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Case Report
Web GIS Based Information Visualization for Pest Infection: A Case Study of Rice Plantation

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Abstract
Rice is the Malaysia national staple food. Rice industry in Malaysia is cultivated in a small scale land by more than 300,000 traditional farmers. A study has shown that estimated tons of grains are lost yearly to insects. Thus, careful pest management is significant. In order to ensure the information is delivered to all farmers, it is proposed to visualize the information via the web geographical information system. The map view is important to help distinguish one place to another and then to make an emergence action to prevent the separation of diseases to the nearest paddy plant. The web geographical information system for pest infection area is produced by using ArcGIS online. The facilities provided has made the development success and deployable, besides easier the maintenance work in updating the information.

Key words: Staple food, pest infection, geographical information system, emergence action, CGT

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In Malaysia, estimated tons of staple food are lost yearly to insect[1]. Information is important for effective decision making and operation. Information is one of the greatest main factors which constitute a realistic world. Zhao and Chen[2] information has been defined as uncertainty of being eliminated, information as the thing's variation degree, information as the sequence of system structure and the attribute that thing reflected, information as the particularity that thing reflected. According to them, every definition hereinbefore has its own strong points, but none are ideal. Nevertheless, it shows that the information is an important element in our daily life.

In today's world of "information at your fingertips", the website has played an important role in delivering information to the audience. There are many ways information can be presented on the website. Tullis[3] describes ten of the most common mistakes people tend to make in presenting information on the web, from a human-factors or usability perspective. It can be on the font used, colours, navigation, links or presentation of information on the web. However, information is only useful when it is interpreted by people and applied in the context of their goals and activities. In order to design technologies that best support information work, it is necessary to better understand the details of that work.

Web based geographical visualization provides a new way to display the information on the internet, the Geographical Information System (GIS) and visualization techniques play a more and more important role in the infectious disease prevention especially in healthcare [4]. The GIS and information visualization techniques use the computer graphics and image processing technology to convert the infectious disease information to graphics or images. Web GIS based visualized information could be used for warning, monitoring, processing and controlling the emergent event with its visible spatial information.

This study intended to present the development of web GIS for information visualization for pest infection area in rice plantation by using ArcGIS online.

WEED PROBLEM IN MALAYSIA

Rice is the Malaysia national staple food and is an important commodity in the national food security agenda. Besides oil palm, rubber and coconut, rice cultivation is the major food crop[5]. Malaysia is one of the top 25 rice producing countries in the world with annual production of 2.51 million metric tons[6]. Generally, rice industry is cultivated in a small-scale land of traditional farmers. Currently, there are more than 300,000 farmers involved in rice cultivation of 674,928 ha of land areas[7].

It is reported that about 187 species of insects on rice[8]. Parasites, predators and pathogens play a major role in the regulation of rice pests. Most parasites of rice pests belong to the order Hymenoptera and some few to Diptera. Egg parasites (mostly Hymenoptera) play a major role in limiting the growth of rice pests. A similar role, though to a lesser degree, is also played by larval, pupal and adult parasites. A major group of predators such as frogs, birds and bats play a minor role[8]. In 1979, the crop losses an extensive outbreak of Surcifera occurred in the muda irrigation scheme causing damage to an estimated 7163 ha, resulting in a loss of RM 1.5 million. And in 2006, it is estimated on losses at the national production level to be around 7%, representing a monetary value of about MYR 6.2 million a year[1].

In Kuala Selangor, Integrated Agricultural Development Area (IADA) plays an important role in identifying the area infected in order to take immediate action to prevent the separation of the diseases to the nearest rice plant.

The IADA is one of project under the Ministry of Agriculture Malaysia (MOA). The IADA Kuala Selangor is responsible for the monitoring the fertility of paddy plants in the territory of Kuala Selangor. They are collecting the information of the infected area and then update the information in the web of IADA. The information is displayed in a table format.

BACKGROUND AND RELATED WORKS

Geographical visualization: Geographical visualization representing georeferenced information in at least two ways; by emphasizing the use of maps and other representation forms to construct knowledge (not just to present it) and by dynamically linking the visual map display with both the underlying geographic data structures and the system users (resulting in maps that change in response to changes in data and/or to actions on the part of users)[9].

