CBAS: An International Platform of Digital Technologies Facilitating Sustainable Development Goals

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Abstract: The Chinese Academy of Sciences (CAS) launched the Big Earth Data Science Engineering Program (CASEarth) in 2018, which laid the foundation for the International Research Center of Big Data for Sustainable Development Goals (CBAS). Building on CASEarth's achievements, CBAS integrates advanced digital technologies to advance the UN Sustainable Development Goals (SDGs) through five key missions: (1) developing SDG data infrastructure and information products via its SDG Big Data Platform, utilizing advanced computing, cloud services, and AI; (2) developing and launching a series of SDG satellites, including SDGSAT-1, which provides crucial Earth observation data through its Open Science Program; (3) providing new knowledge for SDG monitoring and evaluation through annual reports (Big Earth Data in Support of the Sustainable Development Goals, published since 2019) and guiding the development of big data-driven technical solutions and theoretical systems; (4) establishing a think tank for science, technology, and innovation, promoting SDGs through initiatives like the annual International Forum on Big Data for Sustainable Development Goals (FBAS) and the CBAS Fellowship Program; and (5) providing capacity development for SDGs in developing countries through international collaborations, such as the Digital Belt and Road Program (DBAR), which offers professional education and training in big data. Future CBAS efforts will focus on expanding data access, enhancing AI capabilities for SDG indicator monitoring, and strengthening international partnerships to address data gaps and ensure equitable access to technology and expertise for achieving global sustainability.

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Keywords: Digital technology, Big Earth Data, CASEarth, CBAS, SDGs, DBAR, SDGSAT-1, FBAS

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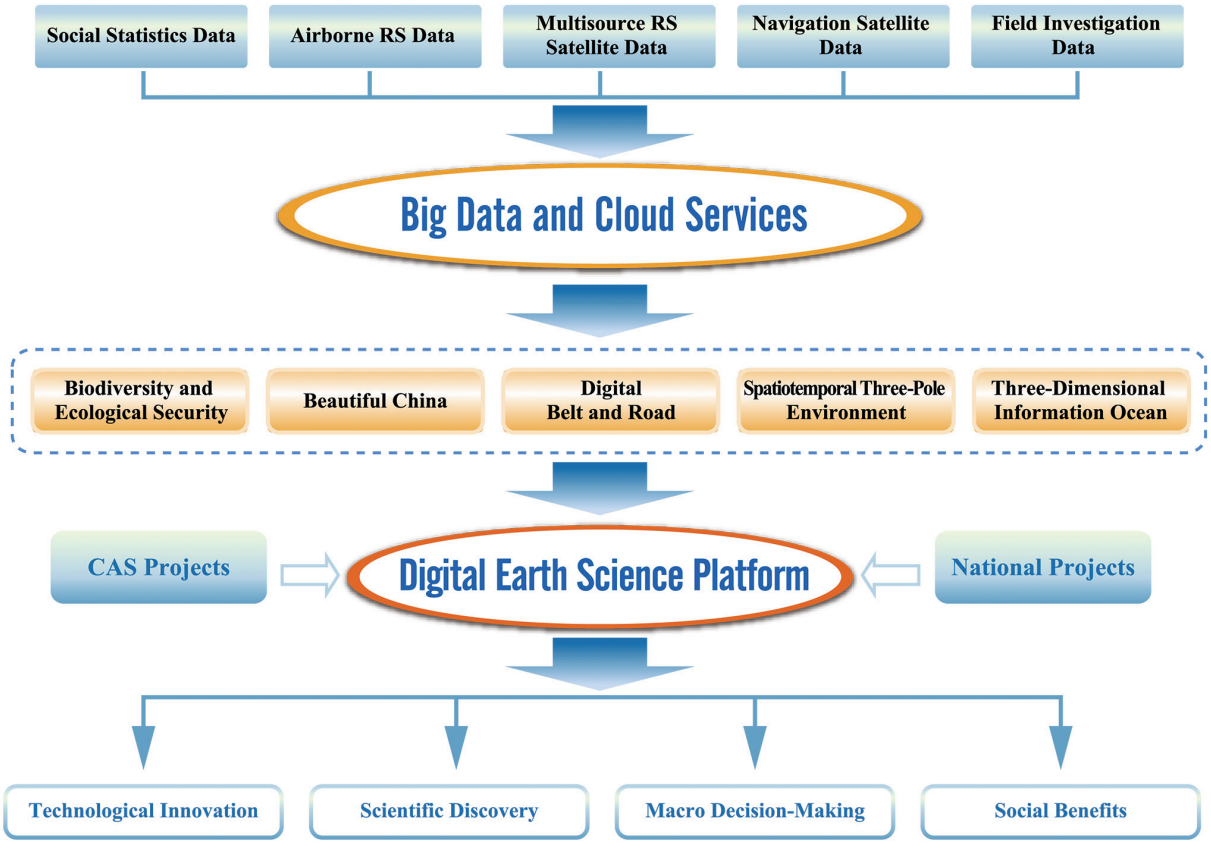
1. Introduction

In September 2015, the United Nations General Assembly adopted the landmark document "Transforming Our World: The 2030 Agenda for Sustainable Development," establishing 17 Sustainable Development Goals (SDGs) (United Nations, 2015). These goals, spanning social, economic, and environmental dimensions, call for immediate global action toward sustainable development. Recognizing the importance of scientific and technological innovation in supporting the implementation and monitoring of these SDGs, the United Nations launched the Technology Facilitation Mechanism (TFM) to harness the collective expertise of the scientific community, businesses, and key stakeholders, advancing sustainable development and promoting the harmonious coexistence of humans and nature.

As part of this global effort, the Chinese Academy of Sciences (CAS), a leading scientific institution, mobilized its research resources to address the demands posed by sustainable development. On January 1, 2018, CAS launched the "Big Earth Data Science Engineering Program (CASEarth)" as a Strategic Priority Research Program, organizing research and scientific responses to global challenges and sustainable development while utilizing innovative ideas

Fig. 1. Overall Framework of the Big Earth Data Science Engineering Program (CASEarth)



(Guo, 2017). It was a comprehensive five-year initiative designed to address significant challenges globally and nationally. Through its integration of advanced big data technologies and multidisciplinary approaches, CASEarth has significantly contributed to scientific discovery, technological innovation, and the global pursuit of sustainable development.

CASEarth consists of eight research components aimed at achieving technological breakthroughs and fostering innovative results, emphasizing data sharing and encouraging scholarly research. The components, titled CASEarth Small Satellites, Big Data and Cloud Service Platform, Digital Belt and Road, Beautiful China, Biodiversity and Ecological Security, Three-Dimensional Information Ocean, Spatio-temporal Three-Pole Environment, and Digital Earth Science Platform, address national demands related to global strategies, the 2030 Agenda, the Belt and Road Initiative, and the Global Development Initiative.

