Using Geographic Information System (GIS) for The Data Collection and Mapping of Fisheries Potential in Indonesia: A Review of Research

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ABSTRACT

Indonesia is an archipelagic country that has a sea area of more than 2.55 million km2, one-third of the total area of Indonesia. The high sea area illustrates the high potential of Indonesian fisheries. In addition, its strategic location which is traversed by the equator makes Indonesia a tropical country that has a high diversity of marine products. The high potential and diversity of fisheries resources in Indonesia demand the need for an information system that can cover all existing fishery potential data. Geographic Information System (GIS) is a basic information system that can cover data on fishery potential in Indonesia. GIS has experienced developments in its use in the world of fisheries, especially in Indonesia. In the last few decades, GIS has been widely used in collecting fishery potential data to mapping fishery potential and fishing potential areas. The use of GIS in the world of fisheries has been very useful in increasing the productivity of fishing businesses through a combination of information from mapping the physicochemical parameters of the waters such as determining areas and potential fishing routes.

Keyword : *fisheries resources, fishing area and routes, geographic information system.*

1. INTRODUCTION

Indonesia is one of the largest archipelagic countries in the world with a total area of 7.81 million km² consisting of 17,499 islands [1]. As an archipelagic country, Indonesia has a sea area of more than 2.55 million km². In addition, Indonesia's geography, which is located between the Indian and Pacific oceans, makes Indonesia a potential international shipping lane [2]. The facts regarding the condition of the region explain the high potential of marine and fishery and maritime resources owned by the Indonesian state.

As a country with high maritime and resource potential, the importance of the need for an information database that includes data collection of all existing potentials [3-5]. Collection of databases well and provide easy access, easy to read, and analyze data is needed. For this reason, geographic information systems (GIS) are experiencing rapid development and the use of which is increasingly in demand in the last few decades [6].

Geographic Information System (GIS) is an activity to capture, store, manipulate, analyze, organize, and display geographic data carried out by a system [7]. This system will provide information about the earth's surface which is processed using software that can be used according to user needs. This Geographic Information System is widely used in the world of fisheries, one of which is the management of fisheries resources [8]. GIS has helped achieve fisheries resource management through every stage of management, from information data collection, analysis, planning, consultation, decision making, resource allocation to implementation, in order to ensure productivity and the achievement of management objectives [9].

Currently, the management of fishery resources in Indonesia has been carried out on a regional basis on a spatial basis. Indonesia regarding the division of fisheries management areas of the Republic of Indonesia. There are 11 fisheries management areas scattered throughout Indonesian waters [10]. The division of the fishery management area is carried out based on various basic considerations in the socio-cultural aspects of the community, biological resources and ecosystems, to the consideration of fish resource stock units [11].

The government has issued a regulation through the Ministry of Maritime Affairs and Fisheries, namely Permen-KP/71/2016 concerning fishing routes for the utilization of the potential of Indonesia's fisheries resources. The fishing lanes that have been determined consist of Fishing Line 1, Fishing Line 2, and Fishing Line 3. Fishing Line 1 consists of two types of lanes, namely lanes 1A and 1B. Line 1A covers coastal waters up to 2 miles measured from the lowest low tide limit, while line 1B covers coastal waters outside 2 miles to 4 miles. Fishing Line 2 is measured 12 miles from the lowest low tide. Fishing Line 3 covers the Exclusive Economic Zone [12].

There are other things that also need to be considered as a form of preventive effort in sustainable management of fisheries resources. One of them is the determination of fishing gear that is allowed and not allowed. One of the fishing gear that has been banned under the Regulation of the Minister of Marine Affairs and Fisheries number 2 of 2015 is the cantrang [13]. Cantrang, which is part of the trawl and seine nets, has been widely distributed throughout Indonesian waters. Some areas even have their own names even though the specifications and technical operation of the fishing gear are similar to the banned cantrang. For this reason, information regarding the specifications of prohibited fishing gear needs to be properly disseminated to the fishing community [14].

Based on the previous description, GIS is a system that can provide a database, perform data processing, to present data that is easy to read and accessible by every fishery actor to the wider community. The potential for GIS development in Indonesia is very high. GIS has been widely developed in terms of spatial mapping of fisheries management areas, fishing routes, important aquatic ecosystems, to databases of fishing gear that are widely operated in each fisheries management area. The existence of GIS can help every policy holder and analyzer (researcher) in the world of fisheries to be able to carry out various scientific studies with the aim of managing sustainable fisheries resources. Thus, GIS can greatly contribute to the achievement of sustainable fisheries management in the future.

2. LITERATURE REVIEW

2.1 GIS in Fisheries Data

GIS is an information-based system that is currently developing rapidly and is widely used for analyzing and mapping natural resources, including the presentation of fishery potential data based on spatial data [15]. Mapping of natural resources in this case is the mapping of fishery potential, especially marine fisheries, generally using acoustic data [16]. In addition, the mapping process requires secondary data, including (1) fish abundance data, (2) fishery potential data, (3) water characteristics data, and (4) potential data recording points from acoustic data retrieval tracks for each distance unit observation. After that, conduct an acoustic survey to collect the required data and then the data is entered into a map so that the information listed is clear and easily understood by all groups [17].

