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AGRICULTURAL LAND MANAGEMENT AND EVALUATION DIVISION

National Mapping, Characterization and Development of Spatial Database for the Coastal Areas Affected by Salinity

PROVINCE OF SORSOGON

2020

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RATIONALE

Salinity is long time known as one of the problem soils. It directly affects the agriculture and fishery sector in terms of productivity and income. Seriously salt-affected soils result to a total crop failure. The reasons for salinity are 1) increasing trend in sea level rise, 2) over pumping of the aquifers, and 3) seepage along the river — that is, when seawater moves upstream into the river during periods of high tide and low river flow.

The Bureau of Soils and Water Management (BSWM) have initiated several studies regarding soil salinity, but a nationwide information system has never been developed for areas affected by salinity. A baseline information on salinity will be a significant input in infrastructure planning in agriculture and fishery, risk management— particularly disaster risk management and climate change adaptation,— and policy recommendations.

Based on BSWM Reconnaissance Survey in 1988, forty five (45) provinces are identified affected by salinity. They represent more than half of the country's provinces. However, the extent of this condition to Philippine soils is not yet established and thus the subject of this project.

This project generally aims to develop a national information system for the coastal areas affected by salinity. Specifically, it aims to:

1. describe the soil physico-chemical characteristics;
2. generate salinity maps;
3. develop spatial database on salinity for the coastal areas;
4. undertake suitability evaluation for agriculture and fisheries and prepare scenarios as input to policy.

SORSOGON

I. SOIL/LAND PHYSICAL CHARACTERISTICS

A. General Description of Saline Affected Area

Sorsogon is a province in the Philippines located in the Bicol Region. It covers a total area of 2,119.01 square kilometres occupying the southeastern tip of the Bicol Peninsula in Luzon. The province is bordered on the north by Albay Gulf, east by the Philippine Sea, south by the San Bernardino Strait, and west and northwest by the Ticao Pass and Burias Pass. The Sorsogon Bay lies within the central portion of the province.

The province has an irregular topography. Except for landlocked Irosin, all the towns lie along the coast.

There are eleven (11) coastal municipalities in Sorsogon that are susceptible to soil salinity, hence the sites for sampling shown in Table 1.1.

Table 1.1. Coastal Areas and Municipalities in Sorsogon

No.	Municipality	No. of Barangay	No. of Sampling Sites	No. of Soil Samples Collected
1	Barcelona	25	2	6
2	Bulan	63	2	6
3	Bulusan	24	2	6
4	Casiguran	25	2	6
5	Gubat	42	1	3
6	Juban	25	2	6
7	Magallanes	34	2	6
8	Matnog	40	3	9
9	Prieto Diaz	23	5	15
10	Santa Magdalena	14	5	15
11	Sorsogon City	64	3	9
	TOTAL	**379**	**29**	**87**

B. Land Management Unit (LMU)

Land Management Unit is a recurring pattern of land which possesses similar physical characteristics such as soil type associated with relatively uniform land use or vegetation cover and parent material. The land management unit is the basis for integration of various resource information in suitability rating

for different crops wherein each suitability class can be fitted with specific sets of management requirements and input. It is the building block of the pedo - ecological zone, which represents a broader landscape grouping such as lowland, upland, hillyland and highland.

Table 1.2. Land Management Units of Sampling Sites

LMU	Description	Municipality	Barangay
04 Marshes (Grassy type)	Includes all the swampy depressions on the back plain, characterized by permanently water logged and poorly drained areas.	Magallanes	Aguada Sur, Caditaan
09 Broad Alluvial Plain	Generally flat low relief. The soil are very deep clay or heavy clay, moderately well drained to poorly drained, highly fertile and adaptable to wide range of crops dominated by paddy rice irrigated and non-irrigated.	Barcelona Bulan Bulusan Casiguran Gubat Juban Matnog Prieto Diaz Santa Magdalena Sorsogon City	Macabari, Layog Otavi, Nasuje Dancalan Ponong, Trece Martires Rizal Binanuahan, Embarcadero Bariis, Manjumlad Gogon, San Isidro, Ulag, Bulawan, Calao San Bartolome, San Rafael, San Antonio, San Roque Gimaloto, Buhatan, Sugod
16 Infilled/ Localized valleys	Narrow and randomly occurring patches of nearly level to gently sloping intervening valleys. The soils are deep and dominantly fine textured with good drainage.	Bulusan Matnog Santa Magdalena	Mabuhay Naburacan San Eugenio

Soil samples are collected in three (3) different Land Management Units: 04 Marshes (Grassy type), 09 Broad Alluvial Plain and 16 Infilled/localized Valleys. Table 1.2 shows the LMUs of the sampling sites per coastal municipality and barangay.

