

构筑“数字地球”，促进中国和全球的可持续发展*

徐冠华

中国科学技术部副部长 中国科学院地学部主任

在迎接 21 世纪的历史时刻,我们来自世界五大洲的科学家、工程师和管理专家亲切聚会,展示“数字地球”相关领域已经取得的丰硕成果,探讨 21 世纪人类社会面临的机遇与挑战,交流对“数字地球”理论、技术、应用等各方面的认识,展望“数字地球”的前景,倍感欣慰。

“数字地球”既是地球科学技术与空间科学技术、信息科学技术等现代科学技术交融的前沿领域,更是科学技术与社会发展以及社会科学紧密结合的结晶。“数字地球”是世界各国可持续发展的必然依托,是新的经济建设增长点,是科学技术、经济、政治、社会、历史发展的必然产物。

当前,我们需要从“数字地球”的战略定位上,在全球、国家和区域的层次上,长远地规划地球表层信息的获取、处理、应用等方面的相关工作,从系统论和一体化的角度来整合已有的或者正在发展的与“数字地球”相关的理论、技术、数据、应用和能力;同时,我们应当建立多比例尺、多应用层面的数字化地球、数字化地区或数字化城市,从而更广泛、深入地为社会提供服务。

中国有关部门和各界人士高度重视“数字地球”的作用,在推动“数字地球”建设的过程中实行“需求牵引、统筹规划、阶段发展、择优支持、共建共享”的方针,争取实现“跨越式”的发展。并且,我们将努力加强与全球各国的合作,为建设“数字地球”作出自己的积极贡献。

1 中国发展“数字地球”的必要性

中国作为世界上最大的发展中国家,在全球可

持续发展承担着重要的责任,中国实现可持续发展是对全球可持续发展的重大贡献。中国当前和未来的巨大的社会需求是发展“数字地球”的驱动力。无论是维持社会的可持续发展,还是提高人们的生活质量;无论是促进当前科学与技术的发展,还是开拓未来知识经济的新天地,都对“数字地球”有着巨大的需求。

(1) 可持续发展和提高人民生活质量的需要

从全球角度来看,在世纪之交的历史时期,人类面临着共同的、日益尖锐的环境问题。中国的基本国情是人口众多、土地资源有限、自然灾害频繁。加强对土地资源、水资源和环境的监测和保护,发展精细农业,逐步实现农业产业化,加强对自然灾害,主要是洪涝灾害的监测、预测和防御,是一项迫切的任务。中国的自然资源相对不足,地质矿产和油气资源的勘探开发,森林、草原的调查和监测,海洋的保护和利用,也需要现代化手段。城市发展如何避免某些第三世界国家和一些发达国家走过的弯路,是中国面临的一个紧迫的社会问题。其中管理、监测和规划具有关键性的意义,“数字地球”作为“地理信息系统”的一个发展,可以在城市规划、管网管理、社区管理以及城市灾害、紧急事务动态管理方面发挥巨大的作用。在经济发展中,劳动力、资金、生产、市场的空间分布、动态变化和合理布局具有重要意义,通过“数字地球”促进经济信息化的进程,将有力地促进中国社会主义市场经济的发展。“数字地球”直接影响到中国居民未来的生活。网上商场、电子银行、电子商务等都涉及到地理信息。在“数字地球”的支持

* 本文系徐冠华副部长在 1999 年 11 月 29 日“'99 数字地球”国际会议上的讲话。

下,提供丰富的地理信息使人们可以方便、轻松地进行虚拟旅游,访问世界各地的数字图书馆、数字博物馆、数字美术馆,这是我们未来的目标。

(2) 科学与技术发展的需要

在空间科学技术领域,中国在“数字地球”的框架下,将根据可持续发展的需要,实现对地观测系统的合理布局;进一步促进高光谱分辨率、高空间分辨率、高时间分辨率的传感器的研制;提高对地观测卫星技术、星载数据处理、星-机-地数据接收技术、地面台站及人文、经济等数据的获取技术以及一体化集成技术的发展。

