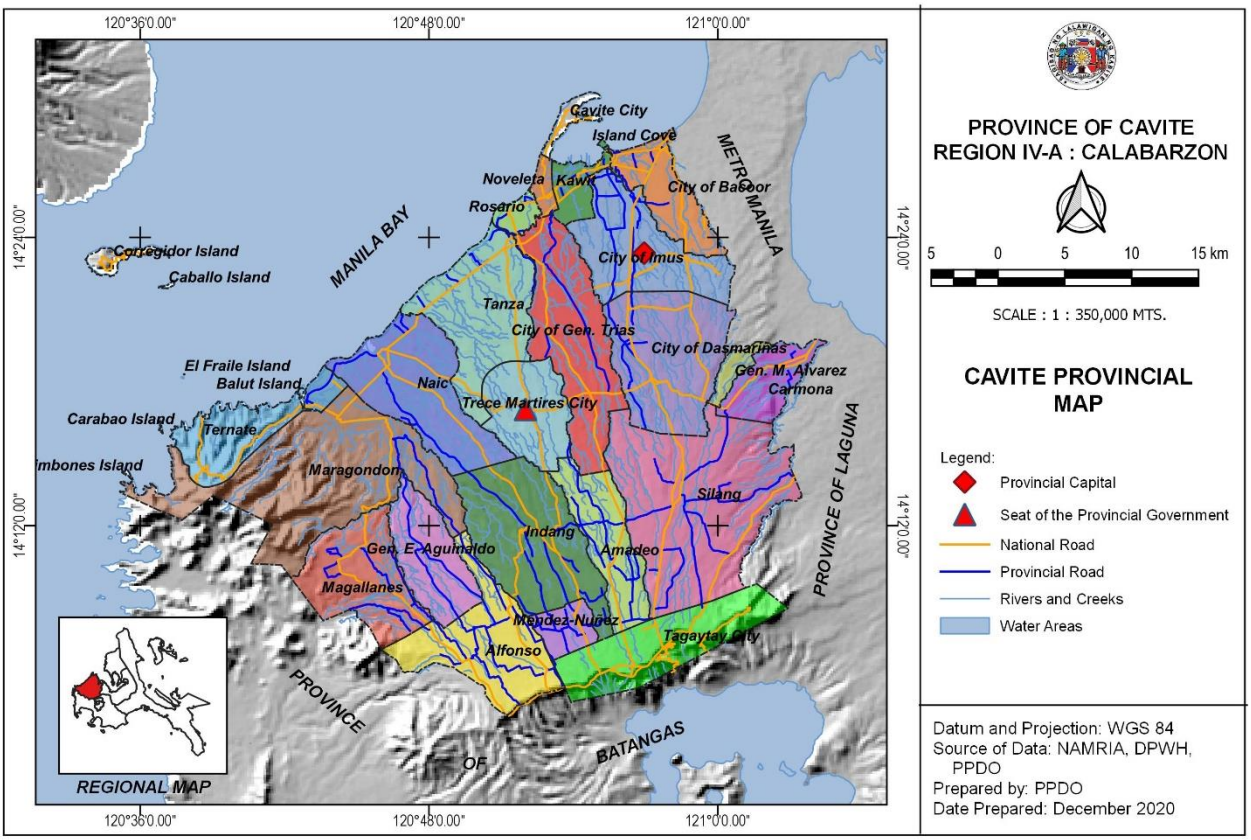
The land is an important resource that is a basis of many governance-related decisions such as budget, cityhood, and programming, among others. Land, referred to as dry land, is the solid surface of the Earth that is not permanently covered by water. It is an area of ground that is being used for a particular purpose. It excludes the area below inland water bodies. The proper usage of land is a major determinant or guiding force on the progress of a province.

Cavite has a total land area of 142,706 hectares or 1,427.06 square kilometers, representing 8.66% of the region's total land area and 0.42% of the country's total land area. Among the eight districts of the province, the 8th District has the largest land area of 572.04 square kilometers, which covers 40.09% of the total land area, and District I has the smallest land area with 36.31 sqaure kilometers or 2.54% of the total provincial land area. The municipalities of Maragondon and Silang have the largest land area of 165.49 and 156.41 square kilometers, respectively, while the municipality of Noveleta has the smallest with 5.41 square kilometers (Table 2.1).

Table 2.1 Land Area, Number of Barangays and Income Class by District/City/Municipality, Province of Cavite: 2020

City/Municipality	Land Area (sq.km.)	Land Distribution	Number of Barangays	Income Classification
1st District	**36.31**	**2.54**	**143**	
Cavite City	11.83	0.83	84	4th Class
Kawit	13.40	0.94	23	1st Class
Noveleta	5.41	0.38	16	3rd Class
Rosario	5.67	0.4	20	1st Class
2nd District	**52.40**	**3.67**	**73**	
City of Bacoor	52.40	3.67	73	1st Class
3rd District	**97.01**	**6.80**	**97**	
City of Imus	97.01	6.80	97	3rd Class
4th District	**82.34**	**5.77**	**75**	
City of Dasmarinas	82.34	5.77	75	1st Class
5th District	**196.71**	**13.78**	**105**	
Carmona	30.92	2.17	14	1st Class
Gen. M. Alvarez	9.38	0.66	27	1st Class
Silang	156.41	10.96	64	1st Class
6th District	**117.68**	**8.25**	**33**	
City of Gen. Trias	117.68	8.25	33	1st Class
7th District	**272.57**	**19.10**	**116**	
Amadeo	47.90	3.36	26	4th Class
Indang	89.20	6.25	36	1st Class
Tanza	96.30	6.75	41	1st Class
Trece Martires City	39.17	2.74	13	4th Class
8th District	**572.04**	**40.09**	**187**	
Alfonso	64.60	4.53	32	1st Class
G. E. Aguinaldo	51.03	3.58	14	5th Class
Magallanes	78.60	5.51	16	4th Class
Maragondon	165.49	11.6	27	3rd Class
Mendez - Nunez	16.67	1.17	24	4th Class
Naic	86.00	6.03	30	1st Class
Tagaytay City	66.15	4.64	34	2nd Class
Ternate	43.50	3.05	10	4th Class
CAVITE	**1,427.06**		**829**	**1st Class**

Source: Provincial Planning and Development Office



Map 2.1 ***Legislative Map, Province of Cavite***

Topography

Elevation

Situated at the entrance of Manila Bay, Cavite is characterized by rolling hinterlands punctuated by hills, shoreline fronting Manila Bay at sea level, and the rugged portion at the boundary with Batangas.

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

The lowest lowland area is the coastal plain. These areas have a shallow ground level of zero to two meters elevation than the high tide level of about 0.8-meter elevation from the mean sea level (MSL). These are the cities of Bacoor and Cavite and Kawit, Noveleta, and Rosario.

Coastal and alluvial plains are considered lowland areas. These areas have a flat ground slope of less than 0.5% and a low ground elevation of two meters to 30 meters. The alluvial plain can be found in the City of Imus and the southern part of the City of Gen. Trias. Into these cities forms the transition area between the coastal plain and the central hilly area. It also covers some areas of Bacoor and the municipalities of Carmona, Kawit, Noveleta, Rosario, and Tanza.

The third topography type is the central hilly area, found on the mountain foot slope, and forms the rolling tuffaceous plateau. This topography includes steep hills, ridges, and elevated inland valleys. The plateau has a ground elevation ranging from 30 meters to nearly 400 meters and a ground slope ranging from 0.5% to 2%. The cities of Trece Martires and Dasmariñas, and the municipalities of Gen. E. Aguinaldo, Gen. M. Alvarez, the western part of Ternate, northern parts of Amadeo, Indang, Silang, Magallanes, and Maragondon have this kind of topography.

The last topography type is the upland mountainous area situated at a very high elevation above 400 meters with slopes of more than two percent found in the city of Tagaytay and municipalities of Alfonso, Mendez, southern parts of Amadeo, Indang, Silang, Magallanes, and Maragondon. Mt. Sungay, the highest elevation in Cavite, is about 700 meters above sea level located east of Tagaytay City. It is characterized by flat to rugged topography. From Tagaytay ridge northward, the areas adjoin Silang, Amadeo, and Mendez-Nunez, exhibiting flat to rolling topography with gently sloping surfaces while eastern and southern Tagaytay City including Alfonso show moderate to rugged topography. Portions of Ternate, Maragondon, General Mariano Alvarez, and Magallanes are fairly rugged with 100 to 200 meters above sea level. At Mounts Palay-Palay and Mataas na Gulod, both about 650 meters above sea level, the steepest climb from the creek to the top of the ridge is about 300 meters or about 50% average slope.

Corregidor Island is about 177 meters above sea level.