Web-GIS and visualization: Web-GIS as the combination of the Web and GIS has grown into a rapid development discipline since its inception in 1993. The web GIS is the technique to set up GIS on Web. User can get the geographical information mutually by web-GIS application

through the Internet. It makes GIS function of system expand to web site by combining web with GIS technology. With the rapid development of web-GIS technology, GIS based applications can be developed with low costs and also with a little maintenances work.

In early time, web-GIS based system was used Common Gateway Interface (CGI) based technology by applying JAVA applet as the front end in browser to display the graphical map. In this technology, the web server transfers outside graphical user interface of GIS system. The CGI is acting as a bridge between the graphical maps and GIS application program on the web server.

Then, web-server will respond to the request from the web browser and transmits the GIS map and data information as a picture and then send back to the web browser.

ActiveX is another technique for the development of web-GIS. The COM technology by microsoft company can develop powerful web-GIS system, both in client/server and browser/server system structure. It also supports visual basic, visual C and power builder and development environment. The COM and ActiveX are served as the plug-in in the browser. The plug-in gets the GIS data server and display the graphical map in the browser. User can directly view and operate the Graphical User Interface (GUI) by plug-in. It solves the deliver bottleneck of graphical data in the network by the amount of data transmitted in the network compared to the CGI based GIS system and. Plug-in also provides database operation function to view attribute data, search information and operate the map by a graphical user interface. However, The COM and ActiveX can only run in browser of IE produced by microsoft company and run on the Windows platform. It limits their application in another browser such as Netscape and other platform such as operating system.

Another web-GIS platform is provided by ArcGIS server that allows organization to collect and share geographical knowledge, data and application to others. The data is aggregated, sometimes augmented, published as a service and then hosted by the Environmental System Research Institute (ESRI) on the web. The following topic will further explain the technology.

Esri and ArcGIS: Esri is an international supplier of GIS software, web GIS and geodatabase management applications. Esri uses the name ArcGIS to refer to its suite of GIS software products, which operate on desktop, server and mobile platforms which includes developer products and web services.

Esri's ArcGIS is a GIS for working with maps and geographic information. It is used for creating and using maps, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications and managing geographic information in a database.

ArcGIS includes the following windows desktop software:

- ArcReader, which allows one to view and query maps created with the other ArcGIS products
- ArcGIS for desktop, which is licensed under three functional levels[10]
- ArcGIS for desktop basic (formerly known as ArcView), which allows one to view spatial data, create layered maps and perform basic spatial analysis
- ArcGIS for desktop standard (formerly known as ArcEditor), which in addition to the functionality of ArcView, includes more advanced tools for manipulation of shapefiles and geodatabases
- ArcGIS for desktop advanced (formerly known as ArcInfo), which includes capabilities for data manipulation, editing and analysis

There are also server-based ArcGIS products, as well as ArcGIS products for PDAs. Extensions can be purchased separately to increase the functionality of ArcGIS.

The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community and openly on the web ArcGIS.

Online is to create a map that can be viewed in a browser, desktop or mobile device. The ArcGIS includes detailed imagery of the world, which reveals both the present state of the planet and change over time. These image layers enable to view recent, high-resolution imagery for most of the world; lower-resolution imagery of the planet updated daily and near real-time imagery for parts of the world affected by major events. The ArcGIS online base maps are designed to emphasize different views of our world, from physical to political. Through Esri's community maps program, thousands of global ArcGIS users are improving the coverage and quality of these base maps by contributing their map data and imagery. It also contains the legend and change a style for data analysis based on suitable spatial analysis.

Graphic variables: Information on a map is usually represented by symbols, points, lines and areas with different properties such as color, shape, etc. Bertin's concept of

fundamental graphic variables for map and graphic design and rules for their use is applied in this project. Bertin's fundamental graphic variables, namely location, size, density/size of texture elements, color hue, color saturation, color value, orientation and shape, are means of communicating data to a map reader. Especially the different variables of color have been studied with regard to their efficiency in representing different kinds of data.