在信息科学技术领域,需要研究新一代大规模并行处理器、高宽带网络、基于网络的分布式计算操作系统;高密度、高速率的海量空间数据储存、压缩、处理技术;多比例尺多时相多源数据集成技术;图象信息智能提取技术等,从而为“数字地球”提供强有力的技术支持。

在地球科学等领域,需要进行多学科的综合研究。科学技术发展到今天,事实上只有空间对地观测技术才能提供全球性、重复性、连续性和多样性的地球表面动态数据。这类海量数据有助于把地球系统作为一个整体来研究,也可以模拟从前不可能观察到的现象,同时能更准确地理解所观察到的数据。建模与模拟给了我们一个深入理解正在收集的有关地球的各种数据的新天地。“数字地球”将有力地促进云、水和能量循环、海洋、大气、陆地表面、生态系统、冰川及极地冰盖以及固体地球等方面的研究,从而促进地球系统科学的发展。

在社会科学领域,在“数字地球”支持下人与地藕合,人与自然的关系以及在空间尺度上分析社会发展等方面的研究将会出现一个新的局面。

总之,建设“数字地球”的过程将极大地促进中国信息科学技术、空间科学技术、环境科学技术和地球科学的发展。“数字地球”所提供的巨大市场在中国经济发展中具有重要意义。“数字地球”创意中的很多思路,例如数据共享、大型仪器设备共享、跨学科合作等等,是我们早已进行过许多探讨,尚未有效实施的思路。“数字地球”创意中的很多工作,例如建立统一的地学数据库、依靠信息技术实现地学数据的集成和一体化等等,是我们很久以来就一直在做、但却做得不够理想的工作。“数字地球”的提出给我们提供了一个从更高层次上整合的机会,从而促进

中国科学创新体系的形成和发展。

2 中国发展“数字地球”的可能性

“数字地球”概念的提出是第二次世界大战以来,特别是本世纪70年代以来“新技术革命”的一个自然的发展。地球科学能够解决资源问题、环境问题、自然灾害问题,在社会的发展中具有重要意义。以地球信息为突破口发展新一代信息技术,是历史的必然。而无论是否提出“数字地球”的概念,无论是谁和以怎样的方式提出“数字地球”的概念,与地球信息的集成和整体化有关的工作都是目前地球科学和信息技术发展的一个重要趋势。

科学、经济和社会的发展具有高度的非线性。 “跨越式”的发展方式不仅是可能的和现实的,而且几乎是一个国家迅速发展、成为世界强国的必由之路。在这种“跨越式”的发展中,抓住新的科技成果和新的生产力所提供的历史性的机遇是一个重要的因素。历史上,英国的崛起是蒸汽机所导致的工业革命的直接结果,德国的迅速发展有赖于钢铁工业和合成化学工业,美国的发展则直接得益于电力和内燃机工业。现在,信息产业的发展提供了新的历史机遇,这一点已没有人怀疑。由此而出现的市场成为国际经济竞争的焦点。中国自建国以来,经济的发展令世人瞩目。在工业化并不十分充分的条件下,按照自己的发展道路,中国完全有条件在信息化方面实现“跨越式”的发展。与“数字地球”本身相联系的悬而未决的科学和技术问题(例如海量数据的动态获取与存储问题、系统复杂性问题、信息系统安全性问题等等),为“跨越式”发展提供了机遇。这些问题中的任何一个问题的解决都意味着科学技术上的一次突破。

中国政府十分重视地球科学技术和信息技术的发展。近几年来,在国务院领导下,中国在地球信息技术及其应用领域的法规建设、空间数据信息收集、传输和处理的基础设施建设、通讯网络建设、国产计算机软硬件软件开发等方面做了大量的工作。国家有关部委和中国科学院在“八五”、“九五”计划中所设立的一些重大科技攻关项目都直接与建设“数字地球”相关。

