Development of Web GIS for Fisheries Surveillance in Fisheries Management Zone of Indonesia

Donny Wicaksono[a], Kudang B. Seminar[b], and Purwanto[c]

[a]*Master of Science in Information Technology for Natural Resources Management*
Bogor Agricultural University
Email:donny@biotrop.org

[b]*Faculty of Agriculture Technology*
Bogor Agricultural University
Email: kseminar@ipb.ac.id

[c]*Director, Center for Capture Fisheries Research*
Department of Marine Affairs and Fisheries

ABSTRACT

Fish is one of Indonesia sea resources that are potential to be utilized for Indonesia's prosperity. Fish is highly demanded, and its abundant resources at sea trigger illegal fishing activities. The Government has regulations for fishing management as the decision maker that needs a reliable and good database management system to support it. Geographic Information System (GIS) is capable in assembling, storing, manipulating, and displaying map and database information. GIS allows us to view, understand, question, interpret, and visualize data in a very informative way. In fisheries management that required good and effective data management, GIS is appropriate to be applied. As its function of providing data and information, GIS application for certain purposes, are then developed in web GIS. It means GIS is able to be accessed via internet. Users that have particular interests about the data and information can access directly through web GIS to get what they need.

Keywords : *GIS, web GIS, information system, database, Indonesia fisheries, illegal fishing, surveillance, IFMZ*

1. INTRODUCTION

Fish is one of Indonesia sea resources that are potential to be utilized for Indonesia's prosperity. Fish is highly demanded, and its abundant resources at sea trigger illegal fishing activities. There are many factors causing these violations, some of them are lack of fishers' awareness to respect the law and concern for sea ecosystem and limited frequency of surveillance activities at field. To confront this problem, the Government conduct Monitoring, control and surveillance (MCS) actions for the fisheries sector. MCS, which has often been thought of as a luxury for developed States, has now become an obligation for all States to work together to conserve the marine resources and their environment [1].
To encourage fishing management activities, it is needed to have a good data management, data process and analyzing and also good outputs for required data and information to support further fisheries management and regulations. These requirements can be fulfilled by applying a Geographic Information System (GIS). GIS is capable in assembling, storing, manipulating, and displaying map and database information that allows us to view, understand, question, interpret, and visualize data in a very informative way. The system is developed in web GIS.

2. OBJECTIVES

The objectives are to design and implement a prototype of system that is able to visualize illegal fishing occurrence in Indonesia Fisheries Management Zone through a web GIS. And the system has also been evaluated to provide recommendations for full its implementation [6].

3. SYSTEM DEVELOPMENT METHOD

Development of information system is implementing prototyping method that simplifies and accelerates the steps of system development life cycle [3]. Generally, method of this research is in three main steps, they are: requirements analysis step, development of information system step, and system implementation step.

The first step, requirements analysis is implemented in four steps, which are: problems identification, user needs analysis, data collection and data preparation. While the second step, development of information system is applied in four steps: software and hardware selection, database design, system design and graphical user interface (GUI) design. The third step, system implementation is applied in two steps: system testing and system maintenance.

3.1. Requirements Analysis

Problems Identification:

- It is needed to develop a good and reliable fisheries data base management system
- To optimize valuable fisheries data utilization, to use the data through web GIS environment

3.2. Users Identification

There are three users of the system:

- The Government, represented by Department of Marine Affairs and Fisheries, as Administrator. It has full access to view complete data and has privileges to add new data, edit and delete any data, and for system management and maintenance.
- The Government as Official, who has privileges to view complete data but is not authorized for data base management, such as to add new data, edit and delete any data
- The Public, who has access to view data with few limitations and not authorized for any data base management.

3.3. Data Collection

The system uses spatial and non-spatial (tabular) data. Spatial data consist of:

- Map of Indonesia (sea and land area) in shape file/shp format
- Coordinates of illegal fishing violations at sea in decimal degree format (latitude and longitude)

While non-spatial data consist of tabular data of fishing vessels and illegal fishing violation data: time, date, type of violation, nationality.

