E3S Web of Conferences **189**, 02020 (2020) https://doi.org/10.1051/e3sconf/202018902020
ASTFE 2020

Design of Visual Platform for Fisheries and Aquaculture Production Based on Geographic Information System Technologies

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Abstract. With the deterioration of ecological environment and the increasing demand for aquatic products, the development of fishing remains seriously threatened from various aspects, especially for production planning and control in particular place and time. Therefore, this technical paper develops a visual platform based on Geographic Information System (GIS) aim to help managers formulate sensible policy with the intention of achieving sustainable fisheries development. The key design of this system lies in the association of attribute database and GIS technologies referring to the Leftlet map. There are mainly two contributions in this article: (i) the visualizations of aquaculture production quantity are first proposed according to the geographical location and species category; (ii) system provides the superior results of statistical analysis on user interface due to the technical processing on data association and light or color intensities presentations. Furthermore, the web service is constructed and extended on the principles of the Browser/Server (B/S) architecture whose purpose is to reach efficiency of exploitation and operations.

1 Introduction

Fisheries, an important part of agriculture, are considered usually as the guarantee of economic growth and residents demand. However, the sustainable aquaculture development is under enormous pressure from some elements, including the increasing human population, overfishing and climate change. Consequently, it is essential that to exploit a visual platform for policy-makers and fisheries production managers with intention of providing the transparent and comprehensive information. With the sensor and computer software equipment mature, a spatial analysis tool named GIS, had been attentive broadly by researchers in term of statistical manifestation of relevant data [1].

GIS is a technique system for analysing and managing spatial information, which is mainly concerned with location of the features as well as attributes of those features [2]. In general, GIS can help user identify geographical areas through querying database. The applications of GIS technologies are becoming increasingly popular in diverse fields because of its unique advantages that the friendly display on visual effects and geographic analysis functions [3-4]. The researches of investigation, analysis and modelling of aquaculture used GIS technologies were widely carried out since the late 1980s and some achievements are achieved [5-7].

To evaluate rationally the water quality in in tropical fish ponds, Closea [8] reviewed applications of GIS to tropical inland fisheries and aquaculture and includes applications from related disciplines. A novel model that integrating the farm-scale models and GIS technologies is exploited by Silva et al. [9] to select the site of shellfish aquaculture. Results showed that the qualitative analysis with spatial information increased the accuracy of site selection method to some extent. Some studies recently suggested that positive influence can be obtained by means of using GIS tools in aquaculture management, i.e. Fisheries local knowledge, artisanal fisheries management and Fisheries surveillance management, etc. [10-13].

Studies on fisheries and aquaculture production are crucial project for guaranteeing grain security and increasing the peasants' income. Therefore, this paper presents a design of visual platform based on GIS technologies through production data from Agriculture Organization of the United Nations (FAO) aim to help to inform researchers or planners about production quality trends that are occurring over a broad area in different regions or countries. This designs are briefly summarized under as following: (i) the visual platform concerning fisheries and aquaculture production quantity used the GIS Technologies is first developed and applied to actual operations; (ii) this system provides the superior results of statistical analysis on interface due to the technical processing on data association and light or color intensities presentations; (iii) To serve the fisheries

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operatives well, we also have extended the functionality of this platform, incresing the current situation and trendcy analysis of domestic fishery, namely breeding, fishing, processing, ocean, fish yearbook and water area protection modules.

The rest of this paper is organized as follows. In the next section, we briefly introduce the technology architecture of system and database construction process, then the system response flowchart is decreased immediately. Subsequently, the detailed system function implementations, including the development environments and the integration technologies mainly, are given in section 3. Section 4, we assess the visual functions in term of statistical analysis and some display modules of fisheries production. Finally, section 5 concludes the paper.

2 Technology architecture of system

2.1 System architecture diagram

This system is developed according to the thought of object-oriented method overall, which adopts Browser/Server (B/S) pattern typically, e.g. Data Access Layer (DAL), Business Logic Layer (BLL), Web User Interface (WebUI). The system architecture diagram is described in Figure. 1.

More specifically, the purpose of DAL is to operate and connect the underlying database using .NET tool for invoking in others layers. The BLL as middle layer that consists of spatial data and business data processing on the basis of some specific application subjects. The WebUI refers to a site where a front-end browser interacts with a back-end server and the function of map display and GIS analysis is completed.

