Construction of Monitoring System of Dangerous and Harmful Species of Import Taiwan Fruits and Vegetables Based on GIS

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Abstract. In order to improve the efficiency of dangerous and harmful species monitoring of import Taiwan fruits and vegetables and achieve informatization, networking and visualization of monitoring, this paper uses geography information system technology to develop monitoring system of import Taiwan fruits and vegetables dangerous and harmful species on the basis of the analysis of monitoring business needs. The system realizes some useful functions, such as showing monitoring data in map, map operation, monitoring data report and monitoring data management. This paper supply informatization supporting platform to dangerous and harmful species monitoring of import Taiwan fruits and vegetables and provide information support for scientific decision-making of alien invasive biological prevention and control department.

Keywords: GIS; import Taiwan fruits and vegetables; dangerous and harmful species; monitoring system.

1 Introduction

In recent years, with the cross-strait relations gradually easing, between two sides of the agricultural cooperation and trade also have entered a development of the fast lane. From the CPC Central Committee and the State Council departments at all levels have issued a series of preferential policies to promote cross-strait agricultural exchanges and cooperation and to encourage Taiwan farmers to the mainland venture capital. Due to the expansion of cross-strait agricultural trade require fast inspection of Taiwan's agricultural products and implement a policy named "green clearance" to fruit and vegetable of Taiwan on entry inspection and quarantine. The fruit and vegetable of Taiwan planting area expands unceasingly in the mainland, constantly

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increasing the risk of pests and diseases of the Taiwan fruits and vegetables at the introduction. The high-risk diseases and pests within Taiwan fruits and vegetables have found on the mainland, which create potential big losses for fruit and vegetable planting in the mainland[1]. In response to this form, to carry out the entry of dangerous and harmful species monitoring of Taiwan fruits and vegetables and to keep abreast of the occurrence and distribution of the epidemic have great significance to formulate scientific prevention and control measures.

Recently, quarantine departments have been monitoring and researching dangerous and harmful species found in fruits and vegetables entering Taiwan and have achieved certain results, in coastal provinces importing a large number of Taiwan fruits and vegetables[2],[3],[4],[5],[6]. However, most of the monitoring also used handwritten notes, which are not conducive to data preservation and could easily damage and loss records. This will impact analysis and research of monitoring data in the future. In addition, most of the monitoring data are detailed position information, reflecting the significant spatial distribution characteristics. The monitoring of the spatial distribution and the route of transmission of invasive alien species is one of the core content of the work of prevention and control. How about making the monitoring data of the spatial distribution characteristics to get a better display, data management and application issues need to be addressed. In view of the above consideration, this paper proposes building a monitoring system of import Taiwan fruits and vegetables dangerous pests based on GIS. With GIS spatial data processing and display capabilities, combined with the techniques of database technology, network technology and rich client technology, develop data reporting and management platform for dangerous and harmful species monitoring, which provides decision support for quarantine and pest prevention and control.

2 System Design

2.1 System Construction Goal

Dangerous and harmful species monitoring monitors and detects the occurrence and development of a certain period of the disease, pests or weeds within a certain range[7]. However, a complete dangerous and harmful species monitoring system should include a standardized monitoring processes and standardized data management system. According to the monitoring requirements, the goal of constructing the monitoring system of dangerous and harmful species of import Taiwan fruits and vegetables includes below elements.

1. Establish monitoring data standard of dangerous and harmful species of import Taiwan fruits and vegetables and establish a unified database.

2. Apply GIS technology to realize dangerous and harmful species monitoring data online publishing, data display and spatial queries, providing decision-making of prevention and control with spatial distribution data.

3. Realize multi-source collaborative dangerous and harmful species monitoring data reporting, auditing, and management, supplying unified data management and sharing platform to monitoring.

2.2 System Framework

The development of the monitoring system of dangerous and harmful species of import Taiwan fruits and vegetables uses the browser/server framework of multi-tier architecture. Improving system maintainability, security, and extensibility, system reasonably splits functionality and business logic in different layers, as fig.1. show The framework of system business functions is divided into four layers except system users. User performance layer is responsible for system interaction with the user, receiving user input or data reported and returning the results of the system running. Data service layer sets up map data and business data transmission channel between the user and the system. Business logic layer achieves all business processing functions of the system. Data storage layer is used to store various types of system information. At the same time, monitoring data standards and data management mechanisms ensure the efficient operation of the system and standardized management.

