4.1.2.2 *Development and Accomplishment of Fishing Site Identification System*

A traditional method practiced by fisherfolk to determine productive fishing areas is generally based on experience and information sharing, notwithstanding the evidence that spatial structure and distribution of the pelagic fish species are not arbitrary. This is considering that these species are particularly vulnerable and adapt rapidly to changing environmental factors and global changes, resulting in diverse distributions and assemblages. This situation complicates the process of identifying abundant fishing grounds by the fisherfolk and makes the conventional practice of predicting the assemblage of fish inefficient. It is with this backdrop that a new system was established for sustainable fish catch and meeting the rising demand for food and enhancing the revenues of fishers.

Generally, the presence of small pelagic fish species could be predicted because their distributions are greatly affected by the physical and biological processes taking place in the sea surface environment. The two most important indicators of the physical and biological processes in marine ecosystems, the sea surface temperature (SST) and chlorophyll-*a* (chl-*a*) are intrinsically related. While chl-*a* is a critical oceanographic parameter that plays a significant role in determining the ocean's productivity, SST is an indicator for the physical environment, which regulates the physiology of organisms and phytoplankton growth.

Satellite remote sensing devices can detect these physical and biological parameters in real-time and have primarily supplanted those traditional practices of fishers, as these are more effective and efficient methods than field sampling. Remote sensing data also offer information on SST variations that affect the existence of phytoplankton, the principal food source for fish, contributing to the formation of fish concentration zones.

Fishing Site Identification System

Known as the fishing site identification system (FSI), the system (**Figure 89**) consists of four main components, namely: image receiving and processing, modeling of potential fishing areas, database, and information dissemination system (IDS).

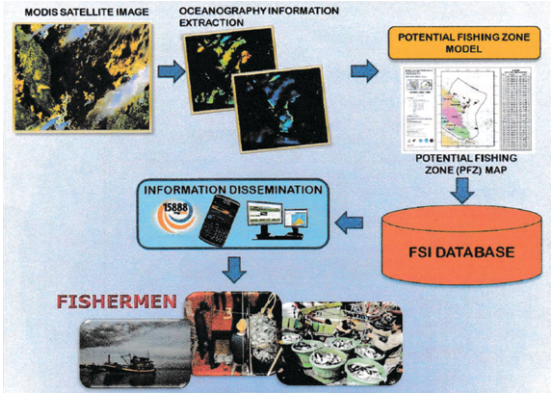

Figure 89. Components of FSI
(Muhammad-Fuad et al., *2012)*

Image Receiving and Processing

The Moderate Resolution Imaging Spectro-radiometer (MODIS) data will be acquired daily. After processing the data, maps of SST and chl-*a* would be generated. Both products are then evaluated to determine the fishing location through the thermal front (**Figure 90**).

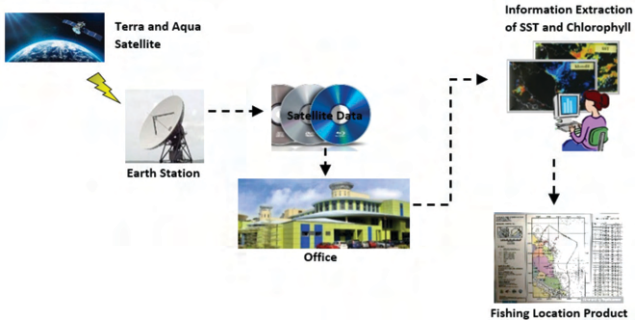

Figure 90. Satellite data analysis and information gathering
(DPPSPM, 2014)

Modeling of potential fishing areas

Chlorophyll-*a* is a well-known indicator of phytoplankton abundance, which correlates with the presence of fish, and SST provides a view of the ocean's surface and contouring it reveals oceanic fronts, currents, eddies, and upwelling (**Figure 91**). These two criteria were examined to generate the possible fishing locations, then stored in the FSI Database by employing geographic coordinates (longitude and latitude).

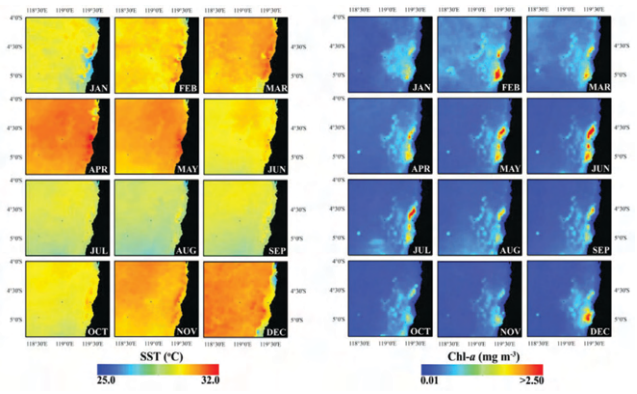

Figure 91. Examples of MODIS monthly climatological composite SST (˚C) and chl-*a* (mg/m^3)
Source: *Suhartono* et al., *2015*

Database

Database development is a critical prerequisite for providing access to information concerning potential fishing areas. It is, therefore, crucial to have complete, accurate, and real-time information for the successful transmission of information on possible fishing locations to the local fisherfolks associations and fishers (**Figure 92**).

