Development of information systems for improving fishing efficiency and effectiveness

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Abstract. Palabuhanratu is one of the centers of small-scale fishing activities. Fish presence is influenced by the oceanographic conditions of waters, including sea surface temperature and chlorophyll-a concentration. Determining the right fishing area will help fishers increase the efficiency and effectiveness of fishing. This study aimed to model potential fishing zones using the maximum entropy model in Palabuhanratu waters and to build an information system as a medium for distributing information on potential fishing zones. The study used the multi-sensor satellite data, namely Moderate Resolution Imaging Spectroradiometer (MODIS) and Vessel Monitoring System (VMS) data. Spatial analysis of fishing ground was carried out by modeling the maximum entropy (Maxent) with machine-learning techniques, in order to analyze the relationship between the distribution of fishing vessels and the environmental parameters. The modeling results showed that based on the probability value and the resulting distribution area, September and October are pelagic fishing seasons in Palabuhanratu, with probability values between 0.0047-0.7398. The modeling results have been used as the basis for building an information system for estimating potential fishing areas, namely Fishpos.
Key Words: application, fishing areas, maximum entropy.

Introduction. Palabuhanratu is one of the centers of fishing activities in Sukabumi Regency, West Java Province, Indonesia. Palabuhanratu has territorial waters included in the waters of the Indian Ocean with great potential pelagic fish resources (Indrayani et al 2017). The efficiency and effectiveness of fishing are influenced by many factors, including fishing areas, commonly referred to as fishing ground. Getting appropriate fishing areas is necessary for anglers to improve efficiency and effectiveness in fishing operations. In this case, fuel use efficiency and efficacy are associated with a great chance of getting the catch. Knowledge of the presence of fish in the sea is essential to estimate the right place and time to catch fish (Nurani et al 2015; Nurani et al 2016; IOTC 2016).

The pattern of fish life in the sea cannot be separated from oceanographic parameters such as temperature, salinity, current, and chlorophyll-a content (Fraile et al 2010; Tadjuddah 2018). Each type of fish has a habitat with different aquatic oceanographic conditions to support its optimal life. The spatial distribution of sea surface temperature affects the temporal distribution of fishing areas in Palabuhanratu waters (Simbolon 2008). However, Gaol et al (2014) and Setyaningrum et al (2017) stated that fish resources in water are influenced by sea surface temperature and the concentration of chlorophyll-a. The concentration of chlorophyll-a indicates the presence of phytoplankton in water. Phytoplankton act as primary producers in the food chain that can affect the fish abundance, including the pelagic fish (Simbolon & Girsang 2009).

The government has made a fishing areas map estimated from oceanographic parameters including chlorophyll-a, temperature, and sea-level height. The effectiveness of fishing areas map is still low. One of the reasons is the inaccurate estimation and the difficulty of using the map. The current fishing grounds map is created manually, with limited data input. Existing satellites produce daily satellite image data that can be used for fishing grounds identification, with up-to-date and real-time data. In addition, the government also has data on the movement of fishing vessels, that can be retrieved from the Vessel Monitoring System (VMS) data, position data and fish catches, obtained from fishing logbook data, that can complement the satellite imagery data. The data is classified as big data.

This study was conducted to create intelligent system designed to identify potential fishing areas using big data processing based on these problems. The specific purposes of the study (1) Mapping potential pelagic fishing zones in Palabuhanratu waters with a maximum entropy model; (2) Building an information system to display a map of potential fishing zones on the android operating system, supported by several features to improve the effectiveness of fishing in Palabuhanratu waters. This system is expected to help fishers reaching suitable fishing grounds, thereby increasing productivity and efficiency of costs. The research was designed by utilizing big data processing in real-time satellite imagery and VMS data to predict the presence of potential fishing areas. The imagery used is sea surface temperature data and chlorophyll-a concentration from Aqua Modis Imagery. The data is then processed using spatial data processing software. After that, the image data is overlaid with VMS data, and logbooks and intelligent systems are created to identify potential fishing areas. Intelligent systems are designed using maximum entropy modeling. Maximum entropy is a model that can estimate the probability distribution of entropy, assessing the most uniform and closest data. The advantage of the Maximum Entropy method is that it has an efficient deterministic algorithm, based on simple mathematical concepts, can combine different variables and performs the identification, that requires only existing data and environmental information (Phillips et al 2006). For localizing potential fishing zones, only data on the vessels location at capture time is needed. Environmental information data is data on oceanographic parameters, including chlorophyll-a content and sea surface temperature.

