Chapter 2
PHYSICAL FEATURES

The Malalag Bay Area (MBA) is characterized by distinct physical features which make it unique within the province of Davao del Sur. This chapter presents information on the land area, topography, hydrology, soil, land uses, and climate in the MBA.

LAND AREA

The MBA has a total land area of 70,783 ha and a coastline of 71 km. Of the five municipalities, Sta. Maria is the largest with a total land area of 20,478 ha while Padada is the smallest municipality with 4,503 ha. However, more than 80 percent of the area is agricultural with less than 20 percent considered as coastal area. In terms of length of coastline, Sta. Maria has the longest coastline with 46 km, followed by Malalag (8 km), Hagonoy (8 km), Padada (6 km), and Sulop (3 km).

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Table 2.1 shows the land area distribution and the coastline length of each municipality within the MBA while Figure 2.1 shows the proportion of non-coastal and coastal *barangay* land area per municipality.

TOPOGRAPHY

The general topography of the MBA is flat with scattered hills and mountains. The level portions of the MBA are in the municipalities of Hagonoy, Padada, and Sulop which partly comprise the Padada River Basin where irrigated land areas are found. The stretch of flat land is estimated to be 55 percent of the total land area.

Table 2.1. Land area distribution and coastline length of each municipality in the MBA.

Municipality	Land area (ha)	Coastal area (ha)	Total no. of *barangays*	No. of coastal *barangays*	Length of coastline (km)
Hagonoy	11,664	2,472	21	5	8
Malalag	18,612	2,040	15	3	8
Padada	4,503	1,133	17	4	6
Sta. Maria	20,478	6,487	22	8	46
Sulop	15,526	288	25	1	3
Total	**70,783**	**12,420**	**100**	**21**	**71**

Source: PPDO (1996).

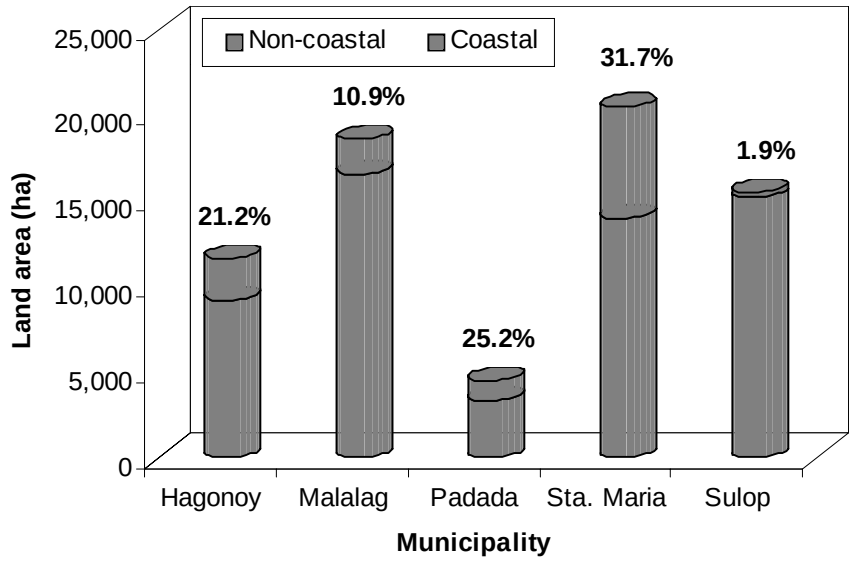

Figure 2.1. Proportion of non-coastal and coastal *barangay* land area per municipality.

On the southern frontiers and most of its borders are hilly lands and mountains. In Malalag Bay, the mountain range serves as a natural barrier from storms or strong winds making it a safe anchorage for inter-island vessels. Along the eastern side of the Sta. Maria coast are narrow white beaches and seagrass beds and coral reefs. On the northern and southeastern parts of Malalag, Sulop, Padada, and Hagonoy are flatlands, volcanic sand, fishponds, and seagrass beds.

HYDROLOGY

The waters of Davao Gulf and Malalag Bay are strongly oceanic as a result of its size and the interaction of the Pacific equatorial current as it encounters eastern mixing during strong monsoons. The inner part of the bay is an estuary.

