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Development and Application of Meteorological Disaster Monitoring and Early Warning Platform for Characteristic Agriculture in Huzhou City Based on GIS

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Abstract Based on the needs of characteristic agricultural production for meteorological services in Huzhou City, we use C# programming language to develop the meteorological disaster monitoring and early warning platform for characteristic agriculture in Huzhou City. This platform integrates the functions of meteorological and agricultural information monitoring, disaster identification and early warning, fine weather forecast product display, and data query and management, which effectively enhances the capacity of meteorological disaster monitoring and early warning for characteristic agriculture in Huzhou City, and provides strong technical support for the meteorological and agricultural departments in the agricultural meteorological services.

Key words Characteristic agriculture, Meteorological and agricultural information monitoring, Fine weather forecast products, Meteorological disaster monitoring and early warning

1 Introduction

In recent years, the issue of climatic anomaly has become a global concern, and the frequent meteorological disasters have caused huge losses of agricultural production, seriously restricting the rapid and steady development of agricultural production. Some meteorological disasters, such as high temperature and drought, low temperature and freezing, continuous rain, snow and wind, have inflicted an enormous impact on the production of characteristic agriculture. Huzhou City has mountains, hills, plains, rivers and lakes, rich in agricultural resources. Grain and oil, sericulture, aquatic products, animal husbandry, forestry, tea and fruit have become the leading industries. In order to avoid or reduce the impact of meteorological disasters on the characteristic agricultural production, it is particularly important to establish the corresponding meteorological disaster monitoring and early warning platform. Presently, many experts at home have done a lot of researches on agricultural meteorological disaster monitoring and early warning techniques, and have achieved some results[1-8]. However, from the operation and key technologies, there are still a lot of defects in these studies on agricultural meteorological disaster monitoring and early warning technology. Firstly, a large number of agricultural meteorological disaster early warning technologies are still in the research stage, difficult to be directly applied; secondly, most of the existing systems use the traditional statistical models or empirical models; thirdly, the disaster indicators can not be fully applied to local characteristic crops; fourthly, the meteorological disaster early warning technology for characteristic agriculture based on fine weather forecasting is still rare. In view of the above situation, we develop a meteorological disaster monitoring and early warning platform for local characteristic agriculture. The platform integrates the functions of meteorological and agricultural information monitoring, disaster identification and early warning, fine weather forecast product display, data query and management. It can provide theoretical basis and technical support for characteristic agricultural meteorological services, and it is of great significance to the rational use of climate resources, adjustment of characteristic agricultural industry, and improvement of disaster-resistant capacity of characteristic agriculture.

2 Platform design

Under Visual Studio 2010, this platform is based on the . Net framework and written in accordance with the C# programming language standard. In order to make the processing algorithms and programs have better reliability, maintainability, scalability and portability, the programming realizes modular design[9]. The platform includes the following four functional modules: meteorological and agricultural information monitoring module; fine weather forecast product module; meteorological disaster early warning module; data query and management module. Fig. 1 shows the overall interface of meteorological disaster monitoring and early warning platform for characteristic agriculture.

3 Main functions of system

3.1 Meteorological and agricultural information monitoring module The module includes two parts: meteorological and agricultural information collection and transmission system in the characteristic agriculture (planting or breeding) region; server data

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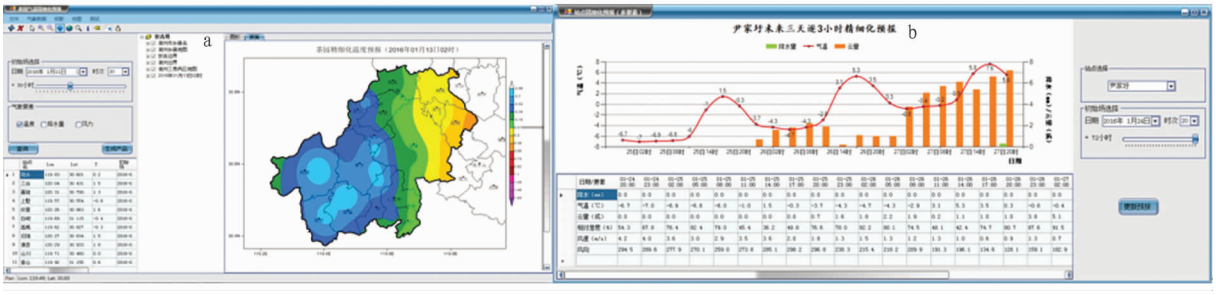
reception and integrated display software (Fig. 2). The meteorological and agricultural information collection and transmission system is responsible for real-time acquisition and transmission of regional digital image information, temperature and humidity and precipitation; the server data reception and integrated display software is responsible for data reception, storage update and display.

Fig. 1 Interface of meteorological disaster monitoring and early warning platform for characteristic agriculture in Huzhou City

3.2 Fine weather forecast product module ECMWF (Europe), JMA (Japan) and NECP (USA) are selected as integrated members, and OCF (Operational Consensus Forecast) is used for objective interpretation of integrated members' forecast results, to form three-hour integrated multi-mode fine gridded objective forecast products with spatial resolution of 5 km × 5 km about precipitation, temperature, wind and relative humidity. The integration approach is based on the study of Woodcock *et al.* [10]. Fig. 3 (a) shows the objective graphical products concerning short-term fine weather forecast for microclimate of Anji tea garden; Fig. 3 (b) shows the fine forecast products of the site, and users can set parameters by "Site Selection", "Initial Field Selection". Precipitation, temperature and other meteorological elements achieve graphical visualization.

