ГЕОИНФОРМАЦИОННОЕ И КАРТОГРАФИЧЕСКОЕ ОБЕСПЕЧЕНИЕ ЭКОЛОГИЧЕСКИХ, ЭКОНОМИЧЕСКИХ И СОЦИАЛЬНЫХ АСПЕКТОВ УСТОЙЧИВОГО РАЗВИТИЯ ТЕРРИТОРИЙ В УСЛОВИЯХ ГЛОБАЛЬНЫХ КЛИМАТИЧЕСКИХ ИЗМЕНЕНИЙ

GEOINFORMATICAL AND CARTOGRAPHICAL SECURITY OF ECOLOGICAL, ECONOMICAL AND SOCIAL ASPECTS OF SUSTAINABLE DEVELOPMENT OF TERRITORIES IN CONDITIONS OF GLOBAL CLIMATE CHANGE

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DBAR: AN INTERNATIONAL SCIENCE PROGRAM FOR REGIONAL SUSTAINABLE DEVELOPMENT

ABSTRACT

The "Silk Road Economic Belt" and the "21st Century Maritime Silk Road" initiatives (abbreviated to "Belt and Road") are a global breakthrough in international cooperation. The Belt and Road is a long-term, complicated, arduous systems engineering feat covering a wide geographical range and long-time periods, and crossing into many fields of study. Earth observation technologies have macro-level capabilities that enable rapid, accurate monitoring of Earth. Earth observation represents a new horizon for human beings to understand our planet with a new method for studying Earth's environment. It will also provide scientific decision-making support for construction and sustainable development in the countries and regions along the Belt and Road. To this end, the "Digital Belt and Road" (DBAR) initiative was launched to facilitate Earth observation and "Big Earth Data" in the Belt and Road region. DBAR has received support from more than 20 international organizations and countries along the Belt and Road. Intercontinental links are an important part of DBAR, allowing for accelerated scientific cooperation in Earth observation. DBAR is bringing new scientific collaboration opportunities for regional and global partners to promote the construction of Earth observation systems and data sharing, and researching the key issues of sustainable development through transnational, synergistic Earth observations.

KEYWORDS:

Big Earth Data, Digital Earth, Earth observation, Belt and Road, Digital Belt and Road, DBAR

BACKGROUND

China is creating a forward-looking vision for cooperation among countries, regions, and organizations spanning the historical Silk Road. The new Silk Road will reach from China across Asia to Europe and Africa as a platform for shared development and mutual relationships. The "Silk

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Road Economic Belt" and the "21st Century Maritime Silk Road" initiatives (consolidated as the "Belt and Road") seek to enable its participants to address the challenges posed by climate variability, intensified use of land and marine resources, and the fragility of many ecosystems. Other transnational problems, such as air pollution and water quality and security, can also be mitigated with cooperation in the Belt and Road region, ultimately striving to meet the United Nations' sustainable development goals (SDGs).

These environmental and societal challenges will require assessment and monitoring of terrestrial and marine ecosystems, so that decisions and policies can be based on sound information. This in turn requires precise, accurate, and timely observation and measurement of processes across a range of spatial and temporal scales. These needs can be met with integrated networks for collecting data, such as in-situ and space-borne Earth observation systems that sample a range of spatial and temporal scales [Guo, Qiu *et al.*, 2017].

In the realm of Earth observation in China, presently the Earth observation system is formed by resource satellites, meteorological satellites, ocean satellites, environmental and disaster mitigation satellites, high-resolution systems, and the BeiDou navigation and positioning satellite. The China Remote Sensing Satellite Ground Station has the ability to receive advanced international Earth observation data and has full coverage of regional spatial data along the Belt and Road. In recent years, macro-level research and dynamic analyses of ecological patterns and development potential for the countries and regions along the Belt and Road have provided fundamental macroscopic scientific data and decision-making support for the formation of the Belt and Road. It is a demonstration of the strong abilities of Earth observation technology in environmental monitoring and resource investigation [Guo, Xiao, 2016].

