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EURO - AFRICA SPACE.

EXPLORING THE POTENTIAL, OVERCOMING CHALLENGES IN THE EU -AFRICA SPACE ECONOMY

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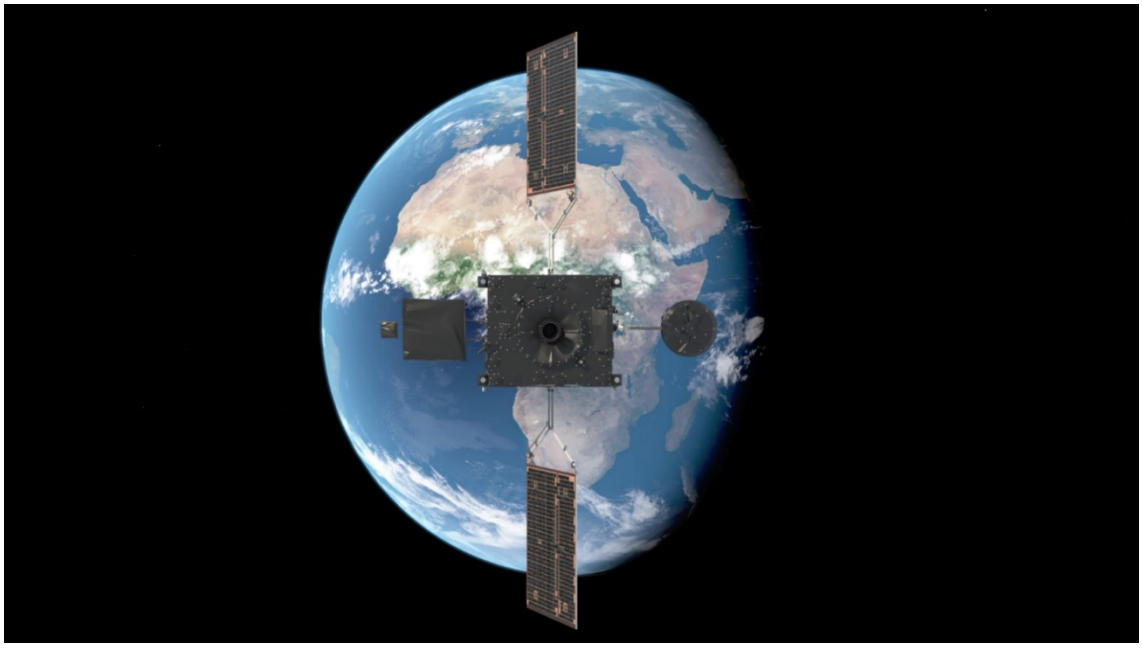

Meteosat Third Generation – MTG-I over Africa. From ESA images

"I have walked that long road to freedom. I have tried not to falter; I have made missteps along the way. But I have discovered the secret that after climbing a great hill, one only finds that there are many more hills to climb. I have taken a moment to rest, to steal a view of the glorious vista that surrounds me, to look back on the distance I have come. But I can rest only for a moment, for with freedom comes responsibilities, and I dare not linger, for my long walk is not yet ended."

– Nelson Mandela.

ABSTRACT

Space technologies and applications play an essential role in our daily lives and the global economy, even though their important role often goes unseen. With the growing demand for space-based services in various sectors, Europe and Africa have recognized the importance of fostering cooperation and collaboration in the space industry.

The dissertation explores this partnership, the potential, and the challenges in the EU-Africa space economy. It examines the current state of the EU-Africa space economy, identifying the challenges that hinder its growth and exploring the untapped potential for mutual development.

Additionally, it investigates the existing technological capabilities and infrastructure in Africa, highlighting areas that can benefit from knowledge transfer and capacity-building initiatives.

EU-Africa cooperation, which has existed for over half a century, can play a significant role in helping to address these challenges. The partnership can facilitate access to financial and technical resources, the transfer of technology, and the promotion of trade and investment opportunities. Thus, EU-Africa cooperation can unlock the potential of the Space Economy in Africa, creating economic growth and opportunities for the continent's people.

Through an extensive literature review, case studies, country-specific analysis, and a SWOT analysis, research questions revolve around these issues, intending to identify gaps in knowledge and research priorities for future studies.

To address the identified challenges, the dissertation proposes policy recommendations and strategies to foster EU-Africa collaboration in the space economy. It emphasizes the need for increased investment in infrastructure and human capital and establishing platforms for dialogue and cooperation to promote sustainable and socio–economic development in both regions.