3.4. Software and Hardware Requirements

Softwares required for the system are PostgreSQL version 8.1.3 and PostGIS 1.2.1 for database management, QuantumGIS Kore and gVSIG for GIS application and MapServer for Windows (MS4W) package version 2.3.1 with Apache 2.2.10, PHP 5.2.6. and KaMap 1.0 for web GIS application. The system is operated under Microsoft Windows XP or above version for the Operating System.

While hardwares required for the system are Personal Computer (PC) with Pentium IV 1.4 Giga Hertz (GHz) processor with 1 Giga bytes (GB) Random Access Memory (RAM) or higher, SVGA monitor with 1024 x 768 pixels minimum resolution with minimum 2 Giga bytes (GB) Hard disk space, or higher .

3.5. Database Design

Database design is performed in several steps:

- Conceptual Database Design: The information gathered in the requirements analysis step is used to develop a high-level description of the data to be stored in the database, along with the constraints that are known to hold over this data. This step is often carried out using the ER model
- Logical Database Design: Logical modeling phase is related to the actual implementation of the conceptual data model in database management system
- Physical Database Design: Physical design represented logical data model in the software scheme. It describes the data physically where every entity is set based on database software used [5].

3.6. System Design

The system is based on client/server GIS architecture. The client-side components are separated from server-side components (databases and programs) [2]. Client/server architecture allows distributed clients to access a server remotely by using distributed computing techniques. Clients are responsible for user-interface issues, and servers manage data and execute transactions. Thus, a client process could run on a personal computer and send queries to a server running on a mainframe [4].

3.7. Graphical User Interface (GUI) Design

Graphical User Interface (GUI) is a type of user interface which allows users to interact with electronic devices such as computers, in this case, to connect visually information system and users. A GUI offers graphical icons, and visual indicators such as windows, pull-down menus, buttons, scroll bars, as opposed to text-based interfaces, typed command labels or text navigation to fully represent the information and actions available to users.

Users utilize GUI to access and run the system applications. GUI contains pages that show about the system contents, its facilities, help or guidance to utilize the system, button and links to access system's environment. Therefore GUI should be as simple, easy to use, user-friendly, and understandable as possible.

3.8. System Implementation and Maintenance

After development of information system, then the system is tested to implement in order to see whether it works properly. Results of system testing are used as basis for the next step, system maintenance. Technical obstacles or system errors that may occur are observed and fixed. System maintenance is also a step to continually checking the system to perform some updates and modifications for further system utilization

4. APPLICATIONS OF THE SYSTEM

4.1. Home Menu

Once the users access the system, they are logged in as Public user. The *Welcome Screen* appears as shown in the Figure 1 below. It has several main menus: *Home, General*

Information, *Tabular Data*, *The Map*, *Charts*, *Login* and *Powered by.*

Figure 1. Welcome screen of the system

4.2. General Information Menu

General Information menu consist of several sub-menus that describes about Indonesia fisheries conditions and about this system. Figure 2 below shows one of the descriptions.

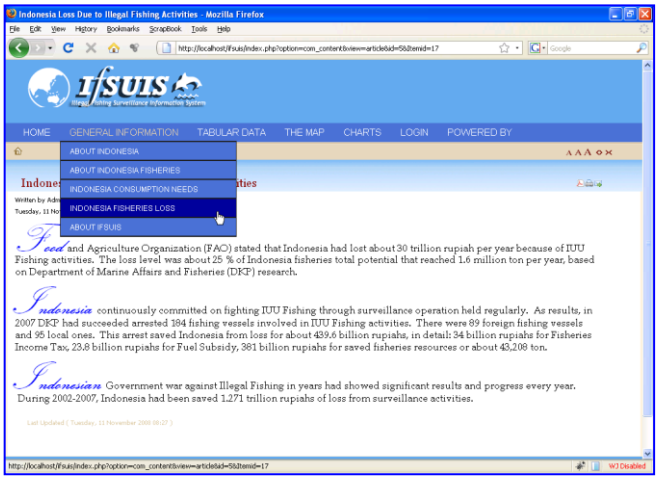

Figure 2. Display of General Information Menu

4.3. Tabular Data Menu

Tabular Data menu consist of several sub-menus: *Fishing Vessel Data* that describes all fishing vessel data including names, vessel types nationalities*; Violation Cases Data* that describes all data of violation occurrences including time and date, coordinates, type of violations; and *Total Accumulation Cases Data* that describes total data of violations. Figure 3, Figure 4 and Figure 5 below shows the tabular data description of the system.

