GIS and Regional Economic Development Planning

Chen Fei[1, 2] Du Daosheng[1] Jiang Jingtong[3]

1. (National Lab in IESMRS, Wuhan University, Wuhan 430079 PRC)
2. (Economy and Management College, Nanchang University, Nanchang 330047 PRC)
3. (National Geomatics Center of China, Beijing 100044 PRC)

Abstract: Regional economic development becomes a common cognition among all levels of government. To obtain a rapid, healthy growth of regional economy, various technologies are introduced into. GIS technology is one of those and is now being applied to the process of economic development at local, regional and state levels. Decision-makers recognize that GIS technology is an interactive visualization and decision-support tool to directly support economic planning. In this article, authors make a preliminary study on how to develop a Spatial Decision Support System(SDSS) to promote regional economic development planning.

Introduction

In the past decade, economic geographers, Decision-makers, and other development specialists have shown great interest in applying Geographic Information System(GIS) technology to the field of economic development, especially to the planning process of economic development at the local, regional and state levels(W. R. Strong & E. D. Lenz 1988, R. A. Wright, K. T. Adair & F. Koleszar 1991, Shih-Lung Shaw 1993, W. J. Drummond 1993, P. Longley & G. P. Clarke 1995, G. Clarke 1997, E. Irwin 1999, H. Gary 1999, L. Greenwell 1999, B. Harris 1999, A. Kalinski 1999, N. Kristina 2000, C. Wayne & E. Fladager 2001). Regional economic development planning is a comprehensive process. It is not only a way to achieve objectives, but also as a process for learning more about all kinds of resources and regional economic system being managed.

Nowadays, GIS technology, as an interactive visualization and decision-support tool, plays an important role in regional economic development plans as well as traditional analytical systems or approaches(Louie Greenwell 1999). In according with most underlying or completed researches, GIS activities for regional economic development show special emphasis on spatial analyses, which can be intended to identify areas for industrial development, to locate suitable sites for development, or to identify environmental constrains to development(R. H. Pittman 1990, M. F. Goodchild 1987, 1991, 1992, 1993, W. J. Drummond 1993, A. Kalinski 1999).

According to geographical, historical, political reasons and other aspects, economy is underdeveloped in western China compares with eastern regions, especially compares with coastal regions. Furthermore, the gap between Western and Eastern regions becomes more and more distinct since 1980’s. How to reduce the gap quickly, how to obtain a rapid, healthy growth of economy in western regions, how to realize socio-economic development equilibrium among regions are practical facing problems in China. Recently, the resolution of Grand-scale Development of China's western regions is approved and is being carry out as a national basic policy all over the country. In this article, authors pay more attention to the use of GIS for economic development planning of western regions, and to the illustration of some integrative approaches and the design of spatial information support system for economic development planning.

1. Regional economic development planning

The need for a scientific and quantitative analysis of the economic, social, demographic and environmental characteristic of a region is the main reasons for regional development plan. Economic development plan, as an important part of regional development plan, is being considered

more extensively. The major aim of economic development plan is to deal with economic development and resources utilization within a certain region in a scope of time in future.

In the past, nature is reckoned as a world lack of spatial dimension usually. Time is considered as the most vital factor in commonly economic plan and economic analysis, while spatial factor is ignored. Spatial organizing forms and principles of economic activities are less thought essentially in the process of economic planning. These approaches, which are adopted in the process of economic planning and analyzing, are mainly based on the developing history, current situation of regional economy(Haixiao Huang and Walter C. Labys 2001). For instance, Economic time-series analysis models, Econometric analysis methods Network analysis, Statistical analysis models and so on.

In fact, spatially optimal configuration of resources and regional equalization are not the consequentially results of market power. Differences are inevitably existing among regions for spatial friction in price, cost, income and other aspects. Traditional economists aware of gradually that those characteristic differences among regions should be taken into accounted adequately in the process of regional economic development planning. The importance of spatial planning of economic activities is also recognized. Currently, most of them try to syncretize spatial dimension within the theoretical framework of traditional economic planning and analyzing, and study economic phenomena from the aspects of spatial angle(Elena Irwin 1999). Some theories are developed and formed. Among them, a few representatives include Development Stage Theory, Growth Pole Theory, Neo-classical Regional Growth Models and so on. For more, see F. Perroux(1960), W. Isard(1956, 1960, 1969, 1999), E. Hoover(1975), H.W. Richardson(1973, 1978), L. Lefeber(1974), M. Webber(1984), A. Nelson(1993), M.Fujita(1999).

