

Building the “Digital Earth”, Promoting China's and Global Sustainable Development

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On the threshold of embracing the new millennium, we are pleased to see that scientists, engineers and management experts from all over the world are gathered here to review the progress of “Digital Earth”-related fields, to discuss the opportunities and challenges which human society will face in the coming century, and to exchange views on “Digital Earth” theory, technologies and applications.

“Digital Earth” is located at the interdisciplinary forefront of earth science, space science and information science and technologies, and it will be a fruit of natural science and social science, and closely associated with human requirements. As a powerful supporting tool, “Digital Earth” can play a key role in new economic growth and in global sustainable development. It is the inevitable outcome of science, economy, politics, and society and their historical development.

Currently, from the strategic point of view regarding “Digital Earth”, we need to draw up a long-term plan at world, country and regional levels for acquiring, processing and utilizing information about the earth's surface, and we need to systematically integrate and develop the “Digital Earth”- through related theory, technology, data and application methods. Meanwhile, we should diversify services for social development - through building the multi-scale and multi-layer “Digital Earth”, including digital regions and digital cities.

Relevant Chinese institutions and experts give a high value to “Digital Earth” development. To progress, we follow the principle of “requirement-driven, comprehensive planning, phase-by-phase progress, optimization of projects, joint development and sharing”. We are glad to enhance co-operation with other countries and contribute more to building the “Digital Earth”.

1. The Necessity for China to Develop “Digital Earth”

Present and future social needs provide the impetus to develop “Digital Earth” based on geographic information, not only to maintain sustainable development, but to improve people's living standards. “Digital Earth” is driven also by the need to develop science and technology, and by new prospects in the future knowledge economy.

1.1. The Need to Maintain Sustainable Development and to Improve People's Living Standards

At the turn of the century, many countries are facing such thorny problems as resource shortage, environmental pollution, frequent occurrence of natural disasters and population explosion. China faces the problem of a big population, limited land resources and frequent natural disasters. It is an urgent task for this country to enhance land, water and environmental protection, develop technology-intensive agriculture and intensify disaster prevention, especially in the forecasting and control of floods. China must also use modern technologies to explore mineral, oil and natural gas deposits, while conserving its forest, grassland and ocean resources. It is important for China to avoid the errors committed by some other countries in the process of urbanization, by committing itself to scientific urban planning, management and monitoring. “Digital Earth”, which is an outgrowth of the development of geographic information systems, can play an active role in modern urban planning, community management and emergency preparedness. In view of ongoing economic growth, it is important to rationalize the use of the labor force, capital, production and market structures. “Digital Earth” will accelerate the development of the information-based economy and therefore propel China's market-oriented economic growth. “Digital Earth” is closely related with people's lives, because electronic shopping centres, electronic banks and electronic business are all underlain by a need for geographic information. With the support of “Digital Earth”, we can provide spatial information to help people travel around the world, virtually visiting global libraries, museums, art galleries, music halls. It is our future objective.

1.2. The Need to Develop Science and Technology

Under the “Digital Earth” framework and according to sustainable development principles, China will realize a rationalized plan for earth observation system, developing high-quality sensors to improve resolving power in the spectral, spatial and temporal domains; improving earth observation satellite technology, satellite-borne data processing technology, satellite-plane-ground data receiving

technology, and technologies of ground-based social, demographic and economic information acquisition as well as their integration technologies.

In the field of information technology, we have to develop a new generation of large-scale parallel processors, high speed and broad band networks, network-based operating systems, high-density and high-speed data storing, compressing and processing technology, multi-scale and multi-source data integration technology and intelligent technology for recognizing image information. These should lay a technological foundation for "Digital Earth" development.

In the field of earth science, "Digital Earth" will cover such aspects as cloud, water and energy circulation, the chemical composition of ocean and air, interaction between land surface, water and ecosystem, studies on glaciers, polar regions' ice sheet and solid earth, and interaction between ocean and atmosphere.

In the field of social sciences, new progress will be achieved in the study of coupling relations between humans and earth, human and nature and social development analysis based on spatial scale with the support of "Digital Earth".