IMPLEMENTATION AND DISCUSSION

Figure 1 shows the block diagram representing the development of the web GIS information visualization for pest infection area. The administrator will update the information in pest infection for each area in IADA Kuala Selangor into the excel file that saved in CSV format.

Then the file will be imported into the ArcGIS online by adding the file as a layer. The map will be updated. However, if the Admin intends to do some changes on the legend and futures, he will need to edit it accordingly. The updated map will be embedded in the website and the map will be displayed according to the updated data.

Study area: The study area is located in Kuala Selangor, Selangor, Malaysia and each location is blocked and each block is given a name. Sample data can be referred to Table 1.

Data collection: Table 1 shows the data collected in the project. Each block is infected with same or different pests and witan estimated total of pest. In order for each block can be visualized on the map, the longitude and latitude for each block must be identified. Please take note that the total pest in the table is only test data for testing the web GIS.

Visualization of infected area: Figure 2 shows the map that displays the pest infected area for paddy plantation in Kuala Selangor. As shown, the legend is set based on number of pests has been infected in the area. Red legend indicated that the area has been infected most of the paddy pest.

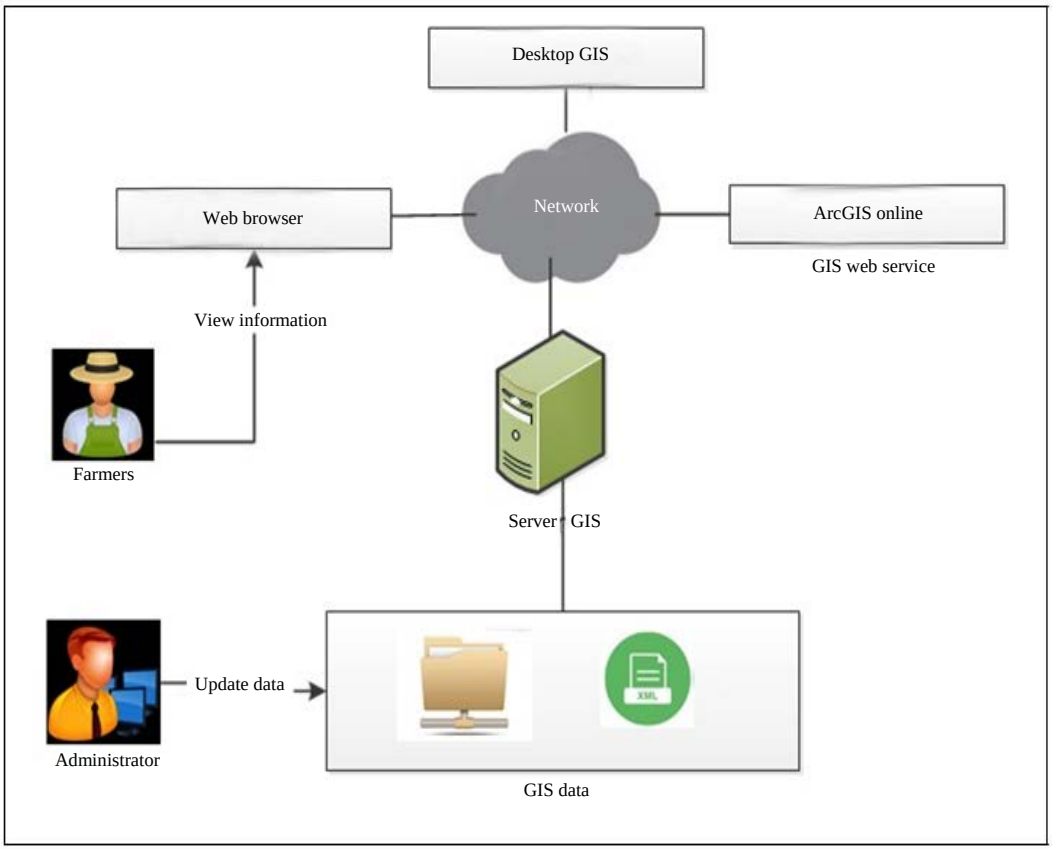

Fig. 1: Block diagram for web GIS information visualization for pest infection

If the cursor is put on the area, the popup information will be displayed to show the details of pest infected in the area as shown in Fig. 3. The pop-up information shows "Kod Block" (Block code), "Nama Blok/Kawasan" (Block name), "Nama Perosak" (Name of pest) and "Jumlah Perosak" (Total of pest).

