

Chapter 22

Digital Earth in China



Jiantao Bi, Yongwei Liu, Ainong Li, Min Chen, Ruixia Yang, Wenwen Cai,
Yang Hong, Bingfang Wu and Cheng Wang

Abstract In the promotion of economic digitalization as an important force driving the realization of development through innovation, countries around the world have made forward-looking arrangements in frontier technology research and development, open data for sharing, privacy security protection, and personnel training. China also attaches great importance to the development of Digital Earth technologies and applications. In this chapter, we introduce the development of Digital Earth in China in recent years and provide readers a broad overview of Digital Earth technologies and applications in China.

Keywords Digital Earth in China · Big data · New generation information network · Internet + · Cloud computer · 5 Generation

22.1 Introduction

Research on technologies related to Digital Earth has been the focus of attention in fields such as science and technology, the economy and society. Many countries have raised Digital Earth and big data research to the national strategic level. In the promotion of economic digitalization as an important force driving the realization of development through innovation, countries around the world have made forward-looking arrangements in frontier technology research and development, open data

J. Bi (✉) · Y. Liu · W. Cai
Chinese National Committee, International Society for Digital Earth, Beijing, China
e-mail: [bjjt@radi.ac.cn](mailto:bijt@radi.ac.cn)

J. Bi · Y. Liu · R. Yang · B. Wu · C. Wang
Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing, China

A. Li
Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, Chengdu, China

M. Chen
Nanjing Normal University, Nanjing, China

Y. Hong
Peking University, Beijing, China

for sharing, privacy security protection, personnel training and other areas. China also attaches great importance to the development of Digital Earth. In 1999, the first Digital Earth Symposium was held in Beijing, which began Digital Earth research all over China. In 2006, the Chinese National Committee of the International Society for Digital Earth (CNISDE) was established. As the national member of the ISDE, the CNISDE promotes the ISDE's ideals for national acceptance. Since 2006, Digital Earth has experienced high-speed development in China. Focusing on the development of Digital Earth in China caters to and promotes information technology development and acts as an endogenous driving force to promote economic transformation and upgrading as well as sustainable development.

22.2 China's Digital Earth Strategy and Policy

In recent years, the Chinese government has attached great importance to information technology development, especially for Digital Earth technologies. It has strengthened the top-level design and overall layout and made a strategic decision on building Digital Earth in China. Digital Earth is a new strategy for information technology development in the new era, a new measure to meet the people's growing demands for a better life, and a new driving force leading high-quality economic development. Digital Earth in China covers information technology construction in various fields such as the economy, politics, culture, society and ecology. In his congratulatory letter to the first Digital China Summit held in April 2018, President Xi Jinping noted that the information technology innovation in today's world is changing with each passing day, and in-depth development of digitalization, networking and intelligence plays an increasingly important role in promoting economic and social development, modernizing the state's governance systems and capabilities, and meeting the people's growing demands for a better life.

As Digital Earth development in China enters a peak period, the digital economy will also naturally add momentum to China's economic development. To speed up the development of Digital Earth in China, China will continue to improve the policy environment by formulating and introducing a series of policy documents on the development of Digital Earth in China. Information technology has become a major force for the government to serve the people and adds new momentum for economic development. The development of Digital Earth in China has brought changes to people's daily lives and the production of enterprises.

22.2.1 National Macro Strategic Plans for Digital Earth in China

In recent years, relevant departments in China have successively issued major strategic plans for national information technology development to indicate a road map and timetable for the development of Digital Earth in China and clarify that the general goal of Digital Earth development in the new era is to adhere to and achieve the synchronous promotion of the “Two hundred-years Goals” to fully support the development of the causes of the country, to promote balanced, tolerant and sustainable economic and social development and to provide solid support for the modernization of the national governance systems and capacities. The development plans note that China must adhere to people-centered development thinking and take the improvement of the people’s well-being as the starting point and foothold for the development of Digital Earth in China, to better benefit the people. The three strategic tasks of Digital Earth in China are to greatly enhance the ability of information technology development, focus on improving the level of information technology development in economic and social fields and continuously optimize the environment for information technology development.

(1) **“Broadband China” Strategy.** On August 17, 2013, the government of China issued the “Broadband China” strategy implementation plan and deployed the broadband development goals and paths for the next 8 years, meaning that the “Broadband Strategy” went from a departmental action to a national strategy, and broadband became the national strategic public infrastructure for the first time. By 2020, China aims to finish the construction of a high-speed and smooth broadband network infrastructure with advanced technology to cover urban and rural areas and offer convenient services.

(2) **Outline of the National Information Technology Development Strategy.** The outline is a regulation formulated to promote modernization through information technology development and to build network power. The outline stipulates that, by 2020, the core key technologies will reach the international advanced level, the international competitiveness of the information industry will be greatly improved, the digitalization, networking and intelligence will make significant progress in key industries, the networked collaborative innovation system will be fully formed, e-government affairs will firmly support the modernization of national governance systems and capacities, and information technology development will become a leading force driving the modernization construction (The State Council 2016). The internet bandwidth for international export will reach 20 Tbps to support the implementation of the “Belt and Road” initiative and achieve network and information connection with neighboring countries. The China-ASEAN Information Port will be built and the online Silk Road will be established to significantly improve the international competitiveness of information and communication technologies and products and internet services.