Material and Method

Research time and place. The research was conducted with data sources obtained from 1) chlorophyll-a and SPL data (2015-2020) from Aqua Modis Imagery, 2) statistics on Archipelagic Fishing Port (AFP) of Palabuhanratu fisheries for the period 2015-2020, 3) logbook data, and 4) VMS data. Data and information are also obtained from Palabuhanratu AFP Manager, interviews with fishers, field observations, and other relevant sources. The field survey was conducted at Palabuhanratu AFP, Sukabumi, West Java Province, in May, July, and November 2021 (Figure 1).

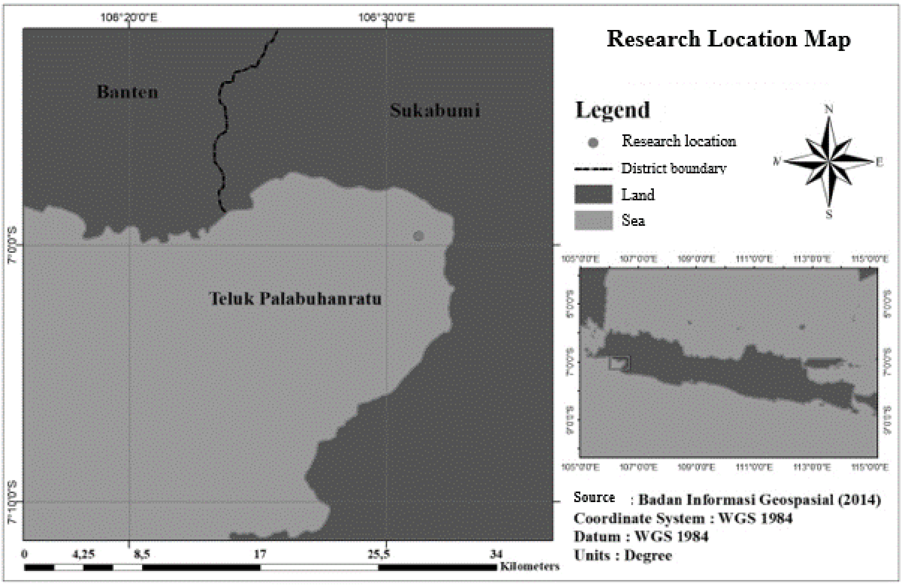

Figure 1. Research location in Palabuhanratu Bay.

Data collection. Secondary and primary data are used to estimate the area of fish presence. Secondary data consists of oceanographic parameter data, fishing data recorded in Palabuharatu AFP, and VMS data. The primary information is the result of interviews and questionnaires, such as identifying problems and needs. In addition, primary data such as capture locations and catch book logbooks are collected to validate secondary data. Determination of respondents' data sources in the study using techniques and accidental sampling. Accidental sampling was selected to determine respondents, namely pelagic fishing fishers in Palabuhanratu. The use of accidental sampling is due to the lack of accurate data on fishers', making impossible to determine a random sampling of the respondents.

Processing and data analysis

Image data processing. The image data on chlorophyll-a concentration and sea surface temperature data for the study were obtained through the https://oceancolor.gsfc.nasa.gov/ website maintained by the National Aeronautics and Space Administration (NASA). The downloaded data is a monthly AQUA MODIS Level-3 image from 2016 to 2020. This data has a resolution of 4 km, with a slight excess of cloud cover and has gone through a correction process, performed by NOAA. The chlorophyll-a concentration values extraction process uses the Ocean Chlorophyll 3-band algorithm MODIS (OC3M). According to O'Reilly et al (1998), the algorithm model on OC3M refers to the following equations:

$$Ca = 10^{0.283 - 2.753 * R1 + 1.457 * R2 + 0.659*R3 - 1.403*R4}$$

$$R = \log_{10} (Rrs\ (\frac{443}{551}) > Rrs\ (\frac{448}{551}))$$

Where:
Ca - klorofil-a concentration;
R - reflectance ratio;
Ri - the i^{th} power of R;
Rrs - reflected wavelength spectrum.

While for the sea surface temperature data, the extraction of its value is obtained from the algorithm Theoretical Basic Document Modis 25 (Brown & Minnet 1999), with the following equations:

$$Modis\ SST = c_1 + c_2*T31 + c_3*(T31-T32) + (c_4*\sec(\theta) - 1) *(T31-T32)$$

Where:
c_1, c_2, c_3, c_4 - SPL coefficients in bands 31 and 32;
T31 - *Brightness Temperature* (BT) on the channel 31;
T31-T32 - Diference of the BTs on the channels 31 and 32;
Θ - satellite zenith angle.
The coefficients c_1, c_2, c_3, and c_4 used in the equation above can be seen in Table 1.