Table 1: Pest infected area

	A	B	C	O	E
Kod block	Nama Biok	Nama Perosak	Jumlah Perosak	Longitude	Latitude
501010101 A	S. Sempadan	Bena Perang	126	101.208	3.475833
501010102 B	S. Sempadan	Bena Belakang Putih	100	101.215	3.528889
501010103 C	S. Sempadan	Kutu Brung	50	101.221	3.470833
501010104 0	S. Sempadan	Kesing	60	101.227	3.466667
501010105 E	S. Sempadan	Nezara	150	101.234	3.402222
501010106 F	S. Sempadan	Thrips	90	101.24	3.458056
501010107 G	S. Sempadan	Kutu Brung	123	101.199	3.408056
501010108 H	S. Sempadan	Bena Perang	140	101.202	3.403889
501010109 1	S. Sempadan	Ulat Satang	133	101.206	3.401944
501010110 J	S. Sempadan	Bena Perang	170	101.213	3.45m8
501010111 K	Sempadan	Ulat Oaun	!SO	101.219	3.453611
501010112 L	Sempadan	Hawar Seludung	80	101.192	3.458611
501010113 M	Sempadan	Nyamuk Padi	200	101.193	3.455556
501010114 N	Sempadan	Bena Zigzag	179	101.2	3.450278
501010115 O	Sempadan	Ulat Satang	197	101.206	3.440944
501010116 P	Sempadan	Hawar Seludung	110	101.212	3.438889
501010117 Q	Sempadan	Ulat Daun	140	101.226	3.449444
501010118 R	Sempadan	Nyamuk Padi	70	101.232	3.445556
501010119 S	Sempadan	Thrips	43	101.216	3.436667
501010120 T	Sempadan	Belalang	155	101.224	3.434722
501010121	Pari!	Hawar Seludung	250	101.154	3.4536111
501010122	Pari!3	Ulat Satang	250	101.135	3.4776254