CASEarth is designed to enhance scientific discovery, technological innovation, decision-making, and knowledge dissemination. It integrates various data, including social statistics, airborne monitoring, remote sensing satellite data, navigation positioning, and ground surveys. This comprehensive integration enables the program to provide valuable insights across areas such as resources, environment, biology, and ecology. It employs a multifaceted approach that includes thorough analysis, thematic displays, and distributed network services, ensuring stakeholders access to essential information for informed decision-making and effective action.

During its five-year period, CASEarth produced significant research outputs, publishing over 1,300 SCI papers, with 32 in high-impact journals like Nature and Science. The program filed for 15 international Patent Cooperation Treaty (PCT) applications and over 300 national patents, influencing numerous government decisions. The program provided decision support for more than 150 national or provincial-level activities.

2. Establishment of the International Research Center of Big Data for Sustainable Development Goals

The International Research Center of Big Data for Sustainable Development Goals (CBAS) was officially inaugurated on September 6, 2021. It is a significant outcome of the efforts derived from CASEarth, fulfilling Chinese President XI Jinping's commitment at the 75th UN General Assembly on September 22, 2020: "China will set up an International Research Center of Big Data for Sustainable Development Goals to facilitate the implementation of the 2030 Agenda for Sustainable Development."

At CBAS's inaugural meeting in Beijing, President XI emphasized the platform's potential for exploring sustainable development through big data, enhancing international cooperation, contributing to the implementation of the UN 2030 Agenda, and building a shared future for humanity. UN Secretary-General António Guterres, in a video message, highlighted big data's power in addressing poverty, protecting the planet, and promoting peace.

CBAS is the world's first international research institute dedicated to using big data for the 2030 Agenda. It leverages advancements in Earth system science, socio-economic science, and sustainable development to conduct systematic research on SDG monitoring, evaluation, and prediction in areas such as environmental public domains, urban and rural development, food security, and energy decarbonization (Guo *et al*., 2021). The center provides a theoretical framework and technical methods for big data services, builds a big data platform and decision support system for SDGs, and offers support to address key sustainable development issues globally.

Through CBAS, a new research paradigm driven by Big Earth Data has been established, leading global initiatives to achieve SDGs through data and digital science. CBAS tackles challenges like data gaps and technological deficiencies in SDG assessment, advocates for open data sharing, and supports data-driven decision-making and policy development. Additionally, CBAS aims to be a leader in scientific research on SDGs, disseminating cutting-edge big data technologies, promoting effective information-sharing, and influencing global policy. CBAS also seeks to develop global talent for the next generation of experts.

3. Scientific and Technological Achievements

CBAS and its predecessor, CASEarth, have collectively made significant contributions to the development of a theoretical and technical framework for Big Earth Data, advancing multidisciplinary collaboration across the domains of resources, environment, biology, and ecology. These efforts have resulted in breakthroughs in biodiversity

and ecosystem research, marine sciences, and global change studies, driven by the integration of big data and multidisciplinary collaboration. In support of the UN 2030 Agenda, both CBAS and CASEarth have utilized Big Earth Data assessment methods to monitor SDGs, enabling large-scale, high-frequency, and fine-grained tracking of 40 SDG indicators. The following outlines the key infrastructure and services developed through these initiatives to facilitate national and global Big Earth Data science.

3.1 Big Earth Data

The concept of Big Earth Data encompasses vast amounts of information derived from space-based Earth observation systems, as well as data related to land, oceans, the atmosphere, and human activity (Guo *et al*., 2016). As a large-scale, multi-source and complex dataset, Big Earth Data has emerged as an essential tool for understanding our planet and advancing the SDGs (Guo, 2020a). Its integration of Earth sciences, information sciences, and spatial technologies enables innovative methodologies for scientific research and sustainable development (Guo *et al*., 2020).

Big Earth Data originated from the need to systematically integrate multi-source data and collect Earth observation information from various monitoring platforms (Guo & Liang, 2024). It is recognized as a core element of science, technology, and innovation, serving as a strategic resource in the digital economy. The primary objective of Big Earth Data science is to enhance the informational value of discrete data sources through effective integration and interpretation. This capability addresses data gaps related to global challenges, particularly those concerning the SDGs, while offering insights into socio-environmental interconnections.

Unlike conventional big data, Big Earth Data provides a geographic context to multi-source information, emphasizing the importance of large volumes of Earth observation data and its interoperability with traditional data systems. Big Earth Data science relies on efficient cloud-based platforms that facilitate the sharing, processing, and analysis of multi-source and multi-scale data (Guo *et al*., 2020). These platforms are essential for developing a comprehensive understanding of Earth systems. By leveraging advancements in big data, artificial intelligence, and other emerging technologies, Big Earth Data provides essential methodologies for creating a virtual representation of Earth, in line with the Digital Earth concept (Guo, Goodchild & Annoni, 2020). This interactive model integrates diverse Earth system data related to land, ocean, atmosphere, and human activity across multiple scales and temporal resolutions, offering comprehensive information for decision support and policy development processes (Guo *et al*., 2021). Consequently, Big Earth Data is highly relevant to the SDGs, as it supports informed policy-making by delivering timely and accurate information on social, environmental, and economic dimensions.

Big Earth Data presents several advantages, particularly in addressing existing data gaps that impede the global implementation of the SDGs. Many countries, especially developing nations, face challenges in effectively collecting and analyzing high-quality data, hindering their ability to assess SDG progress. Big Earth Data infrastructure and methods can help reduce costs and create accessible information platforms, providing tools for analyzing and integrating data from digital activities and Earth observations. This facilitates the creation of easily accessible SDG information products for public use, ultimately enhancing data-driven decision-making processes (Guo *et al*., 2022). These systems provide invaluable opportunities for transforming decision support and policy development processes, as well as monitoring and assessing progress and implementation gaps related to the SDGs.

3.2 SDG Big Data Platform

The SDG Big Data Platform is a groundbreaking initiative integrating high-performance computing, cloud services, and intelligent computing to support the SDGs. It offers online computation, interactive analysis, and visualization capabilities, serving as a powerful tool for stakeholders to monitor, assess, and make data-driven decisions in support of sustainable development efforts.

