# Evaluating the impact of Satellite Communication on achieving Sustainable Development Goals in Africa:

## Opportunities, Barriers, and Future Pathways

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**Abstract:**

Access to telecommunication services in remote, rural, and underserved areas remains a significant challenge for Africa. Satellite connectivity can help bridge this digital divide and promote sustainable development. This study examines how satellite connectivity can be used in critical sectors for Africa, such as healthcare, education, agriculture, and disaster management, while addressing costs, regulatory hurdles, and infrastructure needs. Additionally, it explores technological advancements, such as Low Earth Orbit (LEO) satellites and 5G technology. By providing a comprehensive analysis, this paper aims to prompt the use of innovative tools enabled by satellite connectivity to aid ATU Member States in achieving the United Nations Sustainable Development Goals (SDGs).

## 1. Introduction

In an era where connectivity is synonymous with progress, Africa stands at a pivotal crossroads. Despite remarkable strides in various sectors, the continent continues to grapple with a formidable obstacle: the digital divide. Remote, rural, and underserved areas often find themselves isolated from the benefits of modern telecommunications, hindering socio-economic development and impeding the realisation of the SDGs.

At the heart of this challenge is the imperative for access to connectivity. Submarine cables and fibre-optic networks, supported by terrestrial wireless infrastructure, have long been considered the backbone of modern telecommunications on the continent. While these solutions are pivotal for high-speed data transmission, they are often concentrated in urban areas and along coastlines, leaving vast regions of Africa underserved. The high cost of laying and maintaining terrestrial infrastructure presents formidable barriers to extending connectivity to remote and rural areas, perpetuating the digital divide.

This is where satellite connectivity can complement terrestrial networks. Historically, satellite connectivity has been perceived as cost-prohibitive compared to terrestrial solutions. However, advancements in satellite technology and economies of scale have steadily driven down costs, making satellite communication increasingly viable. This is particularly true in remote and underserved regions, where the cost of deploying terrestrial infrastructure is prohibitively high.

However, the journey towards leveraging satellite communication to support sustainable development initiatives in Africa is not without its challenges. This article explores how the ATU encourages the use of satellite communication as a catalyst for socioeconomic transformation, particularly in vital sectors like healthcare, education, agriculture, and disaster management.

## 2. Satellite connectivity in Africa: Opportunities for growth and barriers to development

Terrestrial coverage in Africa varies significantly across regions and countries due to factors such as population density, infrastructure development, and economic conditions. In many parts of the continent, especially rural and remote areas, terrestrial coverage is limited compared to more urbanised and developed regions.

Despite increasing urbanisation, 60% of Sub-Saharan Africans still live in rural areas.[1] For example, in Côte d'Ivoire, 28% of the population lives in areas without mobile broadband coverage, representing a digital divide affecting over 7 million people. In Ethiopia, approximately 80.6% of the population remained offline at the start of 2024, leaving 103.3 million people without internet access.[2] There is a consensus that a connectivity gap exists, with a critical need for innovative solutions that transcend geographical barriers and deliver connectivity where it is needed most.

### 2.1 Leaving no one behind in substantively achieving SDGs

Satellite connectivity can become one of the indispensable tools for advancing sustainable development in Africa. This technology is effective in areas underserved by terrestrial networks due to its ability to provide comprehensive coverage with minimal additional ground infrastructure. Recent advancements have improved the performance and affordability of satellite services, making them a viable alternative for remote and rural regions.

This capability enables reliable deployment and communication to bridge the digital divide, supporting essential services that align with several SDGs.

#### SDG 2: Zero hunger

The agriculture sector can significantly contribute to major continental priorities, such as eradicating poverty and hunger and boosting intra-Africa trade and investments. In Uganda, agriculture accounts for 25% of GDP and employs 70% of the population.[3] Satellite connectivity can play a crucial role in enhancing agricultural productivity and food security in Africa. Through precision agriculture, satellite data provides real-time information on weather patterns, soil conditions, and crop health, enabling farmers to optimise their practices.