Recently, planners pay more attention to the spatial distribution of economic activities. In fact, spatial distribution changes are intertwined with the inter-temporal processes in economic growth and development(Haixiao Huang and Walter C. Labys 2001), but there is usually no continuity about those changes. To obtain a deeper knowledge about those changes, it is need to integrate traditional economic analysis models and econometric methods with GIS spatial analysis approaches.

GIS, as a new information technology, plays a vital role in regional economic plans currently. Sound policies and decision making for regional economic development plan require accurate spatial information, but in many times there is a lack of up-to-data data necessary for building proper economic analysis models and sustainable management policy(Oni Samuel Iyiola 1999). GIS justly claims a role in this support. The application of GIS technology in regional economic development plan can ensure the planning process and supply accurate and quantitative information required. However, the use of GIS in regional development planning contexts is still in relatively low level, administrative functions.

Another new technology approach being used in the practice of regional economic development plan is Spatial Decision Support System(SDSS). Many essential factors, which involved in the process of regional economic development planning, have evident characteristics of uncertainty, randomicity and non-linearity. It is an extremely complicated non-structured problem to analyze those factors in detail. To complete the task of regional economic development planning properly, it is necessary to adopt Decision Support System(DSS) in practice. Thus, Spatial Decision Support System(SDSS), which integrates GIS, mathematical models, database technology, multimedia into a fully interactive tool for economic development decision support at spatial aspect(W. J. Drummond 1993), is developed with deeper researches on regional economic development planning(P. Longley & G. P. Clarke 1995, M. Birkin, G. P. Clarke et al 1996). Regional economic development planning becomes more realistically with the development of SDSS.

2. Application of GIS in Regional Economic Development Planning

GIS is the only information system that can be used for handling data with a spatial nature. Since the 1980s', GIS technology is widely applied in resources management and allocation, environmental modeling, urban planning and management, land information system, emergency response, business and marking facilities management, network system analysis, visualization

application and siting analysis and identification of various spatial economic activities. Things that can be done by GIS in the field of regional economic development planning include: Economy geography researches, Spatial statistical analysis of economic activities, Decision support on regional sustainable development, Spatial decision and Spatial planning of economic activities.

The key feature of GIS is that it links data to geographic locations. It is to say GIS represents and analyzes data from a spatial perspective. GIS also provides a means to link data from different sources. Questions that a GIS can answer for regional economic development planning include:

(1) *Illustrating the location of economic activities.*
(2) *Identifying the change trends of economic activities*.
(3) *Matching sites which meet the criteria or conditions of economic activities.*
(4) *Analyzing and visualizing spatial changing patterns of economic activities.*
(5) *Modeling spatial change of economic activities.*
(6) *Making a proper plan for economic development*.

Nowadays, the application of GIS-based spatial analysis models in the field of regional economic development planning is developing more quickly and extensively. Model applications in the field of economic development comprise two categories: the first or major category can be considered coupling models that link conventional economic models to GIS spatial analysis models, where GIS is used as a preprocessing and postprocessing tool(Darwin et al 1995, Neganban et al 1996, Lee and Pielke 1996, and Chomitz et al 1999). For example, spatial data in combined with other data are used for various regional economic sectors studying, spatial economic statistical analyzing, economic impacts analyzing among regions, constantly monitoring of regional economic activities. The second category that is still underdeveloped and not yet broadly recognized used as the principal tool or language for more sophisticated spatial and temporal economy modeling. For an introductory review, see D. J. Comen & W. Shiner(1989), R. H Pittman(1990), M. F. Goodchild et al(1991, 1993), W. J Drummond(1993), M. S. Fisher(1996), V. K Despotakis(1991, 1993), E. Irwin(1999), Chris Wayne and Eric Fladager(2000). For application examples, see T. A. Woodfin & D. Dignum(1991), Shih-lung Shaw(1993), G. P. Clark & M. Clark(1995,1998) et al.