(3) **“Thirteenth Five-Year” National Information Technology Development Plan.** Aiming to implement the Outline of the Thirteenth Five-Year Plan and the

Outline of the National Information Technology Development Strategy, the plan is an important part of the “Thirteenth Five-year” national planning system and an action guide for information development work in various regions and departments during the “Thirteenth Five-year.” It was issued and implemented by the government of China on December 15, 2016. The plan noted that by 2020, “Digital Earth” development will achieve remarkable results, the level of information technology development will rise sharply, the information capability will rank among the top in the world, and the information industry ecosystem with international competitiveness and security under control will be in place. Information technology and economic and social development will be deeply integrated, the digital gap will be significantly narrowed and the digital dividend will be fully released. Information technology development will fully support the causes of the government and the country, promote balanced, tolerant and sustainable economic and social development and provide solid support for the modernization of the national governance systems and capacities (Gov.cn 2016).

(4) **Big Data Strategy.** Data are basic national strategic resources. China attaches great importance to the role of big data in economic and social development. The government proposed the “implementation of the national big data strategy” and the issued the Outline for Actions Promoting Big Data Development to fully promote big data development and accelerate data development to strengthen the state. The Big Data Industry Development Plan (2016–2020) was also formulated, proposing that the income from big data-related products and services will exceed RMB 1 trillion by 2020, with an average annual compound growth rate of approximately 30%; 10 internationally leading core enterprises in the industry of big data will be cultivated; 10–15 comprehensive big data pilot areas will be built; and 1–2 open source communities with standardized operation and an international influence will be established.

(5) **Network Power Strategy.** The network power strategy includes three aspects, namely, network infrastructure construction, new development of the information and communication industry and network information security (Chen 2016). The proposal for the “Thirteenth Five-Year” Plan approved by the government proposed implementation of the network power strategy and the closely related “internet +” action plan. Accelerating the network power strategy has a direct effect in improving China’s international competitiveness and contributes to the economic and technological development and transformation of China.

22.2.2 *Policies and Plans for Development of Digital Earth in China*

(1) **White Paper on China’s Digital Economy Development (2017).** On July 13, 2017, the China Academy of Information and Communications Technology released the White Paper on China’s Digital Economy Development (2017) at the 16th China

Internet Conference. The white paper noted that, in the next few years, China will deploy 5G, next-generation internet, the Internet of Things (IoT), industrial internet and other technologies on a large scale. With the construction of various network infrastructures and the application of related technologies, development of Digital Earth in China will enter a peak period. It will lay the foundation for development of the digital economy, industrial transformation and upgrading, and the integrated development of various industries in China (China Academy of Information and Communications Technology 2017).

(2) **Action Plan for Promoting Large-Scale Deployment of Internet Protocol Version 6 (IPv6)**. On November 26, 2017, the government issued the Action Plan for Promoting Large-scale Deployment of Internet Protocol Version 6 (IPv6), proposing that in the next five to ten years, China will form a next-generation internet independent technology system and an industrial ecology, build the world's largest IPv6 commercial application network, realize deep integration and application of next-generation internet in various economic and social fields, and become an important leading force in development of the world's next-generation internet.

(3) **"Internet +" Action Plan**. The development of the plan was led by the National Development and Reform Commission and the Ministry of Industry and Information Technology. China introduced and is still developing a series of policies for promoting innovative development of information technology and e-commerce. In the government work report on the two sessions in 2015, Premier Li Keqiang proposed the requirement of "developing an internet + action plan" to promote the integration of mobile internet, cloud computing, big data, and the Internet of Things with modern manufacturing and the sound development of e-commerce, industrial internet and internet finance as well as to guide internet companies to expand the international market (Ning 2015). Representing a new economic form, "internet +" supports industrial intelligence, enhances the momentum of new economic development and promotes improvements in quality and efficiency and the upgrading of the national economy.

(4) **Three-Year Action Plan for Cloud Computing Development (2017–2019)**. In April 2017, the Ministry of Industry and Information Technology developed and issued the Three-Year Action Plan for Cloud Computing Development (2017–2019). The targets of the plan are for China's cloud computing industry to reach a worth of RMB 430 billion, make breakthroughs in a number of core technologies, achieve cloud computing service capability at an international advanced level and significantly drive the development of the new-generation information industry. The international influence of cloud computing enterprises will be significantly improved and two or three leading enterprises with a large share in the global cloud computing market will emerge. The capability of guaranteeing cloud computing network security will be significantly improved, and the network security supervision systems and laws and regulation systems will be gradually improved (The Ministry of Industry and Information Technology 2017).

(5) **"Thirteenth Five-Year" Special Plan for Scientific and Technological Innovation in the Information Sector**. The special plan formulated the implementation plan for "Scientific and Technological Innovation 2030—Major Projects" and started

the implementation of major new-generation artificial intelligence projects (Gov.cn 2017). It steadily promoted major projects such as the space-terrestrial integrated information network and big data and launched the IoT and smart city initiatives, broadband communications, new types of networks and other key projects (The State Council 2015). China will accelerate the implementation of the Outline for Promoting National Integrated Circuit Industry Development and advance system innovation in the information industry. The core technology innovation in the information field will illustrate the new situation of catching up with the leaders at a faster speed, more shoulder-to-shoulder development and new leaders emerging.

22.3 Infrastructure for Digital Earth in China

The development of Digital Earth in China is inseparable from the support of network and information technology. The development of the entire infrastructure and related digital technologies is of great significance to the development of Digital Earth in China.