1 World Bank (2020) Rural population SS Africa (2020) https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ZG.
2 DataReportal (2024) "Digital 2024: Ethiopia." https://datareportal.com/reports/digital-2024-ethiopia#:~:text=Internet%20use%20in%20Ethiopia%20in%202024&text=For%20perspective%2C%20these%20user%20figures,the%20beginning%20of%20the%20year.
3 Africa Portal (2021) "Rooting Africa's COVID19 recovery: the role of innovation, digital technologies and labour markets."https://policycommons.net/artifacts/1453041/rooting-africas-covid-19-recovery/2084878/

For net importers, such as Mauritius, which imports 75% of its food,[4] this technology supports local agricultural production, ensuring food security and mitigating the challenges posed by a changing climate. These include increased droughts, flash floods, and cyclones. Additionally, satellite-based early warning systems for droughts and floods aid in disaster preparedness and response, further protecting food security.

Use Case: A notable example is the eLEAF project in Zambia, where satellite data is used to provide information on crop performance and water use efficiency. This initiative has helped farmers make informed decisions, leading to improved yields and resource management.[5]

### SDG 3: Good health and well-being

In Sub-Saharan Africa, which accounts for 13% of the world's population but only 2% of its doctors, satellite-enabled connectivity solutions can play a crucial role in addressing the continent's 24% share of the global disease burden. Satellite connectivity facilitates telemedicine services, allowing for remote consultations, diagnosis, and treatment. This will improve healthcare access in underserved regions.

Additionally, real-time data collection and sharing through satellite networks enhance health information systems, which are crucial for tracking disease outbreaks and coordinating vaccination campaigns. Experts estimate that USD 25-30 billion in new investment will be needed in healthcare assets alone to meet Sub-Saharan Africa's growing demands.[6] Investment efforts must consider the connectivity needs of the healthcare sector.

Use Case: The Satmed platform in Sierra Leone is a prime example of how satellite connectivity can support the healthcare sector. Deployed during the Ebola outbreak, Satmed supported telemedicine and eHealth services, improving coordination and response efforts in remote areas.[7]

### SDG 4: Quality education

Satellite internet facilitates e-learning by providing connectivity to remote schools, enabling access to online educational resources and virtual classrooms. This technology also supports remote training programmes for teachers, enhancing the quality of education.

4 UNCTAD (2023) "Using satellite technology to transform agriculture in developing countries." https://unctad.org/news/using-satellite-technology-transform-agriculture-developing-countries
5 eLEAF Project in Zambia: https://www.eleaf.com/projects/zambia/
6 Virginia Economic Development Partnership (2021) "Industry Report Africa – Healthcare / Life Sciences." https://exportvirginia.org/sites/default/files/2021□07/Africa_Healthcare_Report_July_21.pdf.
7 Satmed in Sierra Leone: https://www.ses.com/press-release/ses-satmed-platform-deployed-sierra-leone-fight-ebola

Use Case: The iMlango project by Avanti Communications in Kenya exemplifies the impact of satellite internet. By delivering high-speed satellite broadband to schools in rural areas, the project has provided digital learning tools and resources, significantly improving educational outcomes for students. Unlike terrestrial networks, which are almost non-existent in remote communities, this service connects primary schools to the internet, offering access to an e-learning platform. The programme operates in selected primary schools across four counties: Kilifi, Kajiado, Makueni, and Uasin Gishu. These schools were chosen based on factors such as poverty rates, attendance statistics, access to electricity, and the marginalisation of female children.[8]

### SDG 6: Clean water and sanitation

According to a 2024 study by Afrobarometer, water is the top concern in Benin and Mozambique and ranks second in Guinea, Niger, Congo-Brazzaville, Tanzania, Togo, Ethiopia, and Namibia.[9] On numerous occasions, Member States have been compelled to declare a water emergency when reservoirs dried up, triggering a humanitarian crisis and impacting millions of residents. These unfortunate and recurrent instances underscore the diverse and complex nature of water resource management and sanitation issues across Africa.

These challenges are often worsened by factors such as climate change, population growth, political instability, and economic hardships. Satellite technology plays a crucial role in supporting sustainable water management by enabling the monitoring of water quality, availability, and usage patterns. This data is indispensable for effective planning in water resource management and sanitation.