Keywords: Space economy, the EU, Africa, Partnership, Sustainable development

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LIST OF ACRONYMS

ACP: Africa-Caribbean and Pacific Partnership Agreement

AfCFTA: African Continental Free Trade Area

AFRIGIST: The African Regional Institute for Geospatial Science and Technology

AfSA: African Space Agency

ALC: African Leadership Conference

ARMS-C: The African Resource Management Satellite Constellation

ASI. Italian Space Agency

AU: African Union

ASECNA: Agency for Air Navigation Safety in Africa and Madagascar

ASPS: African Space Policy and Strategy

AUC: African Union Commission

CAAST-Net: Network for the Coordination and Advancement of Sub-Saharan Africa–EU Science and Technology Cooperation

CEN-SAD: Community of Sahel-Saharan States

CeRGIS: Centre for Remote Sensing and GeoSpatial Information Services

COMESA: Common Market for Eastern and Southern Africa

CRSPM: San Marco Space Research Centre

EAC: East African Community

ECCAS: Economic Community of Central African States

EEA: European Environment Agency

EEC: European Economic Community

ECOWAS: Economic Community of West African countries

EGNOS: European Geostationary Navigation Overlay Service

ELDO: European Launcher Development Organization

EO: Earth Observation

EP: European Parliament

ESA: the European Space Agency

ESRO: European Space Research Organization

ESTEC: European Space Research and Technology Centre

EUSPA: European Union Agency for the Space Program

EU: European Union

EUTELSAT: European Telecommunication Satellites

FDI: Foreign direct Investment

FOCAC: Forum on China–Africa Cooperation

FRONTEX: the European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union

GMES: Global Monitoring for the Environment and Security

GNSS: global navigation satellite system

GLONASS: the Russian Federation Global Navigation Satellite System

GNI: gross national income

GOVSATCOM: European Union Governmental Satellite Communications

IGAD: Intergovernmental Authority on Development

IoT: Internet of Things

IRAC: International Relations Advisory Committee

IRC: International Relations Committee

ISECG: International Space Exploration and Coordination Group

ISS: International Space Station

ITU: International Telecommunication Union

JAES: Joint Africa Europe Strategic Partnership

LBSC: Luigi Broglio Space Centre

MARECS: Matrixware Research Collection

MDGs: Millenium Development Goals

NASA: US National Aeronautics and Space Administration

NATO: North Atlantic Treaty Organization

NEPAD: New Partnership for Africa's Development

ODA: Official Development Assistance

OWG: Open Working Group

PRC: Permanent Representatives Committee

REC: African Regional Economic Communities

RECTAS: Regional Centre for Training in Aerospace Surveys

SAATM: Single African Air Transport Market

SBAS: satellite-based augmentation systems

SADC: Southern African Development Community

SKA: Square Kilometer Array

SSA: Space Situational Awareness

STISA: Science, Technology, and Innovation Strategy for Africa

SNASS: Satellite Navigation Augmentation System

SOHO: Solar and Helio spheric Observatory

STI: Science, Technology, and Information

TIGER: Technology Informatics Guiding Education Reforms

UMA: Arab Maghreb Union

UNCOPUOS: UN Committee on the Peaceful Uses of Outer Space

UNECA: United Nations Economic Commission for Africa

UNESCO: United Nations Education, Scientific, and Cultural Organization

UNOOSA: United Nations Office for Outer Space Affairs

UNSDGs: United Nations Sustainable Development Goals

US: United States

WAAS: Wide-area Augmentation System of the United States

WMO: World Meteorological Organization

Figure 1 *Galaxies NGC 7733 and NGC 7734. This striking image captures the interacting galaxy pair known as Arp-Madore 2339-661. "The upper one is more round and its arms form two thin rings. The lower galaxy is flatter and its arms make one outer ring; a dusty knot atop its upper arm marks out a third object. Gravity is pulling gas and dust together where the galaxies come close. A number of small galaxies surround them on a black background". SOURCE: ESA/Hubble & NASA, J. Dalcanton, Dark Energy Survey/DOE/FNAL/NOIRLab/NSF/AURA*

INTRODUCTION

The Euro-Africa Space economy represents an exciting frontier in development cooperation and science diplomacy. With two rich continents coming together to harness the potential of space, it opens endless possibilities for scientific advancement, technological innovation, and socio-economic growth. However, like any ambitious partnership, the Euro-Africa Space economy also faces numerous challenges that must be overcome to realize its full potential. This dissertation addresses the vast potential of this collaboration and the key challenges to pave the way for a prosperous Euro-Africa Space economy.