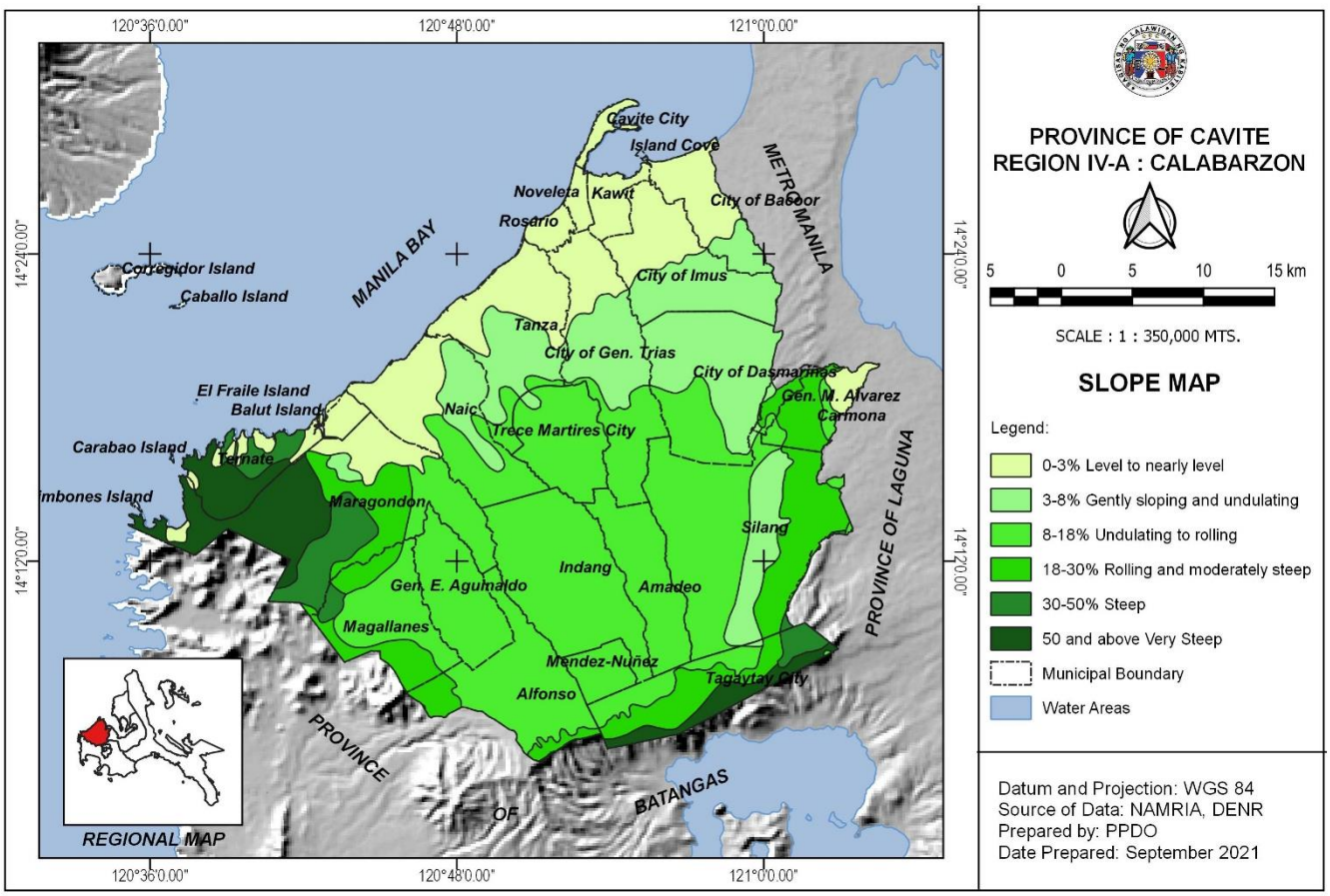
Slope

The slope is the degree of inclination of a given area. It is the number of feet the land rises or falls over 100 feet and written in terms of percentage. The degree of slope affects soil moisture, which influences species selection. It also estimates the erosion potential of the place and helps in selecting the most appropriate planting techniques.

Cavite's slope range is divided into six categories, as prescribed by the National Land Use Committee: level to nearly level, gently sloping to undulating, undulating to rolling, rolling to moderately steep, steep, and very steep.

Table 2.2 Slope Classification, Province of Cavite

Description	Slope (%)	Area (sq.km.)	Percent Share
Level to nearly level	0 - 3	283.1980	19.84
Gently sloping to undulating	3 - 8	267.7866	18.76
Undulating to rolling	8 - 18	586.2041	41.08
Rolling to moderately steep	18 - 30	154.6783	10.84
Steep	30 - 50	52.0280	3.65
Very steep	≥ 50	83.1650	5.83
Total		**1,427.0600**	**100.00**



Map 2.2 ***Slope Map, Province of Cavite***

Level to nearly flat slope ranges from 0-3%, which comprises the cities and municipalities along the province's shoreline. These are Cavite City, Kawit, Noveleta, Rosario, and portions of the City of Bacoor, Tanza, Naic, Ternate and Maragondon which serve as the municipal fishing grounds of the province. Abound with beaches, heritage sites, and historical markers, these areas are also known as tourist destinations for local and international tourists. Other economic activities in the area include the operation of the fish port, aquaculture, inland fishing, and shipping and navigation. Other areas having portions of these slopes are Carmona, Gen. Mariano Alvarez, and cities of Gen. Trias, and Imus, primarily suitable for irrigated rice production and freshwater fishponds.

The central transition area with a slope of 3-8%, gently sloping to undulating partly comprises the cities of Trece Martires, Tagaytay, Dasmariñas, Bacoor, Imus and Gen. Trias and the municipalities of Carmona, Gen. M. Alvarez, Tanza, Maragondon, Naic, and Silang. These areas are for terraced irrigated rice and fishponds, while other areas are suitable for vegetable production, flowering plants, annual crops, and high-value crops. Livestock and poultry production can be a profitable business in Tanza, Naic, Silang, and the City of Gen. Trias.

The undulating to rolling with a slope of eight (8) to 18% comprises the portion of Trece Martires City, Carmona, Gen. M. Alvarez, City of Gen. Trias, Tanza, Tagaytay City, Alfonso, Magallanes, Maragondon, Naic, Silang and the whole municipality of Amadeo, Gen. Aguinaldo, Indang and Mendez-Nuñez. These areas are noted for crop production where bountiful fruit and vegetables are nurtured and

harvested. These also serve as pastures and grazing lands for livestock and are also known for agritourism.

The area with a slope of 18-30%, rolling to moderately steep comprises the portions of the City of Dasmariñas, Gen. Mariano Alvarez, Tagaytay City, Alfonso, Magallanes, Maragondon, Silang, and Ternate where crop production is the main economic activity.

The area with a 30-50% slope comprises the portion of Tagaytay City, Magallanes, Maragondon, Silang, and Ternate. These areas are for pasture and perennial trees or those that live for more than two years.

Lastly, on the south-western tip with 50% and above slope are Tagaytay City, Alfonso, Maragondon, and Ternate. These areas are the province's forest areas, which can be used for recreational activities like hiking and mountaineering. It also serves as a place for research studies for students and researchers.

Areas with slopes ranging from 0-3% to 8-18% categories are utilized for commercial, industrial, and tourism purposes. However, some houses and buildings are built in locations with more than 18-30% slope for vacation, retreat, or training purposes

Geology

Geology is the study of Earth, the materials which it is made, the structure of those materials, and the processes acting upon them. Physical geology is made important in this sub-chapter. Physical geology deals with the study of the physical features of the earth and the processes acting on them. This includes volcanoes, earthquakes, rocks, mountains, and the oceans; just about any feature of the earth.

Landforms

According to the National Geographic Society, landforms are features on the Earth's surface that are part of the terrain. The four major types of landforms are mountains, hills, plateaus, and plains. Buttes, canyons, valleys, and basins are considered minor types of landforms.

The Philippines, fondly called the "Pearl of the Orient", has its diverse environment, well known for its different landforms. Some of it can be found in the province of Cavite.

The province of Cavite has its share in the mesmerizing beauty of nature that every Filipinos can enjoy. Pico de Loro, also known as the Parrot's Beak, is one of the most popular mountains in the Philippines. The wide plains of Cavite, the West Philippine Sea, and the coves and beaches of Nasugbu can be seen at the peak due to its elevation of 688 meters. Mt. Pico de Loro is part of the Mt. Palay-Palay-Mataas-na-Gulod Protected Landscape, the remaining lowland rainforest in Cavite, covering particularly Maragondon and Ternate, and Batangas. Mount Marami, one of the ancient volcanic features of Bataan Arc, Mount Buntis, and Mount Nagpatong, home to Andres Bonifacio Shrine and claim to be the execution site of the said hero, are other notable mountains in Cavite. Another peak in Cavite is Mt. Sungay (Mt. Gonzales) in Tagaytay. The inactive stratovolcano is the highest point in Cavite at 709 meters.

Another notable landform in Cavite is the Lucsuhin National Bridge, locally called Cabag Cave or Lucsuhin Cave, which is a national bridge connecting Barangay Lucsuhin and Barangay Kalubkob in Silang, Cavite. The bridge crosses the Ylang-ylang River and the first national bridge reported in the country.

Lucsuhin National Bridge

Soils and Land Capability Classes

Identification of soil characteristics, most importantly, the soil type is instrumental in recommending the best land-use for that area. Moreover, if intended for agriculture, knowing the soil type will help identify the most suitable crops to be planted in the area. It will contribute to the achievement of optimized land productivity.

The soil surveys conducted by the Bureau of Soils and Water Management (BSWM) revealed that Cavite is composed of 10 soil types. The lowland area of Cavite is generally composed of Guadalupe clay and clay loam. This soil type is characterized as coarse and granular when dry but sticky and plastic when wet. Its substratum is solid volcanic tuff. These soil types are suited to lowland rice and corn; those in the upland are suited for orchards and pasture.

Guadalupe clay adobes are abundant in the southern part of the cities of Bacoor and Imus bordering the city of Dasmariñas. The soil is hard and compact and challenging to cultivate, making it generally unsuitable for diverse cropping. It is very sticky when wet and granular when dry. Forage grass is advised for this type of soil.

Hydrosol and Obando sand are found along Bacoor Bay. The shoreline of Rosario, Tanza, Naic, and Ternate are lined with Guadalupe sand.

The central area principally consists of Magallanes loam with streaks of Magallanes clay loam of sandy texture. It is recommended for diversified farming such as the cultivation of upland rice, corn, sugarcane, vegetables, coconut, coffee, mangoes, and other fruit trees. The steep phase should be forested or planted to root crops.

Cavite's eastern side consists of Carmona clay loam with streaks of Carmona clay loam steep phase and Carmona sandy clay loam. This type of soil is granular with tuffaceous material and concretions. It is hard and compact when dry; sticky and plastic when wet. This type of soil is planted to rice with irrigation or sugarcane without irrigation. Fruit trees such as mango, avocado, and citrus are also grown in this type of soil.

Guingua fine sandy loam is found along the lower part of Malabon and Ylang-ylang River at Noveleta.

The type of soils that dominate the upland areas is Tagaytay loam and Tagaytay sandy loam with mountain soil undifferentiated found on the south-eastern side bordering Laguna province. On the southern tip are Magallanes clay and Mountain soil undifferentiated with an interlacing of Magallanes clay loam steep phase.

The Tagaytay loam 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 a considerable amount of volcanic sand and underlain by adobe clay. Mountain soil undifferentiated is forested with bamboos found on the sea coast. Cavite also has the Patungan sand characterized by pale gray to almost white sand with a substratum of marine conglomerates. It is located at Sta. Mercedes in Maragondon and some coastlines of Ternate.

Land Suitability

Land suitability is the fitness of a given type of land for a defined use. The process of land suitability classification is the appraisal and grouping of specific areas of land concerning their suitability for defined uses.

Land suitability secondary assessment is derived from comparing pre-determined suitability criteria for each of the foreseeable forms of land use with the land resources inventory data.