C. Flooding

Flooding happens on flat or low-lying areas when the soil is saturated by water or when the rate of rainfall exceeds the drainage capacity of the area and water remain on the surface for the certain period of time.

Based on the key informant interviews, all of the farmers experience flooding during the month of December, when the amount of rainfall is maximum. Severe flooding can be at a depth higher than 1.0 m with duration lasting for 3 days or more, and recedes in more than 24 hours.

They also experienced "high tide flooding", wherein flooding occurs with high tides due to climate related sea level rise, land subsidence, and the loss of natural barriers.

D. Elevation

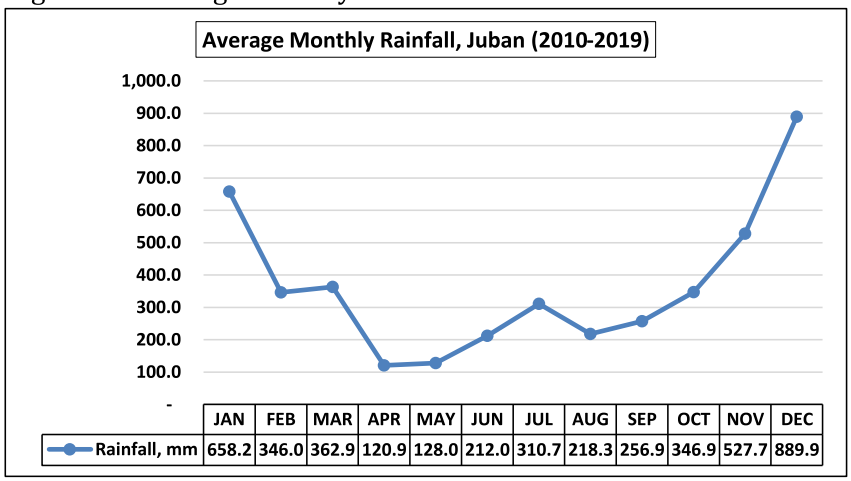
The elevation of a geographic location is the height above sea level (meters above sea level). Since the coastal areas are in the lowland pedo-ecological zone, soil sampling points are taken from elevations ranging from 0-5masl, 5-10masl and 10-15masl.

E. Agro-Climate

Sorsogon belongs to Type 2 climate based on the Climate Map of the Philippines by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). It is characterized by having no dry season with a pronounced rainfall from November to January as shown in Figure 1.1 from Juban, Sorsogon PAGASA weather station.

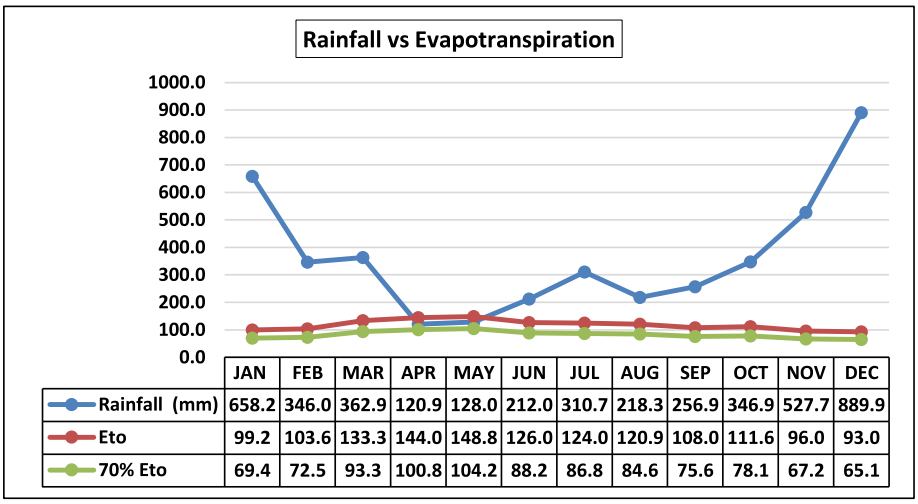
Evapotranspiration (Eto) is the sum of water transpired by the leaves of the crop and evaporation from the surrounding soil when water is not limited. Ideally, rainfall is considered to be sufficient if its amount is equal or higher than the potential evapotranspiration. In Figure 1.2 comparison of rainfall and evapotranspiration in Sorsogon, the average rainfall is relatively higher than the potential evapotranspiration from June to March. This means that soil moisture is sufficient to support crop cultivation. However, for the months of April to May, there is a need for supplemental irrigation.