The SDG Big Data Platform has a data-centric architecture, integrating computing, storage, and virtualization resources. It includes four major subsystems: a High-Performance Computing (HPC) system with a peak performance of 1.27 petaflops, a cloud computing subsystem with over 10,000 cores, a data storage system with *55* petabytes (PB) of capacity, and a high-speed internal network that interconnects these resources for efficient data transmission. This infrastructure supports seamless data transfer and sharing between the HPC and cloud services through a shared storage architecture, significantly reducing data processing time for complex, multi-source, heterogeneous Big Earth Data. These capabilities make the platform

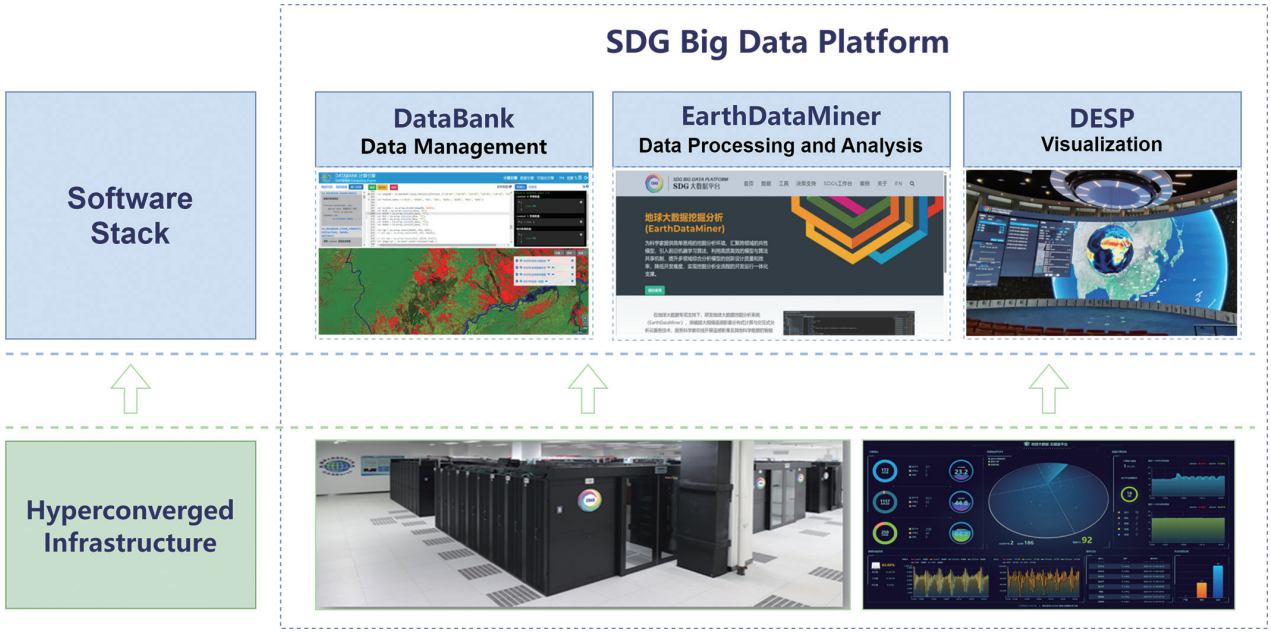


Fig. 2. SDG Big Data Platform.

ideal for conducting large-scale scientific research and delivering high-quality SDG monitoring and evaluation data services.

The platform's data management system supports 19 petabytes (PB) of data, including Earth observation, biodiversity, geographic, and atmospheric-oceanographic datasets, along with 7.7 million satellite imagery scenes. The DataBank system efficiently handles data ingestion, storage, and retrieval, ensuring reliable access to a vast repository for research and analysis. The platform efficiently manages petabyte-scale data processing tasks. Its analytical engine, EarthDataMiner, supports interactive analysis using over 1,300 specialized algorithms and models tailored for SDG indicator monitoring. With AI-powered tools for data extraction, analysis, and visualization, the platform enables users to analyze diverse data types—such as remote sensing imagery and socio-economic statistics—revealing patterns and trends for a deeper understanding of SDG indicators.

For visualization purposes, the SDG Big Data Platform has constructed the Digital Earth Hall, which serves as a venue for data visualization, decision support, and SDG application demonstration. It features a large 3.2-meter sphere display system and an ultra-wide LED sphere curtain display, creating an immersive 660-square-meter visualization environment for research presentations and interactive scenarios. The integrated Digital Earth Science Platform (DESP) provides over 230 analysis models and 500 visualization methods, supporting SDG indicator analysis, global change research, and urban management and emergency response decision-making.

The SDG Big Data Platform is a powerful global resource for advancing sustainable development through high-performance computing, cloud services, and artificial intelligence. Supporting 174 countries and regions, it has accumulated over 680,000 user visits and 120 million page views and facilitated 1.79 million data product downloads, significantly contributing to global SDG efforts. With its advanced infrastructure and the DataBank system for efficient storage and retrieval, the platform enables real-time analysis, interactive visualization, and comprehensive data services. By empowering researchers and policymakers to generate insights and make informed decisions, the platform drives progress toward achieving the 2030 Agenda for Sustainable Development and is poised to play an increasingly vital role in shaping sustainable development worldwide.

3.3 SDGSAT-1

The development, launch, and operation of SDGSAT-1, the world's first science satellite dedicated to the UN 2030 Agenda,

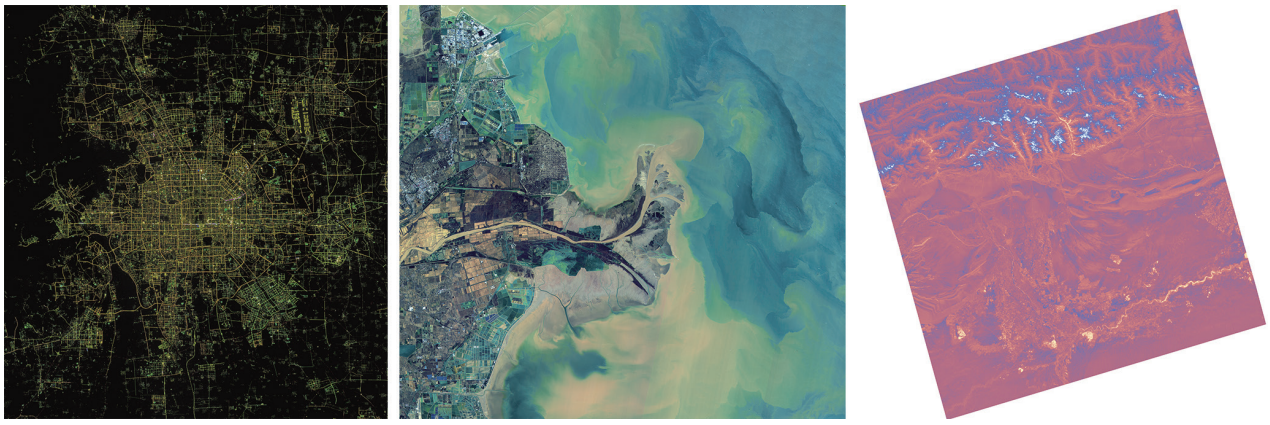
Fig. 3. Data Visualization and Digital Earth Hall.

is a remarkable achievement of CBAS. Designed to support the monitoring and evaluation of SDGs, it was launched on November 5, 2021, using a Long March 6 carrier rocket from the Taiyuan Satellite Launch Center. SDGSAT-1 employs three advanced sensors—Thermal Infrared Spectrometer (TIS), Glimmer (GLI), and Multispectral Imagers (MSI)—to capture human activity in both day and night modes, facilitating global SDG monitoring and the study of human-nature interactions, thus pioneering sustainable development research (Guo *et al.*, 2023).