Forestry plantations:
- slope of less than 30% and the limitations of terrain or rock should be less severe
- no serious erosion hazard irrigated rice/freshwater fishponds:
  - slopes of less than 3% up to 8% if terraced
  - low soil permeability
  - no significant limitation of rock, erosion, soil depth, etc.
  - the presence of problem soil downgrades the suitability but is not necessary limiting

Cultivated annual crops:
- no significant existing erosion (or a low soil erodibility)
- slopes of less than 8% (benchmark of erosion hazard)
- adequate soil depth (750 centimeters)
- no flooding or poor drainage
- no problem soil
- no serious limitations of terrain or rock

Perennial trees and vine crops:
- as for cultivated annual crops but can be placed on a more erodible slopes, a slope of 18 percent may be allowable

Pastures:
- no serious existing soil erosion
- slopes of less than 18% if land is erodible
- slopes of less than 50% if land is stable
- no serious limitations of terrain

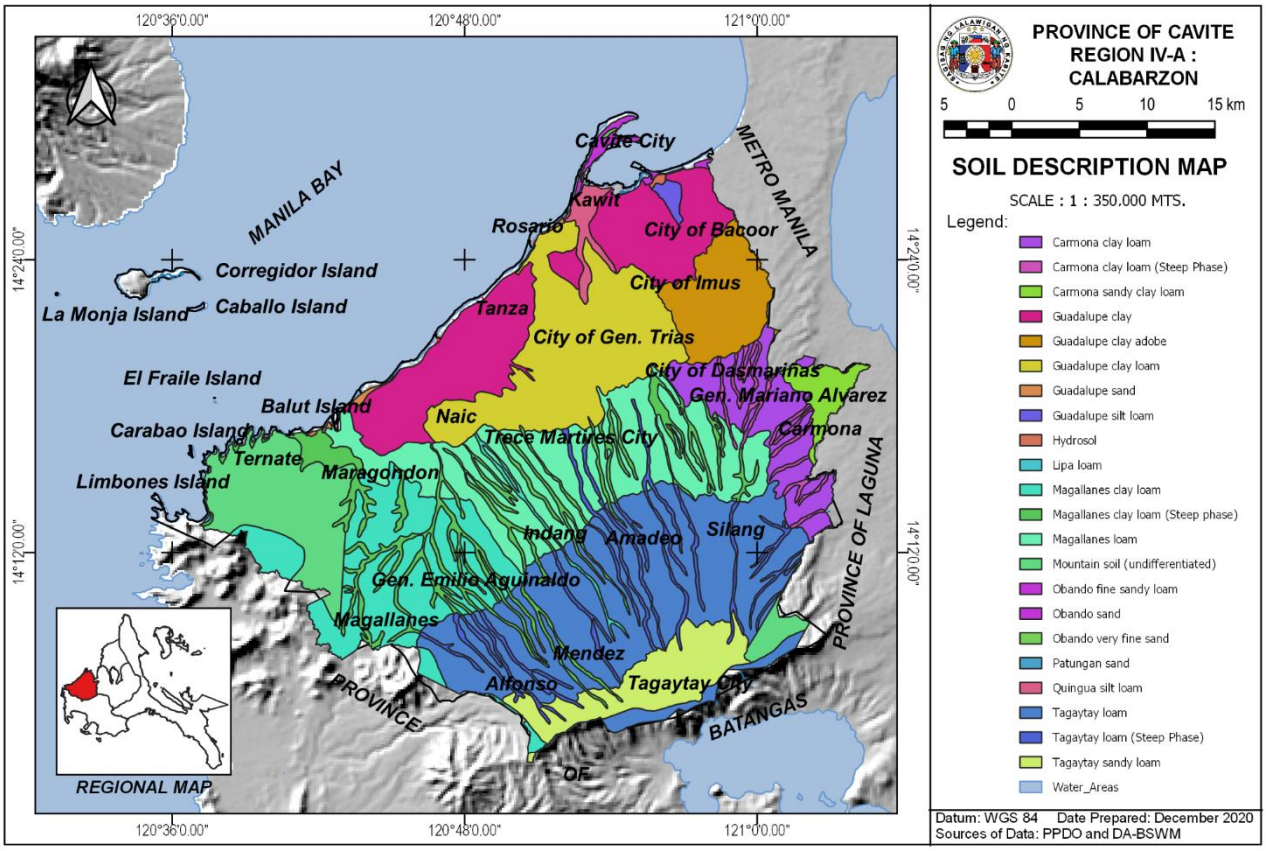
The land suitability information was from the Land Management Unit (LMU) map from the Bureau of Soils and Water Management (BSWM). This information will be used to determine whether the present land use is in congruence with the suitability of the land for that use (Table 2.3).

Table 2.3 Land Suitability by Slope, Province of Cavite

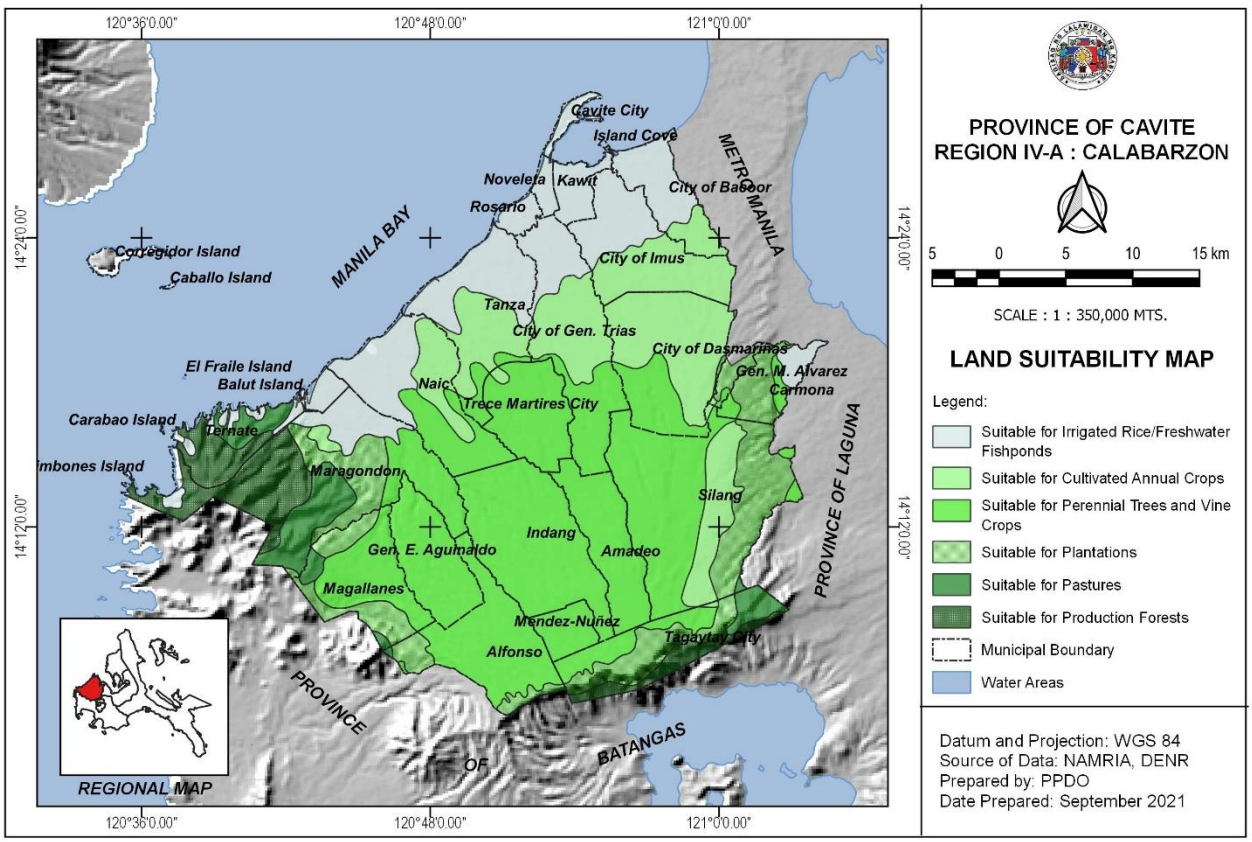
Description	Slope (%)	Area (sq.km.)	Land Suitability
Level to nearly level	0 - 3	283.1980	➢ Pasture (if land is erodible and stable) ➢ Forestry plantation ➢ Irrigated rice/freshwater fishponds ➢ Cultivated annual crops ➢ Perennial trees and vine crops
Gently sloping to undulating	3 - 8	267.7866	➢ Pasture (if land is erodible and stable) ➢ Forestry plantation ➢ Irrigated rice/freshwater fishponds (if terraced) ➢ Cultivated annual crops ➢ Perennial trees and vine crops
Undulating to rolling	8 - 18	586.2041	➢ Pasture (if land is erodible and stable) ➢ Forestry plantation ➢ Perennial trees and vine crops
Rolling to moderately steep	18 -30	154.6783	➢ Pasture (if land is stable)
Steep	30-50	52.0280	➢ Pasture (if land is stable)
Very steep	≥ 50	83.1650	➢ Production forests

Majority of Cavite's area is for highly restricted agricultural use. The lowland areas covering the cities of Imus, Bacoor and General Trias, portions of the municipalities of Tanza, Naic and Rosario are primarily suitable for irrigated rice/freshwater fishponds. The central part of the Province covering mainly the city of Dasmariñas, large portions of Tanza, Naic, Gen. Aguinaldo and Trece Martires City are primarily suitable for cultivated annual crops. Cavite's upland area covering the municipalities of Silang, Amadeo, Indang, Alfonso, Magallanes and a small portion of Gen. Aguinaldo and Maragondon and the City of Tagaytay is principally suitable for perennial tree and vine crop production.

The mountainous portions of the province found at the western side and the area along the Tagaytay Ridge is considered as National Integrated Protected Areas System (NIPAS) land which cannot be altered from its natural habitat.



Map 2.3 *Soil Description Map, Province of Cavite*



Map 2.4 *Land Suitability Map, Province of Cavite*

Land Resources

Land Classification

Land classification ensures the proper location of various land uses, especially of business, residential, and utility areas. This is executed by highly trained urban planners to ensure the harmonious movement of people and their activities. Land classifications and adherence to them by the public promote balanced development.

The land resource of the province is at 1,427.06 square kilometers. This is categorized into Alienable and Disposable (A&D) Land and Forest Land. The Alienable and Disposable Land accounts for 1,293.91 square kilometers or 90.67% share to a total land resource where economic activities (Agriculture – 55.24% share to A&D) and human settlements (44.76 percent share to A&D) occur. On the other hand, forestland, the land covered with forest or reserved for the growth of forests, is 9.33% or 133.15 square kilometers shared to the total (Table 2.4). It is assumed that land resource is preserved to maintain the ecological balance in the province.

Table 2.4 Land Classification, Province of Cavite: 2011 - 2020

Land Classification	Area (sq.km.)	Percentage Share	Percentage Share to Classification
Alienable and Disposable Lands	**1,293.91**	**90.67**	
Production Land	714.75	50.09	55.24
Built-up Area	579.16	40.58	44.76
Forest Lands	**133.15**	**9.33**	
Classified	53.57	3.75	40.24
Protected Areas /Natural Parks	39.28	2.75	
Military Reservation	8.09	0.57	
Islands	6.20	0.43	
Unclassified	79.58	5.58	59.76
Total	**1,427.06**		

Source: Cavite Provincial Development and Physical Framework Plan 2011-2020

Alienable and Disposable Lands

As defined by the Philippine Statistics Authority (PSA), alienable and disposable lands refer to those lands of the public domain which have been the subject of the present system of classification and declared as not needed for forest purposes. It is further classified into production land and built-up areas.

