

AGRICULTURAL LAND MANAGEMENT AND EVALUATION DIVISION

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

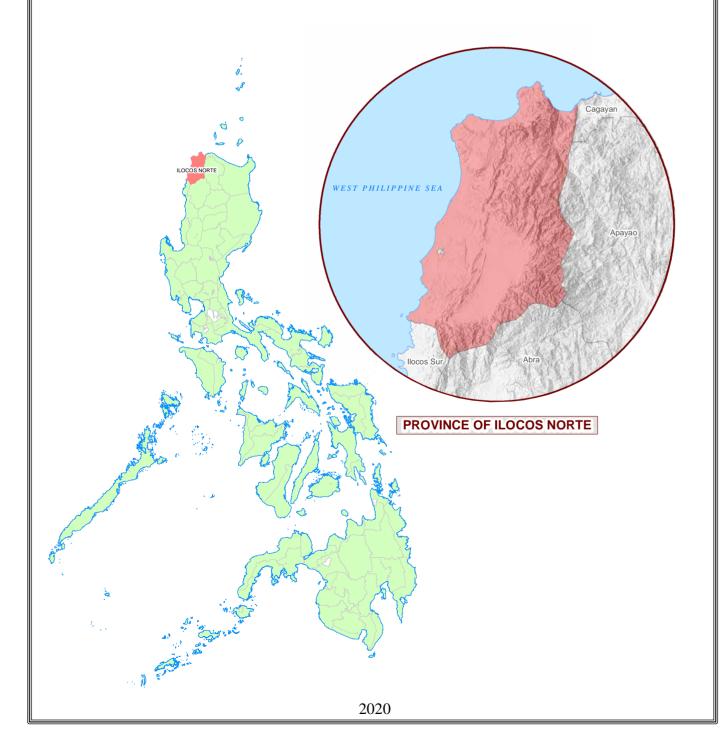


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RATIONALE

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.

ILOCOS NORTE

I. SOIL/LAND PHYSICAL CHARACTERISTICS

A. General Description of Saline Affected Site

Ilocos Norte Province is located on the northernmost edge of western Luzon. It lies on Mainland part of Luzon, approximately 18.1667° North and 120.7500° East. It has a total land area of 346,789 hectares. The province is bordered by Cagayan to the extreme northeast, Apayao by the east, Abra by the southeast, Ilocos Sur by the southwest, the South China Sea by the west, and the Luzon Strait by the north.

There are nine (9) coastal municipalities in Ilocos Norte that are susceptible to salinity, hence the sites for sampling shown in Table 1.1.

Table 1.1. Coastal Areas and Municipalities in Ilocos Norte

No.	MUNICIPALITY	No. of Brgys.	No. of Sampling Sites	No. of Soil Samples Collected
1	Bacarra	43	6	18
2	Badoc	31	6	18
3	Bangui	14	8	24
4	Burgos	11	7	21
5	Currimao	23	3	9
6	Laoag City	80	6	18
7	Pagudpud	16	5	14
8	Paoay	31	4	12
9	Pasuquin	33	8	24
	TOTAL	282	53	158

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, hilllyland and highland.

The sampling sites in Ilocos Norte where the soil samples are collected are from LMU 09 Broad Alluvial Plain. It is characterized as 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.

C. Flooding

Flooding is a seasonal but recurring problem in Ilocos Norte. This is brought about by heavy rainfall that leads to river overflow during peak rain periods. The following are three flooding classes mapped in Ilocos Norte:

- 1. Slight flooding normally characterized by flooding depth of less than 0.5meter for duration of 1-2 days or less.
- 2. Moderate flooding depth equal to 0.5 to 1meter for duration of 2-5 days to 7 days, for 2-3 times a year.
- 3. Tidal flooding flooding depth of 0.5 to 1 meter every high tide.

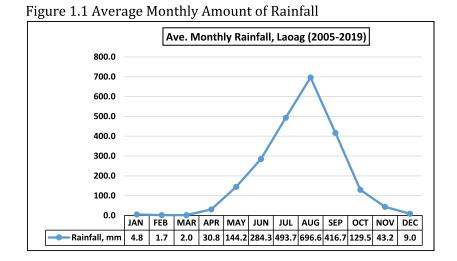
Generally, flooding is experienced in the province of Ilocos Norte (80.4%) during the months of August to November. Almost all of the farmers are not sure if flooding causes salinity in their farm, but they observed salinity (47.8%) during the summer months of April to May.