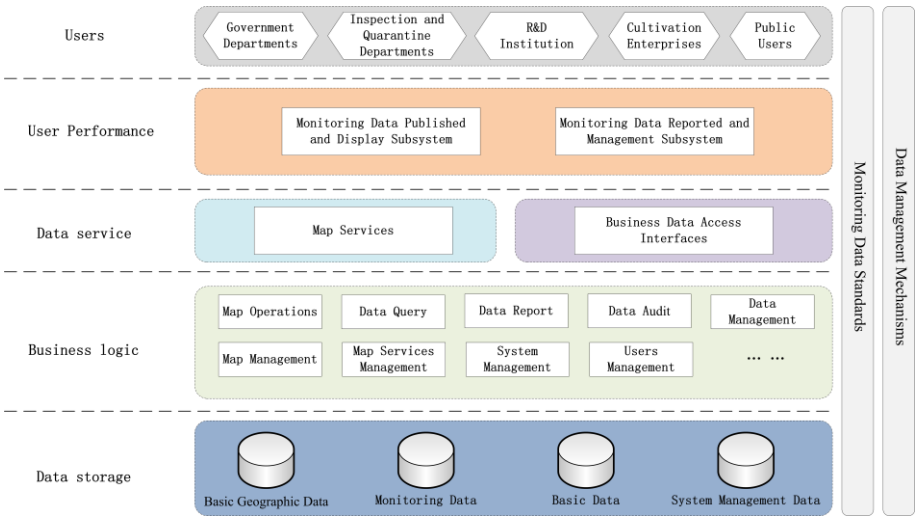

Fig. 1. The system framework

2.3 System Business Process

In the business process, the system operation and management staff can be divided into: fields investigator, data manager, data auditor and administrator. All categories of staff have different permissions, as fig.2 show. The field investigator is responsible

for monitoring the occurrence and spread of dangerous and harmful species and submitting monitoring data to the system through the network. Monitoring positions and monitoring objects depend on the basic data included in the system database. In practice, if the monitoring positions and the monitored objects change, investigator data must require the administrator to apply for basic data changes. The data manager is responsible for basic data management and change. The administrator is responsible for managing system users, user permissions and the map services. The data auditor is responsible for auditing and publication of the data. The monitoring data and the basic data changes passed audit can be entered into the database and data that has not been approved will be sent back to the data submitter to modify. Only approved data will be released.