The production land is the area where agricultural activities and food productions takes place. Most of the areas in Cavite are of this classification (50.09%). Cavite's fertile and alluvial soil types and favorable climatic conditions make it highly suitable for agricultural production. The lowland areas are suited for rice, corn, and vegetable production. The central area is recommended for diversified farming. However, according to the Office of the Provincial Agriculturist, Cavite's agricultural lands are decreasing due to the conversion of these lands to residential/subdivision development and industrial areas.

The built-up areas, on the other hand, are comprised of settlements, industrial, commercial and tourism areas. This area is mainly for the conduct of economic activities as well as for human habitations. It covers up to 40.58% of the total land area of Cavite.

Forest Lands

The forest lands are those that have either national proclamation to become forest reservations or those lands that are not suitable for any particular use. It may be a factor of topography and elevation. Forest lands are divided into two kinds the classified land, which includes protected areas/natural parks, military reservations and islands, and unclassified land, also known as the public forest.

Under classified lands, Mount Palay-Palay and Mataas na Gulod National Parks located in Ternate and Maragondon are proclaimed as natural parks, part of Ternate are military reservation, and Corregidor, Caballo (Fort Hughes), Carabao, Limbones, Sta. Amalia, El Fraile (Fort Drum), La Monja, Balot Island and Island Cove (PuloniBurunggoy) are named islands in Cavite. Unclassified land includes the Tagaytay ridges with slope greater than 50%, Magallanes Forest land and parts of Maragondon.

The national park has the potential for eco-tourism due to its vast diversity of flora and fauna and accessibility. Its development as an eco-tourism destination would enhance its value as a biodiversity conservation area, open laboratory of scientific, biological, other research studies, and venue for recreation and public pleasure. However, despite its bright potential, there are still issues and concerns that need to be resolved to balance the exploration and preservation of the park's rich features.

Protected Areas

Protection land is a portion of land and water set aside for its unique physical, and biological significance managed to enhance biological diversity and protected against destructive human influences or impacts. Protection lands are categorized based on the status of the land. The first category refers to the areas declared under R.A. 7586 (NIPAS Law) as proclaimed National Integrated Protected Area System (NIPAS), including proclaimed critical watershed. The second category is areas classified as to whether the area's elevation is above 100 meters; the slope is higher than 50%; mangrove forest; buffer strips; freshwater swamps and marshes; and lakes and other inland water bodies. These are referred to as the Non-NIPAS areas. The third category is the severely eroded areas, which comprise the area subjected to severe soil erosion.

The only proclaimed national park in Cavite is the Mounts Palay-Palay and Mataas na Gulod National Park declared under Presidential Proclamation No. 1594 in 1976. The declaration aims to preserve the area's natural biodiversity as part of the advocacy to protect the country's natural heritage. Preserving its natural biodiversity is a strategic

move, considering the rapid urbanization in the province and Metro Manila. In addition, Cavite's protection areas are dominated by Strategic Crop Sub-Development Zone, with dedicated land area 556.90 square kilometers, followed by Watershed/Forestry Zone with 142.79 square kilometers. Notably, Agro-forestry Zone has land area of 55.75 square kilometers, while Mounts Palay-Palay–Mataas-na-Gulod Protected Landscape has land area of 39.73 square kilometers.

Aside from areas considered under NIPAS Law, other areas require rehabilitation, conservation, and sustained development and management and classified under Non-NIPAS Protected Areas. These are areas with greater than 50% in slope, located along Tagaytay Ridge with an area of 27.07 square kilometers, Magallanes Forest land with an area of 18.606 square kilometers and an area in Maragondon with a scope of 42.98 square kilometers. Included also in this category are the buffer strips along rivers and escarpments. The province's six main rivers are included; namely, Maragondon River, Labac River, San Juan River, Imus River, Bacoor River, and Cañas River. Included also as protected areas are the nine named islands: Corregidor Island (5.46 sq.km.), Caballo or Fort Hughes (0.27 sq.km.), Carabao (0.56 sq.km.), Limbones (0.24 sq.km.), Sta. Amalia (0.04 sq.km.), El Fraile or Fort Drum (0.01 sq.km.), La Monja (0.0098 sq.km.), Balut in Ternate (0.09 sq.km.), and Island Cove in Kawit with (0.02 sq.km.).

Mineral Lands

Based on the DENR Mines and Geosciences Bureau records, there are no valid and existing mining contracts and permits under the jurisdictions of the national government. Furthermore, applications for mining contracts and permits in the province have not reached the stage of determination of their mineral resources.

For 2016 to 2021, the corresponding maximum extractable volumes of materials (MEVM) for each quarry permit issued by the Provincial Government of Cavite through the Provincial Mining Regulatory Board is presented below.

Table 2.5 Commodity and Maximum Extractable Volume of Materials by Mineral Lands, Province of Cavite: 2011 - 2020

Location	Commodity	MEVM (m^3)
Brgy. Plnagsanhan B, Maragondon, Cavite	Filing Materials	210,030
Brgy. Plnagsanhan B, Maragondon, Cavite	Conglomerate Materials	246,489
Brgy. Plnagsanhan B, Maragondon, Cavite	Conglomerate Stone and Filing Materials	16,421.55
Brgy. Sapang I, Ternate, Cavite	Conglomerate Stone and Filing Materials	521, 234
Brgy. Salawag, Dasmarinas, Cavite	Filing Materials	65,118
Brgy. Punta, Tanza, Cavite	Filing Materials	89,715
Brgy. Punta, Tanza, Cavite	Filing Materials	50,767
Brgy. Sahud-ulan, Tanza, Cavite	Filing Materials	153,844
Brgy. Sahud-ulan, Tanza, Cavite	Filing Materials	74,184
Brgy. Sahud-ulan, Tanza, Cavite	Filing Materials	183,872

Source: CALABARZON Mining and Minerals Industry Profile – Mines and Geosciences Bureau IV-A

Mineral Resources

The upland part of Cavite contains volcanic materials, tuff, cinders, basalt, breccias, agglomerate and interbeddings of shales, and sandstones in the soil. The dormant and active volcanoes (Taal) are within this volcanic area and have been the sources of volcanic materials that form the Tagaytay Cuesta. The drainage systems are deeply entrenched in the tuffs, eroding thin interbedded sandstones and conglomerate, which are the source of little resources of sand and gravel in the larger stream. Adobe stone quarries also flourish in tuff areas. Meanwhile, in the lower part of Cavite, mostly coastal, marl, and conglomerate can be found. Igneous rocks are prominent in the high, mountainous regions of western Cavite. Minerals found in different localities in the province are listed below.

Table 2.6 Mineral Resources, Province of Cavite

City/Municipality	Minerals
City of Bacoor	Andesite, Basalt
City of Dasmariñas	Sand and Gravel
City of Gen. Trias	Sand and Gravel
Gen. Mariano Alvarez	Andesite, Basalt
Indang	Sand and Gravel
Magallanes	Clay
Maragondon	Sand and Gravel
Naic	Sand and Gravel
Tanza	Andesite, Basalt
Ternate	Andesite, Basalt

Source: CALABARZON Mining and Minerals Industry Profile – Mines and Geosciences Bureau IV-A

Coastal Resources

Cavite boasts a stretch of about 122.574 kilometers of shoreline. It is found along Cavite City, City of Bacoor, Kawit, Noveleta, Rosario, Tanza, Naic, Maragondon, and Ternate. The richness of Cavite's coastal resources paved the way for our recognition as a major producer of oysters and mussels. The fisherfolks are also active producers of sugpo/bangus. On the western coastlines lie the breathtaking beaches with pale gray sand. Thus, the coastal resource of the province contributes to the economic activities related to fishery and tourism.

Coral Reefs

Coral reefs are colonies of tiny living animals found in marine waters that contain few nutrients. It is commonly found at shallow depths in tropical waters and grows best in warm, shallow, clear, sunny, and agitated waters. It delivers ecosystem services to tourism, fisheries, and shoreline protection. It also serves as home to marine life.

As of 2013, the Department of Environment and Natural Resources Region 4A – CALABARZON had mapped a total of 0.1926 square kilometers of coral reef areas in Sitio Pinagkainan and Patungan, Barangay Sta. Mercedes, Maragondon, Cavite. Sitio Pinagkaingan, located in the eastern part of Limbones cove opposite Carabao Island, has a 34% live coral cover dominated by non-Acropora corals (32.60%) and a small population of Acropora corals (1.40%).

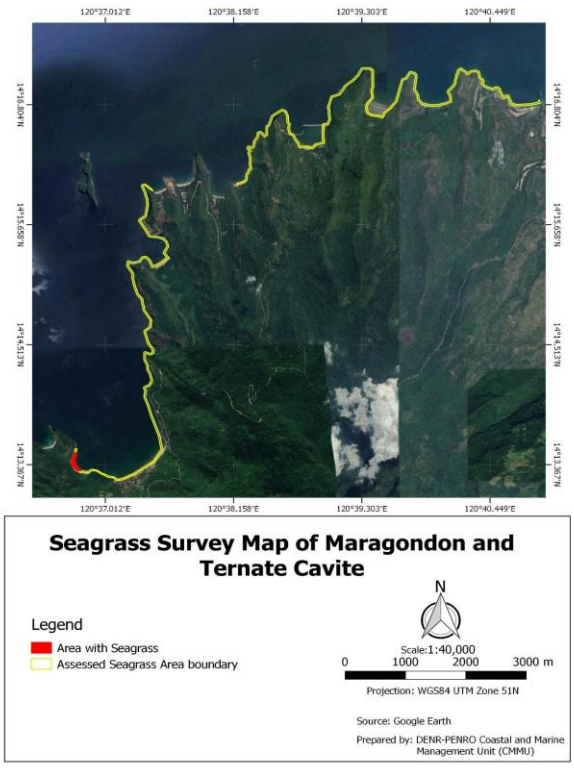
In Sitio Patungan Munti, slightly sloping ground and good water visibility at 30 ft. depth, has about 32.76% live coral cover where the "staghorn" corals (20%) are mostly seen. About 40 percent of the species were members of the two largest families, the Pomacentridae and Labridae. A school of fusiliers (Caesio spp.) were also observed.

In Santa Mercedes Fish Sanctuary, coral reefs found are of families Acroporidae, Alcyoniina, Agariciidae, Caryophyllidae, Euphylliidae, Paviidae, Fungiidae, Meandrinidae, Montraeidae, Mussidae, Pectiniidae, Pocilloporidae, Poritidae.

