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Simple GIS-Based Method to Determine Temperature Susceptibility of Aquaculture Farms

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Abstract: Aquaculture production volume is at 4, 873.7 metric tons in Occidental Mindoro and 3, 136.6 tons in Oriental Mindoro in 2012. Climate change and wider temperature variations threaten this aquaculture development especially for mud crabs for which Mindoro is known. The ability to determine susceptibility of aquaculture sites to temperature variations is useful for planning expansion in the area. A method to evaluate site susceptibility to temperature change was design in this study. Data on Temperature Annual Range were downloaded on an open access source of PhilGIS Clearinghouses. Values of an overall mean and standard deviation was calculated based on sites where mud crab farms occur. These were set as the thresholds to classify pixels in the island as extremely susceptible, moderately susceptible, slightly susceptible and least susceptible. Fifty-two sites known as mud crab farms were mapped using a remotely sensed image. Results showed that northern part of the island are classified as moderately susceptible while the southern area are slightly susceptible to least susceptible for aquaculture development. This method can now be applied and tested in different islands of the Philippines.

Key Words: GIS; Temperature Susceptibility; Aquaculture; Mapping; Mud crab

1. INTRODUCTION

Aquaculture in Mindoro island has an increasing production yield averaging from 2,340 last 1997 and 4,005.15 metric tons during the year 2012 [1]. Milkfish, tilapia, groupers or Lapu-lapu, prawns and mud crab are the aquaculture produce in the island [2]. In spite of the threats from rising temperature during this period, production in the island remains constant.

The threat of rising temperature has to be considered in development of aquaculture industry in Mindoro. This study is an attempt to use publicly available data on temperature over 30 years to predict areas most and least susceptible to temperature increase in the island of Mindoro. In this study, locations of mud crab farms were mapped all over Mindoro Island. Environmental variables were gathered from the open access source of PhilGIS Clearinghouses. All data that has been gathered were processed in Quantum GIS [3] and generated maps to which we could refer results.

2. METHODOLOGY

2.1 Site Identification

Fifty-two locations of mud crab farms were obtained from the Bureau of Fisheries and Aquatic Resources, List of aquaculture Farms in Mindoro and these were used as training data to determine classifications of susceptibility. This was based on the downloaded bioclimatic variable form Philippine GIS Data Clearinghouses. PhilGIS is an open source database wherein we can access file for environmental variable for over 30 years [4] which we can use to integrate with the model we work on with Mindoro Island.

Bioclimatic variable such as Temperature Annual Range (BIO 7) is the minimum and maximum temperature for the warmest and coldest months [5] were downloaded from PhilGIS Data Clearinghouses to be used to classify susceptibility among the locations obtained.

2.2 QGIS Mapping and Processing

Quantum Geographic Information System (QGIS) is an open source Geographic Information System that supports most geospatial vector and raster file types and database formats. [6] Location data and Bioclimatic variable were processed using QGIS 2.14 (Essen) to produce dot and outline map to which we can identify the values for each sites through pixels and classify the susceptibility of each location that are likely to be adapted to temperature rise.

2.3 Susceptibility Identification

The mean and standard deviation of each sites where averaged. Average of the means and average of standard deviation are assigned as the range and anomaly respectively. Looking on anomaly and range helps point out deviations and extent of the values we have gathered. Values greater than average of the means results to high range while values lower than average of the means results to low range. Values greater than average of standard deviation results to high anomaly while values lower than average of standard deviation results to low anomaly. Areas having low temperature range and low anomaly are considered as least susceptible. Low temperature range and high anomaly are considered as slightly susceptible. High temperature range and low anomaly are considered as moderately susceptible. Areas having high temperature range and high anomaly are considered as extremely susceptible.

3. RESULTS AND DISCUSSION

Values for the average of the means assigned as the range is 98.85 and average of the standard deviation assigned as the anomaly is 3.43. Values higher than the average of the means at 98.85 is considered as high range while values lower than it is considered as low range. Values higher than the average of the standard deviation at 3.43 is considered as high anomaly and values lower than it is considered as low anomaly. These values are the basis to determine high and low of the range and anomaly for our model.

Results from QGIS shows the temperature ranges across the island of Mindoro on each individual site. Sites were numbered to determine the temperature ranges where these points are located. Pixels were classified according to the values of the mean per color. The map generated from Quantum Geographic Information System shows that most concentrations from the southern part is at blue to green color which falls on the values 9.3 up to 10.03 and the rest of the northern part is at orange and red color at 10.76 to 11.50. This serves as our basis to classify the temperature range for the sites given. From these values, we have extracted as well the standard deviation per site. (Figure 1.)