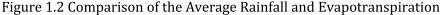
D. Elevation

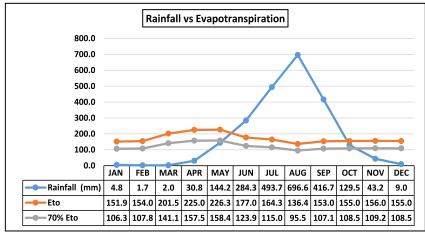
The elevation of a geographic location is the height above sea level (meters above sea level). Soil sampling points are taken from the following elevation that ranges from 0-5masl, 5-10masl and 10-15masl. In some cases however, soil sampling go beyond 15 masl (15-20 masl and 20-25 masl) depending on the suspected saline water intrusion in the area.

E. Agro-Climate

Ilocos Norte is under Type 1 climate based on the Climate Map of the Philippines by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). It is characterized by two extremes: very dry from November to April and very wet from May to October. May is the warmest month, with an average temperature of 28.3 °C, and December is the coldest. It is occasionally visited by tropical cyclones and storms during the southwest monsoon season. The peak of rainfall is August as shown in the Figure 1.1.







Evapotranspiration 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 Ilocos Norte, the average rainfall is relatively higher than the potential evapotranspiration (Eto) from June to September. This means that soil moisture is sufficient to support crop cultivation. However, for the months of October to May there is a need for supplemental irrigation.

F. Land Use/ Vegetation

Table 1.2 Land Use/Vegetation in Ilocos Norte Sampling Sites.

Municipality	Land Use/Vegetation	Some indicators of Salinity
Bacarra	Paddy rice	White crust in soil surface, poor yield/productivity, reddish/yellowish leaves, stunted growth
Badoc	Paddy rice and garlic	White crust in soil surface, wilting, reddish/yellowish leaves
Bangui	Paddy rice and corn	White crust in soil surface
Burgos	Paddy rice and garlic	White crust in soil surface, poor yield/productivity, wilting, empty panicle, reddish/yellowish leaves, stunted growth
Currimao	Paddy rice	Poor yield/productivity
Laoag City	Paddy rice, corn, vegetables	White crust in soil surface, poor yield/productivity, wilting, reddish/yellowish leaves, stunted growth, Baragsanga weeds
Pagudpud	Paddy rice and mangroves	Beard grass, white crust in soil surface, poor yield/productivity, reddish/yellowish leaves
Paoay	Paddy rice	White crust in soil surface, poor yield/productivity, wilting, reddish/yellowish leaves, stunted growth
Pasuquin	Non- irrigated rice	Mangrove/nipa, white crust in soil surface, poor yield/productivity, reddish/yellowish leaves

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 indicative information primarily on the physical and socioeconomic 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 Ilocos Norte sampling sites are presented in Table 1.2. Some indicators of salinity per municipality are also indicated in this table.

II. CROP PRODUCTION ON SALINE AFFECTED AREAS

A. Key Informant Profile

Based on the 46 farmer respondents, the average age of farmers is 57 years old, with 35 average years of experience in farming.

The farmer respondents are 44 male and only 2 female. Owner of their farms are 45.7%, to an average farm size of 1 hectare.



Figure 2.1 Key Informant Interview

B. Farm Production

Agriculture is the main source of livelihood in the province, all lands for cultivation can be planted with rice, corn, garlic, onion, sugarcane, tobacco, cotton and vegetables. The annual/perennial crop is dragon fruit.

Table 2.1 shows the average rice yield from 2015-2017 per municipality, based on the key informant interview.

Table 2.1 Rice Production in Coastal Municipalities of Ilocos Norte

Coastal	Average Yield (kg/ha)				
Municipality	2015	2016	2017		
1. Bacarra	4,275	4,891	4,926		
2. Badoc	1,237.38	1,237.38	1,237.38		
3. Bangui	2,790.42	3,027.71	2,627.88		
4. Burgos	3,145.24	3,069.52	2,924.66		
5. Currimao	604.05	1,250	637.5		
6. Laoag City	4,256.25	4,265.62	4,606.25		
7. Pagudpud	4,191.79	3,878.22	3,933.57		
8. Paoay	1,963	2,038.75	1,783.12		
9. Pasuquin	1,331.33	1,108.75	1,438.165		

C. Farm Input

The project is limited to the coastal communities of the province, therefore the information on farm inputs are mainly based on the key informant interview. Farmer respondents usually use different commercially available seed variety of rice. The most common are RC 222 and Hybrid Rice varieties. For the fertilizer input, they usually apply urea and complete (14-14-14) fertilizer.