Coral Reefs in Limbones Cove
Image source: www.choosephilippines.com (Photos by: Mike Ajero)

Seagrass Communities

Based on the assessment conducted last February 17, 2020, two species of sea grass were observed namely *Thalassia hemprichii* and *Halophila sp.* in the coastal areas of Maragondon. The map below shows the location of the conducted assessment as well as the area where the sea grass was seen.



Map 2.5 *Seagrass Map, Province of Cavite: 2020*
Source: Coastal and Marine Management Unit, PENRO – CAVITE

Mangroves

Mangroves are trees or shrubs that grow in the tropical coastal swamps that are flooded at high tide. Mangroves typically have many tangled roots above ground and form dense thickets. Mangroves provide ecological and socio-economic importance in protecting the shoreline and coral reefs, the nursery for fishes, shrimps, crustaceans and mud crabs, food and sanctuary for marine life, potential eco-tourism sites, protection for reclaimed land and windbreaker during typhoons.

As of 2017, Cavite has a total of 1.21 square kilometers of mangrove areas. These mangrove areas are based on the Bio-ecological assessment of the Department of Environment and Natural Resources – Manila Bay Coordinating Office (DENR) conducted in 2017 located at City of Bacoor, Noveleta, Ternate, Kawit and Rosario. The mangrove rehabilitation project is established from 2001 to 2015. Around 1.0209 square kilometers of mangrove areas are planted in the last ten (10) years.

Mangroves in the province are rehabilitated since 2012 through DENR-PENRO. Rehabilitated mangroves are located in the City of Bacoor, Kawit, Noveleta, and Ternate. In 2020, 0.7119 square kilometers of mangrove areas were assessed. These are located in Noveleta, City of Bacoor, and Rosario.

The species of Mangroves found in the province are:

1. Bakauan Babae *(Rhizophora mucronata)*
2. Bakauan Lalake *(Rhizophora apiculata)*
3. Bakauan bato *(Rhizopora stylosa)*
4. Banalo *(Thespesia populnea)*
5. Api-api *(Avicennia officinales)*
6. Dampol *(Giochidion littorale)*
7. Batikabra *(Ipomoea pescaprae)*
8. Talisay *(Terminalia catappa)*
9. Aroma *(Acacia famesiana)*
10. Pagatpat *(Sonneratia alba)*
11. Tangal *(Ceriops tagal)*
12. Buta-buta *(Excoecaria agallocha)*
13. Ipil-ipil *(Instia bijuga)*
14. Nipa *(Nypa fructicans)*
15. Palaypay *(Acrostichum aureum)*
16. Lagiwliw *(Acanthus ilifolius)*
17. Maragomon *(Brownlowia tersa)*
18. Kulasi *(Lumnitzera racemose Willd)*

DENR also identified Naic as a Marine Turtles Nesting place for Olive Ridley (Lepidochelys olivacea). Conservation and protection efforts include patrolling and monitoring along the coast, transplanting newly laid eggs to hatchery, tagging, and releasing the hatchlings to the sea.

There are also four existing fish sanctuaries in the province located in Sta. Mercedes, Maragondon, Naic Fish Sanctuary, Bulaklakin Fish Sanctuary, Ternate, and Tanza. All fishing activities are prohibited in the fish sanctuaries to allow stocks to recover. It also serves as a feeding and breeding ground for the fishes and is of great importance in the restoration and conservation of habitat.

Table 2.7 Areas Planted or Rehabilitated and Number of Seedlings/Propagules Planted, Province of Cavite: 2012 – 2018

Barangay	Area (sq.km.)	Number of seedlings/ propagules	Species/ Commodity (Mangrove)
2012			
Brgy. Sineguelasan, City of Bacoor	0.0202	5,050	Bakauan babae Bakauan lalake
Brgy. Binakayan, Kawit	0.0109	2,725	Bakauan babae Bakauan lalake
Brgy. Wakas, Kawit	0.1405	36,250	Bakauan babae Bakauan lalake Api-api
Brgy. San Rafael IV, Noveleta	0.0305	8,750	Bakauan babae Bakauan lalake Api-api
Brgy. Sapang I, Ternate	0.0129	3,225	Bakauan babae Bakauan lalake
Brgy. Pinagsanhan A, Ternate	0.0101	2,525	Bakauan babae Bakauan lalake
2013			
Brgy. San Rafael IV, Noveleta	0.2000	50,000	Bakauan babae Bakauan lalake
2014			
Brgy. San Rafael IV, Noveleta	0.5000	250,000	Bakauan babae Bakauan lalake
2015			
Brgy. Pulborista, Kawit	0.2000	50,000	Bakauan babae
2018			
Brgy. San Rafael IV, Noveleta	0.3800	106,400	

Source: Provincial Environment and Natural Resources Office, Trece Martires City, Cavite

Table 2.8 Mangrove Areas Assessed and Species of Mangroves, Province of Cavite: 2020

Specific Place of Assessment	Mangrove Area (sq. km.)	Number of Species	Number of Families	Number of Individuals	Name of Species
Brgy. San Rafael IV, Noveleta, Cavite	0.5740	7	6	121	Api-api Bakauan Babae Bakauan Lalake Pagatpat Kulasi Banalo Aroma
Brgy. Sineguelasan, City of Bacoor, Cavite	0.1190	2	1	125	Bakauan babae Bakauan lalake
Brgy. Ligtong II, Rosario, Cavite	0.0189	2	2	63	Api-api Bakauan Babae

Source: Provincial Environment and Natural Resources Office, Trece Martires City, Cavite

Freshwater Resources

Freshwater is one of the most valued natural resources. Effective management to ensure its sustainable source is essential and is a primary concern of the government.

Surface Runoff

Surface runoff is water from rain or other sources that flows over the land surface and is a principal component of the water cycle. Runoff that occurs on surfaces before reaching a channel is also called overland flow. A land area that produces runoff draining to a common point is called a watershed.

There are six major river watersheds in Cavite such as:

1. Bacoor River Watershed
2. Imus River Watershed
3. San Juan River Watershed
4. Cañas River Watershed
5. Labac River Watershed
6. Maragondon River Watershed

These rivers are known to have various tributaries passing through the different municipalities of the province. These rivers and tributaries generally have a flowing direction from the highlands of Tagaytay City going to Manila Bay with stretches from the City of Bacoor up to Municipality of Ternate.

Along with these six major rivers, the province's topography allowed 12 major river watersheds to be shaped within its boundaries. Except for the Palico River Watershed, Pasig-Laguna Watershed, and Zapote River Watershed that traverses inter-province boundaries, the entirety of the remaining watersheds is from major rivers found in the province. The watersheds rooting from the rivers identified in the province are classified as medium and small-sized watershed. The Pasig-Laguna River Watershed is identified as a large-sized wathershed, resulting in the traversion of the watershed to the east of the province, specifically areas in Carmona, City of Dasmariñas, General Mariano Alvarez, Silang, and Tagaytay City. In addition, 18 surface water bodies are present in the province.

Water sources, especially in the upland areas, are abundant due to numerous natural springs, waterfalls, and rivers. These have become beneficial among 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). Nowadays, these God-given natural wonders are being utilized for recreational and leisure activities like picnics and gatherings.

Water quality of the rivers is observed to be physically deteriorated due to industrial effluents, domestic sewage, garbage disposal, and other site development projects. Surface waters generally exhibit some discoloration, high turbidity, and abundance of suspended materials during the rainy season. Therefore, river rehabilitation is indispensable to counteract the situation.

Table 2.9 Major Rivers in Cavite

Name	Length (km)	Point of Origin	Drainage Location
1. Bacoor River	12.3	Pintong Gubat, Molino passing Tanzang Luma, Salinas and Panapaan	Bacoor Bay
2. Imus River	38.4	North of Tagaytay passing Balite, Sabutan, Biga, Silang, Palapala, City of Dasmariñas, Pasong Bayog, San Agustin and connects to Pasong Bayog passing Salitran, Baluctot, Anabu II & Anabu I going to Tanzang Luma, Palico, Imus down to Salinas and Mabolo, Bacoor toward drainage. Tributaries that started from Bucal going to San Agustin join/connect Imus River in Pasong Bayog. Tributaries found in Baluctot also drain at Imus River.	Bacoor Bay
3a. San Juan River	39.0	Maitim, Amadeo passing Maitim, Lalaan I, Silang, Dagatan, Banaybanay, Calubcob, Panungyanan, Javalera, Biclatan, Manggahan, Jaime Baker; Buenavista, Pasong Kawayan, Bacao, Gen. Trias; Sta. Rosa, Noveleta and Putol, Kawit. Tributaries are at Bucandala and Panamitan.	Bacoor Bay Kawit
3b. Ilang-Ilang River		Pasong Camachile River which started from Santiago passing San Gabriel connects with San Juan River; San Jose, the City of Dasmariñas converging with San Juan River at Bacao, Gen. Trias	
4. Cañas River	38.9	From Kaybagal, Tagaytay City passing Loma, Amadeo going to Polanan River, San Agustin, Gregorio, Osorio, Lucbanan, Conchu, Inocencio, Trece Martires City; Alingaro, Gen. Trias passing Lubluban River, Santol, Bucal to Julugan, Tanza. Also, from Tagaytay City going to Salaban, Amadeo; Balagbag, Mahabang Kahoy, Limbon, Alulod, Indang and connects to Paradahan, Tanza Other tributaries are found in Buna Lejos, Limbon connecting in Alulod.	Manila Bay Julugan, Tanza
5. Labac River	30.5	Two contributory rivers located in the upland area. Starting from Buna Lejos, Indang passing Buna Cerca to Calumpang River going to Palangue, Naic to Kay-alamang River passing San Roque down to Labac River. Patutong Malaki, Tagaytay City passing Habulin River, Barangays II & III, Mendez going to Kayquit, Indang straight to Banaba Cerca going to Malainen Bago, Naic	Manila Bay
6.Maragondon River	35.6	Multi-sources Banaba Lejos passing Pantihan I & II. Tributaries are: Habulin River passing East Tambo to Banaba Lejos; From Palocpoc passing Lumampong and Banaba Lejos; Magay River to Maragondon River; Narvaez River passing Tabora to Maragondon River; Matagbak Buruhan River passing Sinaliw na Munti and Sinaliw na Malaki; Aliang River in Magallanes starting from Kaytitinga joined Narvaez River passing Tabora; Another river (unnamed) from west of Kaytitinga and Aliang River passing Magallanes and joined Tabora to Maragondon River	Manila Bay Ternate

Source: Provincial Government Environment and Natural Resources Office, Trece Martires CIty