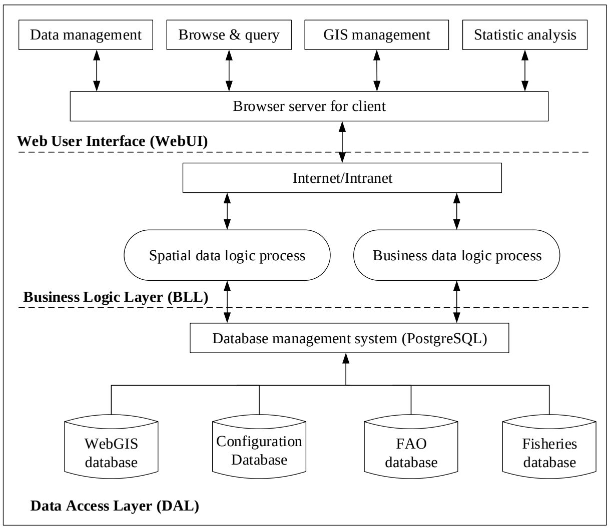

Fig. 1. The visual system architecture diagram.

2.2 Database construction

PostgreSQL is selected as the backend database of system due to its advantages: owning strong stability, strong pressure resistance and compatible with GIS technologies [14]. This database mainly includes aquaculture production, aquaculture value and geographic information. In order to facilitate data management, spatial data and property data of system are stored in different databases, and the association between the two kinds of data is realized through field binding.

To clarify roundly the trends of aquaculture production for stakeholders, the core business data of design is derived from FAO and China Fishery Statistical Yearbook that comprise of rich data types such as aquatic product yield, output value, breeding quantity and processing yield and so on.

2.3 System flowchart

For purpose of describing clearly the response processing of this web server platform, the overall working flow of the system is summarized as shown in Figure 2.

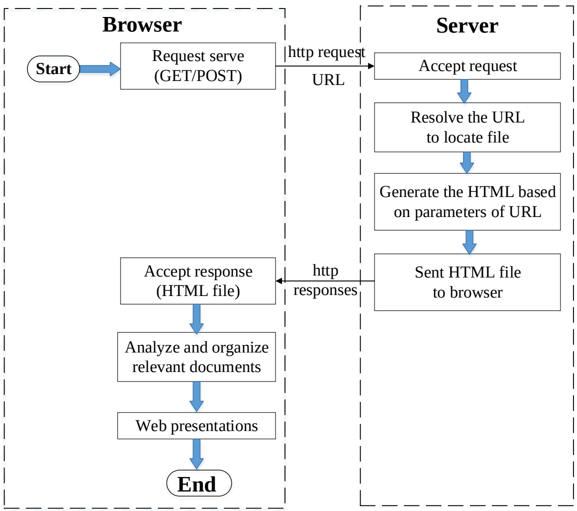

Fig 2. The working flow of the system**.**

Just as in Figure 2, the working process is divided into two stages: Browser and Server. First, the Browser converts this information into a standard HTTP request and sends it to the Web server, when the user inputs instructions to the Browser. Then, serve transmits the page template file obtained by Nginx serve and initializes necessary data from HTTP requests.

3 System function implementation

3.1 Development environment setup

The development environment of the system is shown in Table 1.

Table 1. Development environment configurations of fsheries and aquaculture production platform

Element	Configuration
Development tools	Eclipse、Web Storm
Software operating environment	JDK8、Tomcat8、Nginx
Client operation	Web Browser (chrome)
Data storage	PostgreSQL9.6

The deployment environment of platform is constructed as the form of a separation of front-end code via data transmission. Among the front-end page code is designed with Nginx, and the background service is deployed using Tomcat8 server. Table 2 describes the specific environment settings.

Table 2. Deployment environment configurations of fsheries and aquaculture production platform

Element	Configuration
Operating system	Linux(ubuntu16.0 or above)
Web server	Tomcat8
Database	PostgreSQL9.6
Proxy server	Nginx

3.2 System integration technology

3.2.1 Language of system

The frame of platform uses the typical pattern of Spring + Springmvc + mybatis + redis based on java language. In addition, the page technology adopts VUE+iviewUI form for data presentation, and geographic information data are presented by professional Echarts chart library and open source GIS framework Leftlet.

Actually, the Spring infrastructure [15] has affluent ecosystems and active communities that allows to build enterprise Java applications, Web services, and microservices ect. Meanwhile, since the well-integrated Spring + Mybatis persistence framework, and simplifies access to the underlying database, so that it can be applied to various servers.

3.2.2 Leaflet map

Leaflet, invented by V. Agafonkin [16] and his team, is an open source for JavaScript maps library, which is regarded as a representative of mutual tool in structuring mobile terminal.

The Leaflet design adheres to the ideas of simplicity, high performance and usability with the aim of operating efficiently on all major desktop and mobile platforms. In the browser extension, Leaflet not only leverages the advantages of HTML5 and CSS3, but also supports plug-in extensions in previous browser access. In a word, Leaflet can provide an easy-to-use API documentation and the readable source code.