Existing data is collected into a database. A database is a collection of one or more data files or tables that are stored in a structured manner so that the relationships between different items or different data sets can be used for manipulation and retrieval purposes and in general will serve the availability of data from various sources users [18]. Databases are generally divided into three models formed from spatial data, namely the hierarchical database model, the network database model, and the relational database model. When designing a database using GIS, the design consists of: (1) Using data that has a georeferenced system, (2) Paying attention to the error limits allowed when building a spatial database so that the topology built is right, (3) Using a data model relational when designing the database, (4) Defining attribute data fields correctly, (5) If possible, each attribute data field needs to be formulated correctly, (6) Each variable for data manipulation purposes must be represented in the database. GIS data analysis using ArcGIS software aims to facilitate the process of mapping fishery potential areas. In addition to facilitating the mapping process, ArcGIS can also be used for data analysis because it is also available for simple statistical analysis [19].

Various forms of development of GIS are widely used to detect species that live in the water column with a fairly good abundance accuracy. This detection is generally carried out with the help of acoustic devices [20]. When detecting fish using the acoustic method, fish that are too close to the surface or bottom of the water are not detected properly due to bias if they are above the transducer or at the bottom of the water. Hydroacoustic is one of the most sophisticated methods for determining fish abundance in order to see fishery potential which is useful in mapping fishery potential. The principle of the hydroacoustic method is to estimate the abundance of fish in the number or total individuals per unit area or volume [21].

Estimation of fishery potential can be obtained from data on the abundance of fish in a water area. In addition, the estimation of fishery potential can be used as an estimate of the rate of exploitation, mortality, and recruitment of fish stocks in a waters. When estimating fishery potential, it must be in line with the fishing priority area, where the fishing priority is adjusted to the fishing ability of the fishermen without having to be given territorial boundaries or determining the type of fish caught by the fishermen [22].

Estimation of potential fish resources is obtained from acoustic survey data and catch data that has been carried out by previous researchers in order to estimate fish stocks that have been utilized in a water area. The data that has been obtained can be utilized in the form of geographically referenced information using GIS technology. Currently, geographic information systems are available automatically via satellite, LANDSAT, SPOT, NASA, and NOAA [23].

The development of an example of the use of GIS is to show the presence of overfishing in the northern waters of Java. Overfishing is a major problem in the sustainability of fishery resources that will relate to the socio-economic conditions of fishermen. Efforts are needed to restore small pelagic fish stocks. In addition, there is a need for relocation of fishing vessels above 30 GT to be directed to water areas that are under exploited. Today ring trawlers operate in the Molucca Sea and the Indian Ocean to catch large pelagic fish [24].

2.2 Utilization of GIS in Mapping Potential Fishing Ground

Indonesian waters have a wide distribution of fish collection areas in several areas. The distribution of fish collection areas needs to be known by fishing groups in determining potential fishing areas [26]. In addition, the points of fishing areas carried out by fishermen also need to be well known. This is intended to be able to monitor the impact of fishing by fishermen in fishing areas. In conditions where the impact has exceeded the carrying capacity of the area, it is necessary to determine alternative locations for fishing [27].

The use of GIS and remote sensing has been utilized, one of which is in mapping potential bigeye tuna fishing areas in the waters south of Java and Bali. The mapping was carried out in several stages, (1) determining the optimum sea surface temperature and chlorophyll-a for catches in the positive catches and high catches groups. Sea surface temperature and optimum chlorophyll-a were determined based on the standard deviation of bigeye tuna catch data. (2) overlay data based on its parameters. The chlorophyll-a data of the positive catch group is overlaid with the chlorophyll-a data of the high catch group and the sea surface temperature data of the positive catch group is overlaid with the sea surface temperature data of the high catch group, then (3) intersect for the positive catch group data with the group data. high catch. Intersect was conducted to obtain bigeye tuna catch areas in southern Java and Bali. Finally (4), after obtaining a map of the catchment area, then overlay the validation data that has been classified into positive catch and high catch [26].

Fishing areas can be identified through the application of GIS, where GIS validates based on various parameters of the aquatic environment such as sea surface temperature, current conditions, chlorophyll-a concentration, to the determination of upwelling potential areas. Based on these various parameters, it will be easy to determine potential fishing areas. Access to this information will be updated in time series and can be accessed easily by every fisherman. Utilization of GIS in determining potential fishing areas will increase the productivity of fishing businesses [28].

Technology regarding geographic information systems can be used to overcome fishing problems in Indonesia, one of which is fishing lanes. Utilizing this technology will produce a map of the zoning of fishing lanes. The map can contain information about which areas are still suitable for fishing activities in accordance with the conditions of the

waters. So that people know the waters that have experienced excessive or not excessive use [29]. Through the map there will be information about the condition of a waters. So that fishermen can adjust their boats and fishing gear before carrying out fishing activities. This can prevent damage to an aquatic ecosystem and prevent overfishing. Thus, the fishery resources will be sustainable and can be used optimally and is responsible [30].

4. CONCLUSIONS

The use of geographic information systems in data collection and mapping of fishery potential in Indonesia has developed in the last few decades. Increasing the use of GIS in supporting the achievement of fisheries management in Indonesia is a positive thing. The use of GIS has been in a state of rapid development. GIS is widely used not only in collecting data on fishery potential, but has also arrived at mapping the potential more broadly. This potential mapping is combined with mapping of supporting parameters such as physico-chemical waters to obtain a map of potential fishing areas. The use of GIS can help increase the productivity of fishing businesses and streamline the study of monitoring spatial fisheries management in Indonesia.

5. REFERENCES

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