Use Case: The WaterScope project in Ethiopia uses satellite data to monitor water availability and quality in the highlands, supporting sustainable water management practices that are essential for ensuring clean water and sanitation.[10]

### SDG 7: Affordable and clean energy

Satellite connectivity plays a crucial role in monitoring and optimising energy infrastructure. This guarantees the efficient operation and maintenance of renewable energy sources, such as solar and wind farms. These systems are instrumental in enhancing energy distribution, boosting grid efficiency, and encouraging the adoption of renewable energy sources. For instance, advanced algorithms and real-time monitoring

8 Avanti's iMlango Project in Kenya: https://www.avanti.space/case-studies/imlango/
9 Afrobarometer (2024) "Water and sanitation still major challenges in Africa, especially for rural and poor citizens." https://www.afrobarometer.org/wp-content/uploads/2024/03/AD784-PAP11-Water-and-sanitation-still-major-challenges-across-Africa-Afrobarometer-19march24.pdf
10 WaterScope in Ethiopia: https://www.futurewater.nl/projects/waterscope/

facilitated by satellite connectivity allow grid operators to optimise power flow, balance supply and demand, and mitigate potential instabilities.[11]

As a result, these algorithms support the transition towards affordable and clean energy solutions. Moreover, satellite connectivity aids in rural electrification by enabling the deployment and management of microgrids in remote areas.

Use Case: SolarNow in Uganda uses satellite data to optimise the placement and performance of solar panels. This enhances energy access in off-grid communities and contributes to the goal of affordable and clean energy.[12]

### SDG 9: Industry, innovation, and infrastructure

Technological innovation offers a pathway for engaging Africa's entrepreneurs in addressing local and global problems while creating jobs and wealth. Satellites play a crucial role in infrastructure development by supporting the planning and monitoring of projects, ensuring efficient and sustainable progress. The number of innovation hubs, accelerators, incubators, and startup studios is growing rapidly, particularly in urban areas. In 2019, GSMA registered 618 active tech hubs, a 40% increase over the previous year.[13]

However, businesses in rural or remote areas often struggle with connectivity challenges due to inadequate terrestrial infrastructure, which hampers their revenue and growth. The demand to close the rural-urban digital divide and empower rural SMEs has begun attracting innovative solutions, such as community networks.

Use Case: In Nigeria, BeepTool has launched a satellite solution that integrates TV Whitespaces with Wi-Fi hotspots to provide faster and cheaper solutions for an entire village. BeepTool is utilised by entrepreneurs and small business owners in rural and underserved areas, enabling them to offer free Wi-Fi to their customers while ensuring reliable communication with their service providers.[14]

### SDG 13: Climate action

Between 1970 and 2021, Africa accounted for 35% of natural disaster-related fatalities.

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11 McKinsey and Company (2024) "How grid operators can integrate the coming wave of renewable energy." https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-grid-operators-can-integrate-the-coming-wave-of-renewable-energy#/

12 SolarNow in Uganda: https://www.solarnow.eu/

13 Africa Portal (2021) "Rooting Africa's COVID-19 recovery: the role of innovation, digital technologies and labour markets." https://policycommons.net/artifacts/1453041/rooting-africas-covid-19-recovery/2084878/

14 Space in Africa (2020) "Beeptool launches integrated satellite TV Whitespace wi□fi hotspot terminal." https://spaceinafrica.com/2020/06/25/beeptool-launches-integrated-satellite-tv-whitespace-wi-fi-hotspot-terminal/

However, only 40% of the African population has access to early warning systems, the lowest rate of any region in the world. Mobile Satellite Services (MSS) capabilities and range have expanded significantly since the last allocations at WARC-92 and WRC-95, addressing climate monitoring and disaster response.[15] For example, an increasing number of mobile phone and chip manufacturers, as well as Mobile Network Operators (MNOs), have partnered with satellite system operators to provide Direct-to-Device (D2D) communication services as backhaul connectivity to mobile cellular networks. Currently, D2D services are primarily used for emergencies, but more advanced services could be developed using the MSS spectrum to complement existing terrestrial IMT and Wi-Fi coverage.

Given Africa's vast land mass of 30.37 million square kilometres, as well as its highly variable geography, these new services would be uniquely beneficial to many ATU Member States, bringing mobile coverage and internet connectivity to rural communities.[16] Additionally, satellites provide critical data for climate modelling and early warning systems, helping to monitor environmental changes and predict natural disasters. This capability enhances resilience and informs climate action strategies.