Figure 1.1 Average Monthly Amount of Rainfall



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall, mm	658.2	346.0	362.9	120.9	128.0	212.0	310.7	218.3	256.9	346.9	527.7	889.9

Figure 1.2 Comparison of the Average Rainfall and Evapotranspiration



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall (mm)	658.2	346.0	362.9	120.9	128.0	212.0	310.7	218.3	256.9	346.9	527.7	889.9
Eto	99.2	103.6	133.3	144.0	148.8	126.0	124.0	120.9	108.0	111.6	96.0	93.0
70% Eto	69.4	72.5	93.3	100.8	104.2	88.2	86.8	84.6	75.6	78.1	67.2	65.1

F. Land Use/Vegetation

Land use involves the management and modification of natural environment. It also has been defined as "the total arrangements, activities, and inputs that people undertake in a certain land cover type." Land use and vegetation plays an important role in the identification of areas affected by salinity. It provides primarily indicative information on the physical and socio-economic activities prevailing in the area. On the other hand, salinity reduces the kinds of crops that can be grown for economic purposes due to chemical reactions between salt water and soil clay particles.

The common land use/vegetation in Sorsogon sampling sites are presented in Table 1.3. Some indicators of salinity per municipality are also indicated in this table.

Table 1.3 Land Use/Vegetation in Sorsogon Sampling Sites.

Municipality	Land Use/Vegetation	Some indicators of Salinity
1. Barcelona	Irrigated paddy rice	Mangrove/nipa, white crust in soil surface, reddish/yellowish leaves
2. Bulan	Irrigated and non irrigated paddy rice	Mangrove/nipa, sedges
3. Bulusan	Irrigated paddy rice	Aster weeds, beard grass, sedges
4. Casiguran	Non irrigated paddy rice	Mangrove/nipa, aster weeds, beard grass, poor yield/productivity, sedges
5. Gubat	Irrigated paddy rice	
6. Juban	Non irrigated paddy rice	Mangrove/nipa, beard grass, poor yield, wilting, empty panicle, reddish leaves
7. Magallanes	Irrigated and non irrigated paddy rice	Mangrove/nipa, aster weeds, beard grass, sedges
8. Matnog	Irrigated and non irrigated paddy rice	Mangrove/nipa, aster weeds, beard grass, sedges
9. Prieto Diaz	Irrigated and non irrigated paddy rice	Mangrove/nipa, beard grass, poor yield, sedges, reddish/yellowish leaves
10. Santa Magdalena	Irrigated and non irrigated paddy rice, vegetables	Mangrove/nipa, beard grass, sedges
11. Sorsogon City	Irrigated and non irrigated paddy rice	Mangrove/nipa, beard grass, reddish/yellowish leaves

Figure 1.3 Key Informant Interviews

II. CROP PRODUCTION ON SALINE AFFECTED AREAS

A. Key Informant Profile

Based on the 28 farmer respondents with 1:13 female-male ratio, the average years of age is 55. The eldest and youngest is 88 and 28 years old. Majority of the farmer respondents are the owners of their farm (71%), the rest are tenants (29%). The average farm size is 0.93 hectares per farmer and their average farming experience is 25 years.

B. Farm Production

The main products of Sorsogon that contribute to agricultural productivity are coconut, rice, coconut, abaca, pili nuts, root crops and vegetables. Table 2.1 shows the average rice yield from CY 2015-2017 per municipality, based on the key informant interviews.

Table 2.1 Rice Production in Coastal Municipalities of Sorsogon

Coastal Municipalities	Average Rice Yield , kg/ha*					
	2015		2016		2017	
	1st Cropping	2nd Cropping	1st Cropping	2nd Cropping	1st Cropping	2nd Cropping
1. Barcelona	3750	1118	2100	3150	2000	
2. Bulan	960	840	990	1008	1440	1260
3. Bulusan	705	840	1088	714	1088	903
4. Casiguran	2142	2083	2373	2330	2478	2540
5. Gubat	3000	3500	2750	3250	2500	3000
6. Juban	1430	1800	1330	1680	1495	1840
7. Magallanes	1360	800	1380	700	1180	700
8. Matnog	545	709	840	1014	1313	1118
9. Prieto Diaz	1204	1846	994	2107	1908	2297
10. Sta. Magdalena	546	715	649	734	684	1365
11. Sorsogon	2268	2475	2238	2430	2127	2475

*Based on the key informant interview, rice yield for CY 2015-2017

C. Farm Input

The study is limited to the coastal communities of the province therefore, the information on farm inputs are mainly based on the key informant interviews. Farmer respondents usually use commercially available rice seed varieties as shown in Table 2.2.

Table 2.2 Rice Seed Varieties

Seed Variety	Description
NSIC Rc222	Long maturing rice variety
Bigante	Tolerant to bacterial leaf blight
PSB Rc10	Early maturing & drought tolerant
PSB Rc18	Non flooded condition
SL 8H	Low shattering characteristics

For fertilizers, they use inorganic fertilizers like urea (46-0-0), complete (14-14-14), ammonium phosphate (16-20-0) and magnum. They also use chemical herbicides 2,4-D, and insecticides like cymbus, furadan, and karate.