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The total water area of Malalag Bay is 65 km^2 while the municipal waters extend to cover an area of approximately 135 km^2. There are nine rivers in the MBA; however, only three major rivers drain into Malalag Bay. These are the Mal River and the Balatukan River, both draining in the Hagonoy coast and the Balasinon River that drains in the area bordering Malalag and Sulop. The Balasinon River, though large and of economic importance due to oyster culture, is not really a river but a long estuary that is used as a major canal of adjacent fishponds. Circulation of bay water, however, does not seem to favor the outflow of water from the bay (Figure 2.2).

In 1998, the CRMP conducted an environmental study to determine the health status of Malalag Bay for mariculture (pens and cages) activities. The decision to declare a given portion of Malalag Bay as suitable or unsuitable for mariculture was based on a direct parameter comparison with the DENR and derived standards. The findings based on the amount of wasted feed solids settled at the bottom, indicated that the intensity of fish culture in the bay exceeded its limits by about 2.5 times (Baleña 1998).

The suitability map (Figure 2.3) shows that the whole bay is only conditionally suitable (medium) for culture while nearly two-thirds of the bay is classified as unsuitable (low). Further complications are the mariculture usage of the entrance to the bay, the sanctuary, and the marginal areas shallower than 2 m (tidal range). This result is corroborated by the suitability rating of about 40 percent, averaged spatially from the suitability plot. The findings of the study, however, are valid for the northeast monsoon period of observation, simplified by the virtual absence of tributaries to the bay, due to the prolonged spell of the El Niño.

In 1999, the MSU conducted physical, chemical, and biological studies of the coastal waters of Davao del Sur which covered ten coastal municipalities including four MBA municipalities: Hagonoy, Padada, Malalag, and Sta. Maria. Table 2.2 shows the DENR water quality criteria for coastal and marine waters while Tables 2.3, 2.4, and 2.5 show the physical, chemical, and biological properties of the coastal waters of Davao del Sur, respectively.

As seen in Table 2.3, the nearshore area is flat (depth = 1.2 - 5.0 m) and gradually slopes down in an irregular manner (depth = 25.0 m). Transparency in nearshore waters was low (4.0 m) while highest light penetration was 14.25 m at a depth of 25 m. Temperature readings ranged from 28 to 31^0 C. Highest total suspended solids were obtained in Don Marcelino at 5.88 mg/L which was due to the sediment discharge of the river nearby. pH values in all