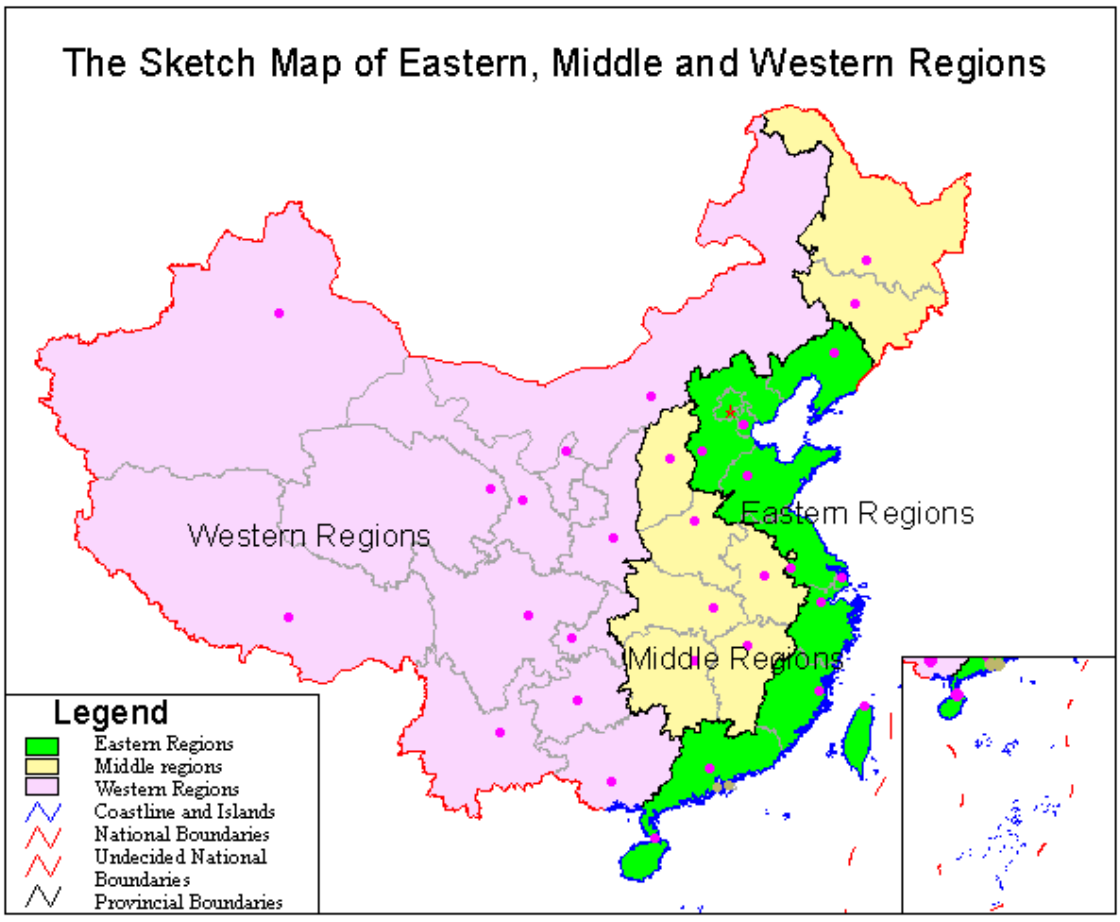
3. Spatial Decision Support System for regional economic development

Spatial Decision Support System(SDSS) is the fruit of the integration of GIS, DSS and regional economic analysis models. We will take western regions of China as an example to discuss about the application of SDSS for regional economic development.

