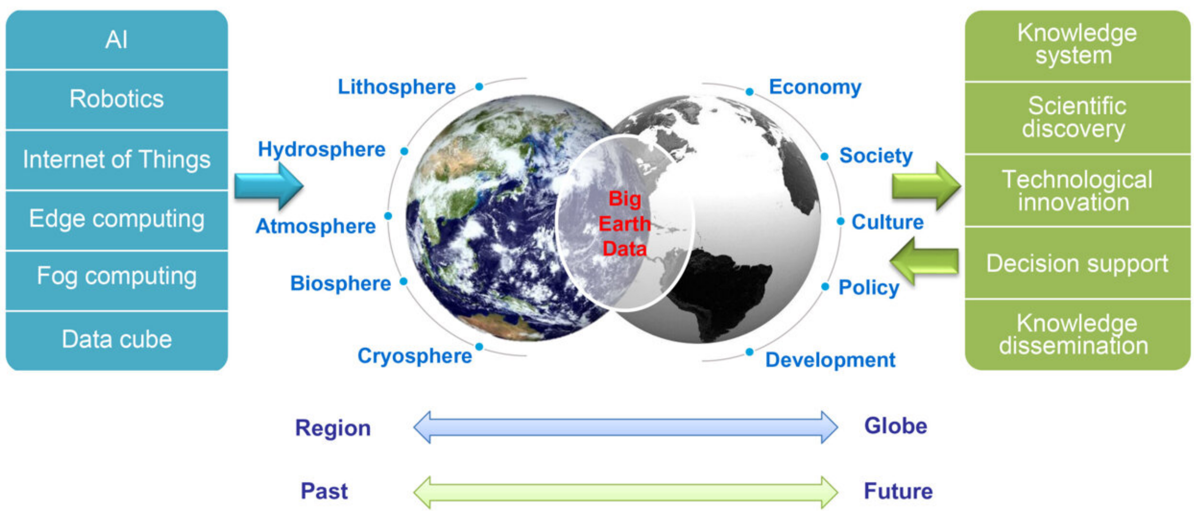
PHYS.ORG

Innovative examples of Big Earth Data for sustainability science

October 17 2022



Big Earth Data enables macroscopic, dynamic, and objective monitoring by making it possible to integrate and analyze data on the land, sea, atmosphere, and human activity to give a holistic understanding of a vast region. This technology can support policymaking by providing dynamic, multi-scale, and cyclical information on multiple SDG indicators closely related to Earth's surface, environment, and resources. Credit: Science China Press

A recent *Science Bulletin* paper compiled by Prof. Huadong Guo and his team discusses the potential and utility of Big Earth Data through a number of case studies to support the 2030 Agenda for Sustainable Development. The case studies demonstrate that, in light of the lack of relevant data in many countries, the availability of growing multi-source data and rapid advancements in big data methods and infrastructure provide unique opportunities to mitigate these data challenges.

The paper introduces Big Earth Data as a special class of big data with spatial attributes. It holds tremendous potential to facilitate science, technology, and innovation and, in particular, integrate social, environmental, and economic perspectives in national developmental strategies toward sustainable societies.

The experts discuss how Big Earth Data draws on the advantages of the growing amount of spatially referenced data on Earth systems and processes that has the potential to fill in the data gaps hindering progress toward SDGs. These advantages are especially relevant regarding rising global trans-boundary problems such as global warming, intensification of disasters, ecological disturbances, resource management challenges, environmental pollution, large-scale rapid land cover changes, and increasing global food and water insecurities.

Broadly speaking, they define Big Earth Data research as using Digital Earth science platforms for the management, processing, and analysis of multi-source data through advanced scientific methods involving data mining, artificial intelligence (AI), and cloud computing.

Important characteristics of Big Earth Data discussed in this paper include: Spatiotemporal Characteristics that involve processing multi-source, high-volume information that requires automation, intelligence, real-time data and batch data processing capabilities; Complex Visualization highlighting visualization of the multi-dimensional characteristics of information; and High correlation and high (multi) dimensionality to deal with complex Earth system interactions that are quantified by thousands of attributes to provide a comprehensive and reliable description of these interlinked processes.

According to the authors, the Big Earth Data system therefore requires technical capabilities for Ubiquitous data perception, Data reliability, Multivariate data fusion, Digital twin and complex simulations, and Spatial Earth intelligence cognition.

The authors have also compiled several case studies to demonstrate the utility of Big Earth Data in sustainability science, in particular in evaluating and monitoring selected SDG indicators. One case study discusses a more accurate method for monitoring water quality with an inversion algorithm utilizing water color index and chromaticity angle to estimate water transparency.

Similarly, another case study proposes updates to indicators in target 11.4 and showed that the "input cost per unit area" is a more reasonable metric compared to the "total per capita expenditure" currently in use for preserving world heritage. Another case study demonstrates the utility of Big Earth Data in estimating the LCRPGR and EGRLCR, showing that the urbanization process in China over the past few decades has become more sustainable due to quality urbanization policies.

The biodiversity risk index presented in one of the case studies will help improve management of protected areas and strengthen habitat restoration. Other global-scale products such as the global net ecosystem productivity, high-resolution global mountain green cover index, and endangered species richness products all have demonstrated improved capabilities in monitoring global progress toward sustainability. The study also presents a comprehensive analysis of China's progress in six selected SDGs utilizing Big Earth Data, suggesting that China is on schedule to meet these goals by 2030.

The researchers argue that the vast amount and diverse forms of Earth observation data currently available from various platforms can significantly enhance the information value of discrete data sources and help fill in various gaps in data and information in regard to SDGs and, if properly integrated and interpreted, provide key insights into socio-environmental interactions.

Furthermore, Big Earth Data can help build upon and complement existing methods and algorithms within the field of big data. They suggest that various tools and algorithms provide innovative opportunities to obtain knowledge and develop theories to explain the operation and evolution mechanisms of physical social systems.

This information is extremely valuable in implementing SDGs, especially goals that are closely related to the environment and resources on Earth's surface dependent on large-scale, periodic processes. Result- and application-oriented research utilizing Big Earth Data has helped highlight its role and value in decision-making processes.

Prof. Huadong Guo also introduced several Big Earth Data-focused research projects and programs that have been initiated to further promote the development of this concept. For example, the Big Earth Data Science Engineering Program (CASEarth) uses Big Earth Data to systematically study a series of major scientific problems with integrity and displays the potential for major breakthroughs in the cognition of Earth system science and decision-making support.

Another program, the Digital Belt and Road Program (DBAR), is a scientific and technological innovation platform for China to serve SDG implementation efforts through Big Earth Data research, which involves 48 national institutions, several international organizations, and an international team of research scientists. Most recently, CBAS was formally established in 2021 as the world's first international scientific research institution focusing on big data research to serve the 2030 Agenda for Sustainable Development.

The team concludes that in future analysis paradigms, algorithms, and models for the application of Big Earth Data should be continuously perfected to form a mature analytical framework for Big Earth Data. Integrating cloud computing, machine learning algorithms, deep learning algorithms, mathematical methods, and spatial analysis methods with Big Earth Data, they suggest, will help to ensure intelligent analysis for informed and actionable policies to mitigate worldwide sustainability challenges.

More information: Huadong Guo et al, Measuring and evaluating SDG indicators with Big Earth Data, *Science Bulletin* (2022). DOI: 10.1016/j.scib.2022.07.015

Provided by Science China Press