Currently, relevant new technologies, such as 5G, IPV6, cloud computing, big data and artificial intelligence, are continuously being applied in the infrastructure of Digital Earth in China. Related technologies including artificial intelligence, cloud computing, big data, and blockchain are also developing rapidly. China has introduced many new related policies, and many industrial alliances have been formed to add new impetus to Digital Earth in China. The infrastructure construction manifested as follows:

(1) ***Deployment of New-Generation Information Network Technology.*** 5G network technology has made important breakthroughs in R&D, testing and verification (Fig. 22.1). In the implementation of the national major science and technology project “new-generation broadband wireless mobile communication network,” the design and R&D of a 3Gsp/s 12-bit ADC/DAC, PA, a wide-area hot-spot baseband chip and a low-delay baseband chip was completed, and the R&D of key technologies such as the 5G core network and ultradense networking based on SDN/NFV is being advanced. 5G R&D and testing work is advancing rapidly; the first batch of specifications for the third phase of testing has been released and the development of the global unified 5G standard is being promoted. The bearing and capacities of the radio and television networks have been improved. The two-way access strategy for radio and television and telecommunications services is being promoted throughout the country. The second stage of an experimental pilot of the cable, wireless and satellite integration network for radio and television is being advanced at a faster speed, and the experimental technology solution and establishment of three standards for the integration network in 11 provinces have been approved. The number of China’s IPTV users has reached 122 million. IPV6 is evolving comprehensively and being upgraded at a faster speed. The implementation of the Action Plan for Promoting



Fig. 22.1 5G network framework (from http://www.freep.cn/zhuangxiu_6/News_1937545.html)

Large-scale Deployment of Internet Protocol Version 6 (IPv6) accelerated the construction of next-generation internet with high speed, wide popularity, full coverage and intelligence.

(2) **Innovative Construction of Cloud Computing Infrastructure.** The implementation of Opinions on Promoting Innovative Development of Cloud Computing and Cultivating a New Format of the Information Industry and the Three-Year Action Plan for Cloud Computing Development (2017–2019) in China has promoted the popularization of cloud computing applications, optimized the layout of cloud computing data centers, enhanced the usage rate and intensification level, and formed an industrial system with international competitiveness. Breakthroughs have been made in key technologies such as large-scale concurrent processing, massive data storage, and data center energy conservation. Cloud computing platforms with international competitiveness have emerged, such as Alicloud’s Apsara platform, Baidu Brain and the WeChat open technology platform. In 2016, the proportion of large and ultralarge data centers increased to 25% from less than 8% in 2010. There are 295 enterprises with large data centers and cross-regional internet data services. The Internet of Things has been deeply integrated, and the pace of generic application has been sped up. The R&D and deployment of NB-IoT are being sped up, and China Telecom has built the world’s first commercial NB-IoT network with the widest coverage and synchronous upgrading of the entire network of 310,000 base stations. The NB-IoT technology solution proposed by Huawei has been approved by 3GPP and become an international standard. The NB-IoT is being expanded to public facilities management, production and life at a faster speed to accelerate the intelligent transformation of power grids, railways, highways and other infrastructure.

(3) **Localization of the GIS Platform.** During the development of Digital Earth in China, geographic information systems (GIS) have played a very important role in promoting Digital Earth in China. After 30 years of hard work, China’s GIS

technology has made remarkable achievements. In the early stage of Digital Earth development, it was mainly based on two-dimensional visualization applications and lacked three-dimensional analysis capabilities. In response to the demand of Digital Earth in China, China has proposed and developed GIS technology that integrates two and three dimensions to gradually form the GIS software covering data models, scene modeling, spatial analysis and two- and three-dimensional software forms. With the development of data acquisition technology, Digital Earth in China has integrated traditional 3D modeling, oblique photography, laser-point clouds, BIM and other three-dimensional technologies based on two- and three-dimension integration technology to develop the new-generation three-dimensional GIS technology, which has realized three-dimensional modeling of multisource heterogeneous data, object-level 3D spatial analysis and visualization of nonvisual information, extending the research scope of Digital Earth in China from the Earth's surface to the entire space. Three-dimensional spatial data specifications have been formed to solve the sharing and interoperability problems inherent in such heterogeneous data in applications to bring real and convenient 3D experience to digital applications. Cloud GIS technology and cloud computing have greatly improved the data resources and computing resource capabilities of Digital Earth in China and expanded its range of applications. Cloud GIS technology has realized the interconnection and intercommunication of information and functions between cloud GIS (servers) and various terminal GIS (desktop GIS, mobile GIS, WebGIS), making applications and services ubiquitous. A client (such as WebGL) that is as thin as possible can also be used advantageously in cloud computing to reduce the client installation and maintenance costs in digital applications. As a result, the network-based intergovernmental and interdepartmental collaborative development of the "Digital Belt and Road" will be promoted.

As the "GIS core" for software platform construction in Digital Earth infrastructure, China's GIS basic software represented by SuperMap GIS has played a unique role. Through multisource heterogeneous data integration, it integrates, shares, analyzes, manages and mines data, and ultimately serves global change research, disaster reduction and prevention, new energy development, new urbanization, and agricultural food safety to aid in the development of Digital Earth in China.

(4) **The Big Data Platform.** Big data has begun to significantly influence global production, circulation, distribution, and consumption patterns. It is changing humankind's production methods, lifestyles, mechanisms of economic operation, and country governance models. Big data occupies strategic high ground in the era of knowledge-driven economies, and it is a new strategic resource for all nations (Guo 2017).