Overall, building the "Digital Earth" will greatly spur the development of information, space, environment and earth sciences. To tap the market potential of "Digital Earth" technology is vital to China's economic growth. Many ideas of "Digital Earth", such as sharing of data and large instruments and interdisciplinary operation, are already discussed but have not been practiced. Other ideas, such as establishing unified geoscience databases and integrating spatial data through information technology, are what we have been studying but more effort is still needed. "Digital Earth" has offered us an opportunity to unify all these related efforts at a higher level, and to further the development of the country's science innovation system.

2. The Possibilities for China to Develop "Digital Earth"

The coin of the "Digital Earth" concept is a logic evolution of science and technology since the end of World War II, especially following the eruption of a new technology revolution in the 1970s. Earth science is significant to a country's development because it can help solve such regional or global issues as resources, environment, and natural disasters. Developing new generation information technologies through the breakthrough of geoscience information is a positive trend of scientific history. No matter whether the concept of "Digital Earth" has been raised, no matter who

raised it or in whatever form, the work concerning the integration of earth information is a significant trend of the current development of earth science and information technology.

Current scientific, economic and social developments demonstrate a highly non-linear character. The "leap forward" development pattern is not only possible and realistic, but also the route to be taken by the country intending to seek rapid development and to become a world power. In the process of such "leap forward" development, to grasp the historic opportunity provided by the new scientific and technological achievements as well as the new productive forces is an important element. Historically speaking, the rise of Britain was the direct result of the industrial revolution fueled by the steam engine, the rapid development of Germany relied on the growth of its iron, steel and synthetic chemical industries, the development of the United States benefited directly from the expansion of its energy and internal-combustion engine industry. Now, the development of information industry has provided a new historical opportunity and few people would doubt such a possibility. Indeed, the market created by the development of information industry has become the focus of international economic competition. Since the founding of the People's Republic of China, China's economic growth has become the focus of world attention. China, under the condition that its industrialization is not fully developed but has pursued its own route, is completely qualified for achieving the goal of "leap forward" development in the information sector. The pending scientific and technological problems which have connections with the "Digital Earth" itself (such as numerous issues of data storage, complicated information system and system security etc.) will provide an opportunity for "leap forward" development and the solution of any of these problems means a great breakthrough in science and technology. High-tech progress has also created realistic conditions for "leap forward" development. With long-term accumulation, especially after experiencing the rapid development in recent years, China has laid a solid foundation for the digitization of earth science.

The Chinese Government attaches great importance to the development of earth science and technology as well as information technology. In recent years, under the leadership of the State Council, the State did a lot of work in earth information technology as well as its application sectors such as the drafting of regulations, infrastructure construction for the acquisition, transmission and processing of spatial data and information, the construction of telecommunication

networks and the development of domestically-made computer hardware and software. Several scientific and technological projects listed in the "Eighth Five-Year Plan" (1991-1995) and "Ninth Five-Year Plan" (1996-2000) by relevant central government departments and the Chinese Academy of Sciences have direct links with the development of "Digital Earth".

China's information highway has achieved remarkable progress after more than a decade of development. China's National Information Infrastructure (CNII) is to be established in 2020. During the period of "Ninth Five-Year Plan" (1996-2000), major efforts have been made to develop the "Eight-Golden Projects".

China's four largest computer networks provide the basic platform for information exchange, including data networks, fiber-optical backbone networks, asynchronous transmission model networks, synchronous digital serial networks and fiber-optical interconnected networks. The information service nets and databases developed in different areas across the country have become the local distribution centers of electronic information resources. By the end of June 1999, the total length of optical cable has reached more than 1 million kilometers, the amount of publicly-owned computers surpassed 12 million, the number of Internet users has reached four million, the number of WWW web sites has hit 9,906, the total capacity of international network has reached 241Mbps, the State public information network has covered 239 cities across the country, the project of putting government departments online has been greatly encouraged, while on-line universities and on-line libraries have appeared and the drafting of national information development strategy, digital products development strategy and the framework of e-commerce are now underway.