The satellite is designed to detect parameters reflecting the interaction between human activity and Earth's environment, studying correlations between human activity and natural systems, and focusing on environmental changes primarily driven by human influence. Leveraging its sensors, SDGSAT-1 explores Earth's surface on a large scale and investigates new methods for observing the environment under low-light conditions, including nighttime, polar night, and moonlight (Guo *et al.*, 2020).

Operating in a sun-synchronous orbit at an altitude of 505 km and covering a swath width of 300 km, SDGSAT-1 revisits approximately every 11 days. Its high-resolution data across multiple spectral bands allows detailed monitoring of temperature variations, vegetation health, water bodies, and human activity, even in low-light conditions. With capabilities to detect temperature differences as small as 0.2°C and spatial resolutions as fine as 10 meters, SDGSAT-1 provides critical insights into urban heat distribution, vegetation growth, and water quality. Calibration methods, including lunar and blackbody calibration, ensure accurate and reliable data. This comprehensive observation capacity supports environmental changes, resource management, and multiple SDGs, such as Climate Action (SDG 13), Life on Land (SDG 15), and Sustainable Cities and Communities (SDG 11).

SDGSAT-1's capabilities are



a) SDGSAT-1 GLI Image of Beijing

b) SDGSAT-1 MSI Image of the Estuary of Yellow River

c) SDGSAT-1 TIS Image of the Aksu Area, Xinjiang

Fig. 4. SDGSAT-1 Satellite Images.

evident from its first images. The GLI sensor detects nighttime light intensity and distribution, revealing social and economic development patterns (Fig 4a for Beijing). The MSI sensor tracks water quality parameters in the Yellow River (Fig 4b) while the TIS sensor captures land and water temperature variations for urban heat distribution (Fig 4c in Aksu, Xinjiang).

The satellite has been used to monitor 9 SDGs, supporting over 100 journal publications. For SDG 1, the GLI sensor improves spatial resolution of nighttime light data, aiding poverty indices calculations. For SDG 2, TIS and MSI data create detailed evapotranspiration products, aiding agricultural management. For SDG 6, MSI data monitors water quality and supports detection of aquatic changes. For SDG 7, high-resolution GLI data identifies electrified areas, supporting energy consumption monitoring. TIS data enhances industrial heat source identification for SDG 9. GLI data aids urban monitoring and cultural heritage evaluation for SDG 11. TIS data monitors global climate change impacts for SDG 13. The sensors' synergy supports vessel detection for SDG 14 and monitors desertification for SDG 15.

These unique sensor capabilities of SDGSAT-1 enable detailed monitoring of urban development, disaster assessment, energy consumption, and environmental changes, laying the groundwork for large-scale SDG monitoring.

3.4 SDGSAT-1 Open Science Program

On September 20, 2022, during the 77th session of the UN General Assembly, the Ministerial Meeting of the Group of Friends of the Global Development Initiative (GDI) was held in New York, chaired by Chinese State Councilor WANG Yi. UN Secretary-General António Guterres contributed via video message. WANG Yi announced the launch of the "SDGSAT-1 Open Science Program," providing free global access to SDGSAT-1 data for monitoring and research in sustainable development. So far, the program has shared over 370,000 scenes of imagery data, totaling 1.6 PB, with more than 100 countries. Collaborative projects with organizations like UNOSAT and UNDRR have utilized this data to assess disaster damages, resulting in over ten joint reports aiding global sustainability and disaster management efforts.

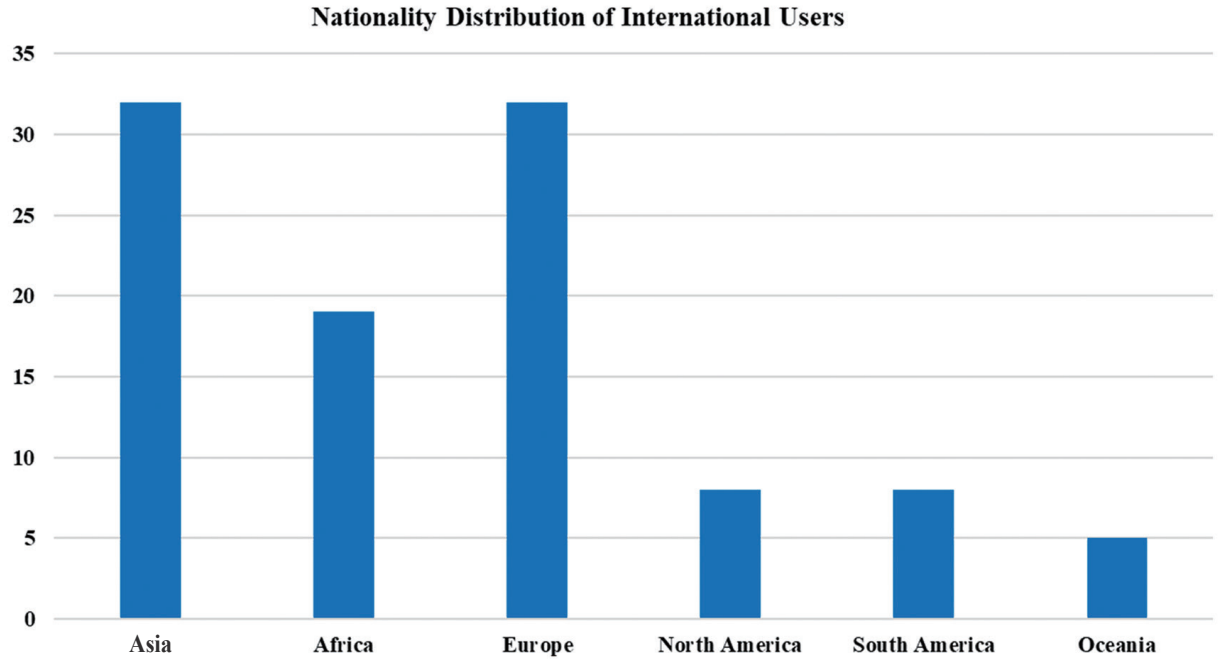
Under the Open Science Program, CBAS has published four key imagery atlases showcasing SDGSAT-1's capabilities:

1) Atlas of SDGSAT-1 Satellite Nighttime Light Image (Chinese version): Features 10-meter-resolution nighttime imagery of 147 cities in 105 countries, capturing urban vibrancy and cultural richness.