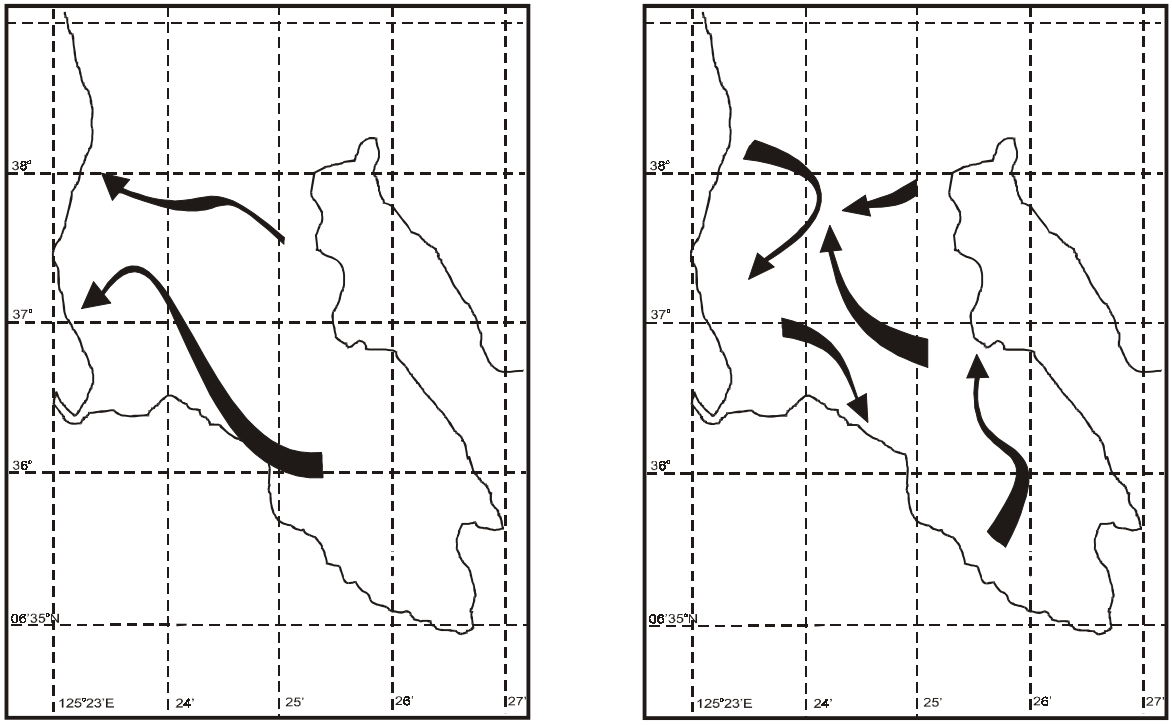
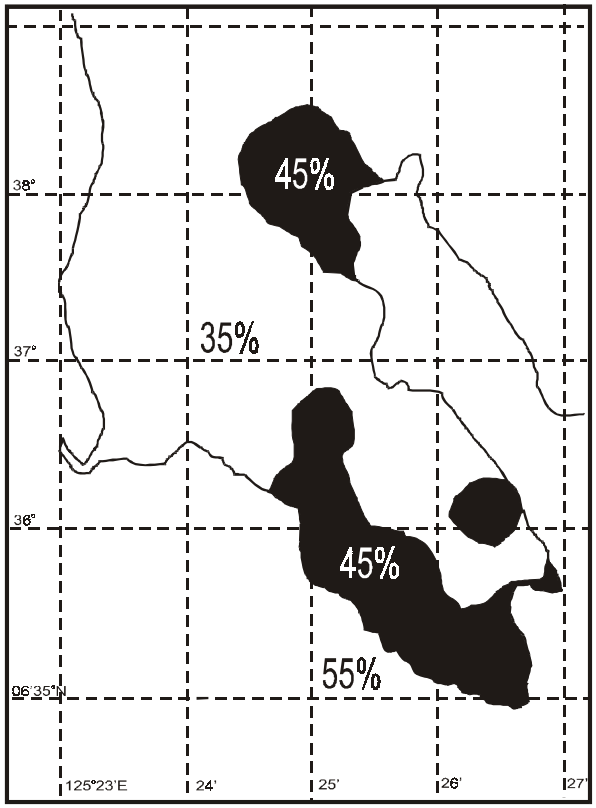


Figure 2.2. The circulation of Malalag Bay.

Notes: Left: during the rising tide; Right: during the falling tide.



Notes: LOW (0-33%) - unsuitable; MEDIUM (34-67%) - conditionally suitable (supervised or regulated mariculture); HIGH (68-100%) - suitable
The whole bay area is classified under MEDIUM suitability and, hence, allows only supervised mariculture activities. Nearly 2/3 of the bay is almost suitable for these activities.

Source: Baleña (1998).

Figure 2.3. Suitability of Malalag Bay for mariculture.

Table 2.2. Water quality criteria for coastal and marine waters.

Parameters	Units	SA	SB	SC	SD
Physical					
Temperature	^{0}C	3	3	3	3
pH (range)	-	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.0-9.0
Dissolved oxygen	mg/L	5.0	5.0	5.0	2.0
Total suspended solids	mg/L	<30/L inc.	<30/L inc.	<30/L inc.	<30/L inc.
Chemical					
Cadmium	mg/L	0.05	0.01	0.01	-
Chromium	mg/L	-	0.02	0.05	-
Copper	mg/L	0.05	0.05	0.05	-
Mercury	mg/L	0.002	0.002	0.002	-
Biological					
Total coliform	MPN/100ml	70	1,000	5,000	-
Fecal coliform	MPN/100ml	Nil	200	-	-