3.1 Economy Background of Western Regions

In our research, Western Regions includes Chongqing Municipality, Shaanxi Province, Gansu Province, Ningxia Hui Autonomous Region, Qinghai Province, Xinjiang uyger Autonomous Region, Sichuan Province, Guizhou Province, Yunnan Province, Tibet Autonomous Region, Inner Mongolia Autonomous Region, Guangxi Zhuang Autonomous Region. Middle Regions includes Shanxi Province, Jilin Province, Heilongjiang Province, Anhui Province, Jiangxi Province, Henan Province, Hubei Province, Hunan Province. Eastern Regions includes Beijing Municipality, Tianjin Municipality, Hebei Province, Liaoning Province, Shanghai Municipality, Jiangsu Province, Zhejiang Province, Fujian Province, Shandong Province, Guangdong Province, Hainan Province, Tawan Province, Hongkong Special Administrative Region, Macao Special Administrative Region. See Map1. Because of geographical, historical, political reasons and other aspects, economy is underdeveloped in western China compares with eastern regions, especially compares with coastal regions. Furthermore, the gap between Western and Eastern regions becomes more and more distinct since 1980’s. See Fig1, Table1-Table3.

As mentioned above, it is extremely significant in practice that the strategy of Grand-scale Development of China's western region comes into effect to promote the coordinating of regional economic development all over the country. And it is necessary to provide various aspects technological support for Grand-scale Development. GIS technology is no exception. How to establish Spatial Decision Support System based on GIS technology is the core.



Map1. The Sketch Map of Eastern, Middle and Western Regions

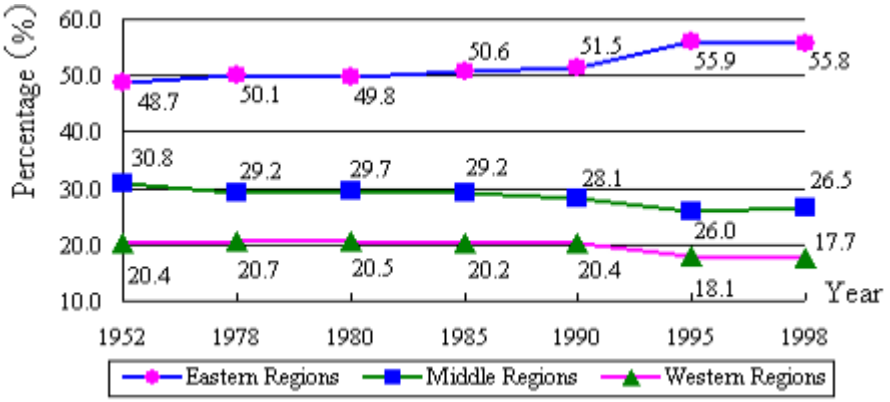


Fig1. The Proportion change of GDP in Eastern, Middle, Western Regions From 1952 to 1998

Table1. The Relative Coefficient of Per Capita Local Government Expenditures From 1952 to 1998

	1952	1978	1980	1985	1990	1995	1998
Eastern Regions	1. 24	1. 09	1. 09	1. 12	1. 17	1. 35	1. 37
Middle Regions	0. 84	0. 91	0. 90	0. 87	0. 82	0. 73	0. 73
Western Regions	0. 86	0. 99	1. 00	1. 00	0. 99	0. 87	0. 84

Table2. The Change of Per Capita GDP in Three Regions From 1952 to 1998

	1952	1978	1980	1985	1990	1995	1998
Nationwide	109	360	446	823	1615	4839	6749
Eastern Regions	138	480	593	1111	2217	7247	10113
Middle Regions	102	311	391	709	1336	3708	5268
Western Regions	80	260	319	581	1155	3050	4143
Western - Eastern	−58	−220	−274	−530	−1062	−4197	−5970
Units: RMB							
Western : Nationwide	0.73	0.72	0.71	0.71	0.72	0.63	0.61
Western : Eastern	0.58	0.54	0.54	0.52	0.52	0.42	0.41

Table3. The Proportion change of Investment in Fixed Assets in Three Regions From 1952 to 1998

	1978	1980	1985	1990	1995	1998
Eastern Regions	38.97	42.58	50.15	51.92	61.79	57.63
Middle Regions	24.89	23.68	27.67	23.21	19.77	21.20
Western Regions	20.97	20.05	19.68	17.41	15.22	17.77
Not Classified by Region	15.17	13.70	2.51	7.46	3.22	3.40

3.2 Major aims of SDSS

Based on the analyzing and manipulating of fundamental geographic background database, various thematic spatial databases, historical and current data of population, socio-economic development and so on, various results can be displayed explicitly, include present status, existing problem answering, developing trend modeling. Querying, searching, expressing, viewing about those data can be done successfully by the use of GIS technology. And planning and decision-making support is also provided for the set down of short-term and long-term plans for Grand-scale Development. The major aims of that SDSS are summarized as fellows.