Use Case: The SERVIR program in West Africa, a joint initiative by NASA and USAID, utilises satellite data to offer environmental monitoring and climate information services. This programme supports climate resilience and disaster management efforts across the region.[17]

### 2.2 Barriers to enabled satellite communication

Improving connectivity and including more citizens in the digital economy is imperative for Africa's socioeconomic transformation. According to the International Finance Corporation (IFC), a 10% increase in mobile internet penetration boosts GDP per capita by 2.5%. This indicates that the digital economy could contribute USD 180 billion to Africa's economy by 2025.[18]

Satellite connectivity is critical for achieving several SDGs in Africa. Accelerating access to affordable and sustainable connectivity will revolutionise the performance of key productive and social sectors across the continent. It can also bridge the digital divide

15 Fair Tech Institute (2022) "The Role of Satellite Communications in Disaster Management." https://accesspartnership.com/wp-content/uploads/2022/03/The-Role-of-Satellite-Communications-in-Disaster-Management.pdf

16 VisualCapitalist (2020) "True Size of Africa." https://www.visualcapitalist.com/map-true-size-of-africa/#:~:text=A%20Geographical%20Jigsaw&text=The%20African%20continent%20has%20a,and%20many%20European%20nations%2C%20combined.

17 SERVIR in West Africa: https://www.servirglobal.net/Regions/West-Africa

18 IFC (2020) "e-Conomy Africa 2020." chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ifc.org/content/dam/ifc/doc/mgrt/e-conomy-africa-2020.pdf

and provide affordable solutions in both rural and urban areas. However, various barriers impede the effective utilisation of this technology, including regulatory challenges, high costs, inadequate infrastructure, and sociopolitical issues.

| Regulatory challenges | |
|---|---|
| **Fragmented regulatory environment** | Each nation-state has its own rules and regulations governing satellite connectivity. This fragmentation creates challenges for satellite service providers, leading to delays and increased costs in obtaining the necessary licences and approvals. Harmonising regulations across the continent could facilitate smoother operations and broader access to satellite services. |
| **Licensing and spectrum allocation** | Allocation is often cumbersome and inconsistent. Some countries have restrictive spectrum policies that limit the deployment of satellite services. Others lack clear guidelines, creating uncertainty for service providers. Efficient and transparent licensing processes, coupled with fair spectrum allocation, are essential for fostering the growth of satellite connectivity in Africa. |
| **Enabling regulations for innovation** | Africa administrations should foster a collaborative regulatory environment that encourages partnerships between governments, private sector players at all levels, and research institutions. Emphasizing the importance of interoperability and standardization will ensure that new technologies can seamlessly integrate and enhance existing systems. Additionally, creating incentives for innovative projects and offering support for pilot programs will stimulate creative solutions and drive growth in the satellite communications sector. |
| **Coordination among regulatory bodies** | There is great potential for improved coordination among national regulatory bodies, which can lead to more efficient and effective regulation of satellite services. Additionally, by increasing the use of ATU coordination channels, administrations can streamline processes and foster more unified approaches. |

| Cost barriers | |
|---|---|
| **High costs of satellite services** | High upfront costs for satellite equipment, such as ground terminals and user devices, coupled with ongoing subscription fees, can be prohibitive. Reducing these costs through subsidies, partnerships, and technological innovations is necessary to expand access. |
| **Economic disparities** | Wealthier urban areas may afford satellite services, while poorer rural areas remain excluded. Addressing these disparities through targeted policies and investment is vital for ensuring equitable access. |

| Infrastructure barriers | |
|---|---|
| **Lack of Common Standards in the Region** | Even though satellite connectivity does not require an extensive ground infrastructure rollout, interconnecting satellite networks with other networks and opening up to the rest of the world would require common interfaces and exchange points. Given the global and cross-border nature of satellite connectivity, having common standards and protocols is essential to ensure seamless communication and interoperability between diverse systems. These standards would facilitate the efficient exchange of data, enhance security measures, and promote the scalability of satellite services so that satellite connectivity can be integrated smoothly into the global telecommunications ecosystem. |
| **Power supply issues** | Reliable power supply is critical for all communication infrastructure at various levels and satellite terminals are not exempt from this imperative even though they might be more resilient compared to terrestrial networks. However, many remote and rural areas in Africa suffer from frequent power outages or lack access to electricity altogether. Addressing power supply issues through renewable energy solutions and improved grid infrastructure is necessary to support satellite connectivity. |