The International Symposium on Earth Observation for the Maritime Silk Road (EMSR) was held in Sanya in 2015, releasing the "Sanya Declaration on International Cooperation on Earth Observation for Maritime Silk Road Development". In Beijing in 2016, the International Symposium on Earth Observation for One Belt and One Road (EOBAR) released the "Beijing Declaration on Earth Observation for the Belt and Road". Participants agreed on the establishment of a "Big Earth Data Alliance for the Belt and Road", expecting big data to be the engine driving the construction and operation of the Belt and Road. Big data will become a peace envoy for all countries and regions along the Belt and Road, shining a light on the present and future of the region.

The Belt and Road demands traction, and Earth observation and Big Earth Data are important to helping participants grasp the potential impacts. The "Digital Belt and Road" (DBAR) initiative was launched to this end, and received support from many international organizations and 22 countries along the Belt and Road.

"DIGITAL BELT AND ROAD" INITIATIVE

The "Digital Belt and Road" (DBAR) initiative is an international science program for the sustainable development of the Belt and Road region using Big Earth Data. It is based on multi-source, massive data from space-based, air-based, and ground-based systems using simulation techniques to understand the Belt and Road. It is a huge information system including aggregation and representation of data and information related to Earth and space. DBAR is a digital, virtual system which can remodel complex geological processes and socioeconomic phenomena to support decision making. The goal of DBAR is to promote the construction of Earth observation systems and data sharing, implement regional and global scientific cooperation, and understand the key issues of the environment and development along the Belt and Road quickly and accurately through cross-border, stereoscopic, synergistic Earth observation.

DBAR was conceived to deal with a multifold challenge:

1. Advance scientific knowledge of the Earth System processes determining the state and evolution of natural and human environments in the Belt and Road countries, particularly the sites and areas most impacted by the construction of the Belt and Road;

2. Develop and implement an effective mechanism for multilateral cooperation involving many countries in the Belt and Road region, where such cooperation is unprecedented;
3. Identify and address "show-stoppers" in current human and technological resources that may block the progress of the initiative.

The mission of DBAR is to mobilize Earth observation in scientific knowledge, technology, and data to enable the Belt and Road countries to sustainably develop their infrastructure, economy, natural resources and culture, and to support decision makers towards meeting the SDG targets relevant to Belt and Road countries.

Figure 1. *DBAR Work Flow: from space-borne observations to implementing international conventions*

The vision and mission call for DBAR to meet the following three objectives in its implementation:

1. To address knowledge gaps in Earth system processes that constrain the attainment of the SDGs in Belt and Road countries.
2. To promote advanced science and decision support services to extract effective information from massive and diverse data from ever-growing volumes of Big Earth Data.
3. To enhance capacity building and technology transfer towards a system of partnerships and research networks.
4. The DBAR Initiative was conceived to link four levels of actions:
5. Design and development of an information communications technology (ICT) infrastructure to support remote discovery, access, processing, and analysis of Earth observation data in a virtual (cloud) environment;
6. Research on Earth system science primarily based on Earth observation data;

7. Interaction within communities of scientific and professional stakeholders;
8. Dissemination of SDG-relevant outcomes.

DBAR's Work Flow (Figure 1) foresees the synergistic exploitation of multiple data streams by developing an integrated data processing and analysis system to extract effective information from the data streams. DBAR has established seven Working Groups (WGs) named Big Earth Data (DBAR-DATA), Agriculture and Food Security (DBAR-AGRI), Coastal Zone (DBAR-COAST), Environmental Change (DBAR-ENVI), Natural and Cultural Heritage (DBAR-HERITAGE), Disaster Risk Reduction (DBAR-DISASTER), and Water (DBAR-WATER), and two Task Forces (TFs) named Urban Environment (DBAR-URBAN) and High Mountain and Cold Regions (DBAR-HiMAC).

DBAR IN DIGITAL EARTH

Digital Earth is a global initiative aimed at harnessing the data and information resources to quantitatively describe and represent the planet, and to monitor, measure, and forecast natural and human activities on Earth. Put forth in 1998, the vision of Digital Earth was articulated as a multi-resolution and three-dimensional visual representation of Earth that would help humankind to take advantage of geo-referenced information on physical and social environments [Gore, 1999].