D. Source of Irrigation

Table 2.3 Source of Irrigation for Paddy Rice

Source of Irrigation for Paddy Rice	%
National Irrigation Administration	11
Communal	11
Shallow Tubewell	3
Rainfed	54
Creeks, river, spring	21

Based on the 28 farmer respondents, only 11% of them have irrigation system assisted by NIA and communal irrigation system. Most of them are rainfed (54%), while others have supplemental irrigation from shallow tubewell (3%) and creeks, rivers and spring (21%).

E. Period of Salinity Occurrence and Practices to Address Salinity

Majority of the farmer respondents (93%) said that salinity affects their rice farms during the months of July-August and December. They consider to adopt other suitable crops like vegetables, but for their daily consumption only and continue planting rice as their main crop.

Most of the farmer-respondents' practices to address salinity are the following: 1) proper timing for planting, 2) applying chemical fertilizer to the soil, 3) using rain water for irrigation, and 4) flushing saline water with fresh water.

Figure 2.1 Auger Boring and Soil Sampling

Figure 2.2 Air Drying of Soil Samples

III. SOIL CHEMICAL CHARACTERISTICS

Soil samples are brought to the BSWM Laboratory Services Division for the soil salinity/alkalinity test which includes pH (1:1) at 25^{0}C, Electrical Conductivity (EC) at 25^{0}C, Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Sum of Cations, Carbonate (CO_3), Bicarbonate (HCO_3), Chloride (Cl), Sulfate (SO_4), Sum of Anions, and Sodium Adsorption Ratio (SAR).

The EC test results are classified according to its salinity class and then used to map salinity in the coastal area. Other laboratory test results are gathered as input to the Saline-Affected Areas Database Information System (SADIS v1.1). This spatial database can be used as reference for future research studies on salinity.

A. Salinity Classification

The laboratory results for salinity testing, specifically the EC readings, are classified using Table 3.1 below, based on the BSWM/FAO Salinity Project in 1999. This salinity classification is rice-based and applicable to Philippine setting.

Table 3.1 Salinity Classification (Crop-based, Rice)

Electrical Conductivity *(mS/cm)*	Soil Salinity Class	Hazard for Crop Growth	Plant Response
0 - 2	Non Saline	Very low	Negligible
2.1 - 4	Slightly Saline	Low	Restricted yield of sensitive crops
4.1 - 8	Moderately Saline	Moderate	Restricted yield of many crops
8.1 - 16	Severely Saline	High	Only a few tolerant crops yield satisfactorily
>16	Very Severely Saline	Very high	Only a few tolerant forage grow satisfactorily

Table 3.2 shows the laboratory EC test results of soil samples per Municipality. Each EC readings are further classified using Table 3.1 above. The Municipalities of Prieto Diaz, part of Casiguran and Sorsogon City have very severely saline soil. These areas have very high hazard for crop growth and only a few tolerant forage can grow satisfactorily. In Magallanes, area in Juban, Barcelona

and Barangay San Roque in Santa Magdalena, the soils are severely saline. These areas are also hazard for crop growth, although at 60-90cm, only very few plants have root system that can reach this depth. Moderately saline soils are in some areas in Bulan, Magallanes, Juban, Barcelona, Gubat, and Sorsogon. These are moderately hazard for crop growth that will result to restricted yield of many crops.

Table 3.2 Electrical Conductivity (EC) of Soil Samples at Different Depths

Auger Ref	Barangay	Municipality	EC (mS/cm) @ 0-30cm	EC (mS/cm) @ 30-60cm	EC (mS/cm) @ 60-90cm
SS1	GOGON	PRIETO DIAZ	0.197	0.16	0.175
SS2	SAN ISIDRO	PRIETO DIAZ	18.05	34.66	10.31
SS3	BULAWAN	PRIETO DIAZ	1.935	8.435	3.395
SS4	ULAG	PRIETO DIAZ	12.43	11.99	15.34
SS5	CALAO	PRIETO DIAZ	11.54	15.24	18.27
SS6	NABURAKAN	MATNOG	0.261	0.139	0.178
SS7	BARIIS	MATNOG	0.219	0.13	0.126
SS8	MANJUMLAD	MATNOG	0.131	0.082	0.097
SS9	SAN BARTOLOME	SANTA MAGDALENA	0.516	0.499	0.435
SS10	SAN EUGENIO	SANTA MAGDALENA	0.184	0.187	0.469
SS11	SAN RAFAEL	SANTA MAGDALENA	0.285	0.101	0.097
SS12	SAN ANTONIO	SANTA MAGDALENA	0.128	0.096	0.097
SS13	SAN ROQUE	SANTA MAGDALENA	0.011	8.178	9.699
SS14	OTAVI	BULAN	7.24	4.843	5.421
SS15	NASUJE	BULAN	5.482	4.347	6.508
SS16	PUNONG	CASIGURAN	37.17	35.84	34.43
SS17	TRECE MARTIRES	CASIGURAN	1.281	0.257	0.243
SS18	CADITAAN	MAGALLANES	12.14	11.17	8.82
SS19	AGUADA SUR	MAGALLANES	6.847	8.589	8.682
SS20	BINANUAHAN	JUBAN	9.55	6.134	8.277
SS21	EMBARCADERO	JUBAN	0.222	0.41	0.303
SS22	MABUHAY	BULUSAN	0.139	0.151	0.082
SS23	DANCALAN	BULUSAN	0.398	0.215	0.119
SS24	MACABARI	BARCELONA	4.238	7.611	11.76
SS25	LAYOG	BARCELONA	6.835	7.853	12.33
SS26	RIZAL	GUBAT	7.289	6.907	7.941
SS27	GIMALOTO	SORSOGON CITY	21.31	18.59	20.99
SS28	BUHATAN	SORSOGON CITY	16.63	13.82	12.84
SS29	SUGOD	SORSOGON CITY	9.361	5.628	6.486