中国的信息高速公路经过十多年的建设已经取得了显著的进步。中国的国家信息基础设施 CNII 计划到2020年建成。“九五”期间,主要建设了“八金工程”。

中国四大计算机网络已成为完善的信息传输基

础平台,主要包括数据网、光纤骨干网、ATM 异步传输模式网、SDH 同步数字系列网和光纤接入网。各地信息服务网和数据库的发展已成为本地电子信息资源的集散地。到1999年6月底,光缆总长度达到100万公里,计算机社会拥有量已经超过1200万台,因特网用户也已达400万户,WWW 站点数约9906个,国际线路总容量为241Mbps的国家公用信息网络已经覆盖全国239个城市,政府上网工程迅速推进,网上大学、网上图书馆开始出现,国家信息化发展战略、数字化产品发展战略、电子商务框架等都在加紧研究、制订。

中国地球科学界、空间科学技术界和信息科学技术界及其相应的应用领域的同仁们经过近20年的共同努力,已经具备或正在发展为建立“数字地球”所需的各种技术和能力,这包括各类标准、规范、面向对象技术、空间数据仓库技术、虚拟现实技术、神经网络、专家系统、图象自动解译、多源数据融合等。

中国有关部委、中国科学院、各省、市、县在近20年间,已经积累了大量建立“数字地球”所需的原始数字化数据和相应的资料,这包括无以数计的各类数字化地理基础图、专题图、城市地籍图等。中国基本地形图系列有多种比例尺,从1:10,000起,到1:25,000、1:50,000、1:100,000、1:250,000、1:500,000和1:1,000,000。目前,全国范围的1:250,000和1:1,000,000的基本地形图已经数字化完毕。下一步将进行1:50,000比例尺的地形图数字化工作。由于地形图几何精度比较高,所以被常用于其它专题地图制作的基础底图。国家有关部委、中国科学院在“八五”、“九五”计划中所设立的一些重大攻关项目为“数字地球”在农业、资源、环境、灾害、人口以及可持续发展决策、全球变化方面的应用积累了丰富的经验。我国许多城市利用航空摄影测量绘制1:500至1:2,000的地形图。管线图、地籍图、房产图则主要是使用地面测绘,少数城市也使用地面测绘1:500地形图。

我国已经发射了68颗卫星,其中科学技术卫星10颗,气象卫星5颗,1颗资源卫星,17颗返回式遥感卫星,获取了高分辨率的全景摄影图象,建立了多个遥感卫星地面接收站,能够接收和处理Landsat TM、SPOT和RADARSAT等卫星图象数据;建立了许多气象卫星接收台站,接收和处理NOAA及静止气象卫星等数据;建立了中、低空高效机载对地观测组合平台和大量的地面观测台站。

目前,在国家、省、市、县不同层次上,我国有一大批经验丰富的专家学者和专门技术人员从事与“数字地球”相关的工作。

3 中国发展“数字地球”的战略

中国政府高度重视“数字地球”的作用,在推动“数字地球”建设的过程中实行“需求牵引、统筹规划、阶段发展、择优支持、共建共享”的方针,争取实现“跨越式”的发展。

(1) 需求牵引

中国以应用和需求来促进“数字地球”建设,做好需求分析,选好应用切入点。全国性的土地资源监测、灾害监测与预测预警、各区域性产业带、城市管理、精细农业等是可能的切入点;全球性的环境、资源问题的国际合作也是应予优先考虑的领域,应扎根应用领域,以效益促发展。

(2) 统筹规划

“数字地球”首先是一种政府行为。国家领导层的超前决策、立法、规范,对避免低级重复和资源浪费至关重要。为此,建议成立国家级的“数字地球”工作协调委员会,由两部分代表组成:一是国家有关综合部门和空间信息专业部门的负责人;二是具有较高学术水平的科学家。其任务是研究中国“数字地球”的发展战略、设计国家行为、制定中长期发展规划、制定相关政策法规、协调各项计划、推进国际合作,避免重复浪费和走弯路。