2) Atlas of SDGSAT-1 Satellite Nighttime Light Image (English version): Expands to include 31 additional cities from 28 more countries, covering 154 cities across 133 countries on five continents.

3) Collection of SDGSAT-1 Satellite Nighttime Light Urban Agglomeration Maps: The first high-resolution set depicting 10 major global city clusters, offering insights into urban agglomerations.

4) Atlas of SDGSAT-1 Satellite Thermal Infrared Image: The world's first remote-sensing thermal infrared atlas, highlighting geospatial landscapes across 118 regions. It provides insights into



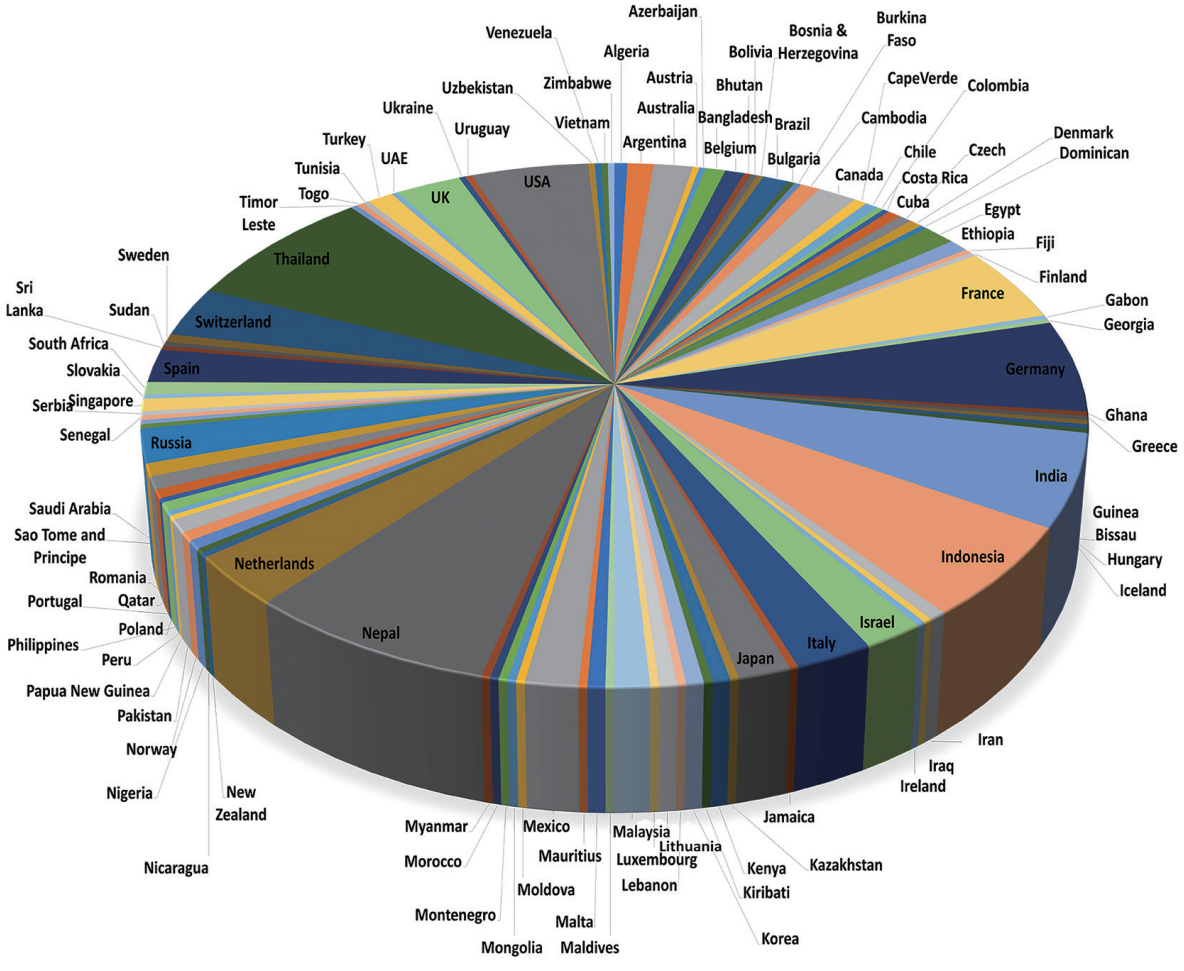


Fig. 5. Distribution of International Users.

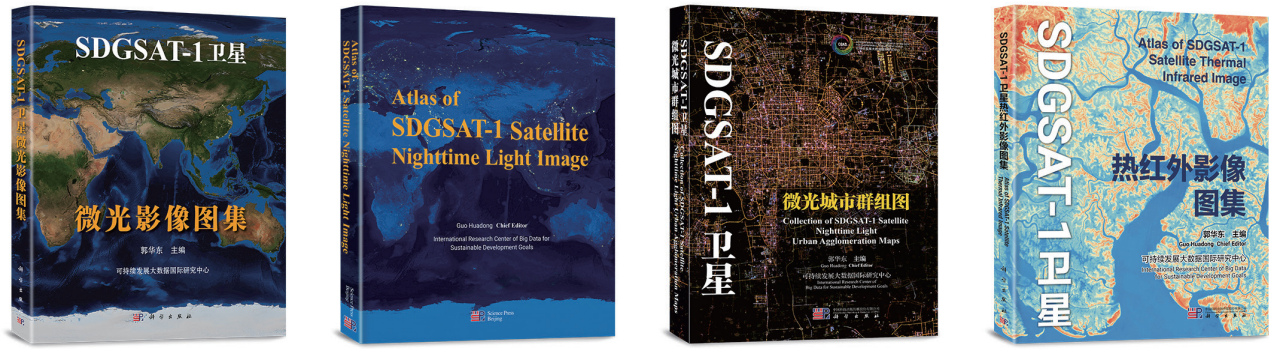


Fig. 6. Four SDGSAT- 1 Imagery Atlases.

surface energy balance, climate change, land cover changes, urban heat islands, and agricultural monitoring.

These atlases support studies across multiple SDGs, including Zero Hunger (SDG 2), Clean Water and Sanitation (SDG 6), Sustainable Cities and Communities (SDG 11), and Climate Action (SDG 13). CBAS offers invaluable resources for understanding global environmental changes, urban development, and human-environment interactions from thermal and nighttime light perspectives.

3.5 Big Earth Data in Support of the Sustainable Development Goals

Since 2019, CBAS has been publishing the annual "*Reports on Big Earth Data in Support of the Sustainable Development Goals*" (Guo, 2019; Guo, 2020b; Guo, 2020c; Guo, 2021a; Guo, 2021b). These reports highlight innovative scientific methods and provide valuable Chinese perspectives on global sustainability efforts. They showcase the latest research in big data for sustainable development and advance the use of such data in supporting the implementation of SDGs. The reports have played a crucial role in generating actionable insights across various levels—global, regional, national, and local—contributing significantly to the UN 2030 Agenda for Sustainable Development.