4 Assessment of visual function

4.1 Main functional modules

In the section, the main functional modules are summarized and presented: first, we standardize and clean the data of various fishery species then build the association model for obtaining insight of theme analysis. Figure 3 shows one of the visual interfaces from word fishery model.

Fig. 3. The main functional modules of interface.

As shown in Figure 3, users can query the overall situation of the world's fisheries, and can also filter the data through geographic information coding to view the production situation in any region. In addition, according to the subdivision ladder, the design utilizes different colors of the map to display the difference in values, enhancing the visual effect.

4.2 Statistical analysis

To provide a direct and precise description of fisheries and aquaculture production, this platform makes data statistics according to the subject classification and presents the results with visual renderings like line, column, pie, and stacked bar chart and so on. The essence of statistical analysis of this platform lies in comparative study based on different area, year, inland/marine environment, species, etc. A typical statistical analysis form is given as Figure 4.

Figure 4 indicates that the comparison results can be presented in histogram as well as statistical table. Status and trend of acquactrual production are easily recognised via this model, which enable stakeholders of fisheries to make more forward planning. It's worth pointing out that this system also developed the functions for downloading picturea and saving data.

Fig. 4 (a). The typical statistical analysis interface.

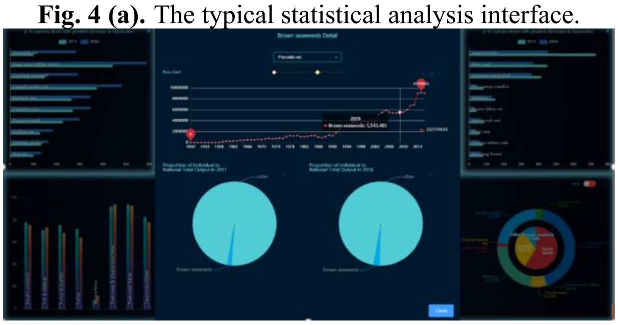

Fig. 4 (b). The typical statistical analysis interface.

4.3 Function extensions

Combining the Leaflet map and statistics analysis techniques, this platform explores the overlapping works in term of chinese fishery such as fishing, fish processing and pelagic fishery and so on. The trend of various fishery-related fields will be presented better via the pop-out outputs and figure illustrations of this module. Typically, an extension function about the aquatic region of improved breeds is given as Figure 5.

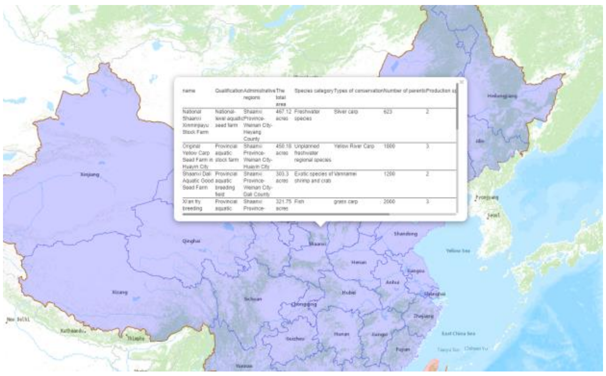

Fig. 5. The aquatic region of improved breeds.

The table data of aquatic region of improved breeds is linked to the location of the administrative division, thus the dynamic visualizations will be implemented during user selects the operation of zooming-out and enlargement. Considering the restriction on entire pages, we have attached a site that intends to provide the nice interface persentations for fishery productors, and the website is available at : *http://huijiao.jianjukeji.com/fish2.0/#/fishBreed*.

5 Conclusions

The world's fish stocks are suffering a tough period that results from polluted ecosystems, disappeared waters gradually and the pressure of growing populations. To maintain sustainable and responsible development of fisheries, recently GIS and remote sensing technologies, regarded as credible spatial analysis tools, have been widely researched and applied since it was proposed in 1980. In this study, a visual platform based on B/S frame and GIS techniques was developed and applied to the information management of fisheries and aquaculture production.

This platform designed by GIS technologies mainly two functional modules. Frist, information relating to fisheries or aquaculture quantity are visually displayed through clicking on the map or selecting fish species. Additionally, the statistical analysis is another feature of this project, which allow conveniently user to seek to the trend and deviations between any areas or aquatic species. With respect to the functions extension, the GIS technologies embedded with the geocoding information are utilized to explore a range of submodule. In summary, the visual system for fishing indeed is promising to improve the likely success of production activities and it can also be transplanted to third-party services.

Acknowledgements

This work was supported by "Fundamental Research Funds of Chinese Academy of Fishery Sciences" (Project Number: 2020TD85) and "Fishery Knowledge Service System" (Project Number: CKCEST-2020-1-15).

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