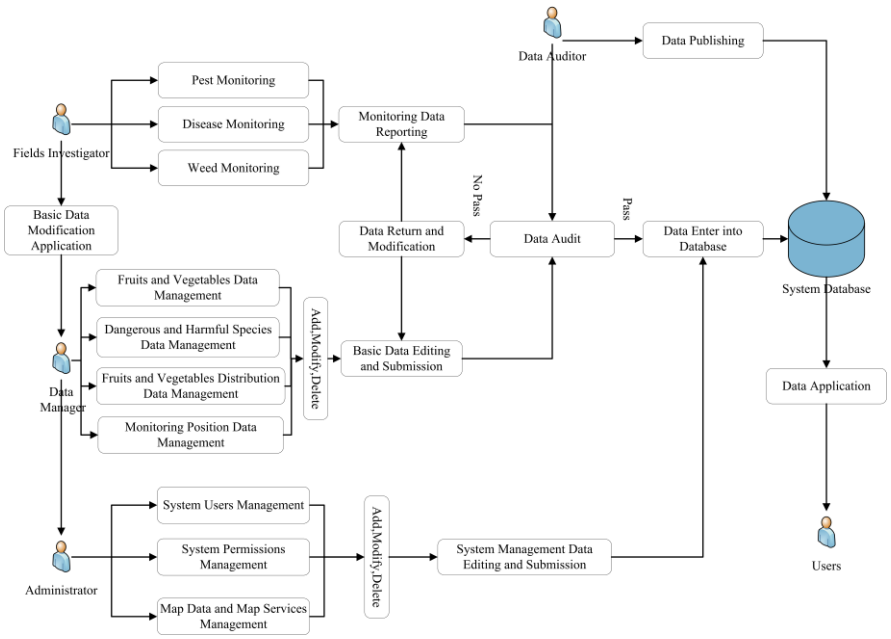

Fig. 2. The system business process

2.4 Data standards and database design

In order to ensure the standardization of the system data resource construction, this paper developed pest monitoring data collection standards and basic data collection standards based on the monitoring practice. Among them, pest monitoring data collection standards include: pest survey standard, disease survey standard, weed survey standard and specimen labeling standards. The basic data collection standards, including: data standards of fruit and vegetable, fruit and vegetable cultivation data standards, data standards of monitoring positon and species data standards. In addition, data forms were specially designed for each type of data content.

The system database design is based on data standards, to meet the needs of business operation of the system. The system databases are made up of business databases and spatial databases. The business databases manage dangerous and harmful species monitoring and systems running data, including five aspects: investigation of dangerous and harmful species data(pests, diseases, weeds, specimen labels), fruit and vegetable varieties of resources data, fruit and vegetable planting data, monitoring positions data(plantation, processing enterprises, distribution center, the port of entry), and system management data(users information, system permissions).The spatial databases store basic geographic data for the map display, including national administrative divisions data (province, municipality and county), national administrative center data(province, city, county, township and village), railways, roads and rivers, etc.

3 System realization

3.1 Development tools and runtime environment

After fully considering the construction goal and the function design, system of the development tools and runtime environment in the following table:

Table 1. The system development tools and operation environment

Classification	Content	Name
Development Tools	Web Development Tool	Microsoft VisualStudio 2008
	Web Development Environment	Microsoft .NET
	Web Development Language	C#
	GIS Development Tool	Adobe Flex 4.0
	GIS Development Language	Actionscript
	GIS Development Component	ArcGIS API for Flex 2.5
Operation Environment	Database Platform	Microsoft SQL Server 2005
	Server Operation System	Windows Server 2003 SP2
	Web Service Platform	IIS 6.0
	GIS Service Platform	ArcGIS Server 9.3
	Client Plug-in	Adobe Flash Player

3.2 Key technology research

3.2.1 RIA technology

The WebGIS rely principally on the map interface for data display and interaction. In the traditional Web application, a number of complex applications often require

multiple data response and transaction processing between the client and server, which cause the page repeatedly refresh and affect the system user experience effect[8]. At the same time, traditional Web applications due to the scalability, interaction, semantic, page links and other problems, resulting in inefficient system development, difficult maintenance, that limits the system application[9]. To solve these problems, the Rich Internet Application(RIA) technologies used in the development of the system to compensate for the lack of traditional Web applications. The RIA effectively integrates desktop applications powerful user interaction with the Web application cost-effective deployment and excellent cross-platform features, representing the new trend of the development of network application[10]. System WebGIS interfaces used Adobe's RIA framework - the Flex, with ESRI's ArcGIS API for Flex development components, achieving rich spatial data display and user experience.

3.2.2 GIS Service technology

GIS service is a set of functional entities of geographic information software in the network environment, exposing package functionality through the interface[11]. It combines the Web Service technology and GIS technology with the characteristics of cross platform, telescopic, fully functional, system integration and low cost, and high degree of standardization, that provides an effective solutions to the GIS system of internal coupling high ,lack of interoperability, difficulty integrate with other systems and other issues[12]. This paper used ArcGIS Server software releases REST standard data interface as GIS services. Independent service for different functional applications is deployed to achieve the efficient sharing of multi-source geographic data, providing basic geographic information support to unified system data display.

3.2.3 Tile map technology

If the client browses the map using real-time rendering mode, each response from the server to the client's request must be each real-time rendering maps and results are returned to the client display. Considering the application environments of the system which are mostly in the relatively backward areas of rural that have terrible network infrastructure conditions,real-time map rendering is not only inefficient but also affect the user operation. Therefore, the deployment of the system used a tile map technology to cache map in the server. When the client initiates a request can be directly read static images in the cache, which can effectively improve the mapping and transmission efficiency and provide fast map display effect[13].