In an initiative led by Guo Huadong, president of the Committee on Data for Science and Technology (CODATA) of the International Council for Science (ICSU), CODATA has worked with other international science organizations and initiatives to explore the value of big data in scientific research and to reinforce the crucial role of science in the development of big data. After the June 2014 "International Workshop on Big Data for International Scientific Programmes: Challenges and Opportunities" sponsored by CODATA in Beijing and cosponsored by the ICSU World Data System, Future Earth, Integrated Research on Disaster Risk, the Research Data Alliance,

the Group on Earth Observations, the International Society for Digital Earth, and the Chinese Academy of Sciences Institute of Remote Sensing and Digital Earth, CODATA and others developed a joint statement of recommendations and actions [6]. This statement emphasized providing a better understanding of big data for scientific research, and strengthening international science for the benefit of society by developing research, policies, and frameworks related to big data. Since then, a series of meetings on big data for science has been organized or coorganized by Guo's research team. These have included the "Xiangshan Science Conference on Frontiers of Scientific Big Data," "The Academic Divisions of the Chinese Academy of Sciences Forum on Frontiers of Science and Technology for Big Earth Data from Space," and the "Exploratory Round Table Conference on Big Data in Natural Sciences, Humanities and Social Sciences." It is our opinion that scientific big data will play a key role in promoting scientific development (Guo 2017).

22.4 China's Experience in the Development of Digital Provinces and Cities

Digital cities refer to the use of spatial information to build a virtual platform that acquires and loads information such as that on natural resources, social resources, infrastructure, culture, and economics of provincial units or city units in the digital form to provide a wide range of services for governmental and social users to improve city management efficiency, save resources and promote the sustainable development of cities.

22.4.1 Digital Fujian

In 2000, when President Xi Jinping was in the position of governor of Fujian Province, China, he initiated the "Digital Fujian" project. He clarified the development connotation and development mode of "Digital Fujian" and proposed the development goal of being "digital, networked, visualized and intelligent." In 2001, the "Digital Fujian" Plan was launched, including one plan ("Digital Fujian" Tenth Five-Year Plan), three projects (Fujian Public Information Platform, Fujian Government Information Network Project and Spatial Information Research Center of Fujian) and one policy (Fujian information sharing policy). Fujian began to build three basic supportive platforms: a unified government affairs network, an information exchange system and an information security system to realize facilities sharing, platform sharing and data sharing, which established the overall framework of "Digital Fujian." Over the past 18 years, "Digital Fujian" has drawn up four five-year special plans using the top-level design as the guiding ideology for the overall coordination and planning of the information technology development of the whole province, to ensure that

the construction of “Digital Fujian” moves forward in a phased, focused and orderly manner.

With the top-level design plan and long-term plans as guides, Fujian Province has advanced the construction of “Digital Fujian” in an orderly manner through the development goals, frameworks, mechanisms and development ideas that were determined in the initial years. The construction of “Digital Fujian” is close to people’s livelihood, enterprises and society. The e-government practice of “Digital Fujian” comprises the joint development and sharing of data in all government systems, acceleration of the digital upgrading of tourism, transportation, taxation, medical treatment, education systems and other areas of people’s livelihood, and reducing the “multiple leadership” in e-government. The new ideology makes “Digital Fujian” a new model that benefits the people. By 2020, the digital economy of Fujian will exceed RMB 400 billion with an annual growth rate of over 20% and a proportion of over 45% of the GDP, forming a development pattern with advanced digital infrastructure, efficient e-government collaboration, integrated and innovative digital economy and a secure, independent and controllable network and information, realizing the goal of being “digital, networking and intelligent.” Fujian will actively promote the establishment of the Digital Earth Core Technology Industry Alliance, add to “Belt and Road” digital economy development funds and Digital Earth development funds, speed up the construction of a number of new smart city platform projects, strengthen organizational leadership, and optimize the development environment.

22.4.2 Digital Hong Kong and Digital Macao

The construction of Digital Earth has penetrated China’s economy, society, and people’s lives and has resulted in remarkable achievements in improving government management, promoting industrial development and serving people, especially the construction of Digital Hong Kong and Macao.

(1) ***Development History***: The government has been the main promoter of digital city construction and actively supports the digital development of cities. Since 1990, the Hong Kong government has spent 6 years establishing the first large land information system using geographic information systems (GIS) technology in Hong Kong and successfully applied it to land usage, cadastral maps and town plans. In 2009, the Hong Kong Transport Department launched a transport information system based on a central database, which provides four major services: a road traffic information service, Hong Kong eRouting, Hong Kong eTransport and an intelligent road network. In addition, the Hong Kong Lands Department is actively expanding smart city infrastructure and environmental detection applications based on mobile measuring vehicles.

In 2000, the government of the Macao Special Administrative Region (SAR) officially launched an environment geographic information system, which was jointly

developed by the Cartography and Cadastre Bureau and Macao Environmental Protection Bureau (DSPA). The system draws a mathematical model to study the environmental conditions and perform evaluations through the comprehensive collection and analysis of existing and new environmental data in Macao, providing services for the urban environment quality evaluation, natural resources analysis, city planning, emergency warning systems and disaster assessment. In addition, to facilitate citizens' access to information on historical urban areas and cultural property reserves, the Macao Cartography and Cadastre Bureau launched the local Cadastral Information Network to include historical heritage and cultural conservation information, contributing to the protection of Macao's historical, cultural and architectural property.

