Advances and Applications of GIS in China (1980-2002)

Guest editors: Jun Chen and Zhilin Li

Year 2002 is special in the history of geographical information systems (GIS) for China (excluding Hong Kong, Taiwan and Macau). It may be said that 2002 is the 22nd anniversary of the development of GIS in China. This statement is based upon the suggestion by He and Jiang (1996) that 1980 be recognized as the beginning of GIS development in (Mainland) China, due to the fact that the first GIS laboratory in China was established at the Institute of Remote Sensing Applications on 19 January 1980. Therefore, this special issue marks the maturity of GIS development in China.

Early Development of GIS in China

When the first geographical information system, Canadian GIS (CGIS), was reported in 1967 (Tomlinson, 1967), marking the commencement of the GIS industry, China had just started the so-called "Cultural Revolution." Communication with the outside world was almost cut off. Schools and universities in China were closed, and scientific research was stalled except that being done for military purposes. Only at the later stage of the revolution, from 1972 onward, was the importance of education and science re-emphasised by then Vice-Premier Deng Xiaoping.

As a major source of geographic information, satellite imagery for resource management and mining exploration also received much attention in the mid 1970s. "China started to import Landsat imagery in 1975 and to produce airborne multispectral scanners in 1987 and synthetic aperture radar in 1983" (Chen, 1987). The Landsat receiving station became operational by the end of 1986. Since the late 1970s, China has paid a lot of attention to the applications of remote sensing. In 1979, the Institute of Remote Sensing Applications was established in Beijing under the administration of the Chinese Academy of Sciences.

In 1980, a formal proposal for the construction of GIS was put forward by Prof. Chen Shupeng, an academician at the Chinese Academy of Sciences, during an academic conference (Chen, 1987). He subsequently set up a GIS division at the Institute of Remote Sensing Applications (Lin, 1994; He and Jiang, 1996). Later, in 1983, the State Commission on Science and Technology organized a working group on resources and environmental information systems, which consisted of experts in these areas (Chen, 1987). This led to the establishment of the State Key Laboratory for Resources and Environmental Information Systems in 1985, which is located at the Institute of Geography of the Chinese Academy of Sciences.

A boost for GIS development in China occurred in 1982, during which the third national population census was conducted. Individual census data was created for 29 provinces (excluding Taiwan). There were a lot of activities involved in the construction of databases and development of software for analysis and for computer-assisted cartography (Chen, 1987). Also in 1982, the first forest database was established, which covers seven large forest areas over 30 provinces. It was also reported that the construction of the first urban GIS for City Tianjin started in 1982 (Chen, 1987).

Milestones and Significant Events in GIS development in China

On 19 January 1980, the first GIS laboratory in China was established at the Institute of Remote Sensing Applications of the Chinese Academy of Sciences. This marked the beginning of GIS development in China (He and Jiang, 1996). This is the *first milestone* of GIS development in China.

The establishment of the State Key Laboratory for Resources and Environmental Information Systems in 1985 is *the second milestone* of GIS development in China. Since the late 1980s, there was a significant increase in software development. The initial efforts came from researchers and university faculties (lecturers and professors). At a later stage, the State Commission on Science and Technology (now the Ministry of Science and Technology) took the leadership by funding a number of software development projects. Since 1997, the Commission organized annual software evaluation jointly with the China Association for GIS (CAGIS) and the Association of Chinese Professionals in GIS (Abroad) (CPGIS). Top ranked products have been recommended to users after the evaluation and more funding has been provided to those successful developers. It has been estimated that China-made GIS software and toolkits now comprise about a 30% share of the domestic market.

In 1988, the first undergraduate program in GIS was initiated at the Wuhan Technical University of Surveying and Mapping (WTUSM) (now Wuhan University). This was another indicator of GIS development in China and marked the recognition of GIS as a discipline in academic community (at least by some

scholars). Now more than 50 universities in China offer GIS programs.

Another significant development of GIS in China in 1990 was the establishment of another State Key Laboratory in GIS at the Wuhan Technical University of Surveying and Mapping (WTUSM). Its full name is the State Key Laboratory on Information Engineering for Surveying, Mapping and Remote Sensing (LIESMARS). In 1986, the National Natural Science Foundation was formed and has since funded a total of 50 GIS and related projects.