3.3 System function realization

The monitoring system of dangerous and harmful species of import Taiwan fruits and vegetables is divided into: monitoring data published and display subsystem and monitoring data reported and management subsystem, as fig.3 show:

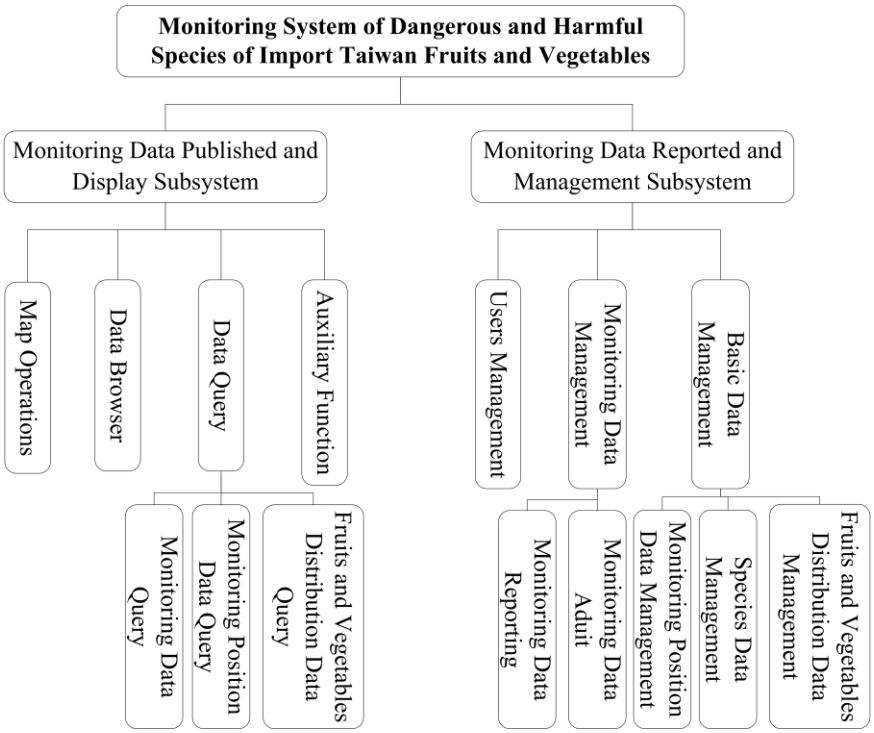

Fig. 3. The system function structure

3.3.1. Construction of monitoring data published and display subsystem

The monitoring data published and display subsystem using GIS technology is responsible for displaying data to public users and realizes data browse and query based on map interface, as fig.4 show. As the use of RIA technology makes interface with drag controls, smooth scrolling animation, effect enhances the display of maps and get rid of the traditional Web page monotonous user operation. This subsystem has main functions below:

1. Map operations: the realization of the basic map interface operations. For example: zoom in, zoom out, pan, full extent, overview map, layer management and so on.

2. Data browser: do not enter any query to display data to help the user quickly view the data on the map. When you open a type of data query window, the subsystem will automatically display in the map for all of this type data spatial distribution points. Click on one point will pop-up detail information box of the data.

3. Data query: the subsystem data query function has three types, including monitoring data query, monitoring position data query and fruit and vegetable distribution data query. Different types have different terms in the query. Subsystem uses separate query window for each query type and the query results also uses a different marker style to show the distinction to increase the contrast effect of the spatial distribution of different data types. In addition, most of the type of query can

be subdivided into subclass, in the same query window using different page tab to arrange query condition. When you close the query window, the subsystem will clear the results of the map and free up system resources.

4. Auxiliary function: provide mapping, positioning bookmark, print and other complex map operations. These features improve the ability to interact with the map interface and a supplement to map operations.