(2) *Preliminary Results*: At present, the construction of Digital Hong Kong and Macao has resulted in many achievements, covering disaster monitoring, urban construction, residents' lives, government management and other aspects.

On August 4, 2017, the Macao SAR signed the Framework Agreement on Strategic Cooperation in the Construction of a Smart City with the Alibaba Group. The government of Macao SAR will make full use of Alibaba's relevant leading technological capabilities, such as cloud computing and the application of big data, to promote the pace of the construction of a smart Macao, to widen the context of the SAR data, improve the modes of economic and social operation, and promote the development of the smart city. In the long term, Macao will be developed into a smart city that is "leading technology by digital development and serving people's livelihood with intelligence."

The construction of Digital Hong Kong and Macao show a good trend of "connecting every place and everything, handling everything on internet, and innovating every business." With the advances in technologies including cloud computing, big data, and the IoT, the deepening cooperation between the government and high-tech companies, the integrated development of different smart platforms, and the continuous improvement of the strategic guarantee system for integrated ground and air information technology, Digital Hong Kong and Macao will develop further and play a more important role in promoting urban economic development and improving the quality of life of urban residents.

22.5 Development of Digital Earth Applications in China

The wide application of Digital Earth technology has resulted in significant and far-reaching impacts on various economic and social areas in China. With the development of LiDAR, microwave and multispectral remote sensing technologies, great progress has been made in Digital Earth applications in China. The applications can be summarized in three aspects.

22.5.1 *Digitalization: Drawing and Depicting China*

To “Draw and Depict China with Digital Earth Technology” means to use digital technology to summarize and present the phenomena and laws that exist but are difficult to find using traditional administrative and technical means. Regardless of whether digital technology is used or not, these phenomena or laws exist objectively, but it is difficult to find or describe them without digital technology.

(1) **Big Earth Data for Digital Earth.** “Big Earth data” is a fundamental aspect for Digital Earth. Big Earth data, including the huge datasets derived from satellite observations, ground sensor networks, and other sources, are characterized as being massive, multisource, heterogeneous, multitemporal, multiscale, high-dimensional, highly complex, nonstationary and unstructured. It provides support for data-intensive research in the Earth sciences (Guo 2017).

As an example, global change research demands the systematization of the Earth and comprehensive observations and has led to the rapid development of ground observation technology. Modern Earth science requires globally established, quasi-real time, all-weather Earth data acquisition capabilities and has developed an integrated space-air-ground observation system with high spatial, temporal, and spectral resolutions. Global change research focuses on global sustainable development and deals with key multidisciplinary challenges, including global change process monitoring, simulation analysis, and response strategies. These studies rely on big Earth data such as long-term, multispatiotemporal Earth observation data, accurate, continuous ground station observation data, and experimental data based on theoretical speculation and estimations. Therefore, big Earth data can provide a new approach to the development of global change research. As a tool in cross-disciplinary research, big Earth data has the potential to provide a virtual Earth that can be used in the Earth sciences and has close relations to information science, space science, technology, the humanities, and the social sciences. Generally, big Earth data include the main features of big data.

(2) **Digital Agriculture.** “Digital agriculture” refers to intensive and information-based agricultural technologies supported by geoscience space and information technology. As an important symbol of agriculture in the 21st century, the development of “digital agriculture” and related technologies is an inevitable choice to support the development of modern agriculture in China.

One of the outstanding manifestations of the applications of information technology is the application of the Digital Earth platform in the field of digital agriculture, in breeding, crop growth, farmland management, and agricultural information (Meng et al. 2011). With the rapid development of Earth observation technology, research on and application of “digital agriculture” has been gradually deepened, providing more diversified information for digital agriculture and promoting the comprehensive development of agricultural information technology (Li 1992). In China, Digital Earth technology is widely applied in the acquisition of farmland plot information, agricultural measures, farmland environments and other information and has been successfully applied to monitor crop growth, soil moisture, crop water stress, crop

nutrients, and crop disasters and in the estimation of the per unit yield of crops and agricultural irrigation guidance. Digital agriculture plays an important role in Chinese food security (Wu 2004).

22.5.2 *Digitalization to Make China Different*

“Digitalization to make China different” refers to a series of changes in the way that society operates and how people live through the extensive use of digital technology. “Digital Earth in China” has gradually led to revolutionary changes in people’s daily behaviors and communication methods, allowing for people to enjoy the digital dividend.

(1) ***Disaster Monitoring and Prevention.*** Digital disaster reduction technology has integrated the advantages of remote sensing, GIS, navigation systems, mobile terminals, and the internet and other technologies to comprehensively acquire and analyze disaster information. Compared with the traditional observation methods, the rapid, accurate and macro acquisition of information by digital disaster reduction technology using Earth observation technology, which is its core constituent technology, has played an irreplaceable role due to its all-weather, all-day, multiangle and highly efficient performance.

At present, digital disaster reduction research has abundant aerospace observation data sources, but there is an urgent need to develop the ability to quickly identify knowledge and obtain effective disaster information from massive data. With the advent of the era of big data, cutting-edge disaster reduction technology supported by big Earth data has brought new opportunities for the development of China’s research on digital disaster reduction. It is expected to make breakthroughs in the bottleneck problem of open data for sharing. By integrating remote sensing satellite data, aviation monitoring data, navigation positioning data, ground survey data and social statistics data, integrated analysis of interdisciplinary and multitype disaster reduction data can be accomplished through the big Earth data platform to reduce the time cost of carrying out collaborative analyses of disasters based on multisource data and improve the ability to rapidly mine disaster information.

