

AN ONLINE VISUALIZATION AND DATA ANALYSIS SYSTEM FOR SOCIAL AND ECONOMIC DATA BASED ON FLASH TECHNOLOGY

Jinqu Zhang^{a,b}, Yunqiang Zhu^a, Yaping Yang^a, Jiulin Sun^a

^aInstitute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
State Key Lab of Resources and Environmental Information System, Beijing, 100101, China

^bSpatial Information Research Centre, South China Normal University, Guangzhou, 510631, China

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ABSTRACT:

Social and economic data are almost paid greatest attention by the country leaders and used to sense the situation of a country. The manner of visualization and data analysis to social and economic data will greatly affects the knowledge detection and information acquisition, so designing a good analysis system would be very necessary. This paper tries to use flash technology to design an online visualization and data analysis system to the social and economic data. By comparisons with the traditional web GIS systems, the system designed by the paper has great priorities in following three aspects: (1) Accelerating the online data analysis speed by changing the common work flow. (2) Enhancing the system interactivity by integrating and associating the spatial map, attribute data and statistics chart. (3) Creating a distribute map for any selected element and generating a time series animation dynamically. The result shows that using flash technology can achieve difficult functions that the traditional GIS software can't realize.

1. INTRODUCTION

Socio-economic data are the most important data for analyzing the development situation of a country. The manner of visualization and data analysis to social and economic data will greatly affects the knowledge detection and information acquisition, so designing a good analysis system would be very necessary. Usually, geographic information systems (GIS), as a good spatial-temporal information processing tool, is widely used to develop various application and decision support systems in planning and development, environmental impact assessment, and real-time analysis of spatially distributed data (Maguire et al., 1991). GIS technology has also been applied to the economic development process at local, regional, and state levels of government, as an interactive-visualization and decision-support tool dealing with the socio-economic data (Drummond, 1993). Itzhak Benenson et al. (1998) offer a simple methodology for the analysis of socio-economic networks and emphasize the role of GIS as a visualization tool.

Although GIS is widely used to visualize and analyze the socio-economic data, these applications are mostly running at local machine. It is obvious that delivering, handling and publishing geo-referenced information on the web are attracting increasing numbers of researchers and application developers. Although ArcExplore, ArcView Internet Map Server, Geomedia, etc. are well-known, web-enabled, GIS applications that permit users to access, retrieve, display and analyze GIS data over the web (Green, 1997; Plewe, 1997; Strand, 1997), these web-enabled software has big limitation in response time for visualizing the socio-economic data. The classic web GIS model includes a client program (a Web browser), which makes a request to a server program, and the server processes that request and returns the information to the client. This process model makes every operation require the response processing done at a heavy server, which is not a good model for visualizing the socio-economic data for its low efficiency. Currently, most leading GIS vendors such as ESRI, Intergraph, Autodesk, MapInfo use heavy GIS map servers and specific applications on the Internet

server to provide web mapping services. But there are still some limitations except for the heavy server and time response.

This paper is trying to use flash technology to design an online visualization and data analysis system to the social and economic data with light server but rich applications in the client. The purpose of the system is to solve the following three problems: (1) To accelerate the online data analysis speed. Usually, the analysis should first submit an analysis task to the server and then get a result response at the client, and this process is very slow, especially referring to the spatial maps data. In the system designed in this paper changes the common work flow and accelerate the analysis speed by using flash technology. (2) To enhance the system interactivity by integrating and associating the spatial map, attribute data and statistics chart. On the one hand, users can understand and recognize the problem with multidimensional views at the same time. On the other hand, by associating technology, the interactivity is greatly enhanced. When the users click the administrative area of interested, the attribute data and statistics chart will accordingly change. (3) To create a distribute map for any selected element and generate time series animations dynamically. This would be very useful to detect the element changes from time series and spatial distribution.