Note: Please refer to Table 3.1

Soil Salinity Maps at three different depths (0-30cm, 30-60cm, and 60-90cm) are delineated using the corresponding Electrical Conductivity (EC) readings, then interpolation is used to estimate the soil salinity at unsampled locations to create a continuous representation. Tables 3.3-3.5 interpret the land area in hectares per municipality at different degrees of salinity.

Table 3.3 Coastal Land Area (in hectares) per Municipality at Different Degrees of Salinity (0-30 cm depth)

Coastal Municipality	Non Saline	Slightly Saline	Moderately Saline	Severely Saline	Very Severely Saline
1. Barcelona				1,078.46	
2. Bulan	10.21	119.30	437.68	4,182.97	
3. Bulusan	234.00	59.96		13.67	
4. Casiguran	71.13	178.17	319.00	259.70	615.04
5. Gubat				3,981.39	
6. Juban	70.57	135.22	781.00	1,631.17	
7. Magallanes			41.93	2,051.33	
8. Matnog	1,878.68				
9. Prieto Diaz	75.90	175.21	683.38	1,594.07	36.28
10. Santa Magdalena	684.71				
11. Sorsogon City				4,073.97	1,574.27
TOTAL	**3,025.19**	**667.87**	**2,262.99**	**18,866.72**	**2,225.59**

Table 3.4 Coastal Land Area (in hectares) per Municipality at Different Degrees of Salinity (30-60 cm depth)

Coastal Municipality	Non Saline	Slightly Saline	Moderately Saline	Severely Saline	Very Severely Saline
1. Barcelona			1,065.22	13.24	
2. Bulan	10.17	421.51	4,318.48		
3. Bulusan	231.34	12.72	63.57		
4. Casiguran	191.10	144.23	290.85	239.27	577.59
5. Gubat			440.19	3,541.20	
6. Juban	95.50	242.30	2,230.76	49.40	
7. Magallanes			8.36	2,084.90	
8. Matnog	1,878.68				
9. Prieto Diaz	42.66	42.98	189.48	1,585.34	704.38
10. Santa Magdalena	417.51	116.03	141.78	9.38	
11. Sorsogon City			457.80	3,995.47	1,194.97
TOTAL	**2,866.97**	**979.77**	**9,206.48**	**11,518.20**	**2,476.94**

Table 3.5 Coastal Land Area (in hectares) per Municipality at Different Degrees of Salinity (60-90 cm depth)

Coastal Municipality	Non Saline	Slightly Saline	Moderately Saline	Severely Saline	Very Severely Saline
1. Barcelona				1,078.46	
2. Bulan	3.66	285.33	287.41	4,173.75	
3. Bulusan	225.04	9.48		73.10	
4. Casiguran	191.82	137.60	296.18	249.26	568.18
5. Gubat			53.29	3,928.10	
6. Juban	78.20	168.51	1,556.37	814.89	
7. Magallanes				2,093.26	
8. Matnog	1,878.68				
9. Prieto Diaz	99.66	231.25	793.58	1,315.25	125.09
10. Santa Magdalena	386.61	108.52	130.63	58.95	
11. Sorsogon City			460.32	3,888.96	1,298.96
TOTAL	**2,863.67**	**940.69**	**3,577.79**	**17,673.98**	**1,992.23**