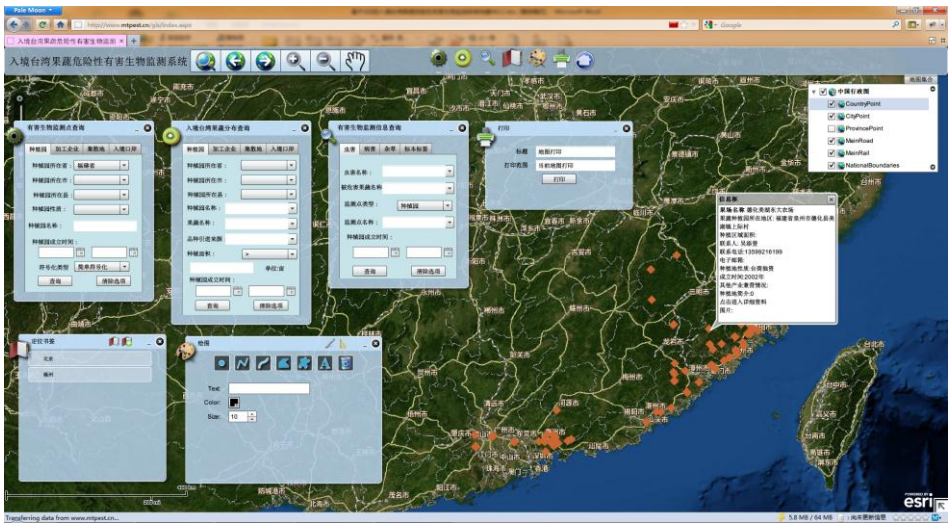

Fig. 4. The monitoring data release and display subsystem interface

3.3.2. Construction of monitoring data reported and management subsystem

The monitoring data reported and management subsystem is responsible for system management and data maintenance, which don't open to the public users. The user groups of the subsystem are limited to the four kinds of system managers. The subsystem through the user account and access control to restrict the operation of the different users, preventing data breaches caused by the different users cross operation. This subsystem has main functions below:

1. Users management: supply the management of the system user data and permissions configuration. Due to the particularity of the system data reporting and management of business, users management operations only by the system administrator.

2. Monitoring data management: this function includes data reporting and audit. Data reporting page provides data furnished, the data submitted and data status view. When submitting large amounts of data, the system can save the data reported in batches until all data furnished. Monitoring data audit page lists the reported monitoring data in list form.The data auditor can select a data record to view detailed information about it. If the data is qualified by the audit, it will be entered into the system database. If the data is not approved, it will be displayed in the data status view page in order to further modify by fields investigator.

3. Basic data management: provide the management operations of the system basic data(monitoring positon data, species data and fruit and vegetable distribution data) such as add, modify, and delete. Three kinds of data are located in a different page tab, arranged in a list and switched through the navigation bar.

3.4 Construction of basic data

The basic data accumulation is a necessary precondition for carrying out applications. This paper has collected some basic data about Fujian and Guangdong which have imported a large number of Taiwan fruit and vegetable. At present, the system has collected 24 records of fruit and vegetable data; 66 records of dangerous and harmful species data; 132 records of various types of monitoring position data; 230 records of fruit and vegetable distribution data.

4 Conclusion and Discussion

This paper introduced GIS technology into dangerous and harmful species prevention and control work, analyzed the needs of the business of import Taiwan fruits and vegetables dangerous and harmful species monitoring data management and proposed construction scheme of monitoring system. The system effectively integrates monitor data reporting, management and presentation of business processes based on collaborative division of multi-role labor. In the system construction of the integrated use of RIA, GIS services, tile maps and other information technology, make the interactive experience of the system map interface has been enhanced significantly. The system could provide the prevention and control of decision-making with data in support of import Taiwan fruits and vegetables dangerous and harmful species occurrence and spread, provide information channels for reporting of monitoring data and supply information platform to inter-regional or cross-sectoral monitoring data sharing.

The dangerous and harmful species prevention and control as a systemic project, monitoring is a key component. However, the lack of the functions of epidemic prediction and analysis in support of the IT technology will restrict the application of the system. How is monitoring data effectively applied? How to play GIS technology advantages in spatial analysis? How to combine the monitoring data and prediction models to provide better information services for the prevention and control of decision-making? All of these issues will be addressed in the further focus.

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