2. WEB-BASED FLASHGIS

2.1 Flash technology

Flash is a multimedia platform used to develop web animations with its files in the SWF format that has been the practically standard of web animations for its highest popularity and currently developed and distributed by Adobe Systems since 2005 (Wikipedia, 2009). Flash can manipulate vector and raster graphics, and supports bidirectional streaming of audio and video. Previously, Flash is commonly used to create animation, advertisements, and various web page Flash components, to integrate video into web pages. Recently, with the release of its scripting language ActionScript 3.0 and Flash Player 9 in 2006,

Flash was used to develop Rich Internet applications (RIA) which was introduced in March 2002 by vendors like Macromedia who were addressing limitations at the time in the "richness of the application interfaces, media and content, and the overall sophistication of the solutions" by introducing proprietary extensions (Jeremy Allaire, 2002). Now, Flash is playing a significant role in the development of RIA.

2.2 Web-based FlashGIS systems

For the excellent features in the performance of the network animation and its ability to manipulate the vector and raster graphics, flash has long been used to express geographic information, and the GIS systems developed based on flash technology can be called a FlashGIS system. Robin Hilliard (2004) tries to handle seriously detailed maps in Flash by reading and processing the Mapinfo mif/mid files. ABC news online from Australia used a simple flash-based GIS system to show the federal elections automatically online in 2004. Zongzhi Li et al. (2004) discussed the development of webGIS based on flash. Some other articles also have a try to use the flash to show the electronic map. Although there are some flash applications in the expression of geographic information, most of them are simple and limited functionality. Until recently, with the release of ActionScript 3.0 by Adobe, its use was greatly expanded. For example, ESRI provides ArcGIS API for Flex which allows the creation of RIA on top of ArcGIS Server based on the free Adobe Flex framework. Google, Yahoo and Microsoft and other large companies have released relative maps APIs for use with the Adobe Flex framework. By using of these various APIs, lots of web GIS systems developed by ActionScript 3.0 have been applied in various fields. However, most of these applications are not true vector-based GIS and still use a heavy server with request/response mode. Dang Van Tuyen et al.(2008) designed a flash-based tool and applied it in the management of the country's precious forest resources, which has the similar architecture with our FlashGIS system. In this paper, we will mainly demonstrate the application of FlashGIS in socio-economic data, especially in the statistical functionalities and construct an online visualization and analysis system.

2.3 Architecture of FlashGIS

The following chart is our overall architecture of FlashGIS. Firstly, prepare the administrative units SWF files totally 385 maps, including one boundary map of China, one provincial administrative region map of China, 34 municipal administrative region maps of 34 provinces or municipalities of China and 349 county administrative region maps of 349 municipal cities of China. Each SWF file expresses one map that is converted from ESRI shp file and also contains the attribute data within the ESRI dbf file. The SWF files are named by their maps administrative codes, so that when one clicks on China map, the corresponding province map containing cities under that click point will be automatically associated, and when one continues to click on the province map the corresponding city map containing counties will be associated. By doing this, the system realizes three-level associations that are country to province, province to city and city to county. On the other hand, when one clicks on an administrative unit, the administrative code will be retrieved from SWF file content, and then a SQL query will be constructed and executed to acquire this administrative unit socio-economic data from the database. Because most of the socio-economic data are acquired according the administrative

unit, taking province and county for example, and every administrative unit has a unique administrative code, so each record of socio-economic data could be associated with an administrative unit shape. By setting different colours to different administrative unit shapes according to the value of socio-economic record data, a ranges thematic map will be created. As far as the socio-economic data is concerned, it can also be separately queried and analyzed by using various statistical charts such as pie chart, bar chart, line chart and so on. Finally, the statistical charts and the thematic maps could be combined together to express much more information just in only one map. For the thematic maps, a timeline is designed and an animation standing for the distribution of one element of socio-economic data of China province would be generated automatically by setting a start time and an end time, which animation map is unique that traditional web-GIS such as ArcIMS and MapXtreme cannot realize.