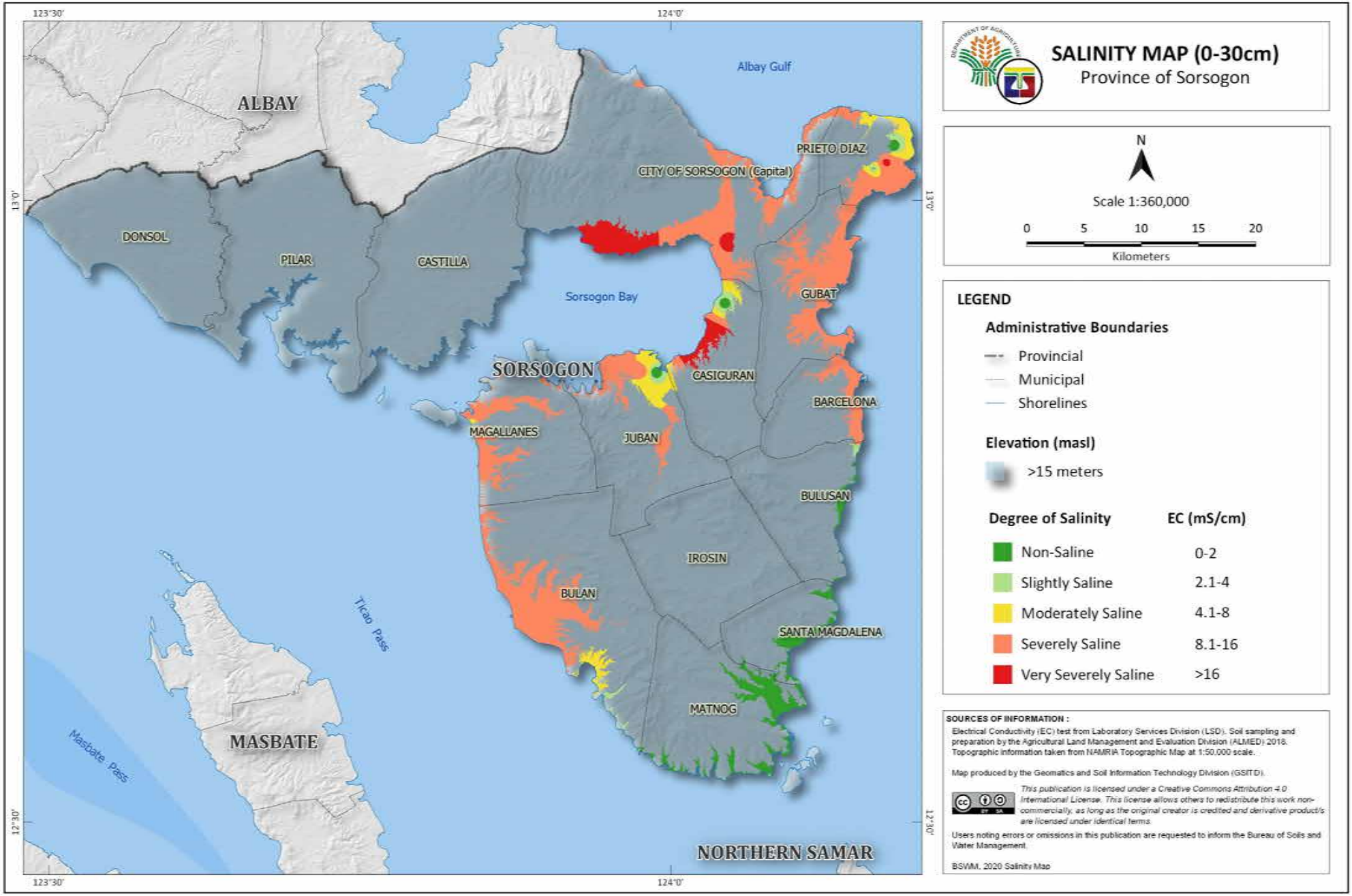
Table 3.6 summarizes the total coastal land area of Sorsogon per degree of salinity. Note that 69.8% of the total coastal land area is severely saline for the 0-30cm depth, almost the same with the 60-90cm depth where 65.3% of the total coastal land area is severely saline.

Table 3.6 Distribution of Coastal Land Area at Different Degrees of Salinity, Sorsogon Province

Salinity Class	Soil Depth (cm)					
	0-30		30-60		60-90	
	hectares	%	hectares	%	hectares	%
Non saline	3,025.19	11.2	2,866.97	10.6	2,863.67	10.6
Slightly saline	667.87	2.5	979.77	3.6	940.69	3.5
Moderately saline	2,262.99	8.4	9,206.48	34.0	3,577.79	13.2
Severely saline	18,866.72	69.8	11,518.20	42.6	17,673.98	65.3
Very Severely saline	2,225.59	8.2	2,476.94	9.2	1,992.23	7.4

B. Output Maps

The following are the output maps of the project: the Soil Salinity Maps of the Province of Sorsogon at 0-30cm depth; 30-60cm depth; 60-90cm depth.