Table 2.10 Major River Watersheds in Cavite

Name	Size Classification	Cities/Municipalities Traversed	Approximate Area (sq.km.)
Maragondon River Watershed	Medium-sized watershed	Alfonso, Cavite City(thru Balut Island) Gen. Emilio Aguinaldo, Indang, Magallanes, Maragondon, Mendez-Nuñez, Naic, Tagaytay City and Ternate	0.3213
Pasig-Laguna River Watershed	Large-sized watershed	Carmona, City of Dasmariñas, Gen. Mariano Alvarez, Silang and Tagaytay City	145.2184
Camachile-Ylang-Ylang River Watershed	Medium-sized watershed	Amadeo, City of Dasmariñas, City of Gen. Trias, City of Imus, Kawit, Noveleta, Rosario, Silang and Tagaytay City	129.4278
Canas River Watershed	Medium-sized watershed	Amadeo, City of Gen. Trias, Indang, Rosario, Silang, Tagaytay City, Tanza and Trece Martires City	111.8525
Imus River Watershed	Medium-sized watershed	City of Bacoor, City of Dasmariñas, City of Imus, Kawit, Silang and Tagaytay City	101.6504
Caisobo River Watershed	Small-sized watershed	Indang, Maragondon, Mendez-Nuñez, Naic, Tagaytay City, Tanza and Trece Martires City	99.1721
Timalan River Watershed	Small-sized watershed	Indang, Naic, Tanza and Trece Martires City	45.3212
Palico River Watershed	Medium-sized watershed	Alfonso and Magallanes	42.2016
Zapote River Watershed	Small-sized watershed	City of Bacoor, City of Dasmariñas and City of Imus	37.6914
San Juan River Watershed	Small-sized watershed	City of Imus, City of Gen. Trias, Kawit and Noveleta	14.1541
Unnamed(1)	Small-sized watershed	Tanza	10.4609
Unnamed(2)	Small-sized watershed	City of Dasmariñas, City of Imus and Kawit	10.1024

Source: NAMRIA through DENR-PENRO Cavite

Table 2.11 List of Surface Water Bodies by Receiving Water Body, Province of Cavite

Surface Water Bodies	Location	Classification	Category
Manila Bay			
Manila Bay	Cavite	Class SB	Marine Water
Imus River	Cavite	Class C	Principal River
Ylang-ylang River	Cavite	Class C	Principal River
Cañas River	Cavite	Class C	Principal River
Labac River	Cavite	Class C	Principal River
Maragondon River	Cavite	Class C	Principal River
Timalan River	Cavite	Class C	Minor River
Calibuyo River	Cavite	Class C	Minor River
Labac River			
Haboling River	Indang	Class B	Tributary River
Caisobo-Obispo River	Indang	Class B	Tributary River
Cañas River			
Balite River	Amadeo-Indang	Class B	Tributary River
Indang River	Amadeo-Trece	Class B	Tributary River
Pulonan River	Amadeo-Trece	Class B	Tributary River
Saging/Cyalinmang RIver	Tanza-Trece	Class B	Tributary River
Zapote River			
Molino River	Bacoor	Class C	Tributary River
Imus River			
Silang River	Silang-Amadeo	Class C	Tributary River
Ylang-ylang River			
Rio Grande River	General Trias	Class C	Tributary River
Dasmariñas River	Dasmariñas	Class B	Tributary River

Source: Provincial Government – Environment and Natural Resources Office, Trece Martires City, Cavite

Groundwater Resources

The groundwater is one of the best sources of freshwater for human and animal consumption. By definition, groundwater is the water found underground in the cracks and spaces in soil, sand, and rock. It is stored in and moves slowly through geologic formations of soil, sand, and rocks called aquifers.

The natural ground elevation or terrain affects the amount of groundwater in an area, as well as the water extraction demand depending on industrial and residential demand.

The vast number of deep wells in the province has become a major source of concern about the decreasing amount of groundwater resources in Cavite. The towns of Naic, Tanza, and Ternate and the cities of Dasmariñas, Bacoor, Imus, and Gen. Trias highly depend on artesian wells. These have become their major source of water. These have caused saltwater intrusion in the aquifers due to over-extraction of water. In 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 groundwater is stored in the pyroclastic rock reservoir and little in the volcano and clastic rock. Potable water is not reported in the nearshore 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 the surface water reservoir and irrigation water also contributes to the groundwater.

Freely-flowing wells occur in the 30-meter elevation of Southern Tanza and the lower portions of nearshore Naic and Ternate, while in the City of Imus, it is at the elevation of about 15 meters.

Land Use

Existing Settlement Pattern (Initial Growth Area)

As one of the first areas in the country to be settled in and developed, the municipalities along the coastal areas of the province such as Cavite City, Noveleta, Kawit, Rosario, and Bacoor became one of its earliest settlement areas. It could be due to the shipyard building facilities that employed skilled Filipinos during the Spanish period and the American Naval Bases, Sangley, and Fort San Felipe, during the American presence. The development of infrastructure projects, the proliferation of employment opportunities, and its proximity to Manila largely contributed to the large population and high urban densities.

In addition, the areas on the eastern side of Cavite continue to be on the heavy side of the province's population growth since these are adjacent to job prospects, educational facilities and serve as a gateway towards Manila and Laguna, another industrialization hub in the CALABARZON Region. These are mainly the Cities of Bacoor, Dasmariñas, and Imus. As an effect, there is a need to plan out their future development that would ensure balance and environmental sustainability in the context of the whole Province.

Existing Production Areas

The province is a predominantly agricultural area, with almost 50% of its land being a production area. The municipalities of Maragondon, Magallanes, Gen. Aguinaldo. Alfonso, Indang, Mendez-Nuñez, Amadeo, and Silang are the primary sources of its food supply.

Existing land production areas are stressed for various reasons such as exploitative use of land, use of land other than its suitable use, and conversion of prime agricultural lands for purposes other than production. Even the mandated protection lands are deforested due to illegal cutting of trees, encroachment of informal settlers, and other unsustainable activities.

Existing Protection Areas

The 8th District of the province has enough land to become the future settlement area; however, most protected areas are in this District.

Located in Maragondon, Cavite, Mounts Palay-Palay-and-Mataas-na-Gulod was declared a National Park by

Proclamation No. 1594 on October 26, 1976. It is a protected area in a range of low hills on the border between the densely populated provinces of Cavite and Batangas. It has three peaks, Palay-Palay, Pico de Loro and Mataas-na-Gulod. The last remaining lowland evergreen rainforest in Cavite is in the northern part of Mt. Palay-Palay. The habitat covers 60% of the park. There are also areas of arable land, small settlements and rural gardens, and some kaingin.

A delicate balance between the use of production lands and the preservation of protected lands is, therefore, a critical requirement to attain sustainability in the development process. The sustainable development process requires a long-term sustainable land use framework plan.

Climate

Based on the Philippine Cavite is identified to belong to Climate Type I. Cavite has two pronounced seasons, dry from November to April and wet for the rest of the year. The province is included in the Philippine areas that are shielded by mountain ranges but are open to rains brought in by Habagat and tropical cyclones.

Based on the PAGASA Sangley Point Observation Center data, the maximum average temperature of the province was between 24.7° Celsius and 31.8° Celsius with a mean of 28.4° Celsius. The hottest temperature is observed in May while it is coldest in January. The vapor pressure is at 30.4 millibars and relative humidity of 78% annually. Wind usually comes from east-southeast with a constant speed of three miles per second.

It can be observed that average temperature is increasing through the years. The increase in temperature can be attributed to the continuous global warming in the world, wherein as the concentrations of greenhouse gases increases, the Earth incessantly warms.

Table 2.12 Historical Average Monthly Temperature, Province of Cavite (Sangley Station): 2016 – 2020

Month	Mean Temperature (°C)				
	2016	2017	2018	2019	2020
January	26.6	27.0	27.9	27.8	27.9
February	27.4	26.9	28.5	28.0	27.6
March	28.6	28.5	28.9	29.3	29.7
April	30.6	30.0	30.8	31.4	31.2
May	31.6	30.9	32.0	31.0	31.4
June	31.1	30.1	29.1	31.0	30.8
July	29.5	28.7	28.2	29.4	30.2
August	29.7	29.5	28.9	28.6	29.3
September	29.7	29.3	29.2	28.8	30.3
October	29.4	28.8	30.0	29.8	28.9
November	29.6	29.9	29.5	28.9	28.6
December	28.2	27.8	28.2	28.4	28.3
Annual	**29.3**	**29.0**	**29.3**	**29.4**	**29.5**

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Sangley Point Observation Center, Cavite City

Most torrential rains are experienced in July, and there is almost no rain at the onset of the year in April except in 2017, where tropical depression "Crising" hit the Philippines. The heaviest in three years was experienced in July 2018. It was due to rain showers brought by the super typhoon "Maria" with a local name "Gardo" enhancing the southwest monsoon or "hanging habagat."

Table 2.13 Historical Amount of Rainfall, Province of Cavite (Sangley Station): 2016 – 2020

Month	Rainfall (mm)				
	2016	2017	2018	2019	2020
January	0.4	52.5	16.4	5.7	4.2
February	3.3	5.4	0.8	2.0	31.6
March	7.2	6.4	105.8	2.4	2.0
April	1.2	39.3	0.2	3.6	0.0
May	84.5	186.4	20.0	61.9	190.2
June	321.4	105.1	723.0	271.1	268.9
July	523.4	467.2	757.3	309.8	230.4
August	296.8	323.0	427.2	622.9	214.2
September	460.3	382.7	194.7	330.1	130.9
October	212.9	196.1	72.8	33.2	375.7
November	27.8	116.4	13.7	149.8	203.6
December	163.2	57.1	132.9	119.5	123.9
Annual	**2,102.4**	**1,937.6**	**2,464.80**	**1,912.0**	**1,775.6**

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Sangley Point Observation Center, Cavite City

Projected Climate Change

Since Climate Change is inevitable, the respective LGUs should brace themselves for its effects and implement the necessary mode of action to adapt or mitigate its eventualities, one of these by knowing the right information and essential data related to it.

Based on the publication "Climate Change in the Philippines" (PAGASA 2011), the seasonal rainfall changes in the province in 2020 and 2050 under medium-range emission is 92.31 mm in 2020 and 101.40 mm in 2050, an increase of 9.09 mm of rainfall.

Global sea-level rise is another hazard caused by the melting of ice glaciers and mountain ice caps and the thermal expansion of ocean waters. At the local level, sea-level rise is also attributed to groundwater resources' over-extraction for drinking and domestic purposes, which causes subsidence. Sea-level rise causes flooding of low-lying coastal areas, coastal erosion, and saltwater intrusion into the barangay's groundwater resources.