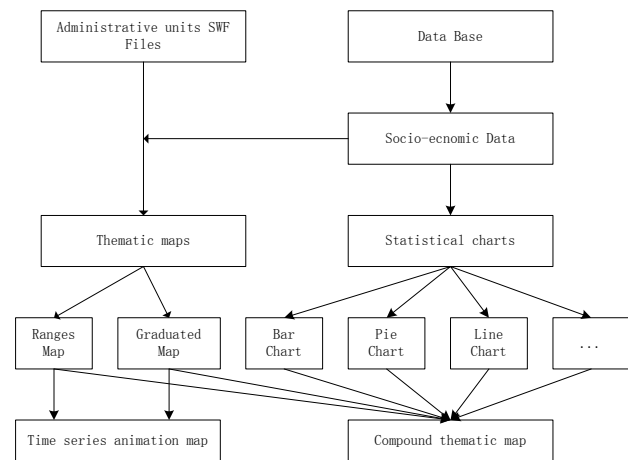


Fig 1. Flow chart of statistical flashGIS to the socio-economic data

3. SOCIO-ECONOMIC DATA VISUALIZATION AND ONLINE ANALYSIS

3.1 Socio-economic database construction

Almost every socio-economic data is recorded by the administrative unit and has an administrative code as a unique identification number, so it is possible to design a universal table structure to organize and administrate every table of socio-economic data. In our database construction, three kinds of table are designed and they are separately index table, content table and structure table.

There is only one index table of the whole socio-economic database and it is used to record the metadata information of every content table, that is to say, when you add a table to the database, you must first add a record to the index table to memorize the overall information of the new table. Table 1 shows the structure of index table. By using the index table, a content table can be easily queried according to the data content key words, cover area or statistical year et al. For a content table, it refers to one of the tables in a statistical yearbook and stores the table values. Corresponding to every content table, there is an associated structure table that stores the fields' information in a content table. It describes the field name, field meaning, field unit and some other field information. By creating these three kinds of tables in the socio-economic database, an interactive query interface can be easily designed to acquire any table that the user wants to. Once a content table

is selected, the corresponding metadata and table structure information will be automatically retrieved.

Until now, we have collected more than fifty years' data of every province in China, including more than 100 elements values of each province from 1950 to 2007 and 33 county-level data on key economic indicators of 3400 counties in China.

Table 1. The structure of index table

Field Name	Field Type	Field meaning
ID	Integer	The table number of a content table
Table_Name	String	The physical name of a content table
Stat_level	String	Expressing the administrative statistical unit, e.g. province, county.
Table_content	String	Expressing the key words of a content table.
Content_Type	String	Expressing the data acquisition mode, e.g. statistical data according to the administrative unit or the sampling spot check data
Cover_Area	String	Expressing the spatial range of a content table; record the covering provinces, cities and counties.
Data_Source	String	Expressing the data source of a content table.
Stat_year	String	Expressing the statistical year of a content table
Table_Structure	String	A table name recording the structure of a content table.
xMin	Number	The leftmost coordinate of the cover area of a content table
xMax	Number	The rightmost coordinate of the cover area of a content table
yMin	Number	The southmost coordinate of the cover area of a content table
yMax	Number	The northmost coordinate of the cover area of a content table
Ch_show	String	The external logical Chinese name of a content table.
En_show	String	The external logical English name of a content table.

3.2 SWF files preparing

Because the SWF file is the web animation file format with vector and raster data supported, so it is very easy to visit and browse the content of SWF directly on the internet without any configuration, which is different from the traditional GIS data, such as ESRI shape file, only be visited on the local machine. The predominant characteristics of SWF file promote us to convert the GIS information stored in the ESRI shape file to the SWF file, and then the SWF file is used for the spatialization and visualization of the attribute data queried from the socio-economic database. The shapes in a SWF file are assigned different colours according to the selected field value in its corresponding record data. The shapes in a SWF file can be generated in two ways: (1) the one is to generate SWF files in advance; the other one is to store the ESRI shape files coordinates data in a database and generate SWF shapes at running time according to the user's request. In order to accelerate the internet visit speed, the first way is adopted and a

series SWF files, containing a series of administrative units spatial shape, are created in advance. These SWF files are converted from ESRI shape files with attribute data and coordinates included by using a C++ programme written by ourselves. In a SWF file, each shape corresponds with a feature in the ESRI shape file and the attribute data are stored as an array with shape number associated.