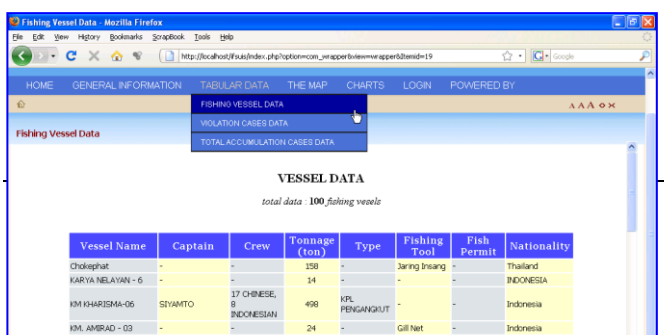

Figure 3. Fishing vessel data display for Public

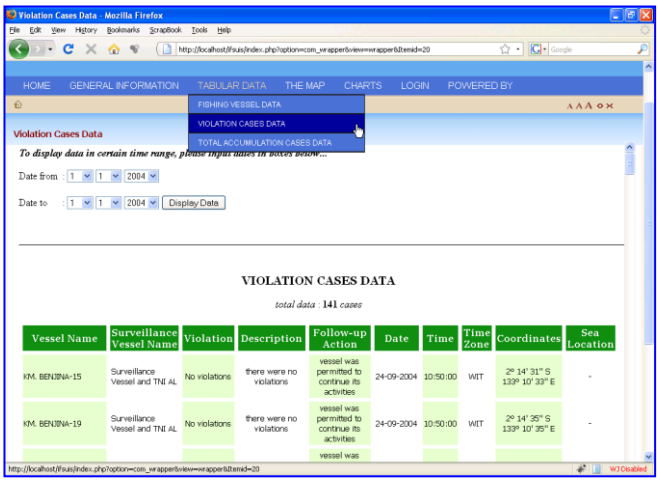

Figure 4. Violation cases data display for Public

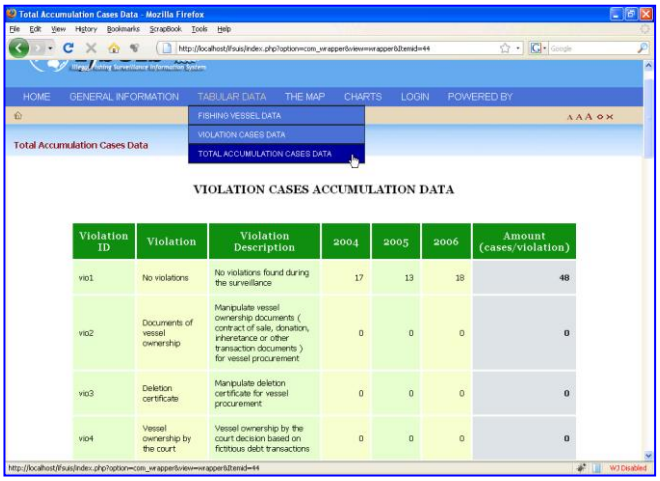

Figure 5. Total violation case accumulation data display for Public

4.4. The Map Menu

Web GIS application is provided under *The Map* menu. When this menu is accessed, the application can be utilized. Figure 6 below shows map application of the system.

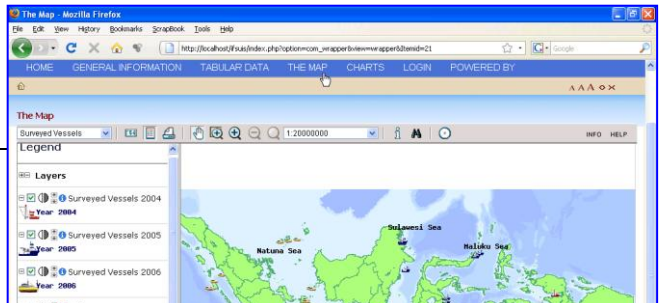

Figure 6. Map application of the system

There are two section of the map display, right and left section. The right section shows map of Indonesia and icons of vessels that indicates points of all surveyed vessels in a certain coordinates.