D. Source of Irrigation

Based on the farmers' interview, most of the rice area in Ilocos Norte is rainfed (67.4%), so most of the farmers (50%) have shallow tubewell (STW) or pump irrigation water from the creeks (37%). Irrigated rice areas assisted by the National Irrigation Administration (NIA) is only 6.5%, while the communal irrigation including the Sanjeras is 19.6%.

E. Period of Salinity Occurrence and Practices to Address Salinity

Majority of the farmer respondents said that they are not sure if salinity affects their rice farms. But generally, they are not willing to adopt to other suitable crop considering salinity because they still want to plant rice in their farm.

The farmer-respondents' practices to address salinity are the following: 1) crop rotation, 2) change the rice variety, 3) apply humus and organic fertilizers, and 4) use water pumps in irrigation to increase crop productivity.



Figure 2.3 Soil Pulverization



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°C, Electrical Conductivity (EC) at 25°C, Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Sum of Cations, Carbonate (CO₃), Bicarbonate (HCO₃), Chloride (Cl), Sulfate (SO₄), 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 Municipality of Pasuquin have a very severely saline soil. This area have a very high hazard for crop growth and only a few tolerant forage can grow satisfactorily.

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

No.	Barangay	Municipality	EC (mS/cm) @0-30cm	EC (mS/cm) @30-60cm	
SS1	Poblacion 2	Pagudpud	0.22	0.241	0.213
SS2	Burayoc	Pagudpud	0.578	0.319	0.219
SS3	Ligaya	Pagudpud	0.643	0.261	0.175
SS4	Poblacion 1	Pagudpud	3.697	4.655	
SS5	Tarag	Pagudpud	0.971	0.268	0.253
SS6	Davila	Pasuquin	16.52	11.20	7.064
SS7	Davila	Pasuquin	1.19	0.603	1.29
SS8	Davila	Pasuquin	0.996	0.599	1.132
SS9	Estancia	Pasuquin	0.44	0.384	0.331
SS10	Pasuquin	Pasuquin	0.873	0.403	0.0212
SS11	Sulongan	Pasuquin	0.949	0.334	0.219
SS12	Nalvo II	Pasuquin	1.030	0.275	0.192
SS13	Nalvo II	Pasuquin	1.25	0.777	1.145
SS14	Lanao	Bangui	0.677	0.347	0.325
SS15	Malasin	Bangui	0.473	0.212	0.147
SS16	San Lorenzo	Bangui	0.598	0.257	3.219
SS17	Baruyen	Bangui	0.373	0.24	0.177
SS18	Taguipuro	Bangui	0.366	0.236	0.194
SS19	Taguipuro	Bangui	2.023	0.839	0.417
SS20	Utol	Bangui	0.569	0.194	0.138
SS21	Taguipuro	Bangui	0.241	0.303	0.347
SS22	Sangil	Bacarra	0.568	0.227	0.116
SS23	Ganagan	Bacarra	1.121	0.430	0.195
SS24	Casilian	Bacarra	1.482	0.444	0.723
SS25	Binsang	Bacarra	3.445	4.288	1.467
SS26	Cadaratan	Bacarra	0.157	0.202	0.502
SS27	Cadaratan	Bacarra	0.627	0.153	0.11
SS28	Abulao	Paoay	0.388	0.241	0.264
SS29	Callaguip	Paoay	6.390	4.274	4.242
SS30	Bacsil	Paoay	3.686	0.303	0.293
SS31	Suba	Paoay	0.473	0.315	0.604
SS32	Maglaoi Sur	Currimao	0.944	0.711	0.328
SS33	Pias	Currimao	0.657	0.410	0.492
SS34	Currimao	Currimao	1.952	0.658	0.448
SS35	Navotas	Laoag City	0.559	0.447	3.439
SS36	Cataban	Laoag City	0.333	0.192	0.184
SS37	Madiladig	Laoag City	0.658	0.271	0.232
SS38	Talingaan	Laoag City	1.228	1.831	0.429
SS39	Saud	Badoc	1.067	0.631	0.335
SS40	Sta. Cruz Norte	Badoc	0.813	1.129	0.181
SS41	Pagsanhan	Badoc	2.741	1.637	1.293
SS42	La Virgen	Badoc	1.121	0.562	0.786
SS43	Gabut Norte	Badoc	2.163	0.869	0.539
SS44	La Virgen Milagrosa	Badoc	0.370	0.313	0.247
SS45	Paayas	Burgos	2.232	1.357	0.970
SS46	Ablan	Burgos	0.597	0.339	0.300
SS47	Pagali	Burgos	3.883	0.625	0.349
SS48	Pagali	Burgos	2.471	1.096	1.423
SS49	Saoit	Burgos	1.868	-	0.621
SS50	Bugon	Burgos	1.285	0.878	0.359
SS51	Ablan	Burgos	0.880	0.417	0.329
SS52	Cavit	Laoag City	4.268	1.789	4.146
SS53	Mangatob	Laoag City	0.563	0.231	0.174