Table 1

Coefficients for MODIS bands 31 and 32 SPL algorithms

Coefficients	*ΔT ≤0.7*	*ΔT ≥0.7*
c_1	1.11071	1.196099
c_2	0.9586865	0.9888366
c_3	0.1741229	0.1300626
c_4	1.876746	1.627125

Selected chlorophyll-a and sea surface temperature data downloaded from the site https://oceancolor.gsfc.nasa.gov/ in a NonConformance (.nc) format was extracted using the SeaDAS 7.5.3 application and the cropping was performed according to the coordinates of the research area, then the mask pixels were exportedand stored in the form of Text Tab Delimited (.txt). The text data generated through the SeaDAS processing is then opened in Microsoft Excel to correct the cloud and land cover and to eliminate irrelevant chlorophyll-a and SPL values. The following process is the creation of chlorophyll-a and SPL distribution maps using the ArcGIS 10.8 application. ArcGIS is used to convert text data into shapefile data to facilitate spatial interpolation of data and layout processes. The interpolation method used is Inverse Distance Weighted (IDW). The advantages of the IDW interpolation method are that the interpolation characteristics can be controlled by limiting the input points used in the interpolation process. In addition, it also can easily remove points located far from the sample point and points that have little spatial correlation or even no correlation (Pasaribu & Haryani 2012). After the interpolation process, the data will be exported in ASCII format to get the dominant SPL and Chlorophyll-a values along with their range values (Simbolon 2008). These results are further processed using the Maximum Entropy.

Analysis of estimating fishing areas with maximum entropy. Maximum entropy is an analysis of the development of fish habitat models based on the presence of a species and on the environmental parameters for estimating the probability distribution. The result of the maximum entropy is the probability value of a species to be present at a given location within a range of values 0 (no potential) to 1 (high potential) (Phillips & Dudik 2008). Maximum entropy's mathematical formulation is a logistic regression analysis of the species spatial distribution model. The resulting model will be evaluated for suitability using the Receiver Operating Characteristic (ROC) curve. The ROC curve consists of an x-axis that indicates the model's specificity and a y-axis that shows the model's sensitivity. The ROC curve will form an area referred to as the Area Under Curve (AUC) with a range of values of 0-1. This AUC value is then used as a model selection criterion, where the requirements are excellent, very good, good, sufficient and poor, with the AUC value of 0.90-1.00, 0.8-0.9, 0.7-0.8, 0.6-0.7, and 0.5-0.6, respectively (Monserud & Leemans 1991). These criteria are also supported by Elith (2000) and Papes et al (2016), which states that a model with an AUC value of more than 0.75 has an excellent potential to be successfully implemented.

The density estimates described by maximum entropy represent the probability of presence data over the environmental data. If the target class is assumed to be y, then P (y=1 | x) is the probability of presence. According to Bayes (1763), the equation for calculating the probability of existence is as follows:

$$\mathrm{P}\ (\mathrm{y}=1 \mid \mathrm{x}) = \frac{\mathrm{P}\ (\mathrm{x} \mid \mathrm{y}=1\ )\ \mathrm{P}(\mathrm{y}=1)}{\mathrm{P}(\mathrm{x})} = \pi(x)\ P(y-1)|x|$$

Where:

$\mathrm{P}\ (\mathrm{y}=1 \mid \mathrm{x})$ - probability of presence;
$P\ (x \mid y=1\ )$ - likehood;
$P(y=1)$ - prior target;
$P(x)$ - prior evidence.

The value of the probability of presence will indicate the probability of a species being present at point x, or in this case, a specific coordinate. The next step is to calculate the exponential distribution by the Gibbs Distribution, using the equation (Phillips & Dudik 2008):

$$q(x) = \frac{\exp\ (\sum_{j=1}^{n} \lambda_j f_j(\mathrm{x})}{z_\lambda}$$

Where :

$q(x)$ - estimation of $\mathrm{P}\ (\mathrm{y}=1 \mid \mathrm{x})$;

λ_j - weight of x on variable j;

f_j - value of x on variable j;

z_λ - exponential number of feature weight vector set x.