(2) ***Monitoring and Protection of Natural and Cultural Heritage.*** Digital heritage refers to the applications of digital technology with spatial information technology as the core in the fields of cognition, protection and utilization of cultural and natural heritage. The applications of remote sensing, GIS, modern measurement technology and VR technology in the fields of heritage discovery, protection, display and utilization are the key endeavors. Entering the 21st century, digital heritage has entered a fast lane. Relevant national projects are being carried out one after another, such as the national project on exploring the origin of Chinese civilization and monitoring of the Chinese Grand Canal and Great Wall. In 2016, Guo Huadong established a “Protection and Development of Natural and Cultural Heritage Along the Belt and Road” project in the Digital Belt and Road (DBAR) research initiative. In 2017, a research team led by Bi Jiantao went deep into the Angkor Wat and Preah

Vihear temples in Cambodia to implement the monitoring and protection of natural and cultural heritage and realized the acquisition and modeling of centimeter-level 3D architectural cultural heritage data in a country along the Belt and Road for the first time. In 2018, a research team led by Wang Xinyuan found 10 archaeological sites of ancient Rome in Tunisia. The continuous implementation of these projects marks the beginning of a new development stage of digital heritage research.

(3) ***Applications in the Digital Mountain Field.*** As a scientific subset and application example of Digital Earth, digital mountain research is the unification of spatial information methods and tools for mountain science research and integrated mountain management. It provides reliable basic data, analyzes solutions and simulates lab environments for mountain research through the integration of data, models, and analytical methods. Recently, a new phase of progress has begun in fields such as mountain cover mapping, digital terrain analysis and digital watershed construction. The development of the digital mountain observation and experiment platform needs to comprehensively consider the terrain gradient, vegetation gradient and multiscale nested observation methods to build a ground-air-space three-dimensional observation system with the help of UAV remote sensing platforms, to obtain multisource and multiscale surface observation data sets to support breakthroughs in mountain remote sensing theory and application research on digital mountain science.

(4) ***Research and Education.*** Since the beginning of this century, China has established institutes, national and provincial key laboratories, and companies relevant to Digital Earth and Digital China. These include the Institute of Digital China, Peking University (IDC-PKU), founded in 2004, and the Beijing Key Laboratory of Environmental Remote Sensing and Digital City, founded in 2002. China has also hosted symposiums, summits, and workshops to discuss topics relevant to Digital Earth and Digital China, such as the Digital China Forum organized by PKU held annually from 2004 to 2018.

China has developed Digital Earth-related education activities for undergraduate students, graduate students and teenagers. Universities offer courses covering Digital Earth and Digital Cities, such as 'Introduction of Digital Earth' at Peking University (PKU) and 'GIS and Digital Earth' at Zhejiang University. Institutions and universities also offer large public science popularization activities for Digital Earth. For example, the Institute of Remote Sensing and Digital Earth (RADI) has 'Poster Walls' to show the development of Digital Earth technologies in China; the China Association for Science and Technology (CAST) and PKU host the annual 'BeiDou Cup' Youth Science Creation Competition to award achievements in the 'BeiDou Navigation Satellite System (BDS) and Digital China' field. Textbooks about Digital Earth have been published by professors from universities since the 1990s, and a variety of popular science books have been published since the beginning of the 2000s.

(5) ***Digital Geographical Names.*** The public service project regarding geographical names includes four tasks: geographical name specification, geographical name marks, a geographical names plan and digital geographical names. The digital geographical names project comprises the informatization of geographical name services. The construction of geographical name information services can further

enhance the scientific and standardization level of geographical name management and achieve multidata collection. The rational use of these data and the development of various geographical name information services will transform such resources into enormous social and economic benefits. Digital geographical name technology makes full use of electronic maps, remote sensing images and other technical means in the field of Digital Earth and expands the use of the internet, big data and other technical methods to achieve the combination of geographical name information, map imagery, geographical name query and statistical analysis.

Relying on the geographical name database, telecommunications technology, the internet and other media will be used for a geographical name informatization service via a toponymic website, toponymic hotline, toponymic disc (electronic map), and a toponymic touch screen as the main contents to realize the sharing of geographical name information with all of society. The public can obtain accurate geographical name information quickly, conveniently and in a timely manner.

22.5.3 Digitalization to Drive and Promote China's Development

“Digital Earth to drive and promote China's development” means the essential improvement of production modes, production efficiency and product quality brought by the application of digital technology in the field of spatial information technology. In addition to the extensive application of digital technology in auxiliary aspects such as R&D, management, marketing, warehousing and logistics, an increasing number of technologies such as the IoT, artificial intelligence, industrial internet and industrial robots have been directly introduced into production to enable improvements in the production of enterprises and to provide a solid foundation to guarantee personalized customization and intelligent manufacturing. Currently, China is vigorously promoting “Made in China 2025” and “building a manufacturing power.” This is a key direction of research and promotion of the ISDE Chinese National Committee to study how to strengthen the role of digital technology in the process.