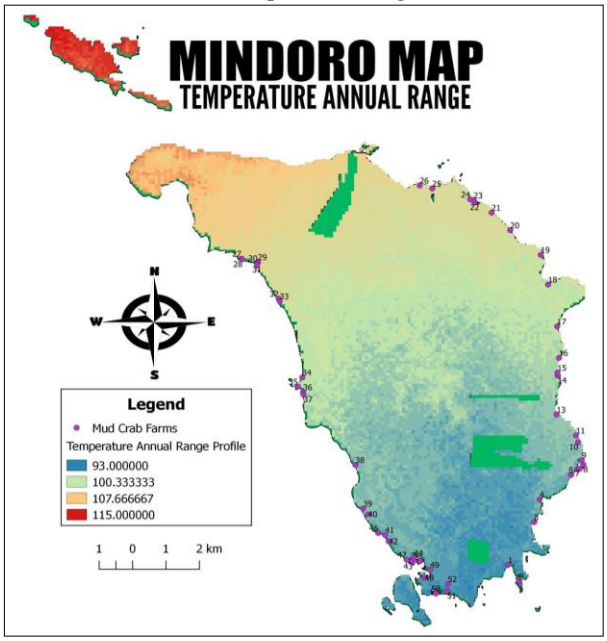

Fig. 1. Temperature Annual Range Map (Minimum and Maximum Temperature) for Mindoro Island.

The more susceptible the site, the more adaptive crabs can be found. Crabs more likely to be naturally adapted to temperature were found on the northern parts of the island while the populations of most crabs that are not likely to be naturally adapted were concentrated on the southern parts of the island. We could infer from the results that areas that need more utilization of aquaculture development are located at the southern part of the Mindoro Island. This result can now be tested on the laboratory and can be used as a model to other islands. (Figure 2)

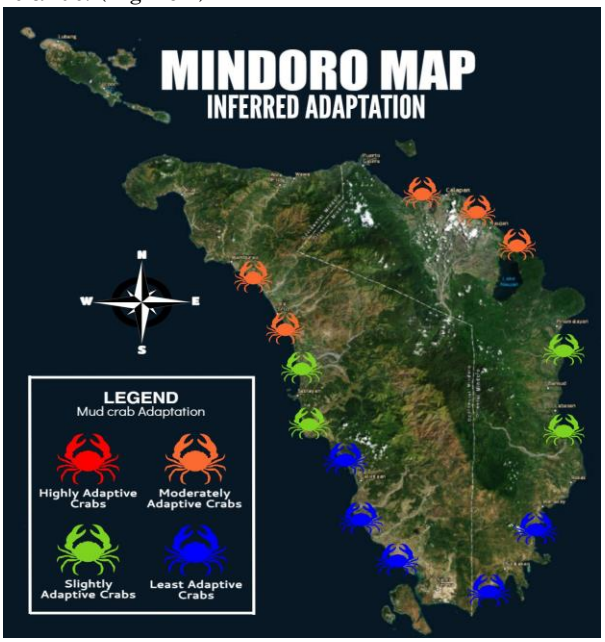

Fig. 2. Inferred Adaptation Map showing adaptation of crabs.

Results from QGIS shows that 33 of 52 sites comprising Bulalacao, Mansalay, Roxas, Bongabong, Baco, Calapan, Poblacion, Calintaan, Rizal, San Jose and Magsaysay are found in the least susceptible area on the southeast and southwest parts of the island because the values for the average mean and average standard deviation is lower than 98.85 and 3.43 respectively. The sites based on the analysis are classified using the table in Figure 2. Where it explains that when a range is low and anomaly is low as well, the area can be classified as least susceptible. 6 sites were also classified as slightly susceptible 13 sites as moderately vulnerable and no sites were classified as extremely susceptible.

Fig. 3. Temperature Range and Anomaly Classification to determine susceptibility of a site.

4. CONCLUSIONS

Investments for development of mud crab farms may be directed by looking into the susceptibility of the sites. This can only be done using mapping our aquaculture sites and integrating it with bioclimatic variables that really affects the area of our study. Considering the parameters in determining susceptibility helps us decide where this industry would flourish. Addition of other bioclimatic variables, conversion of ambient temperature to water temperature, looking into other species inhabiting the area and inclusion of all aquaculture sites are among the factors that helps us look at the different aspect for improving our mud crab industry and other aquaculture industry as well.

5. ACKNOWLEDGMENTS

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