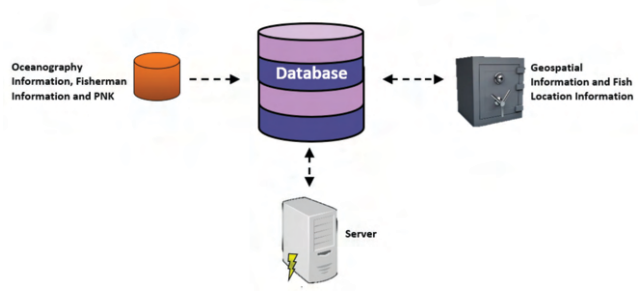

Figure 92. Database

(DPPSPM, 2014)

Information dissemination system

The information dissemination system (IDS) offers fisherfolks information on prospective fishing grounds based on the availability of cloud-free satellite imagery (**Figure 93**). For example, in Malaysia, the fish geolocation can be generated as early as 5:00 PM on any given day and is valid for three days. The precision is within a three-kilometer radius of the specified coordinate.

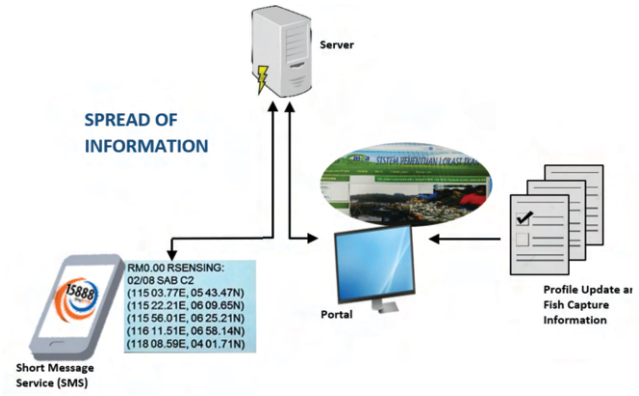

Figure 93. Information dissemination system

(DPPSPM, 2014)

Pilot Studies

The FSI has been pilot-tested in Malaysia starting in 2010 and later in Indonesia. Based on the initial results, several issues and concerns had been encountered during the pilot-testing, especially in the Malaysian setting. Such concerns would be addressed before expanding the pilot testing of the FSI in other Southeast Asian countries.

Malaysia

The recent increase in fuel prices has had a substantial effect on the fishing industry of Malaysia, considering that fuel costs can account for up to 50 % of the overall cost of operating a commercial fishing fleet. In addressing such concern, the development of the fishing site identification (FSI) system was initiated by a Malaysian project team in January 2007 and was completed in December 2010. The system was initially introduced in late 2010 on the east coast of Peninsular Malaysia and was later on expanded to include the west coast, *i.e.* in Sabah, and Sarawak, in early 2011.

The FSI system could be utilized by the trawler, drift net, and hook and line operators. To promote the usage of the system, the project team conducted a nationwide registration and encouraged the fishers to register with their local fisherfolk associations and provide the required information on the owner and vessel registration, capture zone, licensing status, and a cell phone number, to be able to use the FSI.

The initial findings from monitoring and analysis of trawler vessels indicated that their catch has increased by more than 30 % since 2011 upon adopting the FSI system. Based on the fishers' responses to the questionnaires distributed throughout the promotion program, 92.9% of fishers were delighted with the development of the FSI system as it has improved their daily incomes. Additionally, results of the questionnaire survey also showed that trawler operators and fisherfolk from Peninsular Malaysia had indicated a confidence level greater than 90 % on the accuracy of the FSI system. This has been demonstrated from the analysis of trawler landings on Peninsular Malaysia's east and west coasts, which revealed a rising trend of fish landings in 2014. Furthermore, the assessment of the operating costs revealed a decrease of more than 30 %.

Indonesia

A study utilizing satellite-derived SST and chl-*a* data combined with GIS to identify possible fishing areas for Rastrellinger kanagurta was conducted in the archipelagic seas of Spermonde in the Makassar Strait of Indonesia's central region. Satellite data incorporated into the GIS and combined with other databases can provide a more complex and valuable information system that can be used to rapidly and precisely assess possible abundant fishing areas.

The archipelagic waters of Spermonde provide an important fishing area for fisherfolks on the west coast of South Sulawesi. SST and chl-*a* data collected from MODIS measurements were used as the primary satellite data set in the analysis. The relationship between SST and chl-*a* concentrations in the archipelagic waters of Spermonde was calculated, and it was determined that there was a positive correlation between SST and chl-*a*, implying that an increase in SST results in an increase in chl-*a* concentration (Suhartono *et al*., 2015).