The reports contain an extensive collection of data products and methodological innovations that directly align with the objectives of the UN SDGs. To date, CBAS has released 116 data products that offer comprehensive insights into complex global issues, helping to shape a more informed understanding of planetary trends and transformations. In addition, the reports have introduced 79 sophisticated methodological models designed to improve the accuracy and applicability of big data in real-world sustainability contexts.

Furthermore, the CBAS reports have generated 107 policy recommendations that reflect evidence-based analysis and strategic thinking aimed at global policymakers. These recommendations address pressing issues such as climate action, urban development, food security, and ecosystem management, providing pathways for more sustainable practices and policies. By disseminating these comprehensive reports, CBAS strengthens international collaboration and dialogue around big data applications, empowering countries and organizations globally to better harness data-driven insights for achieving SDGs.

3.6 Scientific Journal: Big Earth Data

Big Earth Data (*BEDJ*), available at https://www.tandfonline.com/tbed, is an interdisciplinary open access (OA) academic journal launched in December 2017. It was jointly established by the International Society for Digital Earth (ISDE), the Aerospace Information Research Institute of CAS (AIRCAS), the CAS Strategic Priority Research Program "Big Earth Data Science Engineering" (CASEarth), and the Taylor & Francis Group. As the flagship journal of the International Research Center of Big Data for Sustainable Development Goals (CBAS), *BEDJ* aims to provide an efficient platform for promoting the sharing, processing, and analysis of Earth-related big data, revolutionizing our understanding of Earth's systems. The journal covers all aspects of handling big Earth data, including theories, methods, algorithms, and technologies used in collecting,

Fig. 7. The annual *Reports on Big Earth Data in Support of the Sustainable Development Goals* (2019–2024).

managing, analyzing, and visualizing data.

Supported by the CBAS research team and ISDE, *BEDJ* leads in advocating Open Science to ensure the integrity, transparency, reusability, and reproducibility of scientific findings. It embraces open and FAIR (Findable, Accessible, Interoperable, and Reusable) data principles, strongly encouraging authors to make supporting data, code, and methods openly available. As the first data journal within the Taylor & Francis Group, *BEDJ* features traditional research articles, review articles, perspective articles, as well as data notes and technical notes to disseminate big data sets and software tools across the Earth sciences. Recognized by global research communities, *BEDJ* is indexed in prominent citation databases like Web of Science Emerging Sources Citation Index (ESCI), Scopus, Ei Compendex, and the Chinese Science Citation Database (CSCD). In 2024, *BEDJ* achieved an impact factor of 4.2 and a CiteScore of 7.4, positioning it in the Q1 zone in both rankings.

4. International Cooperation

4.1 Cooperation with UN Agencies and International Organizations

CBAS has forged significant partnerships with various UN agencies and international organizations to promote sustainable

development through big data.

CBAS collaborates with the UN Department of Economic and Social Affairs (UNDESA) to enhance sustainable development in African countries and Small Island Developing States (SIDS). Notably, CBAS has organized side events at the UN STI Forum for two consecutive years. In 2023, the theme was "Big Earth Data: Strengthening Potential of Digital Technologies for SDGs in Post-COVID World," and in 2024, the online event focused on "Strengthening Scientific Cooperation, Technology, and Data Sharing for African Countries," with CAS Member Prof. GUO Huadong, CBAS Director, delivering key speeches.

In June 2024, CBAS became a "Friend of the Coalition on Science, Technology, and Innovation for Africa's Development," collaborating with alliance partners from seven African countries, such as South Africa, Morocco, and Ghana, to support the UN 2030 Agenda and the African Union's 2063 Agenda. Following discussions in Addis Ababa in October 2023, a capacity-building workshop led by Director GUO was organized. CBAS also co-organized a SIDS Capacity Building Workshop with UNDESA in Beijing in September 2024, which included representatives from 10 participating states.

Collaboration with UN-Habitat focuses on urban development and resilience. In October 2023, CBAS and UN-Habitat signed a Memorandum of Understanding (MoU) during the 3rd SDG Cities Global Conference in Shanghai and co-hosted a workshop on "International Cooperation on Urban SDGs in the Post-COVID Society." Further partnerships led to successful sub-forums and publications, including "Future Cities and New Economy, Carbon Neutrality Driven by Green Innovations."

CBAS maintains strategic cooperation with UNCCD through projects like the Good Practice Guidance for SDG Indicator 15.3.1 and the GEO-LDN Initiative (Sims *et al*., 2021). In November 2018, CBAS signed a strategic cooperation agreement with UNEP, resulting in joint reports on "Measuring Progress," recommending Big Earth Data to bridge environmental data gaps (United Nations Environment Programme, 2021).

In addition, CBAS collaborates with the Group on Earth Observations (GEO). This includes the GEO Cold Regions Initiative (GEOCRI), aimed at providing integrated observation services for polar and high-mountain regions. The collaboration focuses on data sharing, talent exchange, and capacity building.

CBAS also partners with the International Centre for Integrated Mountain Development (ICIMOD) to address sustainable development in the Himalayan region. Together, they developed a big data platform for monitoring SDG indicators in representative mountainous areas through the National Natural Science Foundation's Sustainable Development International Cooperation Program (SDIC). Key meetings have explored sustainable development strategies with insights from ICIMOD's Chief Scientist and strengthened research capabilities.

These collaborations with UN agencies and international organizations underscore CBAS's commitment to leveraging big data for sustainable development on a global scale.

4.2 International Forum on Big Data for Sustainable Development Goals

The International Forum on Big Data for Sustainable Development Goals (FBAS) is an esteemed annual international conference initiated and hosted by CBAS. This conference serves as a pivotal platform for fostering dialogue and collaboration among global leaders, researchers, policymakers, and industry experts focused on utilizing big data to advance sustainable development.

In 2021, the inaugural FBAS was marked by a congratulatory letter from President XI Jinping, who expressed hope that the conference would enable participants to fully leverage the CBAS platform. He emphasized the importance of the forum in strengthening international cooperation and contributing meaningfully to the implementation of the 2030 Agenda for Sustainable Development, ultimately promoting a shared future for humanity.

The primary objective of FBAS is to establish a global high-level exchange platform that promotes the sharing of methodologies, technical research, application cases, and experiences relating to big data and digital technologies. By doing so, FBAS supports mechanisms that facilitate the achievement of SDGs on a global scale. It encourages the exchange of innovative ideas and best practices related to data-driven strategies for sustainable development.

