

Earth Observation of Ecological Environment along the Belt and Road

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The Digital Belt and Road Initiative, abbreviated as DBAR Initiative, is an international science program proposed by Prof. Guo Huadong, academician of the Chinese Academy of Sciences, during the International Symposium on Earth Observation for One Belt and One Road (EOBAR) held in Beijing in May 16–17, 2016. After that, the first 10-year implementation phase of DBAR Initiative was launched in December 2016 with the support of the Chinese Academy of Sciences (CAS), China Association for Science and Technology (CAST), and the related, international organizations. Currently, this program has received response from numerous countries and international organizations along the Belt and Road (BAR). The program focuses on international research collaboration on 7 major themes, including data, agriculture, environmental change, heritage, disaster, coastal zones and marine ecosystems, and water, as well as 2 cultivated themes, including urban and cold regions, in order to promote the technological and all-round cooperation between China and BAR countries by providing spatial data, environmental information, and decision supports. This program will enhance the implementation of BAR Initiative to establish the “Belt and Road Spatial Information System and Scientific Model” with

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international organization and international plans.

DBAR environmental change (DBAR-Envi) is one of the 7 major themes of DBAR Initiative. The land surface along the Belt and Road has complex physiographic condition, diverse ecosystem, and obvious regional heterogeneity. Environmental problems widely exist, and will get worse under the impact of global change when most regions along BAR are becoming warmer and drier. Many environmental problems are far beyond the scale of a country and become regional issues that require spatial observations and studies. However, Earth observation (EO) data along BAR is still inadequate especially in developing countries. Many regions have a sparse climate and environmental monitoring station coverage, while the existing satellite observations are in lack of ground verification and regional collaborative network. Besides, the quality of data needs to be further improved, and the capabilities and facilities for studying climate change need to be strengthened. Under this background, high-precision and high-resolution EO datasets, digital earth technologies, an integrated satellite, and ground database focused on global change issues need to be established to provide technological support for environmental improvement of BAR areas.



Cooperation Progress

Based on the international platform constructed by the International symposium for arid and semi-arid environment on Earth observation in 2012, 2014, and 2016, the International Conference on Earth Observation for One Belt and One Road in 2016, International Conference on Earth Observation for Maritime Silk Road in 2015, and the ABCC program, the global cooperation network were preliminarily constructed with the BAR countries. Moreover, the research group has established a long-term cooperation with European institutes such as IETR of University of Rennes 1, DLR, and Milan University of Technology, and jointly developed a series of technologies in SAR image processing, three-dimensional forest parameter inversion, and urban information extraction, and also established a preliminary cooperation with the European Union Joint Research Committee (JRC). These cooperating units have also established a cooperation network with BAR countries, which provides us a more convenient condition to further establish the cooperation network with them.

The DBAR working group is currently setting up and chaired by Prof. Guo. The co-chairs of the DBAR-Envi working group include Prof. Li Xinwu from Institute of Remote Sensing and Digital Earth, CAS, Prof. Jia Gensuo from Institute of Atmospheric Physics, CAS, and Prof. Howard Epstein from Department of Environmental Sciences, University of Virginia. The members of the working group are from 6 countries including Kazakhstan, India, the United Arab Emirates, France, Vietnam, and China. The research interests of these members cover multiple areas including climate change, water resources, cold environment, arid environment, and earth observation via remote sensing.

To ensure a smooth cooperation with BAR countries and technically support the maximum usage of regional resources and geographical advantages in BAR regions, the objectives of DBAR-Envi theme include:

- (1) Establish a cooperation network and employ the frontier earth observation technologies to enhance the monitoring ability of environmental key factors in the belt and road regions. Develop and share integrated field-satellite datasets for environmental monitoring along the BAR. Cooperate with experts in the remote sensing and environmental change areas to develop advanced models and methods of environmental monitoring. Cooperate with typical BAR countries to enhance the pertinence of the regional environmental monitoring methods.
- (2) Jointly carry out the observation and simulation of the impacts of global change on land surface processes cross temporal and spatial scales, to better understand key global change issues over the region. Carry out researches on dynamics of terrestrial ecosystem, changes in snow and ice and the corresponding effect on water resource, land use and cover change, and carbon cycle and budget.
- (3) Develop EO-based environmental evaluation methods, and propose regional suggestions to support the sustainable development goals for the belt and road countries. Evaluate the regional vulnerability and bearing capacity to prevent the impact of economic construction on the ecological environment. Support the less developed countries along the Belt and Road for climate change mitigation and adaptation. Contribute to the sustainable development goals, and link these efforts to the Paris Agreement on Climate Change, GEO identified Societal Benefit Areas and other international program and conventions.