After obtaining an estimate of $P(y = 1 \mid x)$, the next step is to calculate the entropy of q(x) with the following formula (Phillips & Dudik 2008).

$$H(x) = \sum_{x=1}^{n} q(x) \ln q(x)$$

Next is the distribution of the estimated opportunities obtained from the following equation (Phillips & Dudik 2008).

$$P(y = 1 \mid x) = \frac{e^H q(x)}{1 + e^H q(x)}$$

Where:

q(x) - the estimation of $P(y = 1 \mid x)$
H - the entropy of q(x).

The modeling process with maximum entropy begins with storing capture data containing species, longitude and latitude capture into a delimited comma format (.csv). Meanwhile, environmental parameter data in chlorophyll-a images and sea surface temperature were saved in ASCII format (.asc) using ArcGis 10.8. The following process is processed with Maximum Entropy 3.3.3 to input capture data (.csv) and environmental parameter data (.asc) in the environmental layer column. Next is to adjust the settings, with a checklist of columns creating response curves, pictures of predictions, and jackknife test of variable importance. In the maximum iterations, the column set as much as 500 with the random percentage of 25%. Once the data process is complete, maximum entropy will produce several outputs such as habitat conformity response curve, model evaluation, analysis of the contribution of environmental variables, and predictive maps.

Information system development. The development of an information system of potential pelagic fishing zone map of Palabuhanratu waters in the android-based was carried out using Kodular software. Kodular visual programming uses the concept of drag and drops with „Scratch" programming language (Kumala & Winardi 2020). The development of this information system consists of 4 waterfall stages, namely analysis, design, implementation, and testing (Kamil & Duhani 2018).

Information system analysis. This stage is divided into needs analysis, problem formulation, and identification of information systems.

a. Needs analysis
   At this stage, a selective search of the information needs of each of the perpetrators involved in the use of information systems is potentially pelagic fishing in Palabuhanratu waters. Determining the condition for information is done by interviewing the perpetrators of the system and direct observation in the field. According to Setiawan et al (2016), information analysis is the initial and primary stage, namely getting the information and data required by the system 's actors.
b. Problem formulation
   This stage is carried out with the existing formulation problems in the scope of the system. The method used in analyzing problems is by direct observation in the field through interviews and questionnaires.
c. Identify information systems
   This stage aims to get an outline of the system to be created. To illustrate this, , cause-and-effect diagrams and input-output diagrams were used. The resulting

graph describes the relationship between the actors, while the input-output chart explains the system's input and output components and controls.

Design or planning. Generating information consists of data entry, processing, and presenting information into applications with built interfaces. At this stage, the information system architecture design, the data loaded, and the interface design are being done. The storage of loaded data is done with a MySQL database so that at this stage, the creation of the database by the needs of the system. MySQL is software used to create open-source databases (Triamarsiah & Arafat 2017). In contrast, the interface design process is assisted by Figma software. Figma is one of the applications used to design mobile applications, desktops, websites, and even other information systems (Muhyidin et al 2020).

Implementation. This stage is the implementation stage of the design that has been made. This stage involves implementing the design interface created into the Kodular layouts, building blocks programming, writing scripts with hypertext preprocessor (PHP) programming language to connect developed applications and MySQL databases.

Testing. This stage is tested on the information system that has been compiled. Testing for ensuring that the system is built to suit the needs and processes that have been corrected. The method used in testing is black-box testing. According to Cholifah et al (2018), the black-box is testing a software system in terms of functional specifications without knowing the design and code of the program.

Results

The presumption of fishing areas has been analyzed by acquiring chlorophyll-a data and sea surface temperature. Data on oceanographic parameters in chlorophyll-a and sea surface temperature can identify potential fishing areas (Chavula et al 2012; Fitrianah et al 2015). According to Chavula et al (2012), fishing areas exhibit primary productivity characteristics, evidenced by the relatively large upwelling of seawater and phytoplankton. The data processing results are used to create a map modeling the probability of the presence of fish analyzed by the maximum entropy method, which will then be the input for the estimation of fishing areas.

Needs analysis. Needs analysis is used to identify the system needs of each of the actors involved in using the potential area of pelagic fishing in Palabuhanratu waters. The identified perpetrators are fishers, fisheries entrepreneurs, Palabuhanratu AFP officers, and academics. The results of the needs of system actors are obtained from the interview process. The information needs of each actor can be seen in Table 2.