Through nearly two-decades of joint efforts, our colleagues in China's geoscience, aerospace science and technology and information technology circles as well as other corresponding application circles have mastered or been developing techniques and abilities required for establishing "Digital Earth", which cover various standards, codes and technologies such as object-oriented technology, spatial data warehouse technology, virtual reality technology, neural networks, expert systems, automatic extraction of information and multi-source data fusion etc.

Over past 20 years, relevant ministries and commissions under the State Council, the Chinese Academy of Sciences as well as local departments at the provincial, municipal and county levels have accumulated a lot of raw digitized data and

corresponding materials required for establishing "Digital Earth", which include countless kinds of digitized geographic basic maps, thematic maps and city cadastral maps. The series of China's basic topographic maps cover various scales: ranging from 1:10,000 to 1:25,000, 1:50,000, 1:100,000, 1:250,000, 1:500,000 and 1:1,000,000. To date, the digitized versions of the basic topographic maps with scale of 1:250,000 and 1:1,000,000 have been completed in China. The next step is to digitize the topographic maps with a scale of 1:50,000. Because a topographic map has high geometric precision, it is usually used as the basic map for making other thematic maps. Relevant central government departments and the Chinese Academy of Sciences have set up some innovative projects in the "Eighth Five-Year Plan" (1991-1995) and "Ninth Five-Year Plan" (1996-2000), which have accumulated rich experience for "Digital Earth" in agriculture, resources, environment, natural disasters, and demography as well as decision-making on sustainable development and the implications of global change. In China, many cities make from 1:500 to 1:2,000 topographic maps based on aerial photography, while making their pipeline maps, cadastral maps and building maps through ground surveys, and some cities also use ground surveys to make 1:500 topographic maps.

China has not only launched 17 retrievable remote sensing satellites and obtained high-precision panoramic photograph images but also launched meteorological satellites and resource satellite (with Brazil's cooperation). It has also established many remote sensing satellite ground stations to receive and supply image data of Landsat TM, SPOT and RADARSAT etc, covering more than 80 per cent of the country's land, and established many meteorological satellite receiving stations to receive and process data from NOAA and stationary meteorological satellites. Today, at the country's national, provincial, municipal and county levels, a large group of experienced Chinese experts, scholars and technicians are engaged in work related to "Digital Earth".

3. China's Strategy of Developing "Digital Earth"

The Chinese Government attaches great importance to the role of "Digital Earth", whose core is geographic information. It has already embarked on promoting the construction of "Digital Earth", adopting as its basic guidelines "requirement-driven, comprehensive planning, phase-by-phase progress, optimization of projects, joint development and sharing", in order to achieve the goal of "leaping forward" development.

3.1. To Be Requirement-Driven

China utilizes applications and requirements to promote the construction of "Digital Earth" and it is necessary to make good requirements analysis and properly select breakthrough points in the application sector. The national monitoring and survey of land resources, the monitoring and survey of disasters, forecasting and early warning issues, various regional industrial belts, urban management, and technology-intensive agriculture are listed as priority tasks; priority should also be given to international co-operation on issues of the global environment and resources. The focus is to base development on applications and to promote development efficiency.

3.2. Making Comprehensive Planning

"Digital Earth" is, first of all, a form of government action. The correct decisions on prediction, legislation and standardization by the State leadership are very important for the country to avoid low-level duplication of projects and waste of resources. So, the setting-up of a State-level Co-ordination Committee for "Digital Earth" Development is proposed. It should comprise two groups of representatives: one includes leaders of the relevant State comprehensive departments and specialized departments of geospatial information, and the other includes scientists with high academic reputations. Their tasks should be to study China's "Digital Earth" development strategy, design national actions, draft medium- and long-term development programs, make relevant policies and regulations, co-ordinate plans, promote international co-operation and avoid duplication, waste and detours in development projects.

We hope relevant central government departments will pay attention to issues of "Digital Earth" when drafting and implementing the "Tenth Five-Year Plan" (2001-2005). They should strengthen co-ordination and integration of relevant comprehensive departments and specialized departments to give support to and take part in China's "Digital Earth" effort from different directions, and on the basis of positively participating in international co-operation, to finally achieve the goal of building the "Digital Earth" together with all other participating countries in the world and make our due contribution to doing studies and finding solutions to global problems.