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 shows the land area (in hectares) affected by salinity at 0-30cm depth. Very severely saline is 5.65 hectares in Pasuquin. Moderately saline is 186.28 hectares, mostly in Pasuquin. Moderately saline is 579.60 hectares, mostly in Paoay and Burgos.

Table 3.3 Coastal Land Area (in hectares) per Municipality at Different Degrees

of Salinity (0-30 cm depth)

	Non Saline	Slightly	Moderately	Severely	Very
Coastal		Saline	Saline	Saline	Severely
Municipality					Saline
1. Bacarra	2,496.66	478.65			
2. Badoc	1,964.02	198.71			
3. Bangui	1,586.97	2.17			
4. Burgos	417.22	593.76	181.24	6.11	
5. City of Batac	328.29	955.07			
6. Currimao	708.22	656.90	61.75		
7. Dingras	1.72				
8. Laoag City	6,528.87	1,574.33	78.90		
9. Pagudpud	2,270.35	95.39			
10. Paoay	930.83	2,642.87	210.44		
11. Pasuquin	2,721.87	324.98	47.27	180.17	5.65
12. Piddig	0.07				
13. Pinili	291.96	6.56			
14. San Nicolas	1,576.01				
15. Sarrat	959.35				
16. Vintar	0.39				
TOTAL	22,782.81	7,529.39	579.60	186.28	5.65

The area affected by salinity decreases as the depth increases, as shown in Tables 3.4 and 3.5. Severely saline is 68.25 hectares in Pasuquin. Moderately saline is 309.64 hectares, mostly in Pasuquin. For 60-90cm depth (Table 3.5) moderately saline is 222.39 hectares.

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

of Sannity (50-00	Non Saline	Slightly	Moderately	Severely	Very
Coastal		Saline	Saline	Saline	Severely
Municipality					Saline
1. Bacarra	2,494.98	433.66	46.67		
2. Badoc	2,162.73				
3. Bangui	1,589.14				
4. Burgos	933.00	207.26	58.07		
5. City of Batac	1,283.36				
6. Currimao	1,346.34	73.69	6.85		
7. Dingras	1.72				
8. Laoag City	8,182.10				
9. Pagudpud	2,261.36	84.76	19.62		
10. Paoay	3,523.19	237.22	23.73		
11. Pasuquin	2,881.28	175.71	154.70	68.25	
12. Piddig	0.07				
13. Pinili	298.53				
14. San Nicolas	1,576.01				
15. Sarrat	959.35				
16. Vintar	0.39				
TOTAL	29,493.55	1,212.30	309.64	68.25	

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

	Non Saline	Slightly	Moderately	Severely	Very
Coastal		Saline	Saline	Saline	Severely
Municipality					Saline
1. Bacarra	2,975.31				
2. Badoc	2,162.73				
3. Bangui	1,471.91	117.23			
4. Burgos	1,053.95	143.88	0.50		
5. City of Batac	1,283.36				
6. Currimao	1,352.73	68.68	5.45		
7. Dingras	1.72				
8. Laoag City	6,657.83	1,483.50	40.77		
9. Pagudpud	2,365.74				
10. Paoay	3,529.04	234.22	20.88		
11. Pasuquin	3,019.25	105.89	154.80		
12. Piddig	0.07				
13. Pinili	298.53				
14. San Nicolas	1,576.01				
15. Sarrat	959.35				
16. Vintar	0.39				
TOTAL	28,707.93	2,153.40	222.39		