In the next step, we would like to further revise the science plan of DBAR-Envi group, better summarize key scientific problems, and choose research priority areas of cooperation; Establish the cooperative network with BAR countries in Central Asia, Southeast Asia, South Asia, northeastern Africa, and Europe, as well as developed countries in North America; Enhance joint researches with existing partners to strengthen the cooperation networks. Meanwhile, we are going to implement joint researches over the BAR region on spatial and temporal patterns of global change sensitive variables, the impact and mechanism of climate change on regional terrestrial system processes, remote sensing environment evaluation methods, and the regional vulnerability and carrying capacity. We will employ the frontier Earth observation technologies to enhance the monitoring ability of environmental key factors; Jointly carry out in-situ data collection and validation work with BAR countries; Generate thematic products for time and spatial variations of environmental key factors; Propose strategies to sustainable manage the terrestrial ecosystems under global change, and develop a consultation report to support BAR countries. We hope that during the implementation of DBAR program, we can set up an international platform for global change researches, and form a leading scientific research team with experts on the aspect of EO-based environmental studies.

Thoughts on DBAR from Representative Experts

Focusing on DBAR, we have invited seven representative experts from six countries to share their thoughts on different aspects including scientific problems, frontier SAR remote sensing technologies, counter-measures to climate changes, Kazakhstan space technology research, ecological environment observation research progress in stages, and data sharing. The Interviews are sorted in alphabetical order according to the experts' family names.

Howard Epstein: Scientific issues in the Belt and Road region

The Digital Belt and Road Initiative encompasses an expansive geographic range throughout the entirety of Europe, Asia, and northeastern Africa. The region of interest covers three continents, and from an ecosystem perspective, nearly all of the Terrestrial Ecoregions of the World are represented. Many of the Earth's largest rivers, mountain ranges, forests, grasslands, and deserts can be found in this region, as can expanse of rangeland, crop production, silviculture, and many of the world's most densely populated centers of activity. Elevations range from sea-level to the highest location on Earth, and the climates include some of the coldest, hottest, driest, and wettest places on the planet. Climate and land use changes over the next century will be crucial for the exchanges of matter and energy between the land surface and the atmosphere, particularly in how land use and climate interact with one another. The continued monitoring and assessment of the state and function of the landscapes throughout the DBAR region are extremely important for policymaking, environmental planning, and climate mitigation and adaptation. Various ecosystem components will need to be comprehensively studied during the DBAR Initiative, including carbon cycling, water cycling, energy exchange, and land cover and land use dynamics, with regard to how they are altered by climate change, and their potential feedbacks to climate. The wide range of natural and anthropogenic ecosystems, and socio-political situations, within the DBAR region, coupled with existing and new tools for conducting Earth observation, make this a very exciting and important initiative.

Howard Epstein is a Professor of Environmental Sciences at the University of Virginia, USA. His research focuses on vegetation dynamics, nutrient cycling, and plant-soil-atmosphere interactions of arctic tundra and global dry lands



Laurent Ferro-Famil: DBAR and frontier technologies of SAR remote sensing

The Digital Belt and Road Initiative represents for me an unprecedented opportunity to collaborate with colleagues working in my field of activity or in complementary domains in the frame of well-defined objectives related to sustainable development, security, risk management, and so on, for which my research topic, related to SAR remote sensing, presents some interesting potential, but cannot be considered, like many other research fields, as a standalone solution. Sharing ideas, data and experience at such a wide scale and over many different kinds of applications, will permit all of us to transform our, sometimes isolated, own scientific initiatives into comprehensive approaches which will, I hope, provide more valuable information to the concerned deciding instances, in order to define the best local and global policies. In this aspect, the DBAR, will permit to reach the critical mass required for establishing robust and representative results and analyses.