Data from NOAA/Laboratory Satellite Altimetry TOPEX, J1 and J2, shows that the province has an observed sea-level rise of about 7 mm/year (September 1992-June 2012) or about 56mm from 2012-2020 or a total of 266 mm up to 2050. In its proper perspective, the global sea-level rise for the past century was around 0.17 meters.

On the other hand, the number of dry days in the province is projected to lessen from 6,635 days for 2020 projections to 6,565 days for 2050, meaning wetter days is ahead for the province. Also, the frequency of extreme events (El Niño and La Niña) or the days with temperatures more than 35° Celsius-is expected to be 1,697 days in 2020 and expected to increase to 2,733 days by 2050. The projected change in the number of hot days and dry days in the province are relatively related, as the hot days in the province is expected to increase by 169% in 2020 and 334% in 2050 from the 1971-2000 baseline while the number of dry days is expected to increase in by 9.75% in

2020 and 10.71% in 2050 from the 1971-2000 baseline. It is also associated with the decrease of rainfall during the DJF, MAM, and SON seasons in 2020 and 2050, which negates the increase in rainfall during the JJA season. In addition, the number of extreme daily rainfall events is expected to increase by 50% in both 2020 and 2050 from 1971-2000 baseline. It indicates that an extreme rainfall events in the province within 2020 and 2050 may last up to nine days.

Table 2.14 Frequency of Extreme Events under Medium-Range Emission, Province of Cavite (Sangley Station): 2020 and 2050

	Observed (1971 – 2000)	Projected	
		2020	2050
Number of Days with Temperature greater than 35 °C	630	1,697	2,733
Number of Dry Days	7,352	6,635	6,565
Number of Days with Rainfall greater than 300 mm	0	4	2

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

Natural Hazards and Constraints

Hydrometeorological Hazards

Hydrometeorological hazards are phenomena caused by natural processes and atmospheric, hydrological or oceanographic phenomena. Most hydrometeorological hazards in the province are caused by tropical cyclones, rains and storms, resulting to floods, rain-induced landslides, and storm surges. The hydrometeorological and geologic hazards present in the province are tsunami, flooding, storm surge, ground shaking, ground rupture, liquefaction, earthquake induced landslide, rainfall induced landslide, volcanic hazard.

Flooding is a spilling over of water onto land that is regularly dry. Floods can occur during weighty downpours, when sea waves come onshore, or when dams or levees break. Generally, flooding in Cavite is only experienced in low-lying towns and coastal towns of the province based on the study conducted. There are major rivers of the province that serves as catchment areas. They catch the water volume coming from the upland municipalities of the province in the occurrences of heavy rains, typhoons, and other environmental phenomena. Densely populated regions are at a high danger for floods. Development of structures, expressways, carports, and parking areas builds overflow by decreasing the amount of downpour consumed by the ground.

Incessant rains not only affect coastal-lying areas but also in mountainous or high-altitude areas within a municipality or province. It has resulted in several rain-induced landslides in the past. The City of Bacoor, City of Imus, City of Dasmariñas, Carmona, Silang, City of General Trias, Amadeo, Indang, Tanza, Trece Martires City, Alfonso, General Emilio Aguinaldo, Magallanes, Maragondon, Mendez-Nuñez, Naic, Tagaytay City, Ternate. In addition, most localities exposed to rain-induced landslide are located in the upland area of the province, which have higher slopes that are most susceptible to rain-induced landslide. The exposure of City of Bacoor and City of Imus to these hazards are located in and near the river and coastal edges of the cities.

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

Geological Hazards

On the other hand, geologic hazards are large-scale, complex natural events that happen in land caused by extreme weather conditions and activities taking place in the earth's interior. These hazards may occur suddenly, or slowly. Among the geologic hazards, ground shaking, ground rupture, earthquake-induced landslide, liquefaction, tsunami, and volcanic hazards exist in the province.

One of the main hazards emanating from an earthquake is ground motion or ground shaking. The passage of seismic waves causes ground shaking, especially surface waves near the earthquake's epicenter are responsible for the most damage during and after the earthquake. The intensity of ground shaking depends on local geologic conditions in the area, the 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. The distance factor depends on the type of material underlying the area. 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.

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

Carmona and Silang are susceptible to ground rupture in the province. These areas are traversed by active faults resulting to the occurrence of ground rupture.

Earthquake-induced landslide prone areas in the province are City of Dasmariñas, Carmona, General Mariano Alvarez, Silang, Indang, Trece Martires City, Alfonso, General Emilio Aguinaldo, Magallanes, Maragondon, Tagaytay City, Ternate and Mendez-Nunez. Areas in Carmona and Silang are along the West Valley Fault resulting to the occurrence of this hazard, while Tagaytay City has steeply sloping areas such as the Tagaytay Ridge. Deeply incised rivers are also present in the province that are prone to this hazard.

Liquefaction takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking. Coastal areas in the province located in Cavite City, Noveleta, Kawit, Rosario, City of Imus, City of Bacoor, Carmona, City

of General Trias, Tanza, Maragondon, Naic and Ternate are prone to liquefaction.

The marine industry and built-up areas in the affected areas will be damaged by tsunami. As it occurs in the water zones, the coastal areas of Cavite City, Kawit, Rosario, Noveleta, City of Bacoor, City of Imus, City of General Trias, Maragondon, Naic and Ternate are susceptible to tsunami.

Lastly, due to the province's proximity to Tagaytay City, Alfonso, Mendez, Amadeo, Silang, and portions of Magallanes, General Emilio Aguinaldo, City of General Trias, Carmona, City of Dasmariñas, Indang and Trece Martires City are susceptible to volcanic hazard. These areas are calculated to be within the 30km radius of the volcano.

Table 2.15 Summary of Hazard Characterization by City/Municipality, Province of Cavite:2020

City/Municipality	Flood	Rainfall-induced Landslide	Storm Surge	Ground Shaking	Ground Rupture	Earthquake-induced Landslide	Liquefaction	Tsunami	Volcanic Hazards
1st District									
Cavite City	■		■	■			■	■	
Kawit	■		■	■			■	■	
Noveleta	■		■	■			■	■	
Rosario	■		■	■			■	■	
2nd District									
City of Bacoor	■	■	■	■			■	■	
3rd District									
City of Imus	■	■		■			■	■	
4th District									
City of Dasmariñas	■	■		■		■			■
5th District									
Carmona	■	■		■	■	■	■		■
Gen. M. Alvarez	■	■		■		■			
Silang	■	■		■	■	■			■
6th District									
City of Gen. Trias	■	■		■			■	■	■
7th District									
Amadeo		■		■		■			■
Indang		■		■		■			■
Tanza	■	■	■	■			■	■	
Trece Martires City		■		■		■			■
8th District									
Alfonso		■		■		■			■
Gen. Emilio Aguinaldo		■		■		■			■
Magallanes		■		■		■			■
Maragondon	■	■		■		■	■	■	
Mendez-Nuñez		■		■					■
Naic	■	■	■	■			■	■	
Tagaytay City		■		■		■			■
Ternate	■	■	■	■		■	■	■	

Environmental Management

Cavite has the Cavite Environment Code (Provincial Ordinance No. 001-S-2008) that guides the province in formulating and implementing programs with the ultimate goal of safeguarding and conserving the land, mineral, marine, forest and other natural resources of the province. In each aspect of environmental management, Cavite also enacted specific ordinances in support of the Environment Code.

Table 2.16Legislations on Environmental Management, Province of Cavite: as of 2020

Ordinance/ Resolution No.	Year	Title
004	2002	An Ordinance prohibiting the smoking and selling of cigarettes in all public and private primary and secondary schools and within a radius of 100 meters from the school compound, premises and providing penalties for violations thereof
001	2003	An Ordinance prohibiting the improper disposal of used oil generated from automotive and industrial lube oil and petroleum sludge, providing penalties for violation thereon and for other purposes
004	2005	An ordinance to curtail illegal activities of professional and illegal squatters in the province of Cavite
005	2005	An ordinance creating the Cavite Youth Development Council
007	2005	An Ordinance prescribing safety measures in the refueling at any gasoline satiation within the territorial jurisdiction of the Province of Cavite and providing penalties for violation thereof
005	2006	An Ordinance regulating the operation of all junkshops and other similar business establishments and individuals engaged in buying and selling of metals with monetary value within the province of Cavite and for other purposes
004	2007	An Ordinance on the establishment of animal quarantine checkpoints for foot and mouth disease and other zoonotic diseases at strategic entry points in the Province of Cavite and imposing fees thereof
001	2008	Cavite Environment Code

Ordinance/ Resolution No.	Year	Title
005	2011	An Ordinance adopting the National Code on Sanitation in the Province of Cavite
001	2012	An Ordinance for the implementation of anti-dengue campaign at the barangay level
003	2012	An Ordinance adopting the Manila Bay Oil Spill Contingency Plan
007	2012	An Ordinance prohibiting, regulating, prescribing certain uses of plastics for goods and commodities that end up as residual wastes and promoting the use of eco-bags and other environment-friendly practices as an alternative and providing penalties for violations thereof
026	2012	An Ordinance regulating cigarette smoking within the Provincial Capitol compound of Cavite and providing penalties thereof
007	2013	An ordinance establishing the "Greening Program" within the province of Cavite
008	2013	Water Consumers Protection Ordinance of Cavite
015	2013	An ordinance creating the Water Quality Management Are (WQMA) Governing Board for Imus-Ylang-ylang-Rio Grande River pursuat to DENR Administrative Order no. o2, Series 2013
021	2013	An ordinance amending certain Provisions of Provincial Ordinance No. 007-2012 otherwise known as an Ordinance Prohibiting, Regulating and Prescribing certain uses of Plastics for Goods and Commodities that end up as Residual Wastes and promoting the use of Eco Bags and other environment friendly practices as an alternative and providing penalties for violation thereof
038	2013	An ordinance amending the Provincial Ordinance No. 2008-001, otherwise known as the Cavite Environment Code, specifically, Article XII, Organization, Section 104 and 105
061	2014	An ordinance establishing the Provincial Clean Air and Anti-Smoke Belching Program and appropriating funds and providing fines and penalties thereof
129	2015	An ordinance requiring all car wash facilities operating within the territorial jurisdiction of the province of Cavite to install septic tanks in their respective premises and providing penalties for violations thereof
167	2017	An ordinance prohibiting the littering of solid wastes in the province of Cavite and providing penalties for violation thereof
006	2019	Ordinance prohibiting any person, business, firm, corporation or association to conduct balloon releasing activity in violation of RA 9003 or the Ecological Solid Waste Management Act of 2000 and prescribing penalties thereof.
126	2019	An ordinance prohibiting the Littering of Solid Waste in the province of Cavite and providing penalties thereof
173	2019	An ordinance to regulate the use and disposition of plastic bags and other plastic products for goods and commodities, promoting the use of eco bags and other native reusable bags and providing penalties for violations thereof

Solid Waste Management

Management of solid waste is a major environmental concern of the government. The Republic Act 9003 stipulates the law on proper ecological disposal of solid waste, which does the least harm to the environment. In support of this, the provincial government has enacted Executive Order No. 29 requiring all cities and municipalities of the province to establish waste reduction and recovery schemes and to convert their open dumpsites to controlled ones. It is complemented by Provincial Ordinance No. 007-2012 that regulates the use of plastics and promotes the use of environmentally friendly packaging and practices.