| Sociopolitical barriers | |
|---|---|
| **Lack of awareness and digital literacy** | A lack of awareness and digital literacy among potential users in remote and rural areas limits the effective utilisation of satellite connectivity. Educational programmes and community engagement initiatives in particular with the vertical sector such as agriculture, health or education stakeholder are needed to raise awareness and build digital skills, enabling users to fully benefit from satellite services. |
| **Political instability** | A lack of stability in some African countries can disrupt the deployment and operation of satellite services. Conflicts and governance issues may lead to infrastructure damage, service interruptions, and investor reluctance. Promoting political stability and good governance is key to ensuring the sustained growth of satellite connectivity. |

Addressing these barriers requires a multifaceted approach involving regulatory harmonisation, cost reduction strategies, infrastructure investment, and sociopolitical stabilisation. By overcoming these challenges, Africa can fully harness the potential of satellite technology to drive sustainable development and improve the quality of life for its people.

## 3. Implementing regulatory frameworks that encourage satellite connectivity

African administrations within the ATU and regional economic communities, such as ECOWAS, SADC, and EACO, are invited to recognise the economic and social significance of satellite technology. Given that satellites have a lifespan of 15 years or more and require substantial initial investment, regulatory stability is essential. This stability will provide the industry with the necessary business assurance to support long-term investments and operations.

A regulatory framework that fosters satellite connectivity should address several key considerations:

**Common Licensing Frameworks:** Harmonising licensing frameworks is crucial to ensure consistent regulatory practice, promote cooperation across ATU members, and support the growth of a robust economy. The ATU Task Group established in 2021 to develop a satellite licensing framework has made a significant progress to achieve this goal. While the Model Framework developed by the TG is not binding, it offers guidelines for Member States in formulating and implementing their regulatory frameworks.

**Spectrum Harmonisation and Availability:** A unified approach to spectrum allocations across Africa minimizes interference, enables efficient and reliable satellite services across borders. Additionally, with the new market entries and innovative technologies, there is a scarcity of available spectrum for newcomers and new technologies. Allocating more spectrum to satellites supports the increasing demand for bandwidth, fostering technological advancement and investment. A coordinated spectrum policy not only promotes sustainable development but also strengthens Africa's position in the global communications landscape.

**Spectrum fees:** Reasonable spectrum fees are an important step towards making satellite communications an affordable and effective solution to the digital divide. As a general principle, and a matter of good economic governance, regulatory fees are best kept to a level that allows governments to recoup administrative costs covering, among others, equipment imports, technology, type approval, licensing charges, and the functioning of national authorities.

**Regulatory framework for emerging satellite technologies:** As with all digital technology, the satellite industry is constantly upgrading its systems to enhance efficiency. Emerging technologies such as Earth Stations in Motion (ESIMs) or Direct-to-Device should be included in a country's regulatory framework. Blanket licensing regimes that enable

facilitated compliance for new technologies also reduces the administrative burdens of both the national administrations and the applicants regarding the authorisation of terminals.

**Regulatory framework on terminal licence should be clear:** Type approval, identification, and authorisation of terminals are fundamental features for the smooth operation of satellite systems. The licensing process on terminal authorisation and approval processes should be clearly articulated and harmonised as much as possible across the region.

**Affordable tariffs:** Although satellite services can be available anywhere and at any time, the different architectures of systems bear differing cost elements. The identification and billing of calls made in different contexts could require technical and operational agreements to lower costs, as well as to ensure that they are affordable and can be utilised by as many citizens as possible. Regulators can drive the affordability of connectivity by taking the appropriate regulatory decisions regarding interconnection fees, government charges, and transit charges. The introduction of special rates for local communications inside a country or community telecommunications centres may assist regulators in promoting affordable services in rural areas.

**Aligned WRC-27 objectives:** MSS capabilities and range have expanded significantly since the last allocations were made at WARC-92 and WRC-95. The upcoming WRC-27 will provide an opportunity to further enhance satellite communication services. As consumer demand for MSS increases, both in terms of total users and the proliferation of smartphones with satellite capabilities, additional spectrum might be needed to handle the increased traffic. Also alternative ways of increasing the utilisation of spectrum for various services are discussed during the cycle as well. New MSS allocations would enable satellite communication service providers to offer more sophisticated services.



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