3.3. Seeking Phase-by-Phase Progress

There are a lot of things to be done in China to develop the "Digital Earth" and the principle of "doing something and not doing something else" should be observed to implement policies in line

with the project's importance and urgency. Now, the most important task is to draft a unified standard and regulations to create conditions for the common sharing of data. The construction of an earth observation system should be implemented step by step in accordance with requirements and plans. The National Foundation Committee for Natural Sciences and 973 Project should give support to research on basic scientific issues which have connections with "Digital Earth"; the State 863 Project should support research on key technologies related to "Digital Earth"; the State scientific and technological innovation projects in the "Tenth Five-Year Plan" (2001-2005) should include and support the construction of our National Spatial Data Infrastructure and typical application systems of "Digital Earth".

3.4. Optimizing of Projects on a Selective Basis

China is now in the process of economic restructuring. In order to improve the efficiency of using limited resources, it is of extreme significance to establish a competitive mechanism. The development of China's "Digital Earth" will observe the principle of optimizing projects on a selective basis. Through fair and reasonable competition, the State will concentrate its support on projects done by qualified research institutions so as to improve cost-efficiency and put an end to the "all eating from the same big rice bowl system" -- the Chinese idiom for absolute and irrational egalitarianism.

3.5. Conducting Joint Development and Sharing

Initiatives from all parties should be fully employed and working achievements of all departments should be fully utilized to integrate current data. Therefore, in accordance with unified regulations and standards, a large amount of scattered geoscience data should be collected, sorted out, edited and digitized so as to form a big framework of digital earth which includes data from both China and abroad. State-level major projects should lead and guide practice; in order to achieve the goal of "conducting joint construction and sharing", a spatial information sharing mechanism, which is suitable for China's conditions, should be studied and established as soon as possible, relevant policies and regulations should be drafted, which should include the clear definition of rights, responsibilities and obligations of different departments and units for keeping, supplying and using geographic information, the regulation of openness of geographic information and the clarification of opening levels, the property rights definition and protection policy of information and data, and the value-compensation policy in the

information sharing process.

4. Strengthening International Co-Operation in the Construction of Digital Earth

The construction of "Digital Earth", which is the largest information system in the history of humanity, cannot be successfully accomplished unless and until joint efforts are made by governments of all countries, relevant departments, non-governmental organizations and people from all walks of life, so an extensive international co-operation will be the foundation for the success of "Digital Earth". All countries should strengthen exchanges and co-operation in drafting rules and standardization, developing information infrastructure, constructing application systems as well as sharing information resources, and these practice will greatly improve the compatibility and mutual complementarity of current and future sub-systems.

The concentration of finance and human resources from international partners may increase the number of practical programs in a country and may also enable participating countries to have the opportunity of utilizing common research results. The science of the earth system and research on global change need global efforts and continuous international participation; any single organization or country cannot provide the comprehensive systems needed for knowing all sciences of the earth system. The development road of promoting mutual exchanges and seeking mutual benefits is extremely useful in developing a giant project for mankind like "Digital Earth". Capital, technologies,

human resources and markets of all countries should be utilized to promote progress; the practice should be in line with international markets; while international norms and standards should be followed to develop and utilize international information resources; respect should be given to relevant international regulations, systems and intellectual property rights; and international practice should be observed in such work. Developed countries should shoulder more responsibility for developing "Digital Earth" - not only because most current global problems are caused by the uneven growth of modern industry and agriculture as well as by imbalance in economic and social development, but also because it is hard for developing countries to provide the necessary human resources, materials and finances. We urge developed countries to take forceful measures in this sector and promote the construction of "Digital Earth" and its application in all countries.

I appeal to scientists, entrepreneurs and government decision-makers of all countries to make joint efforts, under the common requirement of peace and development, to positively conduct international co-operation and exchanges, promote construction and continuous perfection of "Digital Earth", face the challenge of the information economy era, make "Digital Earth" truly become an undertaking conducive to all human existence, push the lives of human beings to a better future and jointly embrace the prosperous 21st century.