With the development of Digital Earth over the last 17 years, the initial goals of Digital Earth have been basically achieved. Digital Earth could now be defined as an approach to understanding Earth by simulating it based on huge space-borne, air-borne, and ground-based multi-source data. With new methods, technologies, and applications emerging, Digital Earth has evolved into a new connotation from the concept of 'putting Earth into the computer' to 'Big Earth Data', a perspective influenced by big data. It could be proposed that, serving as a typical data-intensive research methodology and system in Earth science, Digital Earth was driven to advance to the new stage of "Big Earth Data"[4]. To this point, Digital Earth is Big Earth Data, which has been enabling knowledge discovery and proving itself as the new power behind Earth sciences. Based on widely collected Big Earth Data combined with models of the Earth system, the development of theory and methods for knowledge discovery related to Big Earth Data is an important scientific issue needing attention.

The 6th Digital Earth Summit, hosted by the International Society for Digital Earth (ISDE), was held in Beijing, China, from July 7 to 8, 2016, under the theme of "Digital Earth in the Era of Big Data". About 300 delegates of scientists, engineers, technologists, and scholars from 30 countries attended the summit. During the summit, the participants discussed collaboration between ISDE and DBAR and explored the development of DBAR under the support of Digital Earth. It was concluded that DBAR can provide the Belt and Road region with important Digital Earth technology to conduct "Big Earth Data" applications for the ecological environment and enhance the productivity, wellbeing, and lifestyle of humankind.

DBAR's Working Groups and Task Forces fit within the realm of Digital Earth. DBAR-DATA was established to improve regional Earth observation data cooperation. DBAR-AGRI aims to enhance the capacity of partner countries in the field of monitoring food resources, including building upon the CropWatch system. DBAR-COAST will focus on promoting cooperation with countries along the Maritime Silk Road to deliver critical sustainable development policies and strategies for coastal or near-shore environments. DBAR-ENVI aims to establish a dynamic analysis of the Belt and Road ecological environment, cooperatively carrying out a remote sensing evaluation of the ecological environment in the region. DBAR-HERITAGE will serve as the forum to bring together all concerned international, regional, national, and local actors to clearly demonstrate the added value that Earth observation science, technology, and expertise can bring for the conservation and sustainable development of natural and cultural heritage. DBAR-DISASTER aims to integrate Earth observation and social vulnerability data to promote the implementation of the Sendai Framework in the Belt and Road region. DBAR-WATER mainly focuses on using Earth observation techniques in research topics such as the water cycle, water resources management, crop water use efficiency, droughts, and floods. DBAR-URBAN aims to develop technologies to derive in-

formation and products on human settlements with Earth observation data. DBAR-HiMAC focuses on “High Mountain and northern Cold Regions”, linking existing data, archiving and documenting Earth observation products, and producing knowledge and services based on a scientific understanding of changes and these fragile high-altitude and high-latitude ecosystems [Guo, Qiu *et al.*, 2017].

CONCLUSIONS

The common challenges, opportunities and risks human beings are facing have brought a panoramic image of future development for Earth observation technology. DBAR’s impact for sustainable development of the countries and regions along the Belt and Road will be increasingly significant, and could contribute to all 17 sustainable development goals (SDGs) adopted by the UN in September 2015. DBAR will integrate “green”, low carbon, and sustainable approaches to social and economic growth that are vital for the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) adopted in Paris in December 2015 and the Sendai Framework for Disaster Risk Reduction 2015-2030. The DBAR Initiative is a pioneering international venture to share expertise, knowledge, technologies, and data to demonstrate the significance of Digital Earth applications for large-scale sustainable development. The extensive geographical scope of the Belt and Road calls for smart uses and applications of “Big Earth Data” in the design, development, and implementation of diverse projects related to infrastructure improvement, environmental protection, disaster risk reduction, water resource management, urban development, agriculture and food security, coastal zone management, and the conservation and management of natural and cultural heritage sites.

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