In 1994, the China Association for GIS (CAGIS) was founded. This is *the third milestone* of GIS development in China and marked the recognition of GIS as a profession. CAGIS now has more than 3,000 individual members and about 300 corporate members.

In 1995, the National Geomatics Center of China (NGCC) was founded by the State Bureau and Surveying and Mapping. The NGCC and provincial and municipal geomatic centers now serve as the major providers of multi-scale fundamental spatial data. Morever, the importance of data sharing and standardization to the GIS industry has been fully recognized by professionals, scholars and government officials in recent years. The National Technical Commission on Geographic Information Standards was formed in 1997. More recently, a National Coordination Commission on Geospatial Information also was set up to coordinate the sharing of geospatial data.

Special Meaning of this Special Issue

All in all, GIS has undergone a 22-year development in China. This year is the 22nd anniversary. Indeed, 22 is the marriage age in Chinese laws because, a few years ago the ages for marriage were changed to 22 for men and 20 for women. Similarly, in Western culture, the age of 21 is particularly meaningful because it marks full maturity as an adult. Indeed, after 22 years of development in China, GIS as a technology has matured into adulthood and found a large variety of applications.

Although GIS development and applications in Mainland China have been quite active since 1980, in the last 22 years few academic papers have ever been published by Mainland Chinese scholars in reputable international journals. This situation changed only recently. For example, since Prof. Chen Shupeng published the only (review) paper in the *International Journal of GIS* in 1987, no additional papers authored by scholars from Mainland China appeared in that journal until Prof. Chen Jun and his collaborators published two in the last three years (Li et al., 1999; Chen et al., 2001). Therefore, it is time to let GIS professionals and scholars outside of China know about the advances and applications of GIS in China on the occasion of its 22nd anniversary. This special issue serves that purpose.

The Content of this Special Issue

In this issue, six papers are included — an overview paper, an analysis paper, and four technical papers.

The first paper, authored by Chen and his collaborators, provides an overview of GIS advances and applications in China. It covers the development of operational application systems, the development of multi-scale geospatial databases, advances in technical system development, advances in research activities, and institutional and policy development.

The second paper, by Zhou and Li, provide a tentative view of GIS software development in China. In this paper, the development and progress in this respect is reported, the special nature of Chinese GIS software is examined, an intensive comparative analysis between Chinese GIS software and international products is made, and the potential impact on the development of the GIS software industry are also discussed.

The third paper is authored by Li and Yeh. The paper describes the integration of principal component analysis and cellular automata for urban simulation in a fast growing region in South China to deal with a large set of spatial variables. This topic was selected because GIS-based urban studies for City Tianjin was one of the very first GIS applications in China.

The fourth paper, by Jiang and Chen, reports the development of a GIS-based Computer Supported Collaborative Work (CSCW) system for urban planning and land administration. Such a system is in operational use in the Bureau of Urban Planning and Land Administration at various cities such as Changzhou in Jiangsu Province (Southeast China).

The fifth paper, by Zhu and colleagues, describes the development of a CyberCity GIS (CCGIS). Here a CyberCity means a virtual representation of a city that enables a person to explore and interact, in cyberspace, with a vast amount of environmental and cultural information gathered about the city. CCGIS refers to a GIS for a CyberCity. This paper covers various technical issues such as 3D data model, hierarchical modeling to control the scene complexity and to accelerate the rendering for real-time visualization of complex 3D scenes, and integration of DEMs, Images and 3D Models. A case of application is also provided.

The last paper, authored by Lin and Gong, describes a distributed Virtual Environment (DVE) for Managing Country Parks, taking Shing Mun Country Park in Hong Kong as a case study. It also describes the design of DVEs to disseminate 2D and 3D data and to implement public participation in the management of the country parks, called *VirtualPark*.

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and intuitive to use. Menus make it easy to follow a logical workflow, and a table-like frame editor helps to keep track of which steps have been completed with red or green boxes.

