POLICY BRIEF

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China and Africa in Global Space Science, Technology, and Satellite Development

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POLICY POINTS

Expand international cooperation in space science and technology development with African partners.

Investigate the roles of space-based technologies in African development, disaster management, and climate change mitigation.

Examine the co-evolution of indigenous space capacity and broader governance regimes.

SAIS JOHNS HOPKINS SCHOOL of ADVANCED INTERNATIONAL STUDIES

SPACE PROGRAMS IN AFRICA VARY IN THEIR HISTORY AND COMPOSITION, but they are all internationally embedded: when African space programs request bids for satellite contracts, Chinese firms compete alongside international firms to offer the most competitive package. The roles of China's institutions in the development of African countries' space programs are smaller compared to other international partners.. But China's successes in providing relatively low-cost, reliable, and comprehensive satellites to African counterparts have created important milestones for both sides. The development of satellite technologies involves a vast array of complementary industries, from optics to metallurgy to data management, so public investments in satellite development stimulate a range of sectors.

Fourteen of continental Africa's 54 countries have active space programs and dozens of others have the capacity to process satellite data. Together, they have launched 42 satellites as of January 2020. Ninety percent of space projects in Africa have been funded by African governments and investors. Russia has launched the most satellites for African agencies with thirteen completed launch contracts, followed by France (10), the US (8), China (5), India (4), and Japan (2). In addition to China's National Space Agency (CNSA), Brazil's National Space Research Institute *(Instituto Nacional de Pesquisas Espaciais – INPE*), Russia's *Roscosmos*, Japan's Aerospace Exploration Agency (JAXA), and several European agencies have had active partnerships on the continent for many years.

Human engagement with outer space is governed by the 1967 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (OST). This treaty, to which all current and aspiring space-faring states are party, stipulates that space can only be used for peaceful purposes and cannot be subjected to exclusive claims. This international legal framework has enabled the safe placement of keystone technologies for scientific research, communications, and economic globalization in Earth's orbits by dozens of national space agencies and firms from across the globe. This is significant because national development requires space-based technologies. Domestic capacity in this field is now considered essential, not only by the governments of many African states, but by the United Nations (UN), World Bank, and other multilateral organizations that endorse the 2030 Sustainable Development Goals.

CHINA'S SPACE ENGAGEMENT WITH AFRICAN COUNTERPARTS

SINCE 1990, CHINA'S LONG MARCH rockets have been launching satellite payloads for international partners, including private firms, universities, and national space programs. China has built and launched satellites for Nigeria, Algeria, Sudan, and Ethiopia. It is the fourth largest recipient of satellite contracts from African countries, and the third largest recipient of launch contracts. As of 2019, 60 percent of Africa's satellites were built by foreign entities, but the proportion is expected to diminish as African entities increase indigenous capacity.

This trend is by design. International satellite partnerships undertaken on the part of African space programs generally include technology transfer and training. The "Learning by Doing" approach entails sending teams of African scientists and engineers to the contracting party to work on site for the duration of the design, construction, and test phases. This accomplishes the goals of technology transfer and capacity building for African space programs. In some cases, this approach has preceded the development of national space programs, building a domestic human resources pool before forming a national agency.

China's government has provided scholarships to students from African countries to complete undergraduate and graduate education in China since the 1960s. These comprehensive programs generally cover transportation, housing, medical, and living expenses for students and their families to relocate to China for the duration of the program of study. Each year, approximately 80,000 students from African countries study in China. This provides an important legacy of human capital development and diplomatic engagement between China and African partner states that is now several generations old.

SPACE AND DEVELOPMENT IN AFRICAN COUNTRIES

MOST SPACE RELATED ACTIVITY OCCURRING in Africa is driven by Africans. Several African countries launched national and multilateral space science and technology initiatives in the mid-20th century. Many of their trajectories were influenced by multiple domestic and international political factors, often attributed to changing loyalties following the end of the Cold War, or more frequently, to misallocated investments due to conflict or corruption. While these are possible explanations, preliminary analysis suggests that the Oil Shocks of the 1970s and Debt Crises of the 1980s played a larger role interrupting space science advancement on the African continent: no new space agencies were established between 1971 and 1987. This suggests that the debt-driven development and structural adjustment programs widely implemented across sub-Saharan Africa (SSA) during this period are negatively associated with the advancement of space science and technology in loan-recipient countries.