(1) ***Digital New Technologies, New Industries, New Formats and New Models Are Constantly Emerging.*** In 2017, China's digital economy reached RMB 27.2 trillion, showing a yearly growth of 20.3% and accounting for 32.9% of the GDP, and became an important engine to drive economic transformation and upgrading. The electronic information manufacturing industry, software and information services industry and communications industry continued to develop rapidly. In 2017, the information industry had a revenue of RMB 22.1 trillion, showing a yearly growth of 14.5%. In 2017, China's information consumption increased to RMB 4.5 trillion, a yearly growth of 15.4%, which was approximately twice the growth rate of final consumption during the same period. It accounted for 10% of final consumption and contributed more than 0.4% to GDP growth. The overall strength and global competitiveness of the network and information technology enterprises in China

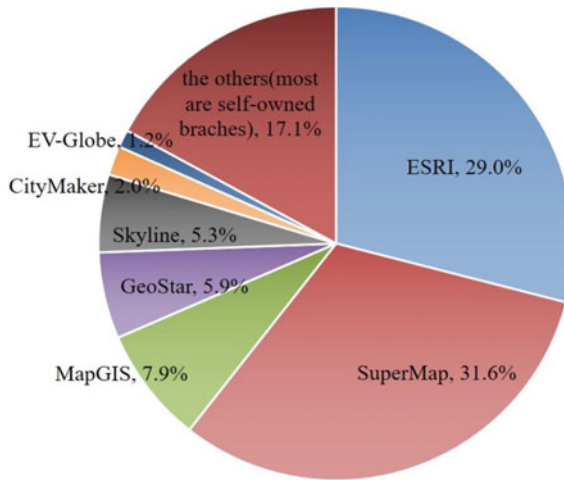


Fig. 22.2 GIS software market share in China (2015)

have been continuously improved (see Fig. 22.2), and seven internet enterprises rank among the top 20 in the world in terms of their market values.

(2) **Digital Information Technology Promotes Changes in the Quality, Efficiency and Power of Economic Development.** The Guiding Opinions on Deepening the Integrated Development of the Manufacturing Industry and Internet and the Guiding Opinions on Deepening “Internet + the Advanced Manufacturing Industry and Developing Industrial Internet” have been implemented to promote the in-depth integrated development of the manufacturing industry and the internet. The implementation has been defined by software, driven by data, supported by platforms, added value to services and led by intelligence (Figs. 22.3 and 22.4). With the rapid development of industrial internet, a number of industrial applications for complex products such as high-speed trains and wind power have been developed and initially achieved commercialized applications. The pace of rural and agricultural information technology has been obviously sped up by fully implementing the project to deliver information into villages and households and offer services for the convenience of 233 million people. A number of demonstration templates for digital agriculture have been created to continuously improve intelligent agricultural production, business based on networks, and online services. “Internet + convenient transportation” has been promoted at a faster speed to develop intelligent transportation and facilitate passenger travel. A national transportation and logistics public information platform has been built and improved to promote the sharing of logistics information and promote cost reduction and efficiency improvements in logistics.

(3) **E-government Has Been Advanced.** At the national level, the National General Plan for E-government was released to establish an overall coordination mechanism for national e-government, organize the implementation of national comprehensive e-government pilots, deepen the applications of e-government and explore the

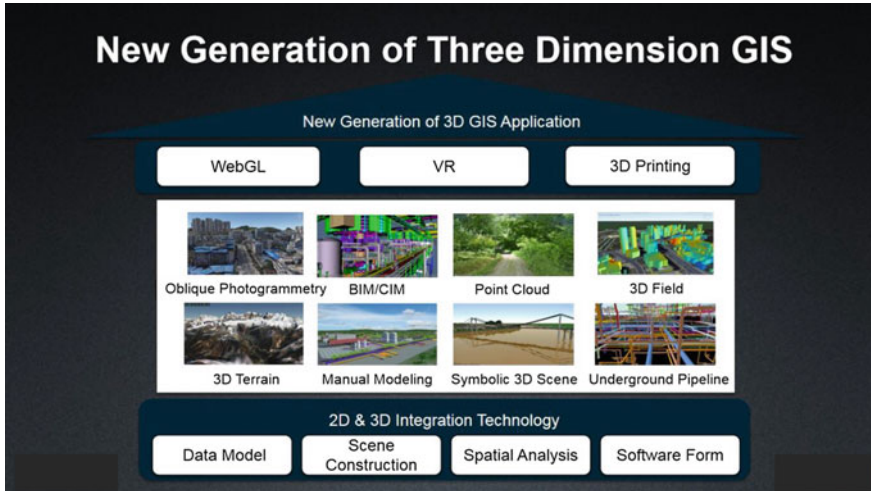


Fig. 22.3 The new generation of 3D GIS technology

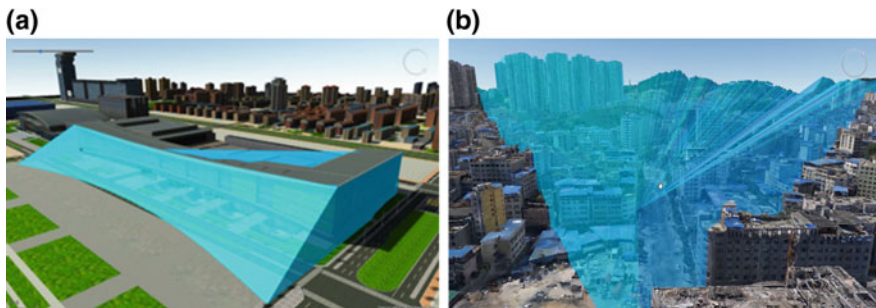


Fig. 22.4 Using a 3D entity model to describe abstract 3D objects: **a** 3D of shadow, **b** 3D of visibility

development of a comprehensive e-government pilot to promote the modernization of national governance systems and capabilities.