Fig. 2 Dragon fruit in greenhouse and meteorological element monitoring



Note: a. Anji tea garden; b. farmland

Fig. 3 Objective graphical products concerning short-term fine weather forecast for microclimate

3.3 Meteorological disaster early warning module

3.3.1 Meteorological disaster early warning model. The model first uses the real-time monitoring data and fine weather forecast products of automatic weather stations, combined with characteristic agricultural meteorological disaster indicators, to measure the meteorological disaster grade; secondly, through the digital images and meteorological elements collected by the meteorological and agricultural information collection and transmission system, it uses SVM for retrieval of weather events and meteorological disasters; finally, it uses the retrieved weather events and meteorological disasters to verify and correct the meteorological disaster grade, and generate early warning results[11]. Fig. 4 shows the schematic model.

3.3.2 Module function and interface. The meteorological disaster early warning module interface is shown in Fig. 5. This module uses MeteoInfo, wContour dynamic link library for secondary development[12], to achieve the early warning function of characteristic agricultural meteorological disasters, and users can select the initial field time, meteorological element and other parameters. The early warning products are finally exported in the form of graphical and textual lists to provide a reference for agricultural weather service personnel or relevant agricultural departments.

4 Data query and management module

The background data of platform are stored in SQL Server2008 database of server, and the SqlClient connection methods can be used to achieve access to the database[11]. The database includes historical agricultural meteorological disaster statistics, meteorological data of past years, real-time monitoring data of characteristic agricultural microclimate, digital image information, characteristic agricultural meteorological disaster indicator system, and objective product data of short-term fine weather forecast. The module achieves the query, retrieval, importing, exporting, deleting and adding functions of all the above data.

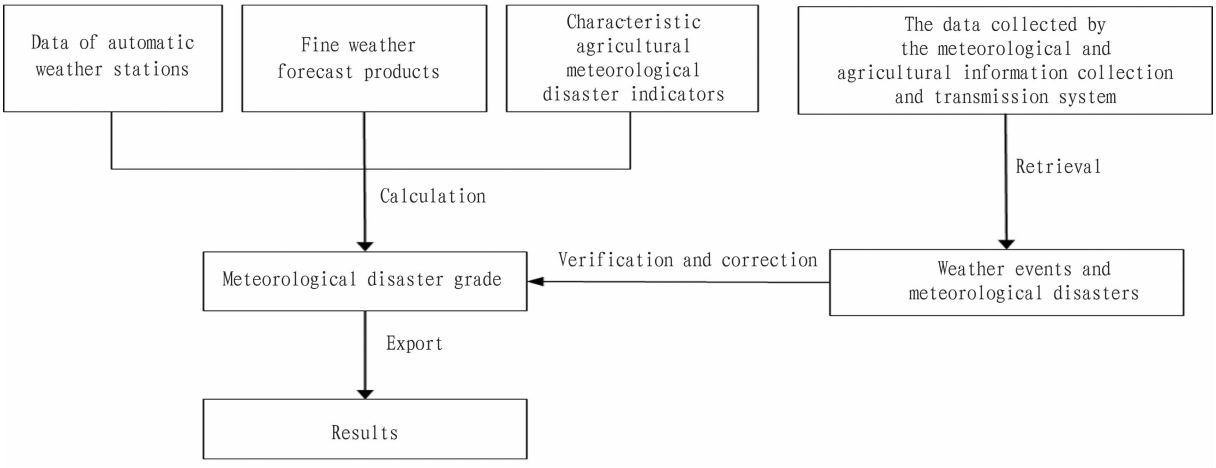


Fig. 4 Meteorological disaster early warning model

Note: a. Anji white tea frost warning; b. meteorological disaster warning and suitability for freshwater aquaculture; c. meteorological disaster warning and suitability for characteristic crops

Fig. 5 Meteorological disaster early warning module interface

Fig. 6 Indicator query interface

5 Conclusions and discussions

Using C # programming language combined with MeteoInfo, wContour dynamic link library, we develop a meteorological disaster monitoring and early warning platform for characteristic agriculture in Huzhou City. Through practice and application in the local areas, it is found that the platform achieves the functions of meteorological and agricultural information monitoring, disaster identification and early warning, fine weather forecast product display, data query and management, and it can improve the efficiency of operational staff. The platform is well applied in practice, effectively improving the meteorological disaster monitoring and early warning service capabilities for characteristic agriculture in Huzhou City, and providing strong technical support for meteorology and agriculture-related departments in agricultural meteorological services.

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(i) The priority development model: for Jishi Village that has large patch size of residential area, centralized population, convenient traffic, excellent ecological environment, and certain population carrying capacity, it is recommended to reasonably plan and build and improve infrastructure and public service facilities, and avoid occupying capital farmland as much as possible.

(ii) The retention limit development model: for villages with relatively concentrated rural residential areas, relatively convenient traffic and high economic level, such as Wangcun Village, Hetao Village, Goukou Village and Lizhuang Village, it is recommended to keep the existing distribution pattern, limit the development of residential areas, improve the separate situation of villages, and control the increase in the quantity of patches of residential areas.

(iii) Migration development model: for the patches of residential areas with poor ecological environment and idle residential patches in villages such as Lizhuang Village, Goukou Village, and Wangcun Village, it is recommended to demolish old and then consolidate, distribute these residential areas in the section nearer to the main road, and improve existing infrastructure through connecting with main road.

In the actual planning process of residential areas, it is recommended to respect the expectation of farmers, make rational planning, and guide rural residents to concentrate through policies. The distribution characteristics of rural residential areas reflect the distribution of external space. To realize optimum distribution, it is required to take consideration of internal distribution. For example, it is required to know whether there is "hollow village" and other problems. In addition, in the process of relocation of rural residents, the adjustment, transfer and withdrawal of land contract and management right and the vacancy of homestead should be further studied from the deep level of three rural issues.

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