Table 2

Identification of system actors needs

No	*System actors*	*System actors needs*
1	Fishers	Map of potential fishing areas Weather and wave height information Ship navigation assistance system
2	Fishers entrepreneurs	Economically significant fish information based on selling value Information on dominant fish by production volume Information on the number of fishing activities
3	Palabuhanratu AFP officers	Easy logging and integration of catch data Report of fishing activity Spatial map of potential fishing
4	Academics	Catch data report Fishing vessel position report

Habitat-based fishing area mapping with maximum entropy. Maximum entropy is an analysis of the development of habitat models based on the presence of the studied species, considering parameters to estimate the probability distribution of targets (Siregar et al 2019). The result of the maximum entropy calculation is the probability value of the presence of a species at a given location with a range of values 0 (no potential) to 1 (high potential) (Phillips & Dudik 2008). The probability map for fish from the maximum entropy method can be seen in Figures 2 to 4.

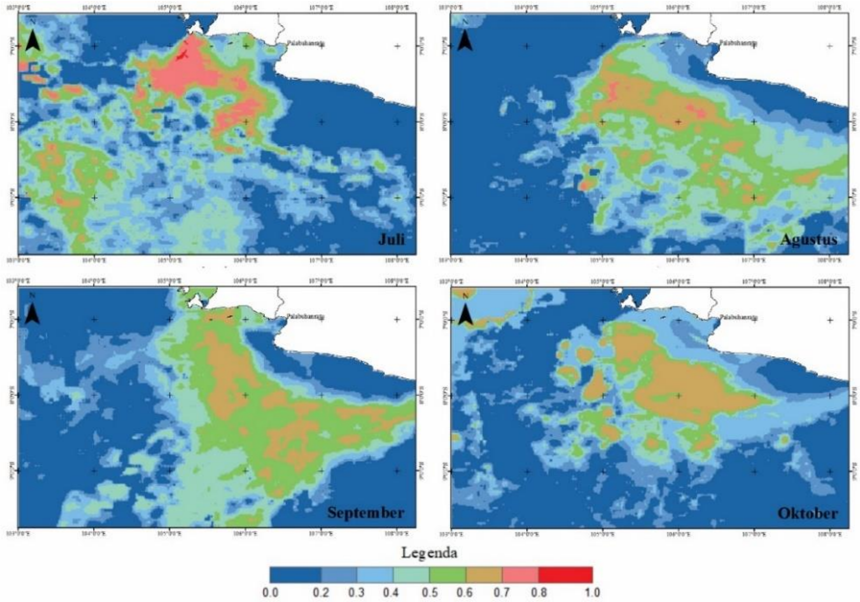

Figure 2. Fish presence probability map in July to October 2019.

Predictions of the probability of pelagic fish's presence in July to October 2019 can be seen in Figure 1. The probability value of pelagic fish presence in July ranged from 0.0501-0.8028 with an AUC value of 0.764, while in August it ranged from 0.0047-0.7655 with an AUC value of 0.838, September ranged from 0.1219-0.6696 with an AUC value of 0.824, and October ranged from 0.0597-0.7398 with an AUC value of 0.863. Based on the AUC value obtained, the resulting modeling from July to October 2019 falls into the category of good to very good.

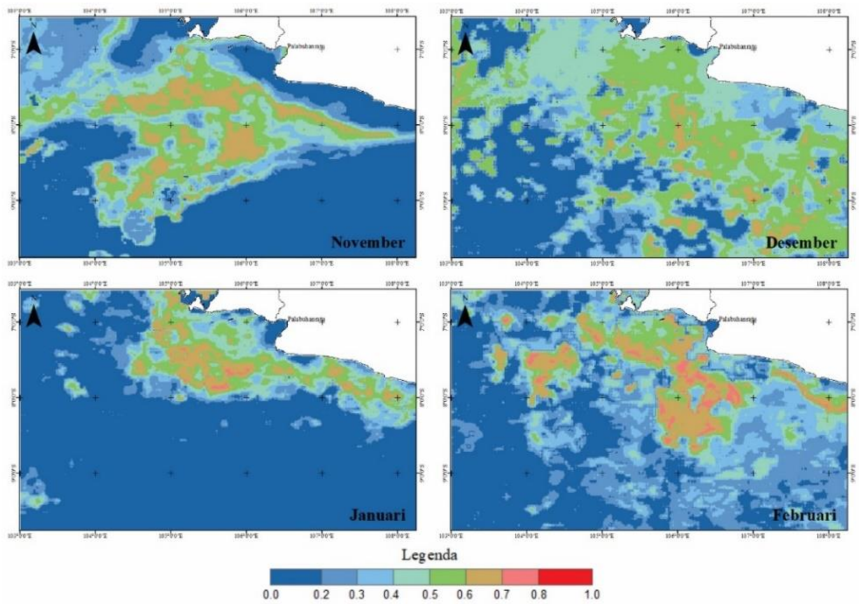

Figure 3. Fish presence probability map in November 2019 to February 2020.