3.3 Socio-economic data visualization and analysis

The online socio-economic data visualization and analysis system are mainly divided into three parts: (1) Spatial distribution thematic map analysis; (2) Statistical chart analysis and (3) Association analysis of the multi-level administrative units.

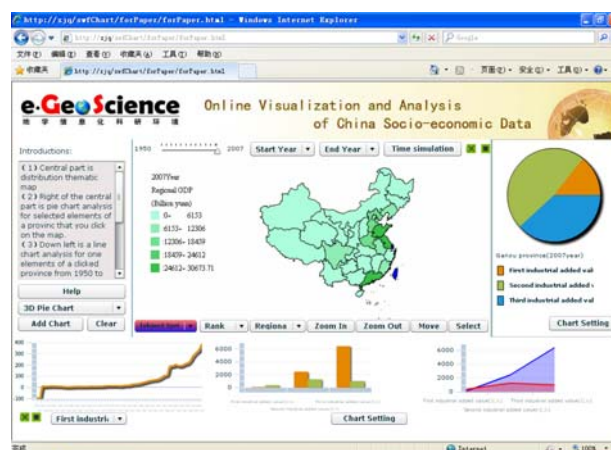


Fig. 1. Index page of online visualization and analysis system

Fig.1 shows the index page of our online visualization and analysis system of china socio-economic data. At the centre of the page is a vector China map which is loaded from a SWF file. When the China SWF file loaded finished, a completed event will be activated and call for a function to run. The function will then link to the database by using a HTTPService component in flex and execute a SQL query to retrieve the regional gross domestic product (GDP) data of every province in China in the year of 2007. On the top of the map is a timeline and a time simulation button, users can click on the timeline to select one year between 1950 and 2007 and also can click the time simulation button to generate a thematic dynamic changing animation map. The most significant characteristic of this animation map is that it is online, real-time, fast speed. The regional GDP is the initial field and user can select any field he needs to generate a thematic map from more than 100 fields of the table. In addition to these, the functions of traditional GIS are provided, taking zoom in, zoom out, move and select for example. Here, the select button has special use. When the user choose select button and click on the map, the province under the click point will be automatically recognized and the statistical charts around the map, including pie chart, line chart, column chart and area chart, are also simultaneously changed. There are setting options for every chart to be set by the user. The statistical chart can still be put on the thematic map to form a multi-factor composite thematic map (Fig. 2). The detailed functions can be tested and visited on the web address of <http://210.77.94.214/chart/index.html>.

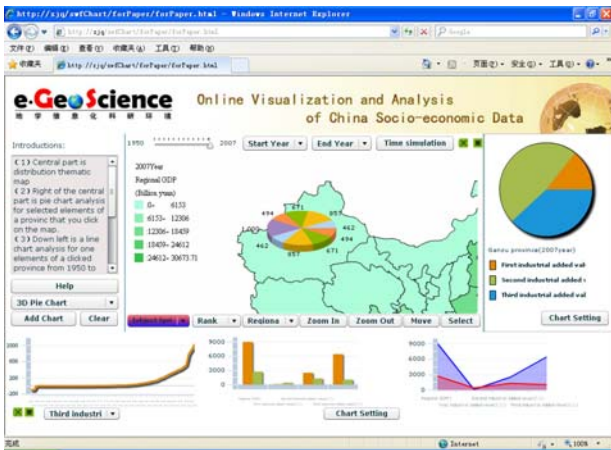


Fig. 2. Add chart to the thematic map

Fig.3 shows the association analysis of multi-level administrative units. The main purpose of this function is to provide not only the micro spatial distribution of some element but also to detect the local distribution at the same time. In Fig. 3, the left is a whole China map, any element field can be selected to generate a thematic map of its distribution in China. When you click on the map, for example, the click point is within the range of Heilongjiang province, the Heilongjiang province map containing its counties will be automatically loaded on the right. In the bottom part is two grids showing attribute data that be selected and related to the map in the top.

