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Socioeconomic Benefits of Space Technology for Africa

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ABSTRACT

Africa is the world's second largest and second most populated continent next to Asia. When we compare Africa's land surface area, it is more than the USA, India, China and Europe put together but facing underinvestment in utilizing space technology. Space technology is a vital tool to overcome socioeconomic threats in developing countries like Africa; however, the existing serious challenges in ensuring adequate provision of basic necessities, such as food, shelter, a clean and healthy environment, and proper education, for its growing population makes Africans not to use efficiently the benefits of space technology. The use of space for socioeconomic development presents many opportunities that cannot be ignored and Africa has to respond to these challenges and opportunities. Hence, in this context, there is a critical need to make the benefits of space technology available to all African countries. There is a growing need for Africa to adopt a policy framework that guides the implementation of space programmes across the continent to enable the continent to exploit its space resources in more efficiently with the overarching objective of contributing to Africa's socio-economic development. Though it is late, by now, Africa is awakening to harness and use the benefits of space technology as a tool to escape from such socioeconomic threats. In this review report, Africa's effort and challenges to harness and use space technology for its socioeconomic development is presented.

1. INTRODUCTION

Africa is the most populated continent in the world next to Asia. The length of land surface of Africa is about 30.3 million km including adjacent islands. It covers 6% of Earth's total surface area and 20% of its land area. Africa's average population is the youngest among all the continents: the median age in 2012 was 19.7, when the worldwide median age was 30.4. Africa is also well-known for agriculture as most of the countries therein largely depend on agriculture as the major source of income and foreign exchange. When we compare Africa's land surface area, it is more than the USA, India, China and Europe put together, yet these countries/region spent more than $100 billion on space activities in 2019, while Africa spent about $10 million which is about 0.1% of the global space budget in the same period. In terms of performance in the space sector, only South Africa in the continent, placed in the top ranking in terms of its space budget, which is about $50 million. These comparisons highlight significant under-investment and sub-optimal activities in the space sector, which limits Africa's potential in a fast-growing sector that can make a vital contribution to addressing the socioeconomic challenges of the continent.

The growing need for Africa to harness space technology enables the continent to exploit its space resources in a more coordinated and systematic manner with the overarching objective of contributing to Africa's socio-economic development. Utilization of space science and technology derives optimal socio-economic benefits that both improves the quality of life and creates wealth for Africans and in addition contribute to the international body of knowledge and the knowledge economy.

The aim of this paper is to reviewing the efforts and challenges in Africa to harness and use space technology for its socioeconomic development.

2. EFFORTS AND CHALLENGES IN AFRICA TO UTILIZE THE BENEFITS OF SPACE TECHNOLOGY

Space has become an attractive frontier for African countries that have launched satellites based on scientific, technological or military ambitions. In Africa in harnessing to Space Technology and who have actually launched their own satellites in the earth's orbit are South Africa, Egypt, Algeria, Kenya, Angola, Rwanda, Ghana, Morocco and Nigeria. Other countries like Ethiopia, Libya, Zimbabwe, Sudan, Tunisia and Gabon have emerging space programs and have not yet launched satellites.

2.1 Efforts in Harnessing to Space Technology in Africa

a) Ghanaian Space Program

The Ghanaian space program was established on January 01, 2011. Despite its dawdling progress, the program is a representation of the country's big ambitions. It is operated by the Ghana Space Science and Technology Center (GSSTC), whose main tasks is to coordinate research across the West African country in key areas such as satellite communications and remote sensing. The Ghana Space Science and Technology Institute (GSSTI) and Ghana Atomic Energy Commission (GAEC) have outlined a road map towards the launch of Ghana's first satellite, Ghanasat 1, a remote sensing satellite by 2020. The project would be a joint venture between the State, GSSTI, GAEC and Menasat Gulf Group Public Limited Company, a UK-based producer of very high resolution (1m) synthetic aperture radar (SAR) used for aerial imaging. When complete, this endeavor would enable Ghana to obtain satellite images and other information of tropical regions. The information will be of significant use in areas such as security, risk management, maritime management, environmental monitoring, road transport, defense and intelligence. It is also used for predicting landslides and building disasters.