One particular strength of IMAGINE OrthoBASE Pro is its ability to process large data sets in a well-organized manner. The user does not have to select much more than a directory and a minimum percent of overlap to start the extraction of DEM data from all stereo image pairs in the directory with the minimum overlap. This is unlike some other products, which often require a lot of mouse click operations to trigger a process.

Besides the ease of operation for a novice user, the system provides a lot of flexibility for the advanced user. Although the software is clearly aimed at the non-specialist and the GIS user who needs to generate his or her own DEM data, fine-tuning the extraction parameters to obtain optimal results requires some understanding of the image matching process as well as some experience with the software.

IMAGINE OrthoBASE Pro runs relatively fast and has minimum requirements for the hardware. Although it is able to generate a variety of output data formats, editing the data requires either *.img format for area editing in ERDAS IMAGINE, or Shapefile format for mass point editing in Stereo Analyst. Stereo Analyst has not been part of this review since it was reviewed for an earlier edition of *PE&RS*. Editing the data in Stereo Analyst naturally has much higher hardware requirements.

The focus of ERDAS IMAGINE has been to provide image analysis tools for photogrammetry, remote sensing, and mapping. Now, the ERDAS Photogrammetry Product Suite, consisting of IMAGINE OrthoBASE Pro and Stereo Analyst, can be linked into ERDAS IMAGINE at a relatively low cost. Today, the cost of a softcopy workstation ranges from roughly $5,000 to $80,000. IMAGINE OrthoBASE Pro can be obtained for the fraction of the cost of a high-end photogrammetric workstation.

Some drawbacks of the software include limitations of the editing capabilities. Also, the algorithm could be expanded to include breakline extraction in addition to mass point extraction. Additionally, in low textured areas or forest areas, points may have to be added in Stereo Analyst.

Overall, IMAGINE OrthoBASE Pro is a very useful production tool to provide DEM data. This data can be used as one of the main layers of any GIS, a prerequisite for orthorectification, or as input for generating fly-throughs in IMAGINE VirtualGIS. IMAGINE OrthoBASE Pro provides comprehensive functionality at a reasonable cost.

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Final Remarks

In summary, the overview paper gives a whole picture of GIS advances and development in China for the last 22 years. The analysis paper provides a deep analysis of the GIS software development in China. The first two technical papers describe applications of GIS for urban analysis and for land administration. The last two describe more recent development in GIS.

In our original design, two review/overview papers were invited and six technical papers were submitted covering six major aspects of development and applications. Papers have been reviewed by scholars from various countries/regions such as the USA, the UK, The Netherlands, Sweden and Hong Kong. In the end, two papers were rejected by reviewers. As a result, only six papers are included in this issue. It is the editors' wish that every one, either researchers or practitioners, could find this volume informative, useful and worth reading.

Finally, the editors would like to express their thanks to all of the authors (including those whose papers were not included in this issue) for their contribution, to reviewers for their kind help, to Dr. Jim Case (Technical Editor of *PE&RS*) for his help in editing work, to Dr. Stan Morain (Editor of *PE&RS*) for his encouragement and support.

References

Chen, Jun, Chengmin Li, Zhilin Li, and C. M. Gold, 2001. A Voronoi-based 9-intersection model for spatial relations. *International Journal of Geographical Information Science,* 15(3), 201-220.

Chen, Shupeng, 1987. Geographical data handling and GIS in China, *International Journal of Geographical Information Systems*, 1(3): 219-228.

He, Jianbang, and Jingtong Jiang, 1996. The 15-year of development in GIS and some current issues, *Geomatics World (in Chinese)*, 1996-1: 6-10.

Li, Chengmin, Jun Chen, and Zhilin Li, 1999. A raster-based algorithm for computing Voronoi diagrams of spatial objects using dynamic distance transformation, *International Journal of Geographical Information Science,* 13(3): 209-225.

Lin, Hui, 1994. International GIS: China, 1994 International GIS Source Book, *GIS World*. 271-274.

Tomlinson, R. F., 1967. *An Introduction to the Geographic Information System of the Canada Land Inventory.* Dept. of Forestry and Rural Development, Ottawa, Canada.