(1) To establish an information system that can be queried and quoted at any moment for planning and decision-making. Including the analysis of regional development superiority, advantaged conditions, restricted factors and potential, the status diagnosis of industrial structure, product structure and spatial structure and the trend analysis for further optimizing and adjusting, and the comprehensive appraisement of regional socio-economic development level and development strength.

(2) To construct a few appropriate models for regional economic development planning and analyzing. (See 3.4.2, 3.4.3)

(3) To supply various planning schemes and reports for decision-makers. (See 3.4.3)

3.3 Main function of system

The main functions of SDSS are listed as fellows: (1) To ensure dynamic linking between Spatial (Graph, Image) database and statistical database dynamic, and realize real-time querying, searching, processing, displaying, drawing and tabling about data. (2) To implement practical analysis based on acceptable analyzing models and major indices referenced, and display analyzing results in the form of map or chart. (3) To display and output thematic maps, dataset and statistical diagram for decision.

3.4 System Design

3.4.1 Data collection

Collect spatial data and statistical data available in hand firstly, then make any effort to obtain new data. Those statistics, including historical and current data in the field of population, socio-economic development, can be obtained from China Statistical Yearbook, Population Census, Industry Census and Local Statistical Yearbook respectively and so on. The fundamental geographic background database, can be constructed by including NFGIS 1:4000000, 1:1000000 database nationally, 1:250000 database of western regions, 1:50000 DRG, DEM of significant development

area. Various thematic spatial databases about natural conditions, natural resources, environmental status should be constructed too.

3.4.2 Integration and modification of spatial database and statistical database

Fig2 is a simplified representation of the interaction between a GIS and a spatial statistical analysis. Classical statistical analysis methods, such as Linear or Non-Linear Programming, Ordinary Least Squares Regression and multivariate statistical methods(PCA, Multivariate Regressive et al), can be used to do the comprehensive analysis about various statistical data related. Those methods can be also used to do the preliminary analysis of attribute information, or generate new attribute values that deserve scrutiny (Z. Zhang and D. A. Griffith 2000). Some spatial patterns of data, which are impossible to make out by the use of traditional statistical analysis approaches, can be quite revealed by spatial statistical analysis. Output from the spatial statistical analysis then can be move back to a GIS for further analysis.