Note:

Class SA: Suitable for propagation, survival and harvesting shellfish for commercial purposes. Suitable as tourist zone, establishment of natural marine parks and coral reef parks

Class SB: Recreational Water Class 1. Areas regularly used for public bathing, swimming, skin diving, etc. Fishery Water Class I. Spawning areas for Chanos chanos *(*bangus *or milkfish) and similar species.*

Class SC: Recreational Water Class II. Boating, etc. Water Class II. Commercial and sustenance fishing. Marshy and for mangrove areas declared as fish and wildlife sanctuaries.

Class SD: Indusrial Water Supply Class II. Cooling, etc. other coastal and marine waters, by their quality, belong to this qualification.

Source: DENR Administrative Order No. 34, Series of 1990.

Table 2.3. Physical properties of the coastal waters of Davao del Sur.

Source: MSU (1999).

Table 2.4. Chemical properties of the coastal waters of Davao del Sur.

Municipality	Sampling station	Nitrate (mg/L)		Phosphate (mg/L)		Orthophos-phate (mg/L)		Ammonia (mg/L)	
		Near-shore	Off-shore	Near-shore	Off-shore	Near-shore	Off-shore	Near-shore	Off-shore
Sta. Cruz	Coronan	0.059	0.068	0.241	0.258	0.363	0.315	-	0.019
	Bato	0.049	0.090	0.630	0.284	0.474	0.306	0.006	0.019
	Tagabuli	0.049	0.043	0.276	0.302	0.297	0.250	0	0.006
Malalag	Centro	0.034	0.610	0.280	0.267	0.261	0.239	0	0.013
	Baybay	0.031	0.078	0.319	0.319	0.341	0.201	-	-
Digos	Aplaya	0.650	0.800	0.238	0.302	0.411	0.450	0	0.043
	Dawis	0.480	0.719	0.051	0.306	0.459	0.540	0	0.023
Sta. Maria	Kisulad	0.859	0.837	0.070	0.358	0.275	0.110	0	0.012
	Basiawan	0.831	0.816	0.044	0.162	0.245	0.123	0.006	0.006
Malita	Tubalan	0.670	0.769	0.039	0.123	0.192	0.070	0	0.006
	Poblacion	0.834	0.766	0.154	0.603	0.083	0.040	0	0.012
Don Marcelino	Kinama	0.834	0.803	0.039	0.092	0.127	0.062	0.006	0.006
	Lawa	0.619	0.734	0.171	0.354	0.210	0.083	0	0.012

Source: MSU (1999).

Table 2.5. Biological properties of the coastal waters of Davao del Sur.

Municipality	Sampling station	Total coliform (MPN/100 ml)		Fecal coliform (MPN/100 ml)	
		Nearshore	Offshore	Nearshore	Offshore
Sta. Cruz	Bato	140	80	110	80
Digos	Dawis	110	80	80	80
Padada	Punta Piape	240	180	210	110
Hagonoy	Aplaya	180	140	180	180
Malalag	Baybay	80	40	80	80
Malita	Poblacion	140	80	110	80
	Sabang	110	80	80	80
Sta. Maria	Basiawan	110	80	80	80
Don Marcelino	Poblacion	240	180	210	180

Source: MSU (1999).

stations ranged from 8.1 to 8.7 which were slightly alkaline while dissolved oxygen (DO) concentration was 2.5 to 5 mg/L. Low DO was obtained in Don Marcelino. The turbidity of the water and the high total suspended solids affected the photosynthetic activity of the phytoplankton resulting in low DO. Decomposition of organic matter was also contributory since wastes from fish landing areas were drained into the sea.

Based on Table 2.4, Sta. Maria, Malita, and Don Marcelino showed a higher nitrate concentration from 0.67 to 0.859 mg/L than the other sampling stations. Ammonia levels were not detected while others had very low concentration. The actual amount depends on the balance between animal excretory rates and plant uptake and bacterial oxidation. Phosphorus that exists as phosphate was highest (0.2 to 0.319 mg/L) in Malalag while other stations had 0.05 to 0.27 mg/L. Orthophosphate in all stations ranged from 0.04 to 0.363 mg/L. The concentration of phosphorus in waters depends on the available sources of phosphorus in the area.