b) Nigerian Space Program

On top of being the largest economy in Africa, Nigeria has a highly advanced space program operated by its own space agency, the National Space Research and Development Agency (NSRDA), which was established in 2001. The West African nation has so far launched five self-made satellites that are used for various tasks, including performing

environmental and scientific studies in the larger Niger delta and locating terrorists from the region's terror group Boko Haram. Nigeria's first telecommunications satellite known as NigComSat-13 was launched in May 2007 and was designed to offer phone, television and internet coverage across West Africa, but it was later shut down due to lack of substantial solar power. Its replacement, NigComSat-1R was launched in December 2011 and utilizes a DFH-4-band to bring telecommunication services to the larger West Africa. In 1976, Nigeria declared its space ambition to members of the Economic Commission for Africa and Organization of African Unity during an inter-governmental meeting in Addis-Ababa. In 1988 the National Council of Ministers' approved the establishment of a National Centre for Remote Sensing, to be located at Jos; with a Ground Receiving Station, at Kerang, in Mangu LGA of Plateau State. The policy document also states to vigorously pursue the attainment of space capabilities as an essential tool for its socio-economic development and the enhancement of the quality of life of its people. The document also states that the Nation shall achieve this through research, rigorous education, engineering development, design and manufacture of appropriate hardware and software in space technology, including transport and payloads, such as satellite, telescopes and antennas for scientific research and applications. It is believed that this will also be achieved by the commitment of Government in fostering Bi-lateral and international cooperation in all aspects of Space Science and Technology in order to ensure that Nigerian Scientists and Engineers benefits from global developments in this enterprise (NASRDA, 2014).

c) Kenyan Space Program

The world's first launch site on, or near the equator, was established in Kenya by Italy in 1964. Just one year after NASA landed a man on the moon, Kenya launched its first satellite. Named Uhuru - or 'freedom' in Swahili, the NASA sponsored satellite (launched on Kenyan Independence Day) was the first earth-orbiting mission dedicated entirely to celestial X-ray astronomy. "Many people got their PhDs from that satellite, but no Kenyans," as Dr. Paul Baki, professor of space science at the University of Nairobi. Overall, the Luigi Broglio Space Center, (or 'San Marco' as the facility is known) launched nine satellites and twenty research rockets between 1967 and 1988. Since then it operates as a communications and logistics hub for various national space agencies and companies. Kenyan legislators have for some time sought a re-negotiation of the 50 year old contract in order to ensure Kenya receives a greater share of revenue, as well as that more Kenyans become part of the site's staff.

d) South African Space Program

In 1999, South Africa launched its first satellite Sunsat I, used for earth observation. IN 2005, the Department of Science and Technology initiated a three year satellite program. This satellite, named Sumbadila was launched in September 2009 and was operated until mid-2011. SANSA, South African National Space Agency, was established in 2010. In 2011, South Africa announced their plan for the third satellite to form part of a new African satellite Constellation(Ghadaki, 2010). South Africa can be considered as the pioneer in harnessing to Space Technology in Africa. According to Dr. Peter Martinez, the South African Council for Space Affairs, South African Astronomical Observatory was established in 1820. It is used as astrophotography to capture the first measurement to the nearest star. Other projects that emerged from South Africa space institutions were project Moonwatch which resulted in observations of satellite transits. South Africa collaborated with National Aeronautics Space Administration (NASA) in 1961 to establish the deep space station 51 that provided ground support to Mariner IV (fly by to Venus), Pioneer 8 (interplanetary weather satellite) and analysis of soil samples returned by the Apollo satellite. Moreover, South Africa hosts the national earth observation archive and disaster management centers that support the country and its neighbors.

e) Algerian Space Program

Established in 2002, the Algerian Space Agency (ASAL) helps the government to come up with space strategies, including the use of the country's four satellites in the facilitation of scientific research and telecommunication. The North African country hopes to use its space technology to improve its social and economic development. ASAL signed treaties with various space agencies from international partners such as France, Ukraine, Argentina, Russia, China and the United Kingdom.