The Republic Act No. 9003 or the Ecological Solid Waste Management Act created the Provincial Solid Waste Management Board.

Solid wastes are collected and disposed to sanitary landfills or managed open dumpsites. As of 2020, the province owns and uses 147 operational garbage trucks, compactors, and mini dump trucks for its garbage collection system with capacities of 10/8 square meters and four-square meters, respectively. The disposal activities also employ around 529 people acting as garbage collectors, street cleaners, and office support staff.

The following table shows the status of solid waste management compliance in the province. As of June 2020, all the cities and municipalities in Cavite, except for Trece Martires City and General Emilio Aguinaldo, have their solid waste management plan approved.

Table 2.17 Status of Solid Waste Management Plan Compliance by City/Municipality, Province of Cavite: as of June 2020

City/Municipality	Year Covered	NSWMC Resolution No.	Status	
1st District				
Cavite City	2015-2025	847 Series of 2016	Approved	Currently Updating
Kawit	2015-2024	316 B Series of 2017	Approved	Currently Updating
Noveleta	2015-2025	844 A Series of 2017	Approved	Currently Updating
Rosario	2015-2026	836 Series of 2016	Approved	Currently Updating
2nd District				
City of Bacoor	2014-2023	111 Series of 2014	Approved	Currently Updating
3rd District				
City of Imus	2015-2024	692 B Series of 2017	Approved	Currently Updating
4th District				
City of Dasmariñas	2015-2025	538 A Series of 2016	Approved	Currently Updating
5th District				
Carmona	2018-2027	182 Series of 2015	Approved	Updated
Gen. Mariano Alvarez	2019-2028	846 Series of 2016	Approved	Updated
Silang	2015-2025	837 Series of 2016	Approved	Currently Updating
6th District				
City of Gen. Trias	2015-2024	833 Series of 2016	Approved	Currently Updating

City/Municipality	Year Covered	NSWMC Resolution No.	Status	
7th District				
Amadeo	2019-2028	N/A	Submitted (Under Review -NSWMC)	Currently Updating
Indang	2016-2025	834 Series of 2016	Approved	Currently Updating
Tanza	2015-2025	838 Series of 2016	Approved	Currently Updating
Trece Martires City	2017-2026	537 B Series of 2017	Approved	Currently Updating
8th District				
Alfonso	2015-2025	845 B Series of 2017	Approved	Currently Updating
Gen. Emilio Aguinaldo				
Magallanes	2015-2024	314 B Series of 2017	Approved	Currently Updating
Maragondon	2015-2024	835 Series of 2016	Approved	Currently Updating
Mendez-Nuñez	2016-2025	722 B Series of 2017	Approved	Currently Updating
Naic	2016-2025	840 A Series of 2017	Approved	Currently Updating
Tagaytay City	2016-2025	848 A Series of 2017	Approved	Currently Updating
Ternate	2015-2025	843 Series of 2016	Approved	Currently Updating

Source: Provincial Government-Environment and Natural Resources Office Cavite

The succeeding table shows the frequency of garbage collection, type of wastes collected and solid waste facilities in the province of Cavite. As of 2020, there are no existing solid waste facility in the province and all waste collected in the province are disposed in sanitary landfills present in the adjacent provinces such as Laguna, Batangas, and Rizal, except for City of Dasmariñas.

All cities and municipalities, except City of Bacoor, Maragondon, Amadeo, Ternate, and Trece Martires City, also have its own centralized material recovery facilities (MRF). The MRF in Amadeo and Ternate are an ongoing construction while the MRF in Maragondon and Trece Martires City are closed and under rehabilitation dumpsite as of 2020.

Table 2.18Status of Solid Waste Management Plan Compliance by City/Municipality, Province of Cavite: as of June 2020

City/Municipality	Type of Garbage Collected	Frequency of Garbage Collection	Current Disposal Facilities
1st District			
Cavite City	Not indicated	Daily Collection	San Mateo, Sanitary Landfill
Kawit	Not indicated	Monday to Saturday (Route Schedule)	Kay-Anlog, Calamba City, Laguna
Noveleta	Not indicated	Monday to Saturday (Route Schedule)	Phil. Ecology System Corp. unload at Vita Marine Loading Station
Rosario	Not indicated	Daily Collection (in Barangay Pick up Station)	Pilotage Trading and Construction Sanitary Landfill, San Pedro City, Laguna
2nd District			
City of Bacoor	Not indicated	Daily Collection	Rizal Provincial Sanitary Landfill and San Mateo Sanitary Landfill
3rd District			
City of Imus	Not indicated	Once a week with collection schedule	San Mateo Sanitary Landfill
4th District			
City of Dasmariñas	Not indicated	Daily (Route Schedule)	City Government (Brgy. Salawag, City of Dasmariñas)
5th District			
Carmona	Not indicated	Daily Collection (Barangay and Municipal Collection)	Pilotage Trading and Construction, Inc., Brgy. Santonio, San Pedro, Laguna
Gen. Mariano Alvarez	-	-	Calamba, Laguna
Silang	Not indicated	Daily Collection	Malingik, Bauan, Batangas
6th District			
City of Gen. Trias	Monday to Saturday (Route Schedule)	Not indicated	Kay-Anlog, Calamba City, Laguna
7th District			
Amadeo	Residual Waste	Monday to Saturday (Barangay Schedule)	Brgy. Alipit, Sta. Cruz, Laguna
Indang	All types of waste (segregated)	Daily (Barangay Schedule)	Purok I, Kay-Anlog, Calamba City, Laguna
Tanza	-	-	Pilotage Trading and Construction, Inc., Brgy. Santonio, San Pedro, Laguna
Trece Martires City	Not indicated	Daily Collection	Brgy. Alipit, Sta. Cruz, Laguna
8th District			
Alfonso	Residual Waste Biodegradable Recyclable Waste (Poblacion)	Monday and Tuesday Tuesday and Friday Wednesday and Sunday	Taysan/Bauan Landfill Batangas
	Residual Waste (other Barangays)	Tuesday, Wednesday, Friday	
Gen. Emilio Aguinaldo	Biodegradable Non-Biodegradable	Monday and Tuesday Wednesday and Thursday	Sta. Cruz, Laguna
Magallanes	Non-Biodegradable Biodegradable	Tuesday Friday	Kay-Anlog, Calamba City, Laguna

City/Municipality	Type of Garbage Collected	Frequency of Garbage Collection	Current Disposal Facilities
Maragondon	Residual Waste	Monday and Thursday	Taysan, Batangas
Mendez-Nuñez	Biodegradable, Non-Biodegradable, Toxic Waste, Non-Recyclable	Monday to Friday (Route/Barangay Schedule and types of waste collection)	Bauan Solid Waste Management Inc.
Naic	All types of Waste	Monday to Saturday (Route Schedule)	Brgy. Alipit, Sta. Cruz, Lagua
Tagaytay City	Not indicated	Collected by Hauler	Pilotage Trading and Construction, Inc., Brgy. Santonio, San Pedro, Laguna
Ternate	Biodegradable Non-biodegradable	Tuesday and Thursday Monday, Wednesday, Friday	Taysan, Batangas

Source: City/Municipal Environment and Natural Resources Office (C/MENRO) thru the Provincial Government-Environment and Natural Resources Office Cavite

Table 2.19 Presence of Material Recovery Facility/Material Recovery System/Material Recovery Receptable by City/Municipality, Province of Cavite: as of June 2020

City/Municipality	Central Material Recovery Facilities (CMRF)/ Ecological Center		Number of Barangay Material Recovery Facility	Number of Barangay Material Recovery System (MRS) / Material Recovery Receptable (MRR)
	Location	Status		
1st District				
Cavite City	District of San Antonio, Cavite City	Functional	7	24
Kawit	Brgy. Aplaya, Kawit	Functional	0	23
Noveleta	End portion of Noveleta Cemetery	Functional	0	16
Rosario	Brgy. Kanluran, Rosario	Functional	0	20
2nd District				
City of Bacoor	None	-	32 [a]	41 [a]
3rd District				
City of Imus	Ecology Center – Brgy. Buhay na Tubig, City of Imus Composting Facility – Pedro Reyes St. Malagasang I-A, City of Imus	Functional	5 [b]	97
4th District				
City of Dasmariñas	Eco Center – Brgy.Luzviminda II Eco Center II – Brgy. Zone III	Functional	3	0
5th District				
Carmona	Carmona Ecological Center, Lantic, Carmona	Functional	0	39
General Mariano Alvarez	Brgy. Olaes, GMA Brgy. Poblacion 5, GMA Brgy. Poblacion 1, GMA	Functional	6	0
Silang	Brgy. Anahaw I, Silang	Functional	-	-
6th District				
City of General Trias	Back of City of General Trias Centralized Public Market	Functional	33	0
7th District				
Amadeo	Poblacion 5, Amadeo	Ongoing construction	-	-
Indang	Brgy. Banaba Lejos, Indang	Functional	4	0
Tanza	-	-	4	-
Trece Martires City	Brgy. De Ocampo, Trece Martires City	Rehabilitation of closed dumpsite	13	0
8th District				
Alfonso	Marahan I, Alfonso	Functional	4	28
General Emilio Aguinaldo	Sitio Pugot, Brgy. Lumipa, General Emilio Aguinaldo	Functional	0	12
Magallanes	Sitio Kayhabol, Brgy. Ramirez, Magallanes	Functional	16 clustered MRF and MRS	
Maragondon	Brgy. Layong Mabilog, Maragondon	Closed and Under Rehabilitation Dumpsite	24	4
Mendez-Nuñez	Maysili Road, Brgy. Asis 2, Mendez	Functional	-	-
Naic	Brgy. Sabang, Naic	Functional	-	-
Tagaytay City	None	-	-	-
Ternate	Sitio Ul-Ong, Brgy. Sapang I, Ternate	Ongoing construction	0	10

a 5 Barangay MRF w/ MOA and 5 Barangay MRS w/ MOA

b can be considered as MRF

Source: City/Municipal Environment and Natural Resources Office (C/MENRO) thru the Provincial Government-Environment and Natural Resources Office Cavite