Over the course of its four successful sessions, FBAS has attracted more than 3,000 experts from 90 countries, making it a vital international exchange platform. Participants include representatives from relevant UN agencies, domestic and international research institutes, government departments, enterprises, and other international organizations. The forum enables these diverse stakeholders to engage in meaningful scientific and technological cooperation, addressing some of the most pressing challenges related to sustainable development.

Fig. 8. CBAS Fellows.

Each FBAS session is carefully curated to foster collaboration, spark innovation, and inspire actionable outcomes that align with SDGs. Topics discussed at the forum range from advanced data analytics and artificial intelligence to the latest technologies in Earth observation and data management systems. The insights and collaborations that emerge from this forum significantly contribute to the global discourse on sustainable development, encouraging participants to implement data-driven approaches and solutions in their respective countries and fields.

FBAS has transcended its role as a mere conference—becoming an enduring community that continues to influence policies and practices around the world. Through its ongoing efforts, FBAS not only fosters a deeper understanding of the power of big data in driving sustainable development but also ensures that technological advancements align with the overarching goals of creating a sustainable, equitable, and prosperous future for all.

4.3 CBAS Fellowship

The CBAS Fellowship program, established in 2023, aims to enhance global collaboration in data and technology for informed sustainable development within the UN framework. Through this fellowship program, CBAS seeks to facilitate global consensus and enhance regional and global multi-stakeholder engagements on common and mutual interests. This fellowship recognizes individuals who have made outstanding contributions to promoting sustainable development through technological innovation worldwide. It is the highest academic honor conferred by CBAS. CBAS Fellows will play a crucial role in realizing the organization's mission to support the implementation of SDGs through the application of science, technology, and innovation.

CBAS Fellows are nominated and selected annually. To date, CBAS has recognized a total of 11 Fellows. These distinguished individuals include: Prof. Quarraisha Abdool Karim, Ms. Irina Bokova, Prof. Peter Gluckman, Prof. GUO Huadong, Prof. Gretchen Kalonji, Mr. Csaba Kőrösi, Prof. Markku Tapio Kulmala, Prof. Chen Deliang, Prof. Abbas Rajabifard, Prof. Simon Redfern, and Prof. Jeffrey D. Sachs.

4.4 Digital Belt and Road Program

Initiated in May 2016, the "Digital Belt and Road Program" (DBAR) aims to leverage Big Earth Data to support the achievement of SDGs in Belt and Road countries (Guo, 2018). This innovative program is supported by 59 countries and organizations, demonstrating a broad international commitment to utilizing technology and data to address global development challenges (Guo *et al.*, 2018). By promoting data sharing, DBAR seeks to enhance decision-making processes that align with global development initiatives, fostering cooperation and understanding among participating nations.

The DBAR Secretariat, based at CBAS, orchestrates collaboration through a comprehensive

structure that includes a Scientific Committee, various Working Groups, and International Centers of Excellence (ICoE). This organizational framework is designed to facilitate the integration of data, the design of cloud-based ICT infrastructure, and the execution of Earth System Science research pertinent to the SDGs. These efforts ensure that DBAR remains at the forefront of scientific discovery and practical applications in the context of sustainable development.

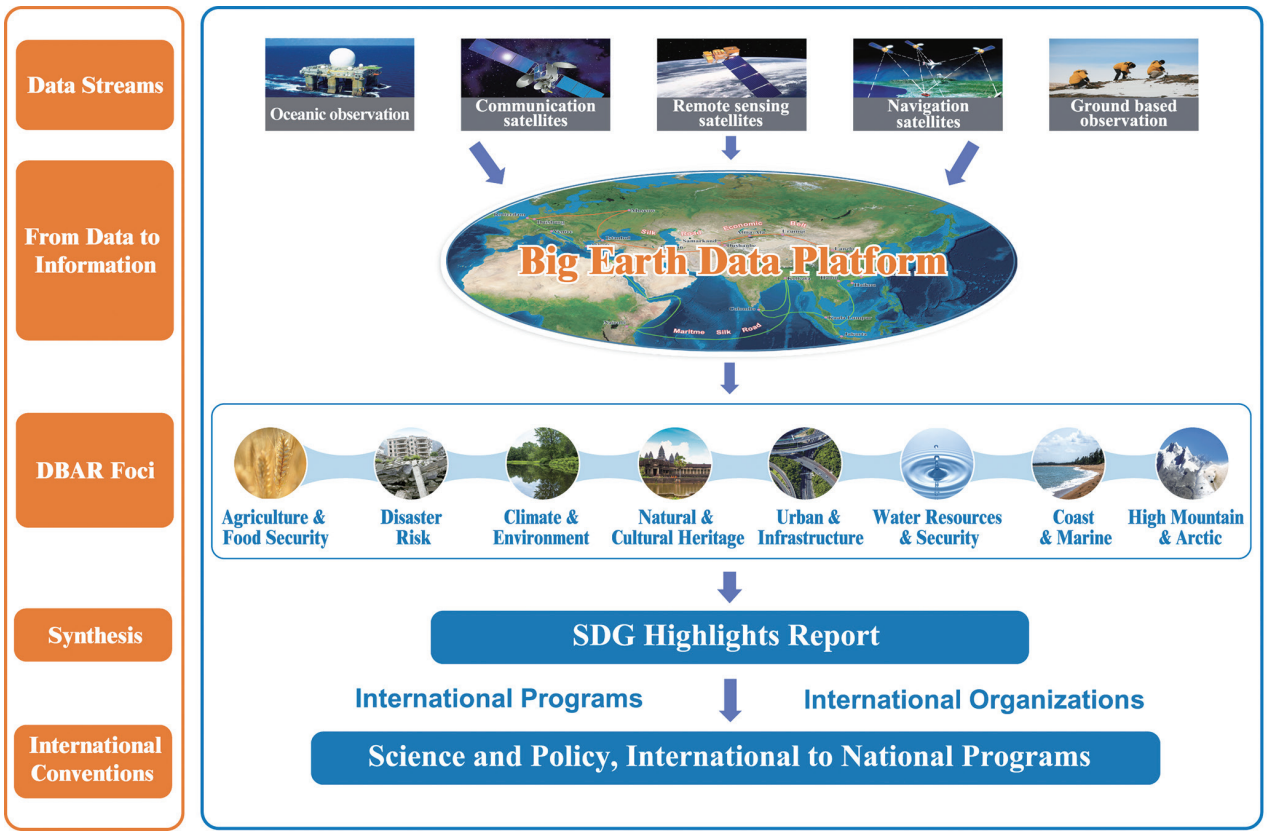
DBAR's wide-ranging initiatives target key areas affected by climate change, such as natural disasters, resource management, urban activity, and agricultural development. By focusing on these critical sectors, DBAR provides valuable insights and data-driven solutions to complex problems, helping countries along the Belt and Road to mitigate risks and enhance resilience. The program's multidisciplinary approach promotes a deeper understanding of environmental and societal changes, fostering sustainable practices across diverse landscapes.