Predictions of the probability of pelagic fish presence from November 2019 to February 2020 can be seen in Figure 2. Based on the AUC value obtained, the modeling produced from November 2019 to February 2020 falls into the category of good to very good. The probability value of pelagic fish presence in November ranges from 0.0306-0.7058, with an AUC of 0.860, while in December it ranges from 0.0575-0.6554, with an AUC value of 0.760, in January 2020 it ranged from 0.1051-0.7695, with an AUC value of 0.913, and in February 2020 it went from 0.1063-0.7832, with an AUC value of 0.849.

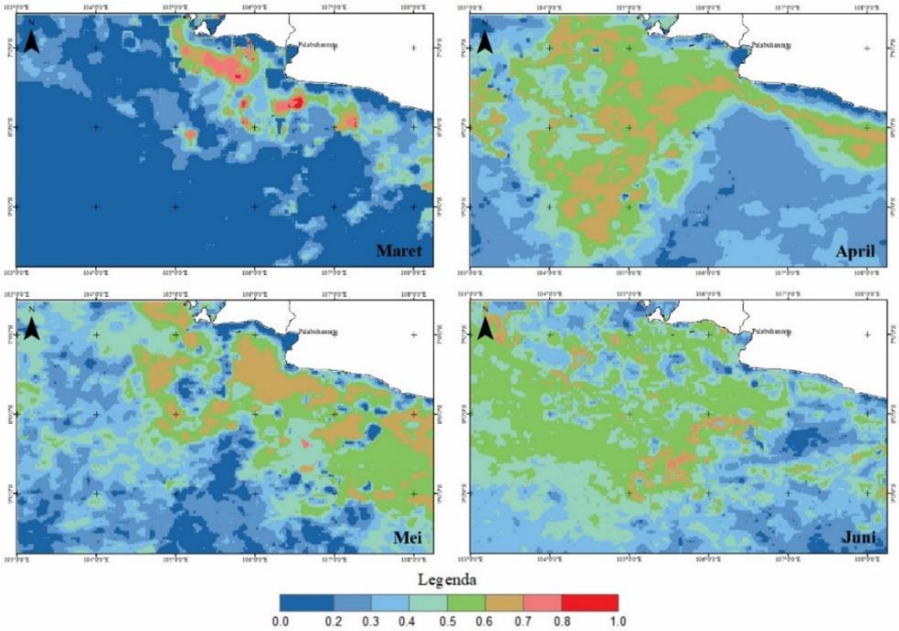

Figure 4. Map of fish presence probability on March to June 2020.

The probability of pelagic fish presence in March to June 2020 can be seen in Figure 3. The probability value of pelagic fish presence in March ranged from 0.0092-0.8935, with an AUC value of 0.895, while in April it ranged from 0.1579-0.6684, with an AUC value of 0.734, in May it ranged from 0.1963-0.7699, with an AUC value of 0.753, and in June it ranged from 0.2047-0.7639, with an AUC value of 0.686. Based on the AUC value obtained, the resulting modeling in March to May 2020 falls into the category of good to very good, while in June, it belongs to the category good enough. March to May is the 1st transitional season, when the abundance of fish is not as high as in the 2nd transitional season, but not as low as in the western season.

Design or planning. Data contained in the system was stored in a MySQL database. At this stage, the database design is carried out according to the needs of the system. The requirements in the system are then translated into menus that will be made in the system. The interface design is assisted using Figma software's capability to create menus. The database used in the program can be seen in Table 3.

Table 3

Databases

a. Registration and login database

Column	*Type*	*Nullable*	*Default*	*Comment*
Full name	Varchar (225)	No		User full name
Phone no	Int (11)	No		User phone number
Username	Varchar (225)	No		User username
Password	Varchar (225)	No		User password
Created at	Timestamps	Yes	Null	Date created
Updated at	Timestamps	Yes	Null	Date edited

b. Fishers data collection database

Column	Type	Nullable	Default	Comment
Full name	Varchar (225)	No		Fishers name
Phone no	Int (11)	No		Fishers phone number
Age	Int (11)	No		Fishers age
Address	Varchar (225)	No		Fishers address
Fishers category	Varchar (225)	No		Fishers category
Created at	Timestamps	Yes	Null	Date created
Updated at	Timestamps	Yes	Null	Date edited