While in left section consists of 'Layers' that functioned as 'Legends' for all features displaying in the right section of the map.

For example above, the 'red icons' appear on the map are indicated as "Surveyed Vessels 2004" as seen in Layer in the left section.

All these Layers are able to be activated and non activated by clicking 'check' icon in the Layer section. The users are able to manage what to be appeared in map display.

4.4.1. Zoom In, Zoom Out, Pan, Zoom to Full Extent

Zoom In is an application to change the map to have smaller scale, so the map will displayed bigger. While Zoom Out, contrast to Zoom in, it changes map display to be smaller.

Pan is used to navigate the map to all direction. Usually Pan is used when the map is in Zoom In condition. Zoom to Full Extent is used after user Pan the map to all direction and needs to go back to default scale, where all area in map can be displayed in one full screen. Zoom to Full Extent will direct the map that has already Zoomed In or Out into Full Extent Scale

The application can be used by clicking appropriate icons placed in the top section of the map display. Figure 7 below shows the map in Zoom In condition where the map appear bigger.

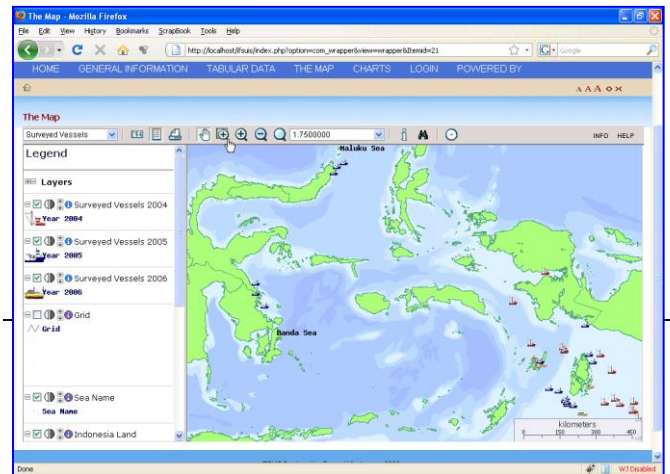

Figure 7. Zoomed In application of the map

4.4.2. Identify Feature

Features on the map, points, lines and polygons, can have information of it or their attributes. This attributes of the feature can be shown on the map. This can be done by clicking Identify Feature icon on the map menu, then click on a certain feature on map. If this feature has attributes, they are directly displayed. The results of Identify Feature are displayed on the left side of the map. Figure 8 below shows the Identify Feature by clicking any points symbol on the map.

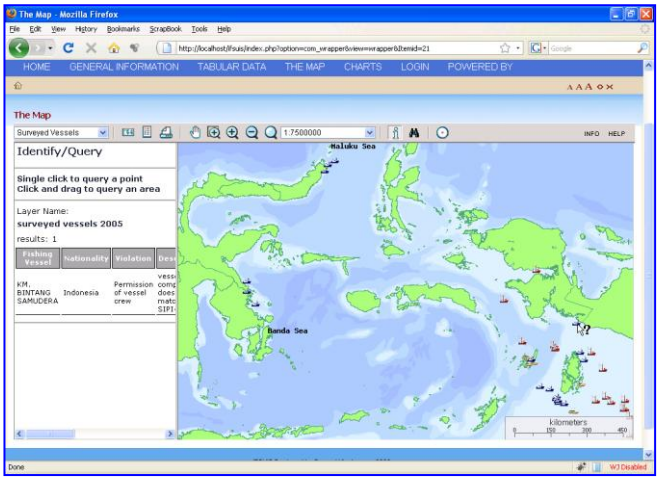

Figure 8. Identify Feature application in the map

4.4.3. Query by Attribute (Search Function)

The web GIS also has Query by Attribute/Search Function. For features that have attributes, could be searched by this application. Points feature can be searched by using Query by Attribute. First click binocular icon on map menu. It will activate Search Function. Then at the left side of the map, a combo box and an empty column appears. The combo box contains two categories of search methods, which are search by "Fishing Vessel Name" or search by "Violation". While the empty column where to type the key word of desired name to be searched. Figure 9 below shows the Query by Attribute aplication