The forecasted model was constructed using satellite-derived SST and chl-*a* as environmental datasets and then integrated with the GIS approach to map the presence of R. kanagurta throughout the Spermonde archipelagic waters (**Figure 94**).

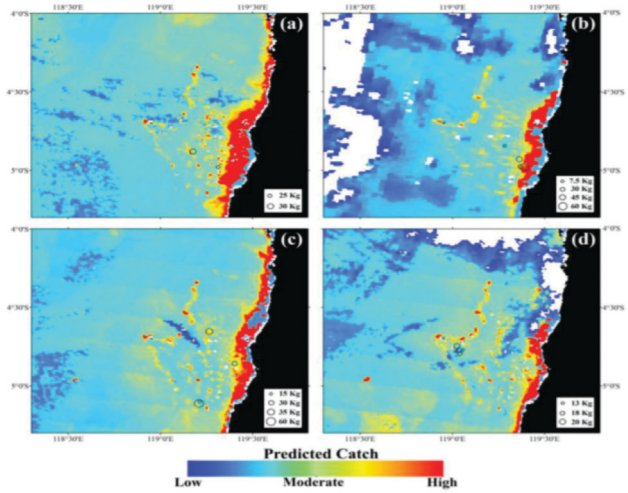

Figure 94. Examples of potential fishing maps: all prediction maps showed the possible fishing grounds which occurred along the coasts

Source: *Suhartono* et al., *2015*

Issues and Challenges

Several concerns and obstacles had been associated with the implementation of this project that includes the following:

a) The tropics have a high cloud cover rate which is greater than 50 % that prevents the daily generation of the potential fishing zone (PFZ) using the MODIS data
b) The use of low-resolution satellite imagery is not ideal for developing this project, despite the fact that it can solve the issue of cloud covering
c) Apart from a lack of technological skills, fisherfolks take a long time to adapt to the latest technology
d) There are challenges encountered in acquiring extensive information on catch, locations, and expenditures from fishers, owing to their low sensitivity to data gathering and storage
e) Need to enhance the initiatives that focus on the involvement of the FSI system by local fisherfolks associations to distribute PFZ to trawl operators

4.1.2.3 Technology on Preservation Onboard Fishing Vessels

SEAFDEC/TD has been developing a design and also initiating the construction of an onboard refrigeration system to be used for fishing vessels by adopting a hybrid technology that can make use of multi-mode operation sources, *e.g.* from the propulsion engine or diesel generator or electricity from the shoreline. In addition, the design also utilizes various types of preservation tools onboard that are more suitable for the fishing gear and target species, such as the refrigeration seawater (RSW) and air blast freezing system. The possibility of using both RSW and air blast freezing systems in unison is also being explored as means of prolonging the freshness of the catch at their premium quality onboard, taking into account the optimum utilization of energy.

Refrigeration seawater (RSW)

Refrigeration seawater (RSW) is a system used onboard fishing vessels to preserve the freshness of the catch. The advantage of using the RSW system is its cost-saving capacity and its ability to preserve the catch at premium quality until it is unloaded ashore or for further processing. Its cooling efficiency is improved, cooling down the catch close to the freezing point much faster than using ordinary ice or limited ice, thus, ensuring the freshness and fresh quality of the catch while being transported onboard. It should be noted that the approximate electricity consumption per ton of ice (box) produced for the icemaker and refrigeration plant for temperate and tropical areas, is approximately 60 kWh/t (Myers, 1981). This does not include requirements for handling, crushing, or storage.

Airblast freezing system

The use of airflow to improve heat transfer from the product being cooled through the refrigeration system is probably the most common method used in commercial fishing vessels. However, the natural convection of the air alone would not give a good heat transfer efficiently, therefore, forced convection using fans has been introduced. To enable the product to reach the freezing point within a reasonable time, the airflow rate should be fairly high (2-6 m/s). Also, to obtain uniform cooling rates throughout the freezer, the airflow should flow over each fish in every fish container.

Power take-off (PTO)

The power take-off is any of several methods used for taking power from a power source, such as the main engine, and transmitting it to an application such as a water pump, hydraulic pump, and/or compressor for the refrigeration system. Usually, the refrigeration system whether in an industrial establishment or on a fishing vessel uses an energy source which is either from the electric motor or engine, to keep the compressor of the refrigeration system going. It is designed to be capable of using more than one type of energy source which consists of the 1) main engine and the 2) electric motor.

Split shaft power take-offs

In a fishing vessel, the propulsion engine or diesel generator has greater capacity in delivering a relatively steady amount of torque at both high and low running speeds. Consequently, the propulsion engine or diesel generator can drive the compressor of the refrigeration system by providing enough power take-off, which is a mechanism to bring power from its operating speed that properly matches with the requirements of the refrigeration unit that utilizes the power source. Split shaft power take-offs have many advantages, making it an excellent option to capitalize on the full potential of the fishing vessels. The split shaft