One of DBAR's notable accomplishments is the development and integration of cutting-edge technologies such as the CropWatch Cloud platform, which has been successfully implemented in Mozambique. This platform exemplifies DBAR's commitment to providing practical tools that assist in agricultural management and monitoring, directly contributing to the broader Belt and Road Initiative. Such technological advancements underscore the importance of data in driving sustainable development and highlight DBAR's role as a leader in global innovation.

DBAR also hosts the annual International Digital Belt and Road Conference, a prestigious event that brings together experts, policymakers, and industry leaders from around the world. This conference serves as a vital platform for sharing insights, methodologies, and case studies related to Big Earth Data and its application in sustainable development. Participants engage in discussions that inspire collaboration and further the collective goal of achieving the SDGs in Belt and Road countries.

Through ongoing international collaboration, DBAR continues to play a significant role in promoting sustainable development along the Belt and Road. By harnessing the power of Big Earth Data, DBAR not only supports informed decision-making but

Fig. 9. DBAR Work Flow.



also encourages the adoption of sustainable practices that benefit both the environment and communities. As the program evolves, it remains committed to fostering innovation, building capacity, and strengthening partnerships that contribute to a more sustainable and equitable future for all participating nations.

5. International Influence and Future Development

CBAS has maintained a strong focus on enhancing global scientific data services. One of the primary contributions of CBAS is the release of sustainable development data products and open access to SDGSAT-1 satellite data. These resources aid global monitoring and evaluation of SDGs in critical areas such as food security, sustainable urban development, clean water, sanitation, and climate action. By providing a scientific foundation for policymaking and resource allocation, CBAS supports decision-making processes for the UN and its member states.

Over the past two years, the Global SDG Partnership has successfully established an international network that includes prominent partners like UN-Habitat, The University of Hong Kong, Nanjing University, and Keio University. CBAS's collaborative effort has successfully leveraged expertise of global partners to enhance research, capacity building, the development of open digital platforms, and policy support. Notable outcomes include an intergovernmental workshop involving Bhutan, Nepal, and Bangladesh through the International Centre for Integrated Mountain Development, which yielded concrete policy recommendations for mountain regions. Additionally, partnerships with UN-Habitat have produced valuable initiatives focused on urban sustainability, including side events at World Cities Day.

Complementing these collaborations, the *Reports on Big Earth Data in Support of the Sustainable Development Goals* have evaluated progress toward the 2030 Agenda at both global and national levels, providing public data products that benefit all countries, especially developing nations. These reports have contributed significantly to the development of recommendations for science-based decision-making, enhancing capabilities in big data acquisition. Data from these reports has been instrumental in the Food and Agriculture Organization's (FAO) Hand-in-Hand Initiative and the UN Biodiversity Lab, supporting decision-making research for SDGs 2, 6, and 15. Furthermore, these reports have facilitated the release of sustainable development data products for BRICS countries and the donation of global sustainable development and water resource data to the UN.

The concepts and applications of Big Earth Data will evolve as research advances, particularly in artificial intelligence, innovative applications of big data, and large-scale digital storage and analysis systems. This evolution is essential for improving the accuracy, understanding, and prediction of the complex challenges associated with sustainable development. To keep pace with innovation in digital applications and technologies, continuous development of Big Earth Data infrastructure is critical, along with expanded access to new and existing data sources. Establishing unified data standards will enhance the authenticity of analyses and facilitate interdisciplinary collaboration, creating an ecosystem for open-source exchange of methods and algorithms necessary for Big Earth Data acquisition and application.

For more effective adoption of information- and science-driven policy and decision support for SDGs, Big Earth Data systems hold the potential to develop a "data-knowledge-service" model that creates value-added data products for the SDGs. This development will require closer cooperation with policymakers to align data with the practical challenges of implementation. In light of this, China should expedite its research and development efforts to create high-quality local and national-scale products that contribute to the UN 2030 Agenda for Sustainable Development.

Similarly, international collaboration also has a critical role in shaping the future of science, technology, and sustainable development. The complexity of global challenges demands collective insights for innovative ideas, and cooperation is an important mechanism to achieve this. International collaboration and cooperation are necessary to meet the growing demand for transparency and open access to data and methodologies, which are essential for fostering ideas and innovation. International cooperation requires inclusive frameworks that engage diverse stakeholders, ensuring that all voices are heard in the decision-making process. CBAS provides such a platform to empower communities through engagement and resources to translate data into actionable knowledge that drives effective policies.

Given the potential of emerging digital technologies and the utility of Big Earth Data infra-

structure, developing countries are encouraged to invest in human resource capacity, leveraging existing big data infrastructure to create relevant information products for local challenges. This strategy can be further enhanced by supporting local technology businesses to modernize and offer innovative solutions tailored to their economic contexts. Moreover, international companies with expertise in these domains should be encouraged to collaborate with local tech businesses, fostering local talent and skills to meet the demands of the next technological wave.

Data is a crucial factor for success. Developing nations, in particular, must enhance their national data collection and analytics capabilities while incentivizing technology companies to adopt data-driven strategies. By doing so, national governments can lay a strong foundation for accessing cutting-edge technologies. The role of big data in managing the pandemic underscores the importance of data infrastructure for all countries, making it imperative to prioritize investment in this area as a technology facilitation mechanism.

As we progress toward the mid-point of the Decade of Action, there is a growing recognition of the urgency to foster scientific collaboration between developed and developing countries. Building capacity in science, technology, and innovation is crucial to bridging existing gaps and promoting equitable growth. CBAS presents a forward-looking approach to international influence and development, advocating for cooperative efforts to enhance access to knowledge and resources, ultimately paving the way for sustainable futures.

Enhancing international cooperation and cross-cutting dialogue is essential for sharing knowledge, data, and innovative solutions developed in isolation across different communities. Platforms like the STI Forum provide opportunities for open discussion and institutions like CBAS can facilitate these processes. Similar centers should be established in other specialized domains of frontier technologies to provide international guidance, develop human resources, and exchange knowledge and expertise.

6. Conclusion

CBAS has played a crucial role in enhancing global scientific data services to support the SDGs. Through collaboration with prominent international partners, CBAS has facilitated significant advancements in research, capacity building, and policy support, yielding concrete outcomes that inform sustainable development practices. As we progress toward the 2030 Agenda, the importance of Big Earth Data systems becomes increasingly evident, necessitating ongoing investment in data infrastructure, technology collaboration, and human resource development, particularly in developing countries. Furthermore, fostering international cooperation and inclusive frameworks is essential for sharing knowledge and innovation, ultimately paving the way for sustainable futures. By harnessing these collective efforts, we can address the complex challenges of our time and drive effective policies for a more equitable and sustainable world.

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