Space and Space technologies are part of our daily lives, even though their crucial role often goes unseen. They form an integral part of the global economy, and modern life is made possible because of the data from or through Space. Weather forecasts, satellite navigation, communications, Earth Observation (EO), and natural environment monitoring, including disasters, depend on space data and technology. The services deriving from them are increasingly important to society. Infrastructures such as telecommunication and increasing commercial digital applications now rely on space technologies. As the digitalization of the economy grows, the exploitation of satellite data and signals will play an essential role in generating value for the global economy.

The history of space travel has brought humanity many social benefits, including skills in human-robot cooperation, implantable heart monitors, improved solar panels, and light-based cancer therapy, among many others (ISECG 2013). In its 2023 Spin-off report, NASA mentions technologies developed for space travel that further benefit society. They include cloud -computing, kidney dialysis, 3D endoscope, precision eye measurements to robots tough enough to withstand the harsh marine environment, ventilators that were designed to meet the immediate needs of the pandemic., ionospheric mapping software, water mapping technology, Landsat imagery, and many more [1].

Twentieth-century technological and scientific progress has also enhanced the understanding of Outer Space, which was relatively unknown.

Starting in the 1950s, “the Soviet Sputnik-1 became the first artificial satellite in Earth's orbit. The same year, Laika became the first animal to orbit the Earth. In 1961, Yuri

[1] See: https://technology.nasa.gov/NASA-Spinoff-2023. Last accessed: 23 September 2023.

Gagarin became the first human to enter outer space and orbit Earth. In 1969, the Apollo 11 crew was the first to land on the surface of the Moon" (Doboš 2019:1).

According to Doboš (2019), the bipolar competition and setting of the basic principles of space law and diplomacy characterized the period from the 1950s to the 1970s. Space held two prominent diplomatic roles during this era—a scene of the struggle for prestige between the two superpowers (USA, USSR) and an enabler of signing crucial international norms. The Soviet Union received many ovations for its space stunts, like sending the first artificial object into the Earth's orbit and the first animal into Space. The US administration was forced to try something similarly daring (Hays 2011, 19–20). The prestige issue culminated in the US lunar landing, placing the country as the ultimate winner in the first space race.

Despite the predominance of the initial actors, the USSR and USA, since the 1960s and 70s, other actors have joined the group of countries capable of developing space assets. For this dissertation, the European and African arenas shall be considered. For example, the intergovernmental institution that later became the European Space Agency stemmed from the French rocket technology and German industrial potential and, with support from the US National Aeronautics and Space Administration (NASA), enabled Europe to establish a sound and sophisticated space program (Doboš 2019).

Although the bipolar space race is over, the terrestrial geopolitical realities still dominate the space policy practice. Evidence of this is "the case of strategic transatlantic cooperation, (non)inclusion of some actors in the ISS project, development of independent national navigation systems (e.g., Galileo), attitude to militarization and weaponization of the outer space, or strategic alliances that usually follow terrestrial diplomatic development" (Doboš, 2019, p.42).

Moreover, the current space arena, of which Africa forms part, looks different from that dominated by the Cold War superpowers. On top of this, the growing presence of non-state actors alongside state actors in Space has created a very different landscape than that characterized by US-Soviet rivalry (Froehlich, Siebrits, 2019). The number of public and private actors in the Space industry has indeed increased; today, more than 80 countries have registered a satellite in orbit, and more than 30 new space agencies or offices are established in high- and lower-income economies on all six continents (Di Pippo, 2022).

Although space exploration goes far beyond a merely technological endeavor, however intriguing, vast, and complex the topic, the dissertation is not about the exploration of

distant planets and bodies across the Solar System, nor pioneering human space exploration to the moon or far away to Mars, or US-Soviet rivalry in Space. It instead aims to uncover the vast potential and address the challenges in the space economy between the European Union (EU) and Africa—the benefits stemming from this industry and the possible impact on the African space arena. A literature review on these complex and interdependent topics attempts to provide historical insight into this partnership by identifying the players and those determinants that induce the EU to seek a new strategy with Africa, the rationale behind the collaboration as expressed in the agreement, the possible benefits, and challenges from the inclusion of Science and Technology in their cooperation.

Research questions revolve around these issues to identify current strengths, future developments, gaps in knowledge, and research priorities for future studies. It also highlights recommendations for adequate policies, such as increased investments and public and private sector partnerships. By harnessing the potential of the space industry, European and African countries can work towards achieving sustainable development and ensuring a more equitable and prosperous future for all.

The potential benefits of this industry can also support sustainable development goals by providing crucial data and services to inform decision-making and improve resource management. Space data and technologies can address sustainable development goals in the United Nations Sustainable Development Goals. World leaders adopted these goals in 2015 as a global framework for sustainable development efforts. However, Africa remains one of the most challenged regions in meeting these goals.