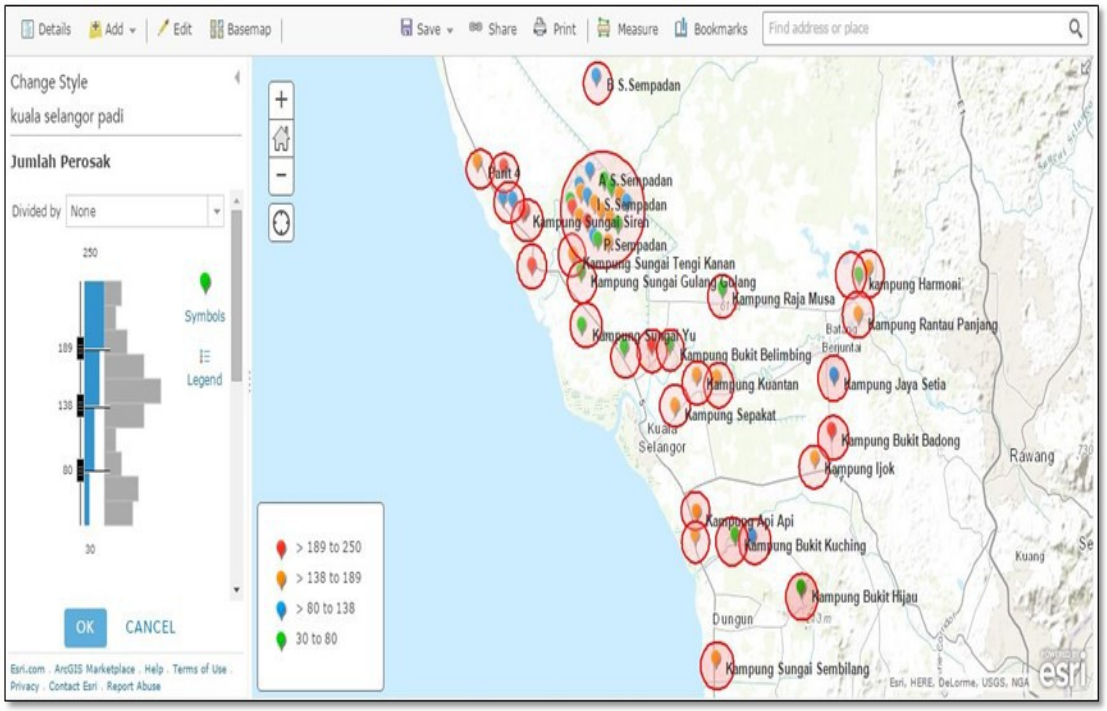

Fig. 2: Map visualization for pest infection area

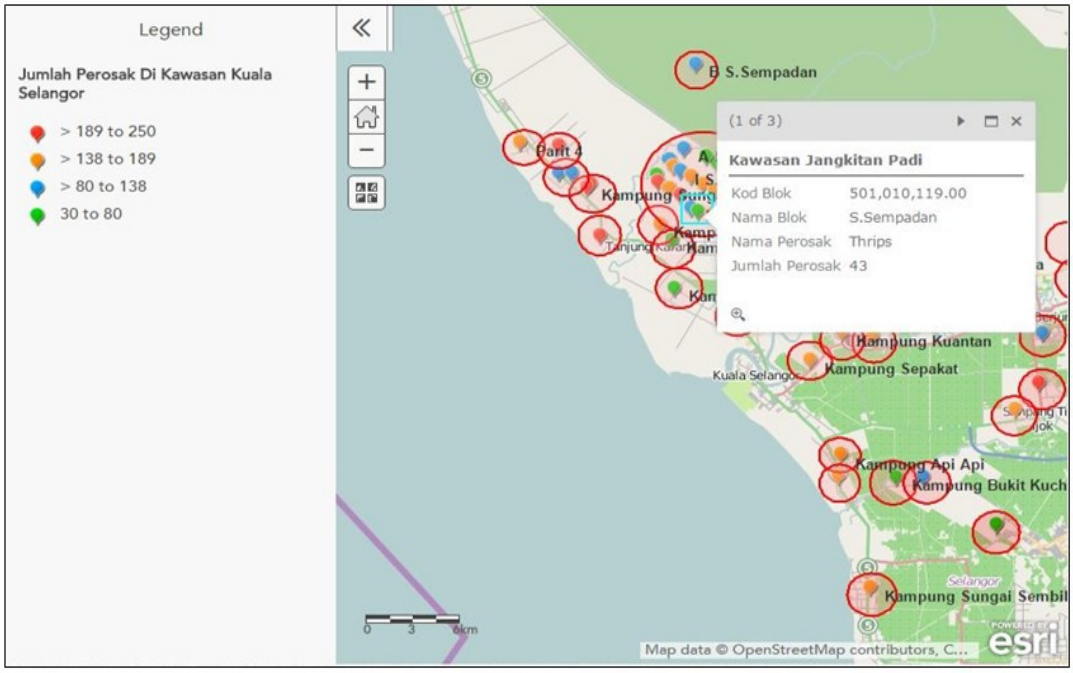

Fig. 3: Map visualization for pest infection area with popup information

CONCLUSION AND FUTURE RECOMMENDATIONS

The development of web-GIS allows visual interaction with data. Since the maps and charts are published on the net, it has help improved the dissemination of information to the farmer. The adopted of ArcGIS online in the development of web-GIS has made the mapping possible. The GIS and various web technologies have efficiently combined as a mechanism to share spatial information freely, openly and easily. The system will help the IADA Kuala Selangor officer to perform the reporting in graphical format. Further development is to develop a web-GIS application for mobile.

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