Between 1998 and January 2020, eleven African countries, eight of these in SSA—Algeria, Angola, Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, Rwanda, Sudan, and South Africa—launched 42 satellites. Multilateral African institutions jointly funded three regional communications satellites. More than half of these were launched in the last five years, indicating an acceleration of space-related activity. The satellite applications reflect the domestic development priorities they are meant to serve: Earth Observation, communications satellites, technology demonstration, scientific experiments, educational projects, and military radar.

National budgets for each space program differs significantly, as does their position within respective government institutional landscapes. The majority of space programs are located under science, technology, or education ministries (or equivalent); this shapes the nature of bilateral and multilateral engagement undertaken by the respective countries. The national space agencies are part of larger networks of international aerospace and astronomical societies, as well as hundreds of university departments, meteorological stations, telecommunications companies, navigation and aviation authorities, and geographic research and monitoring centers on the continent, each of which has their own unique regional and international engagements.

There is robust private sector and start-up activity concentrated in major cities, characterized by hackathons, innovation challenges, maker spaces, start-up labs, and competitive grant programs, most of which are funded by African sources. There is also sustained and dynamic space-related activity with UN entities, such as the Food and Agriculture Organization, the Office for Outer Space Affairs, and the Space Generation Advisory Council.

CHINA AND AFRICA IN MULTILATERAL SPACE COOPERATION

IN ADDITION TO THEIR CENTRAL CONTRIBUTIONS to advancing global earth and space sciences, multilateral initiatives such as those summarized here are important for forging connections across diverse societies while advancing the science, education, and technology essential for achieving development goals.

1. Disaster Monitoring Constellation (DMC)

AN INTERNATIONAL DMC WAS INITIALLY proposed at the 47th International Astronautical Federation Conference held in Beijing in 1996, led by Surrey Satellite Technology Limited (UK). Algeria, Nigeria, Turkey, the UK, and China joined the DMC, which launched satellites from 2002 – 2005. The UN recommended efforts such as the DMC to increase coordination among space agencies to better monitor natural disasters and support relief planning efforts. The goal was to achieve daily repeat imagery anywhere in the world transmitted to a variety of ground stations. Algeria provided the first DMC satellite, Alsat-1, which launched in November 2002 from the Plesetsk Cosmodrome in Russia. CNSA launched its indigenously developed Beijing-1 in 2005.

2. The BRICS Remote Sensing Satellite Constellation Agreement

IN 2016, THE HEADS OF SPACE AGENCIES of the BRICS member states met in Zhuhai, China, to discuss constructing joint satellite arrays for Earth observation and remote sensing. In mid-2017, the parties convened in Haikou, China, to draft the BRICS Remote Sensing Satellite Constellation Agreement, followed by the first official BRICS Remote Sensing Satellite Forum in Brasília, Brazil. At the November 2019 forum in Brasilia the leaders of the five BRICS countries proposed a new legally binding agreement that would prevent the placement of weapons in outer space.

3. The China-Brazil Earth Resource Satellite (CBERS) for Africa Program

HAILED AS A MODEL OF SOUTH-SOUTH SPACE cooperation and an inspiration for the BRICS Remote Sensing Satellite Constellation Agreement, the CBERS program began as a joint venture between Brazil's INPE and China's Academy of Space Technology in 1988. The 2007 CBERS for Africa Program provides free imagery, and necessary software for data-processing, to Africa from Brazil's cameras on board the CBERS craft. The first ground station to receive the data was in South Africa in 2007, followed by stations in Kenya and the Canary Islands in 2008. In 2011, China's Ministry of Science and Technology approved Phase II of the construction of South Africa Hartebeetshoek's satellite ground receiving station, which was completed in 2015. The station provides real-time receiving, processing, and distribution of CBERS-4 Satellite data for 13 southern African countries.