我们希望,国家有关部门在制定和实施“十五”计划时应当考虑“数字地球”的有关问题。加强有关综合部门和专业部门的协调和联合,从不同的角度支持和参与中国“数字地球”的工作;并在积极参与国际合作的基础上最终实现世界各国共享的“数字地球”,为全球性问题的研究和解决作出自己的贡献。

(3) 阶段发展

在发展中国“数字地球”方面,要做的事很多,本着“有所为,有所不为”的原则,按轻、重、缓、急实施。当前,首要的任务是制定统一的标准和规范,为数据共享创造条件。对地观测系统建设要根据需要、计划分步实施。国家自然科学基金委员会和“973”计划应当资助对“数字地球”相关基础科学问题的研究;国

家“S863”计划应当支持开展“数字地球”的关键技术研究;国家科技“十五”攻关计划中应当安排和支持国家空间数据基础设施和“数字地球”典型应用系统的建设。

(4) 择优支持

中国处于经济体制转轨过程之中。为了充分利用有限的资源,建立竞争机制具有突出重要的意义。中国“数字地球”的建设将贯彻“择优支持”的方针。通过公平、合理的竞争将项目集中在有条件从事研究开发工作的机构,提高经费的使用效率,杜绝“大锅饭”的倾向。

(5) 共建共享

应调动各方面积极性,充分利用各部门现有的工作基础,整合现有数据。为此,要根据统一的规范标准,将大量分散的地球科学数据归一、整编、数字化,形成包括国内外数据在内的“数字地球”的大框架。应通过国家大项目牵引和引导,实现数据“共建共享”,尽快研究和建立符合我国国情的空间信息共享机制,制定相应的政策、法规,包括明确规定不同部门和单位对地理信息维护、提供和索取的权利、职责和义务;地理信息开放度的规定和开放等级划分;信息与数据的产权界定和保护政策;信息共享中的价值补偿政策。

4 加强“数字地球”建设中的国际合作

建设“数字地球”这样一个人类历史上最大的信

息系统,必须通过各国政府、有关部门、民间组织和各界人士的共同努力才能实现,因而,广泛的国际合作将是“数字地球”成功的基础。各国在标准规范的制定、信息基础设施、应用系统建设、信息资源共享等诸方面应当加强交流和合作,这将会大幅度提高现有和未来各分系统的兼容和互补性。

国际合作伙伴的财力和人力集中起来不仅可以减少费用,而且还可以使参加国获得利用大多数共同成果的机会。地球系统科学和全球变化研究需要全球性努力和不断的国际参与,任何单一机构或国家都不可能提供了解所有地球系统科学所必需的全面系统。对于“数字地球”这样人类共同的巨大工程更应当走相互流通、互惠互利的发展道路。利用世界各国的资金、技术、人力资源、市场来共同推动,与国际市场接轨,要用国际标准、规范去开发利用国际信息资源,尊重国际上有关规章、制度和知识产权,按国际惯例办事。发达国家在“数字地球”建设中应当承担更多的责任,这不仅仅因为当前的全球性问题多数由于现代工业、农业的无序发展和经济社会发展不平衡所引发,而且发展中国家也很难提供必须的人力、物力和财力。我们呼吁发达国家能够在这方面采取有力措施,促进“数字地球”的建设和在各国的应用。

我呼吁世界各国的科学家、企业家、政府决策者共同努力,在和平与发展的共同需求下,积极开展国际合作与交流,促进“数字地球”的建设与不断完善,迎接信息经济时代,使“数字地球”真正成为对全人类都有利的事业,将人类生活推向一个更美好的未来,共同走向繁荣的21世纪!

Building the "Digital Earth", Promoting China's and Global Sustainable Development*

Xu Guanhua

Member, the Chinese Academy of Sciences

Vice-Minister, Ministry of Science and Technology of China

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

* Towards Digital Earth—Proceedings of the International Symposium on Digital Earth

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 al-

ready 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 com-

pletely 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 sens-

ing 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 S863 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 ob-

serve 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.