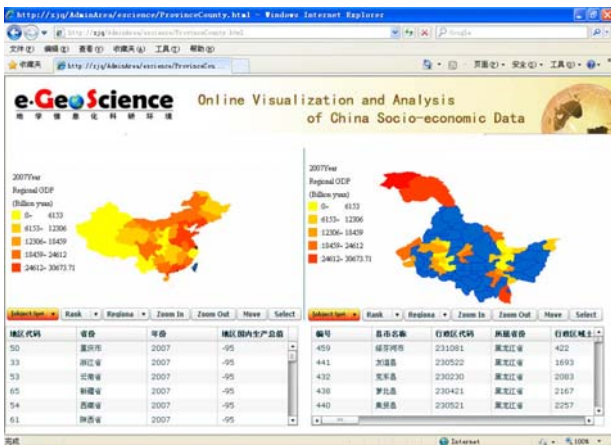


Fig 3. Association analysis of multi-level administrative units

4. RESULTS AND DISCUSSION

By using the flash-based technology, we construct a vector-based flashgis system and apply it to develop an online visualization and analysis system for the socio-economic data of China. Originally, the socio-economic data is only attribute data with each record bounded with an administrative unit and they are incomprehensible. In order to acquire information much easier and detect more useful knowledge, we convert the China province level, municipal level and county lever GIS graphic data to the SWF files and combine them with the socio-economic data use an index field as association so that we can give a visualization analysis to the socio-economic data. Our application shows that it's a better approach to analysis the attribute data than the traditional GIS system manifested at least in three aspects: (1) web-based and cross-platform; (2) small file and fast speed; (3) rich rendering and strong expression.

4.1 Web-based and cross-platform

So far, there are many web animations created by Adobe flash software and they are all SWF file format, which make the SWF file the fact standard of web animation. Comparing with the traditional GIS data files, such as ESRI shp and Mapinfo tab files, we convert them to the SWF files and they are naturally web-based. On the other hand, SWF files are cross-platform without any additional configuration, not only on the Windows platform, but also on the UNIX platform and even the mobile phone can support the SWF files too. These characteristics make the SWF file have a high priority in developing web-based and mobile GIS system.

4.2 Small file and fast speed

The second priority of SWF files is that these SWF files are very small but with a high performance. Table 2 shows the comparison between SWF file and shp, tab files, from which we can find that the SWF file size is almost one tenth of tab file and one ninth of shp file. This is due to the high compression ratio of SWF file format and guarantees the whole file transfer to some extent. The SWF file also has the characteristics of streaming media that let it has a fast transfer on the internet.

4.3 Rich rendering and strong expression

SWF is commonly used to express web animation and good at color rendering, graphic expression and multimedia integration, and these characteristics are just applied to express the spatial information. With the release of action script 3.0, lots of open source statistical charts are developed and can be easily integrated with SWF map files. Fig. 2 just shows an easy example of integration of SWF map and statistical chart.

5. CONCLUSION

As the development and progress of Adobe flash technology, flash has demonstrated high performance and super priority in publish web GIS maps and we just take a try to apply it in the visualization analysis of socio-economic data, which shows a very successful application. However, there are still many problems to be resolved in the wide range of application. Our application is just a lightweight application, and how to support the huge amount of data still need further study. The symbolization method and construction of symbol library are still in study. Also the varieties of geographical spatial analysis, including 2D and 3D analysis, are essential to the success application of flashgis.

6. ACKNOWLEDGEMENT

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