c. Fishers data collection database

Column	Type	Nullable	Default	Comment
Ship name	Varchar (225)	No		Ship name
Ship line number	Varchar (225)	No		Ship line number
Size	Int (11)	No		Ship size in gross tonnage
Fishing gear	Varchar (225)	No		The fishing gear used
Crew	Int (11)	No		Number of crew
Owner	Varchar (225)	No		Owner
Created at	Timestamps	Yes	Null	Date created
Updated at	Timestamps	Yes	Null	Date edited

d. Catch data collection database

Column	Type	Nullable	Default	Comment
ID	Bigint (200)	No		Fish ID
Fish name	Varchar (225)	No		Name of caught fish
Fish weight	Int (11)	No		Fish weight per species in kilograms
Price of fish	Int (11)	No		Price of fish per species in rupiah
Fishing port	Varchar (225)	No		Fish landing port name
Created at	Timestamps	Yes	Null	Date created
Updated at	Timestamps	Yes	Null	Date edited

e. Database of fishing grounds restoration coordinates

Column	Type	Nullable	Default	Comment
Fishing area	Varchar (225)	No		Name of fishing area
Longitude	Varchar (225)	No		Coordinate value
Latitude	Varchar (225)	No		Coordinate value
Created at	Timestamps	Yes	Null	Date created
Updated at	Timestamps	Yes	Null	Date edited

Implementation. The information system for the potential fishing area in the study was called Fishpos. Fishpos was built to facilitate the process of distributing the model of the restoration of fishing areas to fishers. This information system is designed using a scratch programming language with Kodular. Designing the system interface is assisted by Figma, while database building is done with MySQL. At this stage, data processing is also carried out to restore potential fishing areas with the maximum entropy method, which is one of the best modeling methods. Correct testing procedures can improve the model results and reduce the chances of making false, biased or uncertain predictions (Siregar et al 2019; Syah et al 2020). The data obtained in the maximum entropy estimation will then be inputted into the system database in coordinate values. The coordinate values will then be retrieved and displayed into an information system created using the Application Programming Interface (API) from google maps.

Data processing with MaxEnt consists of four stages. The first stage is data collection ad exploration. The second stage is processing the satellite imagery data, producing spatial distribution maps of sea surface temperatures and chlorophyll-a concentrations, each month, from 2016 to 2020. The third stage is to process data with MaxEnt using processed data and to capture location data taken from logbook and VMS data. In this third stage, a map of the potential fishing zone is elaborated, where the previously resulting model's suitability is evaluated using the Receiver Operating Characteristic (ROC) curve. The fourth stage is constructing an information system for the potential fishing areas. Information systems are built using an android-based Kodular and the database is built using MySQL. The database is used as storage media and as a sender of the corelated data from MaxEnt into the program view.

Program view.

1. Login and Registration View
   The login form is an essential part of an android-based application. It limits users who do not have an account to enter the program and it can only be accessed if the user has first registered on the registration form by filling in a username and password. In the registration form, the user must fill in the full name, phone number, username, and password, which will be stored in the system database. When the user performs the login process, the username and password entered will be validated with the data stored in the database. The login process succeeds only if the requested data is from the database.
2. Menu View
   Menu view is the main page used to access the menus in the program. It consists of a help center for maps search, and information/data collection. The help center menu contains an email that can be contacted to report a bug that occurred on the system.
3. Data Collection Menu View
   Fishers Port officials or fishers can independently use the data collection menu to conduct data collection, such as those on the fishing boats, fishers and catches. The data entered will be integrated into the database created so that data collection and processing can be done more efficiently.
4. Potential Map Menu View
   The candidate map menu is the most crucial in the program. It displays a map with potential location points for fishing trips and shows the location of the latest ship along with its coordinates. The possible capture location points in coordinates are obtained from data processing using maximum entropy. The coordinates are then stored into a database which will then be transmitted into the system and displayed using the Application Programming Interface (API) API of Google Maps. One location point in the map represents 4x4 km^2 of the actual water area. As stated by Geronimo et al (2018) in their research, the monthly remote sensing available today for chlorophyll data and the sea surface temperature is limited to a resolution of 4 km (MODIS image). Location points will be updated every month, so the predictions displayed on the program are the updated forecasts.
5. Information Menu
   The information menu consists of tools that can be used to support fishing activities, producing a map of the potential fishing zones, a chlorophyll-a distribution map, a sea surface temperature distribution map, the weather and wave height data (from the Meteorology, Climatology and Geophysics Agency-BMKG), and the fish selling price information (from the Fisheries Port Information Center-PIPP). At the same time, a fuel calculator can support the capture activities to estimate the needs of fuel oil and a compass can determine the wind direction.