The government of China issued the Implementation Plan for the Integration and Sharing of Government Information Systems to accelerate the integration and sharing of government information systems, promote network communication, data communication and business communication, and continuously extend e-government services to the grassroots governments. E-government media have flourished. Party and government organizations and group organizations at all levels actively use Weibo, WeChat, other clients and new media to publish government affairs information, respond to social concerns, provide convenient services and promote collaborative governance, creating effective platforms for building an online and offline community and practicing the government’s mass line. Public security organizations have

accelerated the application of new technologies and continuously improved their ability and level of prevention and control, mass service, and social governance. The construction of the social credit system has achieved remarkable results. The national credit information sharing platform has been linked to 39 ministries and commissions and all provinces, autonomous regions and municipalities. The total amount of credit information collected has exceeded 6.5 billion items, and the system of joint punishment for dishonesty and joint incentives for honesty between departments has been improved.

(4) ***Information Services to Benefit the People and Add Convenience.*** To develop the network and information technology businesses, it is necessary to implement people-centered development thinking. Regions and departments should regard information technology as an important means to safeguard and improve people's livelihood and should vigorously develop information services such as online education, telemedicine, network culture, "internet + public legal services" and "internet + public security" so that people can have a greater sense of gain in terms of sharing the results of internet development.

"Internet + education" expands the coverage of high-quality education resources. Significant progress has been made in the construction and application of the "three accesses and two platforms (network access for each school, resource access for each class and space access for each person, and the educational resource service platform and the educational management service platform)," the level of educational information technology has been significantly improved, and the promotion mechanism for the participation of all society has been continuously improved. Applications benefiting the people have been rapidly popularized. The interconnection of national transportation cards has been advanced rapidly. China has actively promoted the model of "internet + public security" and built the "internet + government service" platform for public security to improve the service efficiency and extend the service range. Many areas have expanded applications in other government public service areas including resident health, civil assistance, and financial subsidies, and initially established a mechanism for the coordination and sharing of pension services and community services.

(5) ***International Cooperation in the Digital Economy.*** International cooperation in the digital economy has become a new highlight. China has promoted the launch of the G20 Digital Economy Development and Cooperation Initiative and the Initiative for International Cooperation in "Belt and Road" Digital Economy, actively promoted negotiations on nearly 20 e-commerce topics of free trade agreements such as regional comprehensive economic partnerships, deepened pragmatic cooperation in cyberspace, and promoted the joint construction and sharing of the Digital Silk Road. The system for serving enterprises that work overseas has been continuously improved. The channels for acquiring overseas enterprise information services have been expanded, and the release of early warning safety information has been strengthened. The "Belt and Road" big data service system has taken shape to actively provide effective information and services for relevant enterprises, organizations and individuals involved in construction of the "Belt and Road".

22.6 Summary

The goal of building Digital Earth in China is to provide crucial information technology and support resources for promoting China's economic, political, cultural, social and ecological civilization construction progress. The Chinese government has attached great importance to and strengthened the top-level design for long-term planning and specific implementation steps for Digital Earth in China. With the rapid development of basic theory and innovations in common key technology and information infrastructure in spatial information technology, Digital Earth in China has experienced explosive development, such as in digital agriculture, digital disaster reduction, and digital heritage. Digital Earth in China has been a model for the digital economy in some countries but not in other countries. This may be due to several reasons, but the social system and government organization are important aspects for the rapid development of Digital Earth in China. Although it has been successful, there are also many problems regarding the future development of Digital Earth in China, such as privacy, politics, possible access to government data by the public and data sharing. The Chinese government must work to overcome these issues and continue to focus on the development of Digital Earth in China

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Jiantao Bi is a Professor in Sanya Research Center of the institute of Remote Sensing and Digital Earth, CAS. He researches geographic information systems, data sharing and geographic information standards. He was the vice secretary-in-chief of ISDE Chinese National Committee.

Yongwei Liu is a professor in Remote Sensing at the Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences. His major focus is on the research, management and strategic planning of remote sensing technology. He has participated in the writing of “The Development Trend of Space Earth Observation”, “The International Frontier of Earth Observation and Digital Earth”, “Research on Hainan Commercial Space Development Strategy”, etc.

Ainong Li is a professor and director of the Digital Mountain and Remote Sensing application, Institute of Mountain Hazards and Environment, CAS. His main research interests focus on mountain remote sensing and Digital Mountain. He is also the director of the Digital Mountain Committee, Chinese Committee of International Society of Digital Earth (CNISDE).

Min Chen is a Professor and the Vice Director of Key Lab of Virtual Geographic Environment (Ministry of Education of PRC), Nanjing Normal University, China. His research interests are geographic modeling and simulation, virtual geographic environment. He is the executive editor of *Annals of GIS* and an editor of *Environmental Modelling & Software*.

Ruixia Yang is an Associate Professor in Digital Natural and Cultural Heritage at the Institute of Remote Sensing and Digital Earth, CAS. Her research field focuses on digital environmental archaeology and geographical information technique for conservation of natural and cultural heritage.

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