Despite its vast resources, the continent faces many complex and multifaceted challenges, including high levels of poverty, inequality, security, unemployment, health, and governance issues. It is still home to many poor and hosts over 350 million people living below the poverty index, and almost thirty-six of the world's most fragile economies are in Africa. Due to domestic and external shocks, the economic and social situation remains weak and vulnerable. As stated by the IMF, investments remain subdued, limiting efforts to diversify economic structures and boost growth (IMF, 2000). In addition, climate change is also having a devastating impact on the region, particularly in the form of extreme weather events, droughts, and desertification. These challenges make achieving the SDGs in Africa challenging and present opportunities for innovation and growth. Furthermore, recent World Bank reports estimate that currently, on our

planet, about 9.2% of the world's population, over 719 million people are living on a daily income of less than $ 2.15, and one in five persons in developing regions still live on less than US 1.25 per day, and globally, over 20,000 children still die each day from poverty-related causes (World Bank, 2021). Again, two-thirds of the world's population uses the Internet, but 2.7 billion people remain offline, according to the International Telecommunication Union (ITU, 2022). By 2030, almost 60% of the world's population will live in Urban areas, and 95% of the Urban expansion in the coming decades will occur in developing countries (UN,2018). These figures reflect and amplify existing social, cultural, and economic inequalities in our society.

On the other hand, EU-Africa cooperation, which has existed for over half a century, can play a significant role in helping to address these challenges. With the rapidly expanding global space industry, both regions have recognized the importance of collaboration and exploration to unlock new opportunities and drive economic growth. This joint effort between EU and African countries seeks to leverage their respective strengths and overcome the hurdles that hinder the full realization of the space economy's potential. The partnership can facilitate access to financial and technical resources, the transfer of technology, and the promotion of trade and investment opportunities. Thus, EU-Africa cooperation in this area can unlock the potential of the Space Economy in Africa, creating economic growth and opportunities for the continent's people. In the dissertation, Euro-Africa cooperation in the space sector is part of the broader EU-Africa Partnership, which outlines the areas of collaboration between the two regions. The first multilateral collaboration on these issues started in Cairo in 2000. A renewed relationship, with a long-term policy framework, was adopted in 2007 during the second Summit held in Lisbon and attended by the leaders of 27 European and 54 African states and the Presidents of the continental institutions.[2]

The EU Commission, being fully aware of the challenges and opportunities facing both continents, has strengthened its partnership to engage in a political and policy dialogue with Africa, also due to common values and interests both continents share. Ursula Von de Leyen expressed this willingness to implement a new strategic partnership during her first official visit as the President of the EU Commission at the African Union (AU)

[2] See: https://knowledge4policy.ec.europa.eu/publication/joint-africa-eu-strategy_en. Last accessed: 07 October 2023.

headquarters in 2019. In a further statement on 9 March 2020, she underlined that "*both continents can build a more prosperous, more peaceful and more sustainable future for all*." This vision for the future Africa-EU is represented in the joint communication document "*Towards a Comprehensive Strategy with Africa and Supported by the Council Decisions,*" which also outlines the partnership for Space cooperation.[3]

The EU also provides financial assistance to African countries under the African Space Program, launched in 2010, to promote the development of space activities in Africa. The program also enhances African countries' capacity in the space sector and supports the implementation of the African Space Policy and Strategy adopted by the African Union in 2016 (AU 2016).

The interest in this sector is growing fast in Africa, particularly for Earth Observation, drought monitoring, and resource mapping and management. The highest potential market opportunities are agriculture, emergency response, transportation, and infrastructure monitoring. Broadband communications and connectivity are also other space-related areas with enormous potential. While the immense potential of the space economy is exciting, it is essential to note that a significant portion of African countries still need the infrastructure, resources, or regulatory frameworks to take advantage of these opportunities. According to Euro Space reports (2022), administrative and policy compliance requirements, corruption, lack of private sector participation, and Chinese Influence constitute significant barriers and challenges that impede growth in the EU-Africa Space arena. Nigeria, Ghana, and South Africa are important beneficiaries of Chinese Foreign direct Investment (FDI) as part of the Belt and Road Initiative. China has built several satellites for Nigeria, Ethiopia, and Sudan, and it is also helping other African countries develop downstream applications (EU Global Action on Space, 2022). The dissertation explores these complex and interdependent topics through a literature review, case studies, a country-specific analysis of key economic and Space assets in Nigeria, Ghana, and Kenya, and a SWOT analysis of the Euro-African space.