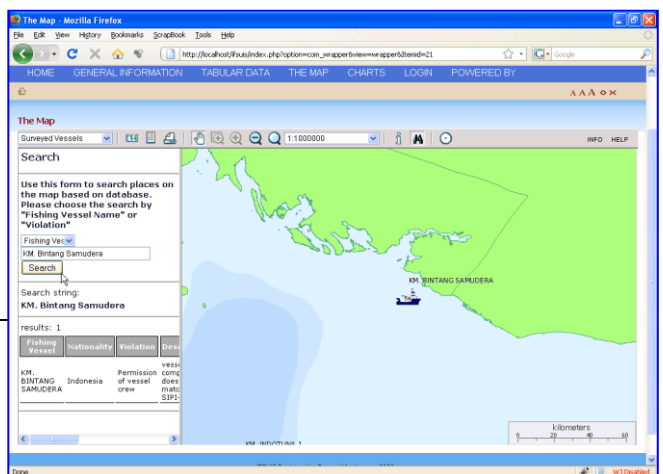

Figure 9. Query by Attribute application in the map

4.5. Charts

The system provides chart display of data that are generated directly from database by using PHP. Charts allow user to observe data more conveniently. There are three sub-menus of this menu, which are *Total Violation Cases* and *Total Violation Cases per Year*. The charts show violation cases occurrences as result of surveillance activities.

Figure 10 below shows bar chart of violation case in total years and Figure 11 shows pie chart of violation case in total years.

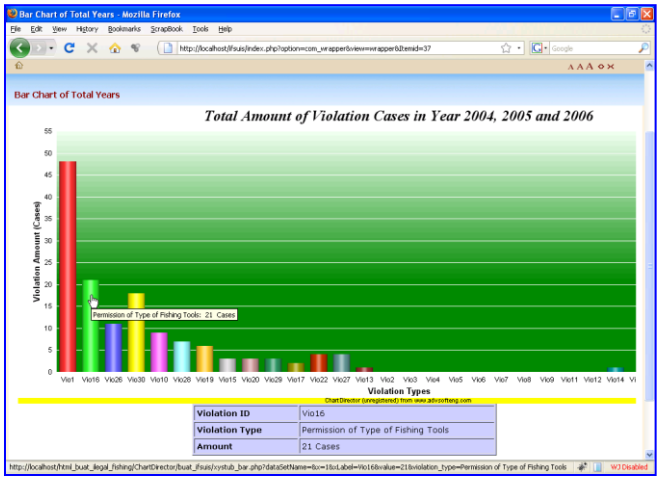

Figure 10. Bar chart of violation case in total years

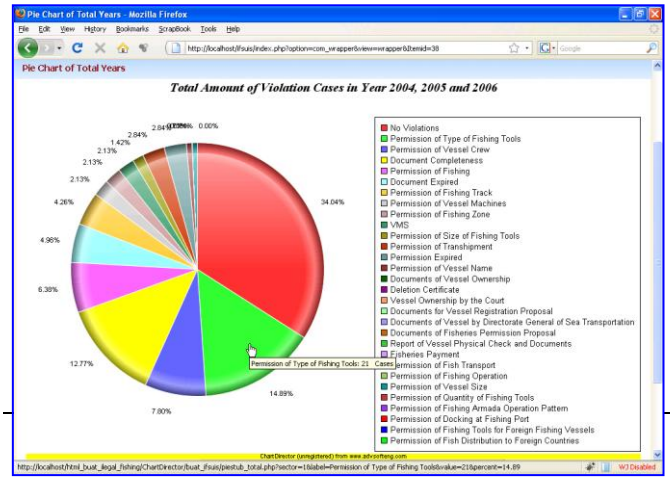

Figure 11. Pie chart of violation case in total years

Chart of total violation cases per year displays total violation cases in each year as result of surveillance activities categorized by violation types. Figure 12 below shows Bar chart of violation case in each year and Figure 13 shows Pie chart of violation case in each year.