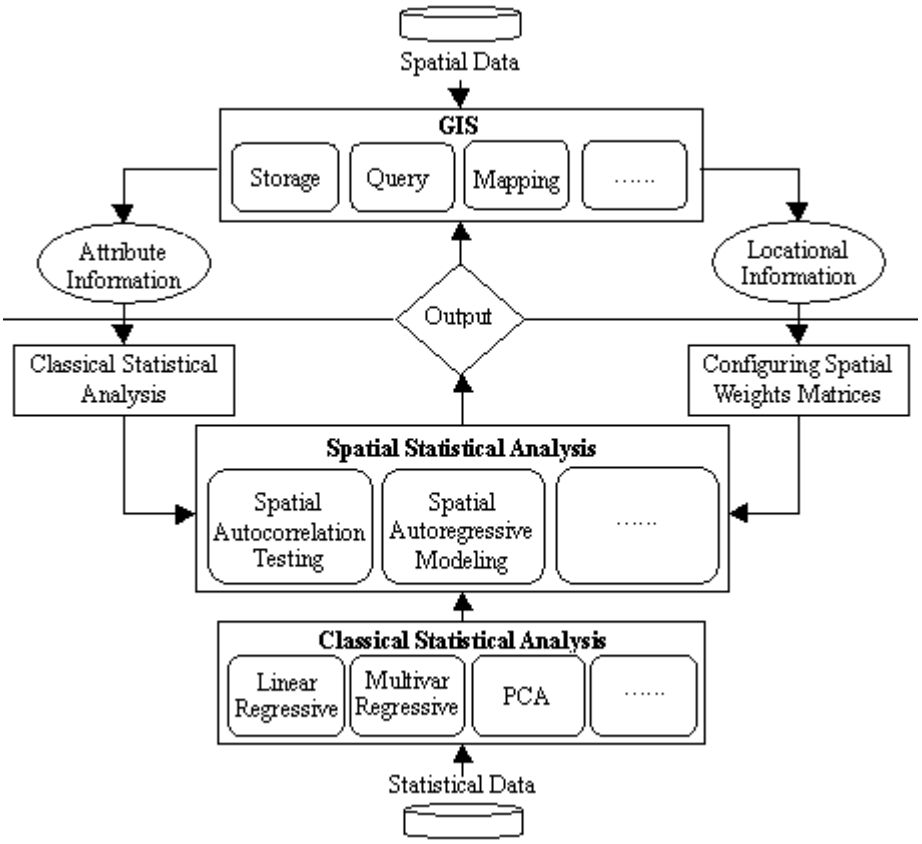


Fig2. Interactions between GIS and spatial statistical analysis

3.4.3 Analysis system Framework

Fig3 shows the framework of analysis system in a SDSS. More attentions should be paid for the design and construction of Model System. In this aspect, the construction of Model LIB, Model DICT, Exterior Database, which are three key components of Model System, is very difficult because there is no a single computer language can interpret all models. Recently, more researchers try to find and establish an acceptable language for that, but there is still a long distance to realize it. In fact, different models are still explained by different computer language in general, especially for Model DICT. The major concerns of the design and construction of Model System are how to overcome that obstacle and how to integrate different models interpreting by different language into a comprehensive and efficient system. Furthermore, doing so is becoming very desirable and practical with the recent technological breakthroughs in object-oriented programming and

component-based rapid application development, embeddable GIS component technology is no exception too. ActiveX technology has profoundly impacted the entire software development.

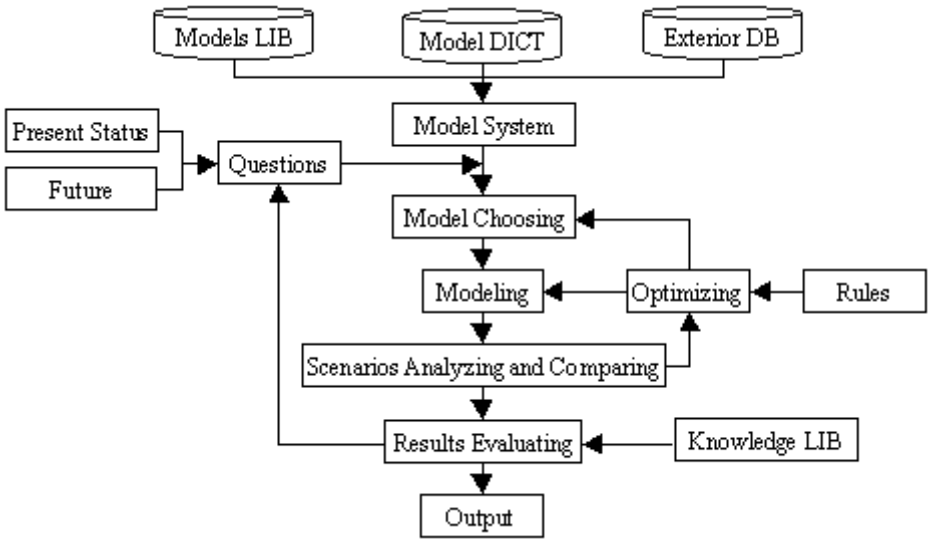


Fig3. The Framework Map of Analysis System in SDSS

Such analyses are divided into two categories: spatial operations analysis and statistical model analyses. Most analyzing processes are completed by the combination of spatial operations analyses, mainly include Overlay operation, Network analysis, Buffer or regional economy stripe Buffer analysis, with statistical model analyses, include linear or non-linear regressive model, multivariate regressive model, autocorrelation regressive model and so on.