Algeria launched its first satellite in 2002 known as Alsat 1. It was the first microsatellite launched under the Disaster Monitoring Constellation for the time period of 2002-2005. The objective of the mission was to provide medium resolution multispectral images for monitoring natural disasters as well as other thematic remote sensing applications. Alsat-1B is a satellite designed for agricultural and disaster monitoring. It was launched on the Indian ISRO PSLV-C35 mission on September 26, 2016. Alsat-2A, an earth observation satellite, was successfully launched from the Sriharikota site of India on 12 July 2010. Alsat-1N contains amateur radio payloads and was launched on the Indian ISRO PSLV-C35 mission on September 26, 2016. Alcomsat-1is the first Algerian telecommunication satellite launched in December 2017 at Xichang Satellite Launch Center in China. The Alcomsat-1 equips with 33 transponders in Ku, Ka, and X band transponders. Two ground control stations were built, one in Medea and the second in Ouargla, which controls the satellite. Adopted by the Algerian Government on November 28, 2006 and spanning 15 years (2006–2020), with a review every 5 years, the National Space Program (NSP) is the reference instrument for space policy: it is an instrument for the government support for sustainable development and strengthening of national sovereignty. Algeria's objective is to make space tools a powerful instrument in national prosperity in the fields of earth observation, meteorology and communications. The Algerian Space Agency, (ASAL) was established on January 16, 2002 in Bouzareah, Algiers. It is in charge of the Algerian space program (ASAL, 2014).

f) Egyptian Space Program

Egypt has already launched a number of satellites for nonscientific purposes. It launched Nilesat 101 and Nilesat 102 in 1998 and 2000, respectively. These satellites now deliver more than 150 digital television channels as well as radio and multimedia services over the whole of North Africa, from Morocco to the Persian Gulf. With such big hopes and aspirations, risks to Egypt's financial and human resources remain a concern.

Egypt launched its first satellite in 2007, EgyptSat1, which failed due to faulty communication system. It then launched another satellite EgyptSat2 which was successfully launched in 2014. EgyptSat 2 is the second earth observation satellite jointly developed by NARSS and RKK Engergiya Russia. The satellite has a resolution of 1m in panchromatic & 4m in multispectral. EgyptSat A is the third earth observation satellite cooperated with Russia. The satellite was launched in Feb 2019. These satellites are used in remote sensing to monitor natural disaster, geological resources, better agricultural productivity, Archaeological and monitoring aquatic life along River Nile as it is an important source of livelihood for Egypt and neighboring countries (NARSS, 2015).

g) Ethiopian Space Program

Ethiopian space science & technology institute, ESSTI, is the youngest space programs in Africa. It was established On October 14, 2016. Its main objective is to enable the country to fully exploit multidimensional uses of space science & technology, to produce demand based knowledgeable, skilled and attitudinally matured professionals in the field, to develop and strengthen space infrastructures, and to enable the country to robust contributor for the development of aerospace technology. The establishment of ESSTI is one big step forward for the development of Ethiopian Space activities that will give advantage for Ethiopia to be effective and extensive user of space science and technology for its sustainable socioeconomic developments. Though ESSTI is at its infant stage, a large commitment of government in the sector made great achievement. Among these is readiness to launch its first satellite by the end of the year 2019. This satellite is being manufactured by Chinese company and this is a strong government-to-government collaboration between China and Ethiopia. Ethiopia has also an ambition to launch communication satellite within a near future.

Ethiopia also hosts the East African node of Astronomy for Development, an organ of the International Astronomical Union (IAU), the major professional organization that governs Astronomy. Ethiopia had formed the Entoto Observatory and Space Research Centre, a home grown observatory, equipped with the state of art two 1- meter class telescopes to be used in studying space. The state of the art equipment is expected to accelerate the use of space science in tackling socioeconomic development challenges in Africa. The regional node will benefit other East African countries including Rwanda, Tanzania, Burundi, Ethiopia, Sudan, Uganda and Kenya. The Entoto Research Center also provides Masters and PhD training in Observational and theoretical Astronomy, Space Science and Earth observation. This is expected to increase the number of professionals in the East African region (IAU, 2014).