Guihing in Hagonoy was the only sampling area for heavy metals. Cadmium was not detected while chromium was less than 0.009 mg/L and copper, 0.1 mg/L. Lead (0.3 mg/L) and total mercury (0.003 mg/L), however, were detected. Based on the DENR standards for heavy metals, concentration in the area is negligible but slow accumulation can occur in the substratum of the area.

As seen in Table 2.5, all sites sampled yielded positive results for coliform contamination. Highest coliform counts were obtained in Punta Piape (Padada). Results of fecal coliform counts showed that the primary source of concentration is of fecal origin. Animal wastes and garbage were left unattended and fecal matter were seen littered in the coastline. If compared with Table 2.2, the coastal waters of the 10 sampling stations could qualify for Class SB which are generally safe for public bathing, swimming, and skin diving and can be used as spawning grounds for milkfish and other commercially important species. However, these areas are unsafe for consumption of raw seafood especially bivalves and other filter feeders. Intestinal bacteria polluting the water could concentrate in the gills of filter feeding organisms, which when eaten raw, can cause intestinal disorders.

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SOIL

A significant land resource advantage of the MBA is the presence of vast fertile agricultural lowland plains with rivers running through them. Principal soil types in the MBA by municipality are shown in Table 2.6.

LAND USES

The MBA has a total land area of 70,783 ha of which more than 70 percent is classified as alienable and disposable land while about 27 percent is timberland (Figure 2.4). The land-use

plan for the entire MBA is not yet complete. Of the five municipalities, only Hagonoy and Malalag are currently undertaking revision of their land uses.

The MBA is predominantly agricultural. The allocation of agricultural area ensures the

Table 2.6. Soil classification of the MBA by municipality.

Municipality	Soil type	Parent material	Distinct characteristics
Hagonoy	San Miguel silty clay loam	Alluvium mainly washed from uplands, underland with igneous rocks	Fertile and productive soil and adaptable to most agricultural crops
Malalag	Madunga clay loam	Mixture of shale, sandstone, and gravel deposits	Moderately fertile; good for pasture
	Malalag clay loam	Mixture of igneous metamorphic and shale	Limited agricultural use due to thin soil profile suited to forestry
Padada	San Manuel silty clay loam San Manuel clay loam Cabangan clay loam	Alluvium mainly washed from uplands, underland with igneous rocks	Fertile, productive, adaptable to most agri-crops
Sta. Maria	San Manuel silty clay loam San Manuel clay loam Malalag clay loam	Alluvium mainly washed from uplands, underland with igneous rocks	Fertile, productive, and adaptable to agri-crops suited to forestry
Sulop	San Manuel silty clay loam	Alluvium mainly washed from uplands, underland with igneous rocks	Fertile, productive, and adaptable to most agri-crops
	Cabangan clay loam	Alluvium washed from uplands, underland with sedimentaries	Excellent for rice when irrigated Needs drainage for upland crops

Source: PSPT (1994).

highest possible productivity in the agricultural sector for food security and inputs in the industrial sector. The big allocations of the agricultural area support the livelihood and employment of the majority of the people who are not yet prepared for skilled employment in the industrial sector.

Forestlands also comprise these municipalities. A great portion of their areas are timberlands where integrated social forestry (ISF) and appropriate upland farming system are being undertaken to regenerate depleted forest covers and likewise protect the critical watershed areas.

The built-up areas are subdivided into urban and rural. Most of the built-up areas are found in the urban areas which are experiencing an influx of migrating local population.