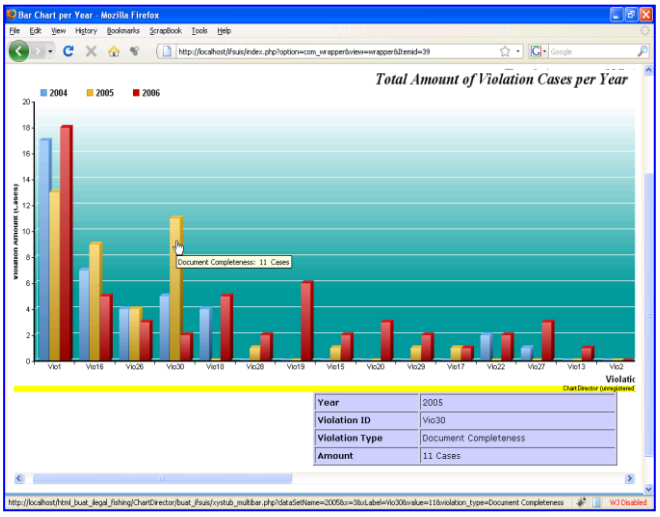

Figure 12. Bar chart of violation case in each year

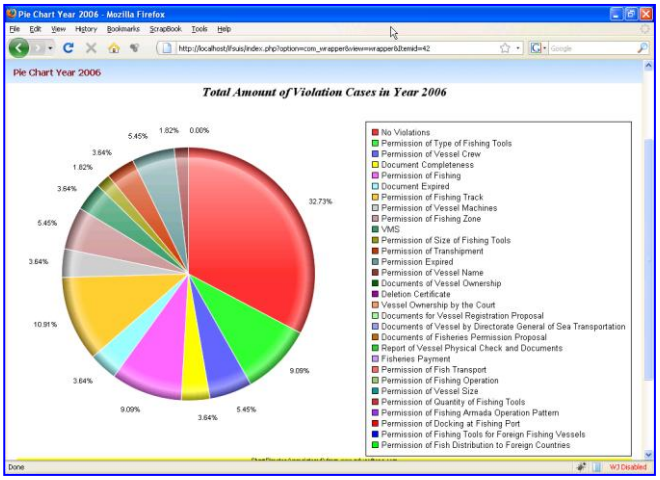

Figure 13. Pie chart of violation case in each year

4.6. User Login

User Login is accessed by users that have special authorization in the system by clicking *Login* menu. The users are Administrator and Official. While Public user do not need to log in to access the system. Figure 14 shows user login of the system.

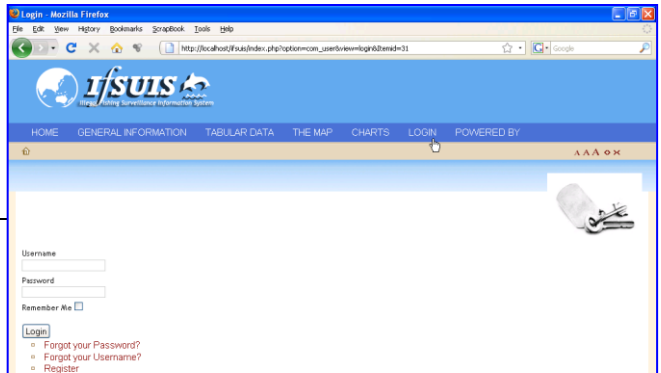

Figure 14. Login function for specific users

4.7. Add, Edit and Delete Function

When Administrator user logged into the system, Add, Edit and Delete data function will appear in Tabular Data Menu. It will give Administrator special privilege to manage data base for the system for system maintenance. Figure 15 shows Add, Edit and Delete data function in violation cases tabular data