3.4.4 Technical support framework

Fig4 shows the components and necessary environment for developing a SDSS. GIS components, classical statistical analysis components, and spatial statistical analysis components, combined with other accessory components, provide the basic buildings blocks for technical support framework, Visual Basic provides the easiest means for accessing and manipulating those components. With different ActiveX controls assembled in a form, which is a visual environment for application development in a Project of Visual Basic, we only need to put a few lines of code inside the procedures that respond to different Mouse Event respectively. The way Visual Basic calls other components is also very straightforward as well as statistical software. For more, see (Z. Zhang and D. A. Griffith 2000).

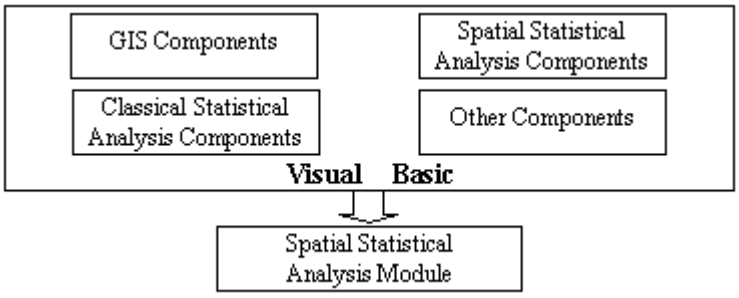


Fig4. The components of a SDSS and its developing Environment

4. Discussions

More attentions are paid to regional economic development planning in the application of GIS technology recently. However, there is still no a suitable spatial economic analysis module for that

application. And there is still a long distance to establish an interactive system for regional economic development planning by the comprehensive use of GIS technology, DSS, statistical analysis models. In this paper we make a preliminary study on how to develop a Spatial Decision Support System for regional economic development planning. Technical Supports, which can be provided by GIS for regional economic development planning, are expatiated. That is vital for the design of interaction between GIS and statistical analysis. With the technological breakthrough of object-oriented programming and ActiveX, the design and establishment of a SDSS for regional economic development planning is becoming more desirable in practice.

There is still much to be done before we can fully understand and design the interactions among GIS technology, Economic statistical analysis models, DSS. In addition, major approaches to GIS spatial operations analysis or econometric models need to be expanded in the process of regional development planning.

Acknowledgement

In the end some acknowledgement are due. For encouragement, special thanks to my superior, Liu Ruomei. My thanks also to my colleagues Zhou Xu, Jia Yunpeng, Li Limeng for extensive discussion on many and diverse subjects over the past year.

References

1. Despotakis, V. K., 1991, Sustainable development planning using geographic information systems, Unpublished Ph. D. Thesis, Amsterdam: Free University.
2. Despotakis, V. K., Giaoutzi, M. & Nijkamp, P., 1993, Dynamic GIS Models for Regional Sustainable Development. Geographic Information Systems, Spatial Modeling, and Policy Evaluation, Edited by M. M. Fischer and P. Nijkamp (Berlin: Springer-Verlag), pp. 235-261.
3. Drummond, W. J., 1993, GIS as a visualization tool for economic development. *Computer, Environment and Urban Systems*, **17**, 469-179.
4. Bennet, T. D., 1997, A framework for the integration of geographical information systems and modelbase management. *International Journal of Geographical Information Systems*, **11**, 337-357.
5. Clarke, G. 1997, Applied Spatial Modeling For Business and Service Planning. *Computer, Environment and Urban Systems*, **21**, 373-376.
6. Keller, C. P. and J. D. Strapp (1996), “Multicriteria Decision Support for Land Reform Using GIS and API”, Goodchild, M. F. et al eds, GIS and Environmental Modeling: Progress and Research Issues, Fort Collins: GIS World, Inc.
7. Zhiqiang Zhang and Danniel A. Griffith, 2000, Integrating GIS components and spatial statistical analysis in DBMSs. *International Journal of Geographical Information Systems*, **14**, 543-566.
8. Kerry Taylor, Gavin Walker and Dave Abel, 1999, A framework for model integration in spatial decision systems. *International Journal of Geographical Information Systems*, **13**, 533-555.
9. http://www.rri.wvu.edu/pdffiles/labys2001-1.pdf
10. http://www-agecon.ag.ohio-state.edu/comregecon/gis.htm
11. http://www.iacm.forth.gr/regional/overview.htm