Laurent Ferro-Famil is a Professor at the University of Rennes 1, France. His current research activities concern multidimensional signal processing techniques for radar remote sensing applications, with an emphasis in SAR polarimetry, PolInSAR, 3D imaging using polarimetric SAR tomography, for the classification, modeling, characterization, and 3D reconstruction of environments



Jia Gensuo: Counter-measures to climate-environmental changes in the Belt and Road



Jia Gensuo is a Researcher of Institute of Atmospheric Physics, Chinese Academy of Sciences and Director of International START East Asia Regional Center. His research mainly engages in climate change, ecosystem-atmospheric interaction, and land surface process

Most of the BAR area is located in the arid and semi-arid regions of Asia's interior, sensitive to climate change and extreme water events (Figure 1). Here, we emphasized that under the dual pressures of climate change and economic development, various countries in the Silk Road Economic Belt must work together to strengthen the management of water resources throughout the region. The theory of orderly human adaptation proposed by Ye Duzheng could be used as a reference for sustainable development in the BAR area. Climate change adaptation recommendations are as follows: set up an international river basin transnational water supply institutions to coordinate the issue of national unity of water use; improve the efficiency of water resources utilization, including the opening of water-saving irrigation technology suitable for local conditions; take the BAR area as a whole to consider climate change

adaptation strategy. on the one hand, there can be South-South cooperation when China transfers water-saving technology to Central Asian countries, promoting a win-win development. on the other hand, through mutual collaboration where both sides complement each other in resources and industries, regional orderly adaptation to climate change can be achieved with the best results and the lowest cost (Figure 1).

Ildan V. Kaipov: “One Belt One Road” and spatial observation researches of Kazakhstan



Ildan V. Kaipov, Director of Earth Remote Sensing Department of National Centre for Space Research and Technologies, Kazakhstan. His scientific interests are the earth remote sensing and physics of atmosphere. He is managing several projects focusing on applying remote sensing methods in detection and monitoring of emergencies (wildfires, floods, drought, oil spills), and has experience in numerical weather forecasting, simulations of regional climate projections and air quality

China's “One Belt One Road” strategic initiative to build transport corridor of the New Silk Road will bring great economic benefits to involved countries. Kazakhstan, as one of them, is ready to take an active part in the consideration of ways to implement “Silk Road economic belt” projects. These plans are not only transit route between the East and the West, but development path to the solving serious ecological and environmental problems. It is essential for all counties along Silk Road to ensure that resources are used more efficiently and country is developing in harmony with nature. This requires future monitoring and research.

One of the most effective ways of Earth observation is the modern satellite remote sensing technique which offers attractive opportunities. The main objective of Kazakhstan's scientists is to develop new scientific methods and tools

to expand the use of space system services by end-users from various branches of the economy (agriculture, emergency, environment, land use, geodesy, cartography, geology, mining, and so on).

Specialists of National Centre for Space Research and Technologies have a more than 15 years of experience in the application of Earth observation data. Activities of our researchers cover the huge range of scientific-research and application-oriented works related to the use of various satellite images and products for deriving information on environmental aspects and include the following topics:

- Agriculture—forecasting of yield, drought detection, crop recognition and condition assessment, detection of soil moisture changes;
- Emergencies—floods, forest and steppe wildfires;