3. SOCIOECONOMIC BENEFITS OF SPACE TECHNOLOGY IN AFRICA

The world is faced with challenges in all three dimensions of sustainable development: economic, social and environmental. More than 1 billion people are still living in extreme poverty and income inequality within and among many countries have been rising; at the same time, unsustainable consumption and production patterns have resulted in huge socioeconomic costs and may endanger life on the planet. Achieving sustainable development will require global actions to deliver on the legitimate aspiration towards further socioeconomic progress, requiring growth and employment, and at the same time strengthening environmental protection. It is only through sustainable development can one hope to address these challenges; otherwise we expose ourselves to additional challenges. The concept of sustainability is closely linked to the carrying capacity of ecosystems, which sets the physical limits to economic development and may be defined as the maximum rate of resource consumption and waste discharge that can be sustained on a permanent basis in a defined planning region without impairing productivity and ecological integrity. Political, social and economic commitments are only effective if there is a global partnership for sustainable development and to ensure the equitable allocation of available resources (UN Report, 2013).

Space science and technology, and the many practical benefits that can be derived from its utilization, has played a significant role in the international, regional and national socioeconomic development efforts. Space presents a unique opportunity for cooperation and sharing of enabling infrastructure in proactively managing, among other things, disease outbreaks, our natural resources and the environment, our response to natural hazards and disasters, weather forecasting, climate-change mitigation and adaptation, agriculture and food security, peacekeeping missions and conflicts.

Space-derived services (Earth observation, satellite communication, navigation and positioning, space science and astronomy) are crucial for the economic development of the continent. The benefits of these services have accrued to Africa indirectly, as a consumer of services provided by multi-national companies and inter-governmental agencies. While some of these products and services have helped to serve the socioeconomic needs of the continent, Africa cannot boast of possessing the technical know-how to participate independently in space-related activities as a service provider, but only as a consumer of space-derived products.

New applications of space science and technology are constantly being discovered, and spin-offs from space technologies have led to advancements in such diverse fields as medicine, materials science and computers. Exploiting these applications and technological advancements for Africa's socioeconomic development provides for immeasurable benefits. However, the high cost of participating in space activities has hindered the ability of the African continent, from fully taking advantage of the practical socioeconomic benefits that space science and technology offers.

Space is benefiting Africa and its people in a number of ways. Space applications are effective tools for monitoring and conducting assessments of the environment, managing the use of natural resources, providing early warnings of and managing natural disasters, providing education and health services in rural and remote areas and connecting people around the world. Space-related applications are widely used in agriculture, which remains an important economic sector in much of Africa. Space-based information systems play a significant role in risk reduction and disaster management on the African continent, which is heavily affected by natural and man-made disasters. Space-related applications are heavily employed in transportation services, which is another essential field that contributes to the achievement of sustainable development in Africa. Access to transport allows mobility,

promotes commerce and fosters education and health. In many African countries, transport access rates and network quality are low (UN Report, 2009).

4. CONCLUSION

As space investment requires multimillion dollar and Africa is striving to escape from food and shelter problems, it becomes a great problem to think about investing in space for Africa. However, the reward of investing in space technology is much more rewarding than the current socioeconomic problems in Africa. To overcome financial problems to invest in space technology, developed countries has to work jointly in terms of win-win cooperation. Africa has to invest not only in infrastructural development of space technology but also in human capacity development so as to make Africans competent in the development of space products by themselves. If Africa is to leapfrog effectively into the technological advancements of the 21st century, the continent needs to develop an indigenous critical mass of trained space scientists and engineers who contribute actively to the solution of the continent's problems. Africa has to build its capabilities in constellation programmes, Earth observation systems, navigation and positioning applications, satellite systems, communications and education programmes within a global context. In the process of developing a continental space programme, Africa will not reinvent the wheel. There are some leading African countries that are in the process of developing their own space-related capabilities and programmes, and have proceeded to build institutions to manage these programmes. These national efforts collectively represent the seed that could be nurtured toward a continental programme, without devolving the focus of the national space programmes. This trend will have a high value for socioeconomic benefit of space technology for Africa.

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