Discussion

The presumed fishing areas have been analyzed by acquiring chlorophyll-a data and sea surface temperature. Data on oceanographic parameters in chlorophyll-a and sea surface temperature can indicate potential fishing areas (Chavula et al 2012; Fitrianah et al 2015). According to Chavula et al (2012), fishing areas exhibit primary productivity characteristics, evidenced by the relatively large upwelling of seawater and phytoplankton. The data processing results are used to create a map modeling the probability of the presence of fish analyzed by the maximum entropy method, which will then be the input of an intelligent system program identifying the fishing areas.

The modeling produced from July to October 2019 falls from good to very good. This is determined based on the AUC value obtained, 0.764 in July, 0.838 in August, 0.824 in September, and 0.863 in October. When viewed from the perspective of the probability value and extent of distribution, August (0.0047-0.7655), September (0.1219-0.6696) and October (0.0597-0.7398) are indicated as the pelagic fishing season in Palabuhanratu. According to the results of Ekaputra et al (2019), the pelagic fishing season in Palabuhanratu waters is in the second transitional season, namely from September to November. The high probability value of the presence of pelagic fish in the 2^{nd} intermediate season is also influenced by the increase in the concentration of chlorophyll-a in Palabuhanratu waters. In the 2^{nd} transition season, high concentrations of chlorophyll-a occur in the southern region of Java to the waters of Bali, Lombok, Sumbawa, Flores, Sumba, and Timor. There is an increase in the south area of Java, including Palabuhanratu bay. The existence of regular annual cycles in the intense pressure gradient between the two oceans indicates that Indonesia's flow is governed by the maximum annual cycle during July and August and the minimum one during January and February (Wyrtki 1987).

The modeling produced from November 2019 to February 2020 falls into the good to an excellent category based on AUC values of 0.860 in November, 0.760 in December, 0.913 in January 2020, and 0.849 in February 2020. Based on the AUC value obtained, December to February is also referred to as the western season, judging from the perspective of the value of probability and of the extent of the distribution of fish presence. The western season is the lousy season of pelagic fishing. This result is corroborated by the research of Ekaputra et al (2019), who state that the lowest number of pelagic catches occurred from December to February, indicating this period as the beginning of the famine season. In addition to the low suitability of habitats such as chlorophyll-a and sea surface temperature, the probability value of fish presence becomes low. The low catch is also caused by the bad weather, such as high rainfall. The chlorophyll-a content in Pelabuhanratu Waters decreased from November until January, the peak of its decline, with a value of 0.06 mg m^{-3}. A decrease in the chlorophyll-a concentration will lead to a decline in the abundance of fish in the studied waters. This is in line with the statement of Mujib et al (2013), where the abundance of fish in the water will tend to increase when the concentration of chlorophyll-a increases.

Probability maps of the presence of fish and other data that have been collected are loaded in the system with a MySQL database to create intelligent systems for the selection of the presumed fishing areas. After the database design is complete, the design interface design is carried out using the Figma software (Ahmar et al 2016). This software can be used online and is easy to apply to make users comfortable (Putra et al 2019). The last stage is implementing the design using Kodular. The android-based information system indicates the potential fishing zones, called Fishpos. Fishers can use it to improve the efficiency and effectiveness of fishing operations.

This information system for presumed fishing grounds still needs to be tested and perfected to be adequately implemented and to maximize the fishers' benefice. The implementation phase includes implementing the interface design made into the Kodular layout, building programming blocks, and writing scripts with the Hypertext Preprocessor (PHP) programming language to connect the created application with the MySQL database. The testing of the information system that has been compiled will be carried out to ensure that the system is built according to the needs and that the processes are correct. The black-box method is used for testing. According to Cholifah et al (2018), the black-box is based on a software system testing the adequacy to the functional specifications, without testing the program's design and code.

Conclusions. Modeling fishing areas with maximum entropy (Maxent) can predict the fishing season. Based on the probability value and on the resulting distribution area, September and October are pelagic fishing seasons in Palabuhanratu, with probability values between 0.0047-0.7398. The modeling results have been used as the basis for building an information system for estimating the potential fishing areas. This information system is designed using the Scratch programming language, with Kodular. The system's interface design process is assisted by Figma, while the database development is carried out with MySQL.

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