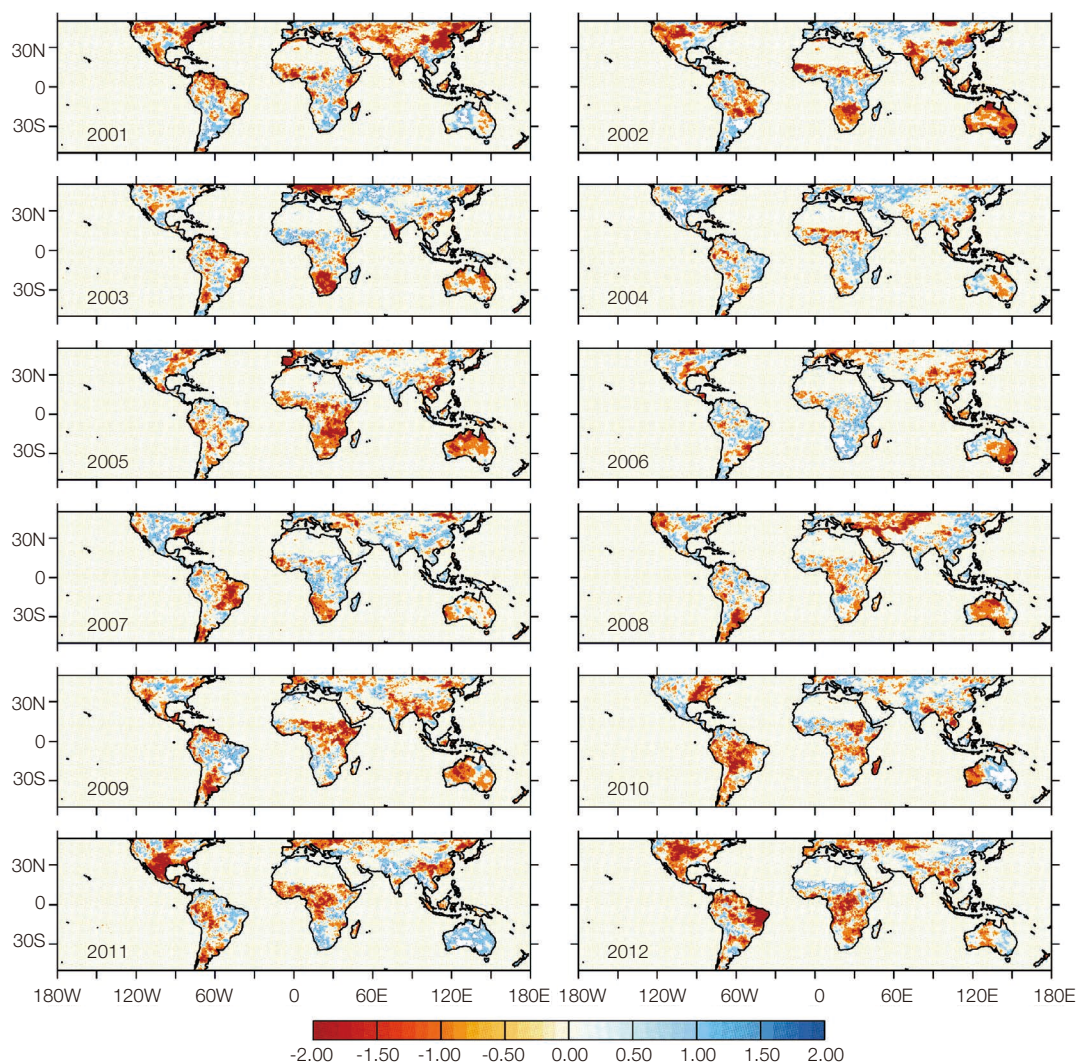


Figure 1 Monitoring of major drought events worldwide in the years from 2001 to 2013

● Environmental hazards—oil spills, illegal landfills of municipal solid waste.

We are interested in cooperation with government organizations and private companies in the field of receiving, processing, archiving and storing remote sensing data, developing a new methods and technologies for the above listed issues, in joint research works related to the common problems for neighboring countries—water resources management, climate change.

Li Xinwu: Advances in scientific research on ecological environment

During the formation stage of the DBAR plan, through the national supported projects, including 973 program “Space Observation of Global Changes in the Sensitivity of Factors and Methods of Research”, the major international cooperation project funded by National Natural Science Foundation of China “Global Environmental Change Remote Sensing Comparative Study”, as well as the national science and technology support program “Xinjiang and the Surrounding Area Remote Sensing Dynamic Monitoring and Emergency Management System”, we have made a series of scientific research progress in global changes. (1) Employed multi-



Li Xinwu, Researcher, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences. His research interests are mainly in global change study and radar environmental remote sensing

source spatial data to study glaciers, snow accumulation, lakes, vegetation, gravitational water, and soil moisture and other sensitive factors and implement the analysis of regional and global climate change; (2) Developed a simulation platform for regional climate change study, and conducted conceptual research on global change scientific satellites and moon-based observation; (3) Developed the “Xinjiang and Central Asia ecological environment remote sensing monitoring platform”, and carried out a comprehensive assessment and analysis of environmental changes in Xinjiang and Central Asia. These studies will lay a solid foundation for the smooth promote of DBAR environmental change theme (Figure 2).