SALINITY MAP (0-30cm)

Province of Sorsogon

N

Scale 1:360,000

0 5 10 15 20

Kilometers

LEGEND

Administrative Boundaries

- Provincial
- Municipal
- Shorelines

Elevation (masl)

- >15 meters

Degree of Salinity	EC (mS/cm)
Non-Saline	0-2
Slightly Saline	2.1-4
Moderately Saline	4.1-8
Severely Saline	8.1-16
Very Severely Saline	>16

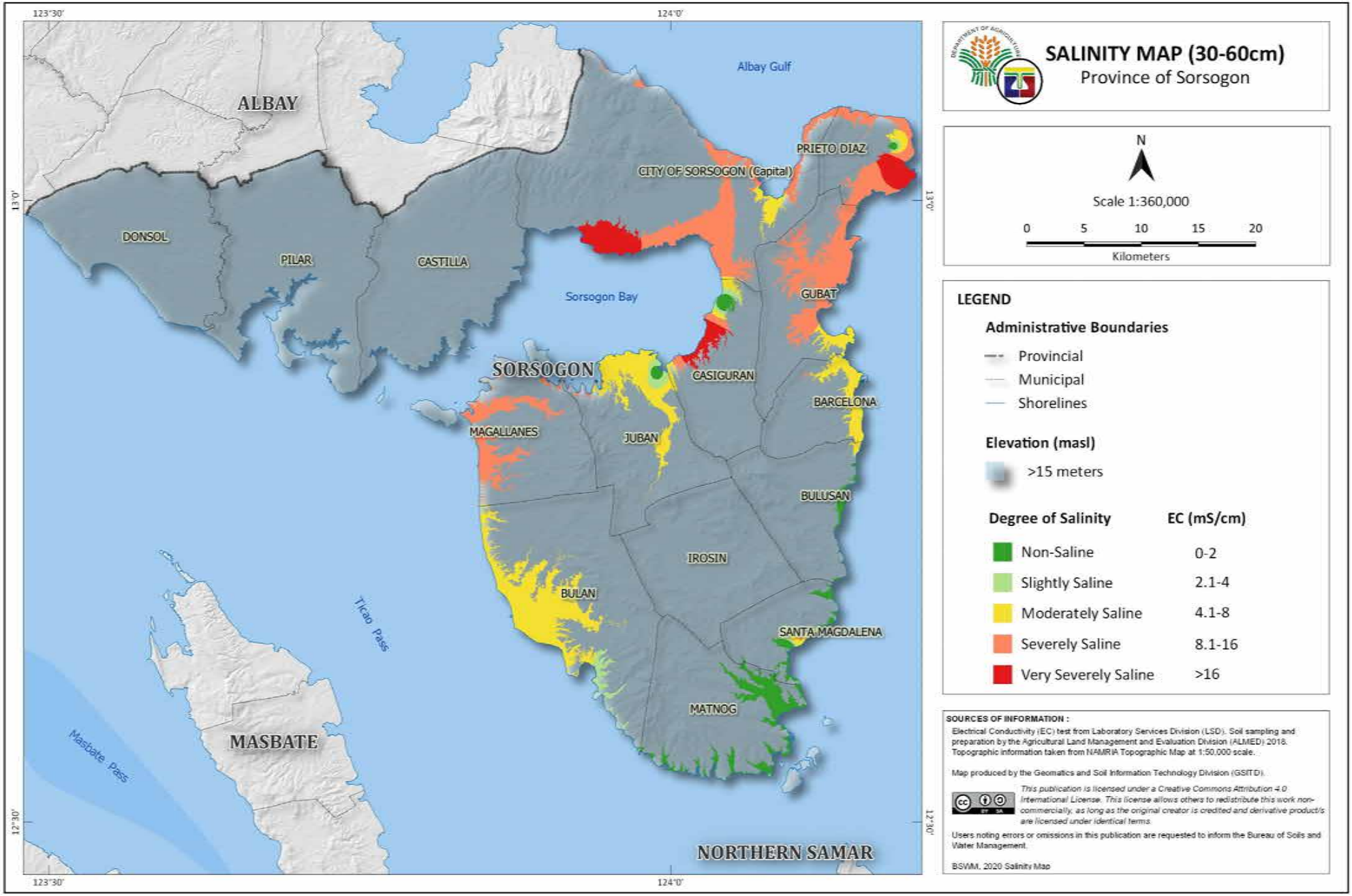
SOURCES OF INFORMATION :

Electrical Conductivity (EC) test from Laboratory Services Division (LSD). Soil sampling and preparation by the Agricultural Land Management and Evaluation Division (ALMED) 2018. Topographic information taken from NAMRIA Topographic Map at 1:50,000 scale.

Map produced by the Geomatics and Soil Information Technology Division (GSITD).

Users noting errors or omissions in this publication are requested to inform the Bureau of Soils and Water Management.