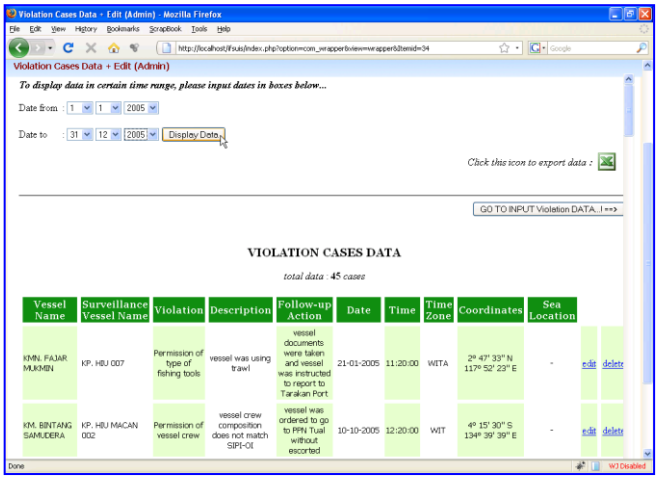

Figure 15. Add, Edit and Delete data function

Another function is Export Data function that also appears when Administrator logs in. This function is useful to export the tabular data into a different format based on user need, in this matter, the data can be exported into Microsoft Excel (*.xls) format.

4.8. *Powered by* Menu

Powered by menu contains list of software that are used in the system development and their links to their own website. This is meant as appreciation to software developers that resulted powerful and useful software that can be utilized in development of this system. Figure 16 shows *Powered by* menu.

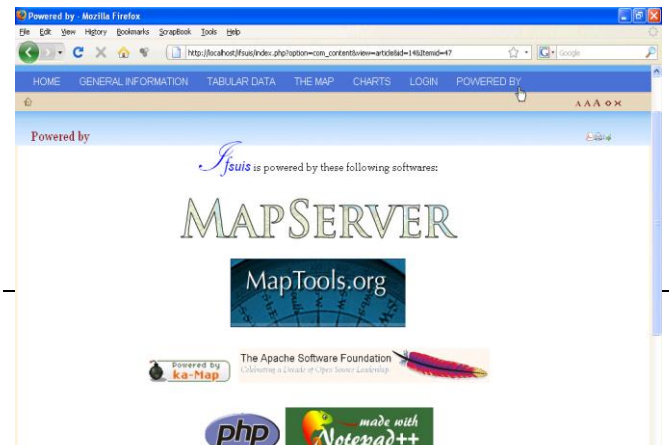

Figure 16. Appreciation and list of software used in the system

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

A prototype design of web GIS has been developed to be able to visualize illegal fishing occurrences in IFMZ and has been implemented to utilize illegal fishing data to become important inputs to mapped illegal fishing occurrences. Therefore, the prototype of the system is capable to provide recommendation for surveillance activities through its facilities in presenting data and information [6].

5.2. Recommendations

1. To ensure the sustainable implementation of the system proposed, regulations must be established by the Government represented by Department of Marine Affairs and Fisheries to standardize data to be collected, including their certain categories, types and formats for recording illegal fishing and other violations as results of surveillance activities to encourage having reliable data records.
2. Furthermore, the proposed system must be also integrated with the existing systems that have been developed in the Department of Marine Affairs and Fisheries in order to have one major fisheries information system that has more comprehensive functions and capabilities [6].

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REFERENCES

[1] Flewwelling P. 1995. An introduction to monitoring, control and surveillance for capture fisheries. FAO Fisheries Technical Paper No. 338. Rome, FAO. 217 p.
[2] Hu S. 2002. Web-based Multimedia GIS for The Analysis and Visualization of Spatial Environmental Database. Symposium on Geospatial Theory, Processing and Applications. ISPRS Commission IV. Ottawa, Canada. http://www.isprs.org/commission4/proceedings02/pdfpapers/449.pdf
[3] O'Brien JA. 1999. Management Information Systems, Managing Information Technology in the Internetworked Enterprise. The McGraw-Hills Companies , Inc. United State
[4] Peng ZR, Tsou MH. 2003. Internet GIS: Distributed Geographic Information Services for The Internet and Wireless Network. John Wiley & Sons, Inc., Hoboken, New Jersey.
[5] Ramakrishnan R, Gehrke J. 2000. Database Management Systems: Second Edition. McGraw-Hill Companies. United States of America.
[6] Wicaksono D. 2009. Development of Web GIS for Fisheries Surveillance in Fisheries Management Zone of Indonesia. Thesis for Master of Science in Information Technology for Natural Resources Management. Bogor Agricultural University.

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