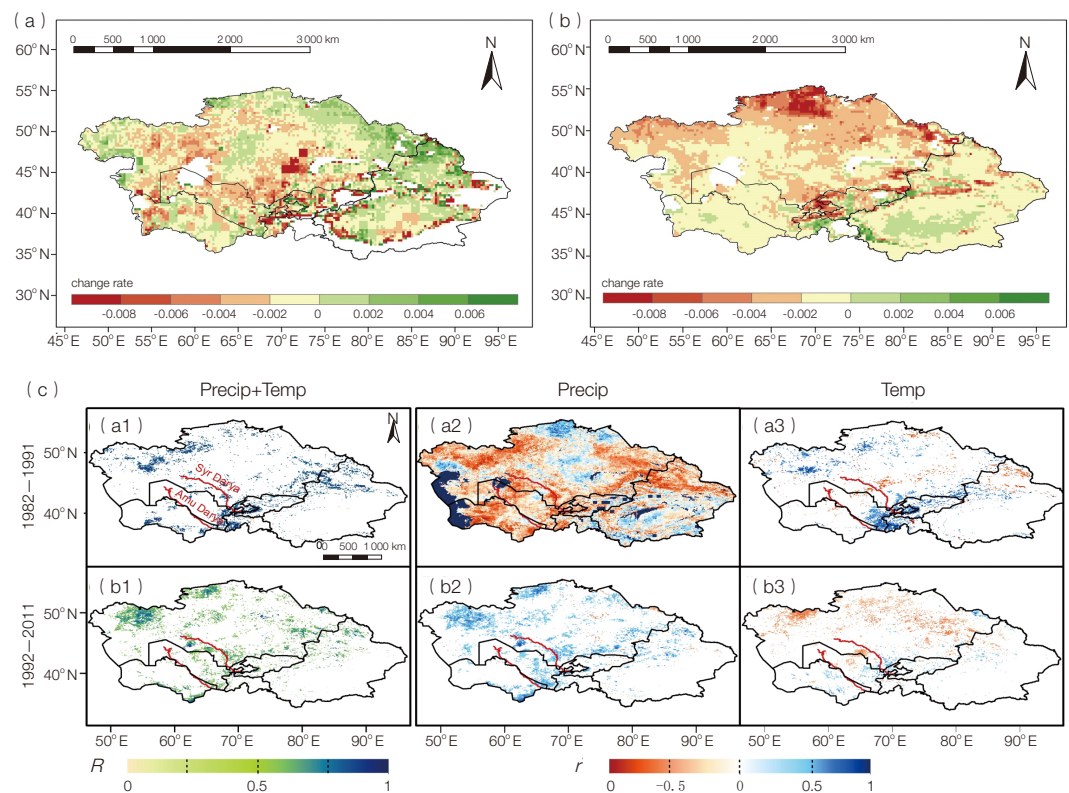


Figure 2 Environmental change of Central Asia and Xinjiang, (a) soil moisture change in 1979–1986, (b) soil moisture change in 1988–2010, (c) the response of vegetation to temperature and precipitation.

Irfan Rashid: DBAR and data sharing

The indicators of environmental degradation have been found worldwide. Cutting across countries, the DBAR Initiative by Chinese Academy of Sciences provides for an important platform for researchers from different ethnicities, cultures, and academic disciplines to develop and use Big Earth Observation Data platform for informed environmental decision making aimed to sustain the resources and safeguard us from disasters. The networking of

researchers under DBAR programme will not only help in capacity building of individuals but be a tipping point for cutting-edge research collaborations and student/researcher exchanges. DBAR Initiative will harmonize the methods adopted for assessment of environment and disasters and as such help in generation of reliable data for use by policy makers and planners for achieving the sustainable development goals which has a potential to improve the wellbeing of people in BAR region. The data sharing and dissemination is another important component of DBAR Initiative where researchers from different regions would have access to the data related to any aspect of environment. Proper analyses of such data can help understand the local and global factors contributing to degradation of otherwise pristine environments. The findings from such assessments under DBAR programme can also help researchers in generating important knowledge that not only could be published in some of the highest impact journals but lay a foundation for building decision support systems related to the state of environment.

Irfan Rashid is working as an Assistant Professor at the Department of Earth Sciences, University of Kashmir, India. His research interests are water resources, climate change, geoinformatics, and ecology



James Terry: DBAR-Envi and sustainable development

The DBAR programme is an important new regional initiative from a variety of perspectives. Focusing on the Working Group for Environmental Change, one of the pivotal roles is the encouragement of greater observation of earth-surface processes, and the integration of multiple data sources in this pursuit. Earth observations are needed in order to determine (amongst other things) how landscape processes may be currently responding to the influences of climatic change, and how the interactions of different factors may converge to drive accelerated environmental change. It is notable that many countries within the DBAR region have rapidly-expanding populations, often concentrated in the coastal zone. Yet at the same time, there is inherent (human) vulnerability both to a range of natural hazards (floods, typhoons, mass wasting, storm surge, drought, seismic activity), as well as to other slow-onset environmental problems in some areas, such as soil loss, erosion, coastline retreat, land degradation, diminishing water resources, and loss of terrestrial and marine biodiversity. Any collaborative scientific efforts, as coordinated through the DBAR platform, which aim to better understand and to address these issues, are worthwhile. Only through combined efforts can the joint goals of improving human resilience and securing long-term environmental sustainability be achieved.

James Terry is currently a Professor at Zayed University in Dubai, UAE. Most of his current research focuses on the Asia-Pacific region. As a field-based geoscientist, he has expertise in coastal and fluvial geomorphology, natural hazards, hydrology, and slope processes, with particular interests in tropical island environments