BSWM, 2020 Salinity Map



SALINITY MAP (30-60cm)

Province of Sorsogon

N

Scale 1:360,000

0 5 10 15 20

Kilometers

LEGEND

Administrative Boundaries

- Provincial
- Municipal
- Shorelines

Elevation (masl)

- >15 meters

Degree of Salinity	EC (mS/cm)
Non-Saline	0-2
Slightly Saline	2.1-4
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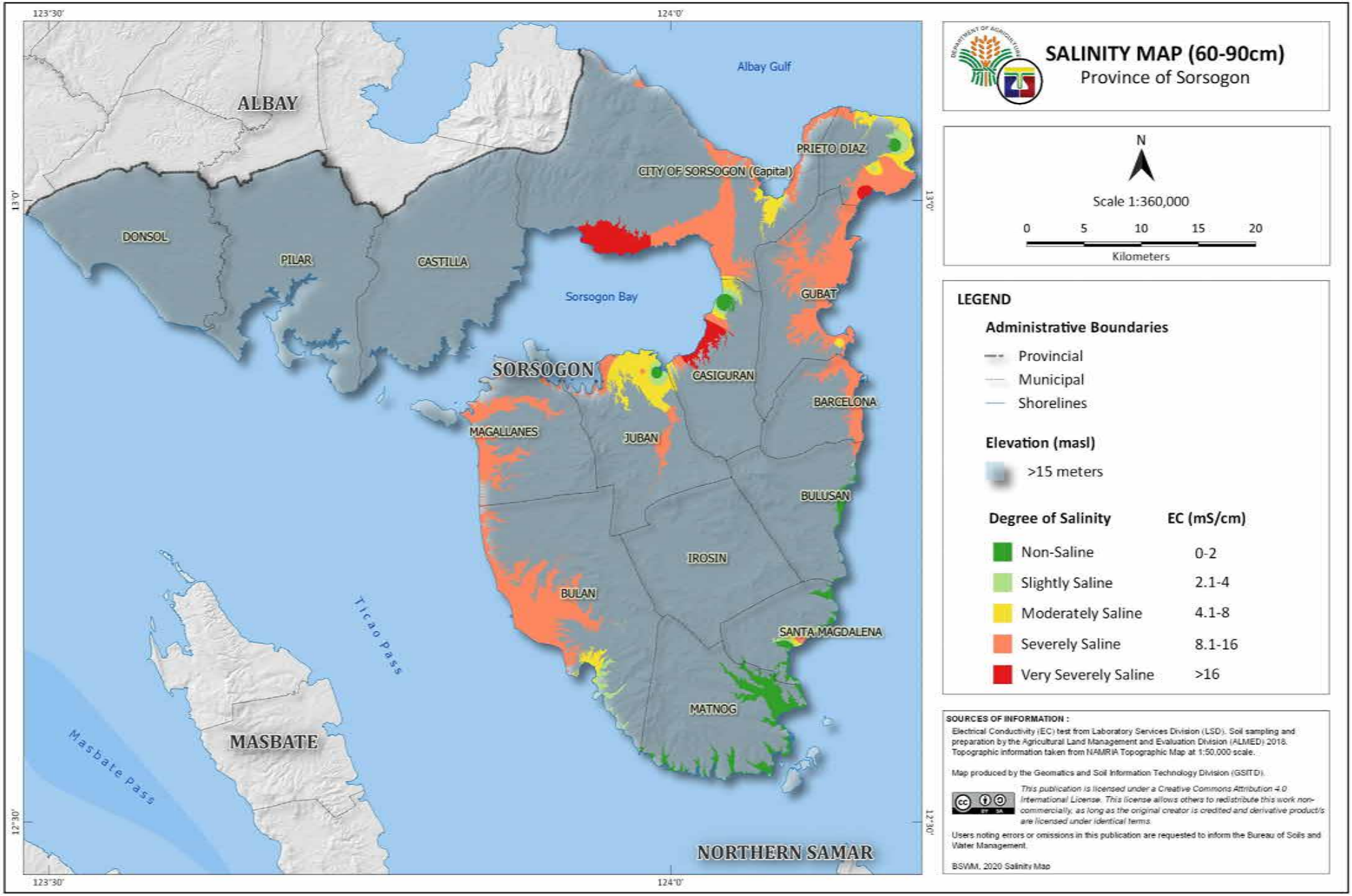

SALINITY MAP (60-90cm)

Province of Sorsogon

N

Scale 1:360,000

0 5 10 15 20

Kilometers

LEGEND

Administrative Boundaries

- Provincial
- Municipal
- Shorelines

Elevation (masl)

- >15 meters

Degree of Salinity	EC (mS/cm)
Non-Saline	0-2
Slightly Saline	2.1-4
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BSWM, 2020 Salinity Map

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