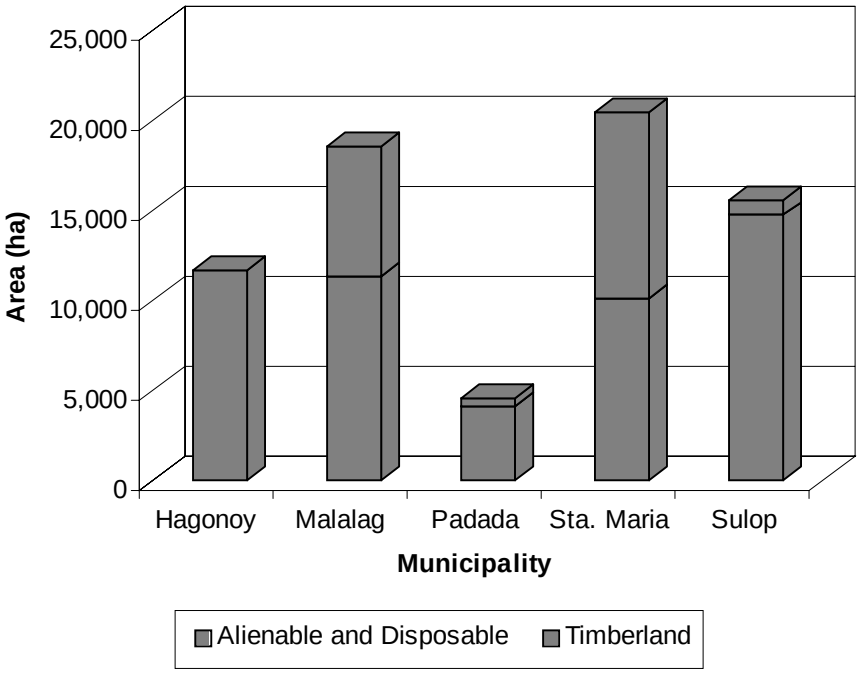

Figure 2.4. Land classification of the MBA by municipality.

Source: PPDO (1993).

A great portion of the coastal areas is allocated to fishponds. Some of these areas are under Fishpond Lease Agreements (FLAs) under the jurisdiction of the Department of Agriculture (DA). There are also some mangroves; however, conversion into fishpond areas has decreased mangrove area, thus depleting the natural productivity of the ecosystem in the bay area.

CLIMATE

The province of Davao del Sur is blessed with a favorable climate characterized by a wet dry season. The coldest time of the year is usually in December and January and the hottest in April and May.

The rainfall pattern generally conforms with type IV, characterized by a more or less evenly distributed rainfall with no marked seasonality. The province falls south of the typhoon belt and is therefore not normally affected by the main thrust of tropical depressions. The MBA has a climate which is favorable for agricultural production since most areas receive rainfall throughout the year and are not directly affected by typhoon and low pressure systems. Its

intermediate climate category is further characterized as receiving an annual rainfall of 1,500 to 2,500 mm, moderate dry season moisture deficit, and average of 210 to 270 days growing period. This type of climate supports cultivation of tree crops, fruits, and aquaculture.

SUMMARY

The MBA with a total land area of 70,783 ha is predominantly utilized for agriculture with less than 20 percent considered as coastal areas. Although the areas within Hagonoy, Padada, and Sulop are generally flat, Malalag and Sta. Maria are along a mountain range which buffers Malalag Bay from storms and strong winds. The MBA, likewise, has a climate which generally favors agricultural production since rainfall is evenly distributed throughout the year and the area is not directly affected by typhoons.

Of the nine rivers in the MBA, only three major rivers drain into Malalag Bay. The circulation pattern does not favor the outflow of water from the bay. The low circulation of water out into Davao Gulf combined with the intensive fish culture have resulted in the low suitability of the bay for further mariculture activities. The results of the CRMP study on the health status of Malalag Bay revealed that the intensity of fish culture in the bay exceeded its limit by about 2.5 times and that the whole bay is only conditionally suitable (medium) for culture while nearly two-thirds of the bay is unsuitable (low).

The physical, chemical, and biological studies conducted by MSU on the coastal waters of Davao del Sur indicated slightly alkaline waters, low DO concentrations, and the presence of coliform. These findings can be attributed to the sediment discharges of the rivers draining to the sea and the decomposition of organic matter from fish landing activities, animal wastes, and garbage littering the coastline.