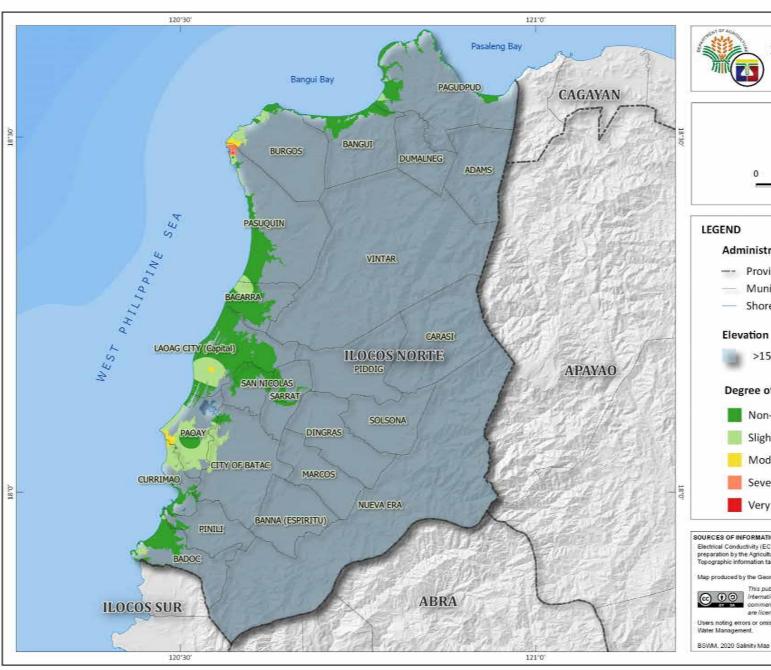
Table 3.6 Distribution of Coastal Land Area at Different Degree of Salinity, Ilocos Norte

	Soil Depth							
Salinity Class	0-30cm 30-60cm		30-60cm		m			
	hectares	%	hectares	%	hectares	%		
Non saline	22,782.81	73.29	29,493.55	94.88	28,707.93	92.36		
Slightly saline	7,529.39	24.22	1,212.30	3.90	2,153.40	6.93		
Moderately saline	579.60	1.86	309.64	1.00	222.39	0.72		
Severely saline	186.28	0.60	68.25	0.22				
Very Severely saline	5.65	0.02						

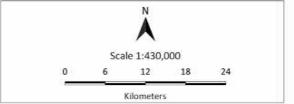
Table 3.6 is the total coastal land area of Ilocos Norte per degree of salinity. Generally, the area affected by salinity in the province of Ilocos Norte is limited and majority of the soil is non saline.

B. Output Maps

The following are the output maps of the project: the Soil Salinity Maps of the province of Ilocos Norte at 0-30cm depth; 30-60cm depth; and 60-90cm depth.







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.

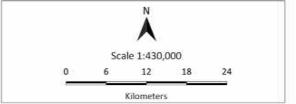
Map produced by the Geomatics and Soil Information Technology Division (GSITD).

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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

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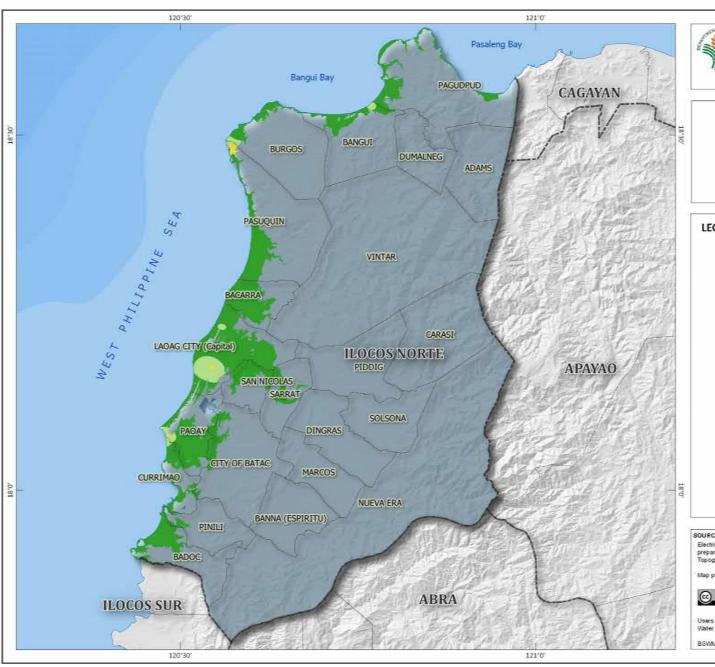
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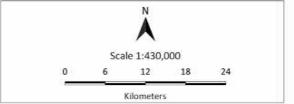
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BSVMI, 2020 Salinity Map







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 Salin	e >16

SOURCES OF INFORMATION:

Electrical Conductivity (EC) test from Laboratory Services Division (LSD). Soil sampling and preparation by the Agricultural Land Management and Evaluation Dhisson (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).



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BSVMI, 2020 Salinity Map



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