4. The China-Arab States BeiDou Global Satellite Navigation System Station (BDS/GNSS)

CHINA'S BDS CONSISTS OF THREE GENERATIONS of satellite constellations. The first three-satellite constellation provided navigation services to China and neighboring states between 2000 and 2012. This enabled China to develop an indigenous navigation system and achieve independence from the US-controlled GPS array. The second, ten-satellite constellation was launched in 2011 and 2012 to provide navigation services to the Asia-Pacific region. In 2015, CNSA began building up the third generation of thirty-five ultra-high resolution satellites to provide global coverage and to present Belt and Road partner states with an alternative to the US' GPS system or Europe's Galileo satellite navigation system. In 2016, the Arab League unanimously voted to establish the first overseas processing station for BDS in Tunisia.

5. Square Kilometer Array (SKA)

THE SKA IS AN INTERNATIONAL ASTRONOMY initiative among thirteen countries to build the world's largest radio telescope array, eventually measuring over a square kilometer across South Africa and Australia, with planned expansions in other African countries. South Africa's government has assumed responsibility for developing the MeerKAT telescope as a run-up to SKA, which became operational in July 2018 and is now the world's most powerful telescope of its kind. Second is the National Astronomical Observatories of China, which operates the world's largest single dish radio telescope, the five-hundred-meter Aperture Spherical Radio Telescope. Since 2005, South Africa's African SKA Human Capital Development Program has awarded more than 1,000 grants to advance studies in astronomy and engineering in Kenya, Madagascar, Mauritius, and Mozambique.

POLICY AND RESEARCH RECOMMENDATIONS

AS THE CURRENT GENERATION OF AFRICAN space scientists, social scientists, and entrepreneurs continue to grow space capacities on the continent, social science research with the African space community should likewise continue to mature in order to inform good policies that promote global collaboration and exchange in space sciences and technologies. Potentially productive research areas include global data sharing politics and practice; the domestic determinants of national space priorities, and the impact of growing space capacity on major governance questions.

1. *Further research should investigate diverse roles of space-based technologies in African practices of climate change adaptation and mitigation.* The global open satellite data movement is driven by the ecological and human crises precipitated by anthropogenic climate change, the effects of which are particularly intense on the African continent. What innovative forms of data-sharing and transparency are being developed by actors in the African space sector? How do data-sharing practices differ among international partners? With what effects for climate change mitigation, adaptation, and disaster response? The extent to which the global open satellite data movement aligns with the interests of national space programs will vary and needs to be empirically studied.
2. *Comparative studies of space exploration programs in developing countries and the evolution of human spaceflight and deep space exploration programs are needed.* With Earth observation and communications already at the forefront of space technology development in Africa, there are many possible future directions for African space programs. How do unique longer-term practices of national investment shape the specific interest areas of national space agencies and domestic space companies? There are several areas of inquiry into the links between broader development trends with the evolution of indigenous science and technology. Policy researchers interested in early-stage space exploration programs could study, from the ground up, how the issue gains traction (if it does) and what strategies are used to generate support in the political and public arena.
3. *Exploring the co-evolution of growing indigenous space capacity and broader governance regimes.* What does the democratized capacity for planetary surveillance mean for the duties to report and act in response to satellite imagery of human rights violations? Will the growing capacity to see, track, and communicate in near-real time support or undermine stable governance and human well-being? What new forms of intergovernmental and grassroots solidarities might emerge, or disappear, as these technologies become more widely available? For Africa-China relations in particular, can the diverse and growing forms of space cooperation documented in this paper serve as a stabilizing force in the international arena? ★

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THE SAIS CHINA-AFRICA RESEARCH INITIATIVE at the Johns Hopkins University School of Advanced International Studies (SAIS) in Washington, D.C. was launched in 2014. Our mission is to promote research, conduct evidence- based analysis, foster collaboration, and train future leaders to better understand the economic and political dimensions of China-Africa relations and their implications for human security and global development.

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