[3]See: https://www.europarl.europa.eu/legislative-train/theme-a-stronger-europe-in-the-world/file-towards-a-comprehensive-strategy-with-africa. Last accessed: 06 October 2023. See also: https://www.europarl.europa.eu/legislative-train/theme-a-stronger-europe-in-the-world/file-towards-a-comprehensive-strategy-with-africa. And About the Africa-EU Partnership: https://international-partnerships.ec.europa.eu/orphan-pages/intpa-landing-pages/about-africa-eu-partnership_en. Last accessed: 08 October 2023.

Chapter one, “Euro – Africa Space,” oversees the geopolitics of the Space domain since the 1950s. A historical track of the dynamics of the EU – Africa Joint Strategic Partnership and the multilateral collaboration on space issues initiated in 2000 is also provided. The purpose is to investigate and reflect on this transformative agenda and its potential in a context marked by asymmetries between the partners. The broader EU-Africa Partnership, which outlines the areas of collaboration between the two regions, is considered. Also, in this section, global challenges in Africa, the AU Agenda 2063, and the Africa Outer Space program[4] are briefly introduced to complete a panoramic view of the continent's efforts to achieve sustainable development and its Master Plan for transforming Africa into a global power and player of the future through Space. The literature review reveals that global challenges facing Africa are multifaceted and require comprehensive solutions. The challenges connect governance, economic, security, and social issues intertwine. The state of the art of the African Space program, after ten years of implementation since the beginning of the AU Agenda in 2013, is also provided in the conclusion of chapter one.

Chapter two explores the potential of the space economy both for Europe and Africa and addresses the United Nations Development Goals (UNSDGs) set for 2030. A focus on three SDGs (1, 11, 17) is also provided, which is particularly significant for the challenges in the dissertation: poverty, increasing urban population, and partnerships. Concerning the potential, one common theme in the literature is the significant economic potential of the space industry. According to the Quarterly Report of the Space Foundation, in 2023, the global value of space activities amounted to 547 billion dollars, an increase of 260 billion dollars in the past decade [5]. The potential opportunities for Africa, expected to be in satellite provision, agriculture, emergency response, transportation, and infrastructure monitoring, are also presented in this chapter.

The considerations drawn from these assumptions bring to the research questions further developed in Chapter Three and perhaps represent the research priorities to explore in future studies. As part one will demonstrate through the literature on the potentialities of the Space Economy, Geospatial Data can contribute to societal well-being by accelerating economic growth and development. These activities will push forward economic growth

[4] See: https://au.int/en/agenda2063/overview . Last accessed: 14 September 2023

[5] See: Space Foundation, "the space report 2023", available at: https://www.thespacereport.org/. Last accessed: 05 October 2023.

on a global scale, and there is no doubt they will accelerate sustainable growth while acting as a flywheel for innovation. Given the above assumption, the African continent lacks the necessary investments in space-related infrastructure, technology, and human resources development. Given the premises of the space industry, can the Space Economy be a flywheel or a shortcut route to overcome global challenges and accelerate growth in Africa? If yes, can the renewed EU–African cooperation unlock the potential of these industries to create change and sustainable development for both continents? What are the strengths, weaknesses, opportunities, and threats in the partnership and their respective Space arena, and what possible policies and recommendations can overcome the EU- Africa Space Partnership challenges?

Also, the support from the European Union Agency for the Space Program (EUSPA), the European Space Agency (ESA), and the role of two European Flagship programs, Galileo and Copernicus, in achieving the Sustainable goals is presented. A mixed methodological approach is adopted and raised in Chapter Three to explore the research topics and corroborate the research questions to the findings. Two case studies assess the contribution of European Space Programs, Galileo and Copernicus, to the UNSDGs and their potential impact on Africa and society. They constitute best practices where Space economy endeavors can help address similar challenges. A country-specific analysis of key economic facts and Space assets of three African countries, Nigeria, Ghana, and Kenya, are also provided. One reason for choosing these countries is that they are considered among emerging "middle powers" in international relations literature. Thus, they are States that are neither great nor small in terms of global power, capacity, and influence. They are also leading their respective Regional Economic groupings (RECs) and are much more in favor of Regional Cooperation and Integration (Froehlich et al. 2019).

A SWOT analysis is performed in Chapter Four to understand the present and future of European and African space. They focus on the current space capabilities and potential for future Euro-African space development.

A summary of the findings and recommendations is provided in Chapter Five. Conclusions, and is followed by bibliographical and archival references.

CHAPTER 1: EURO -AFRICA SPACE: A HISTORICAL TRACK TO A JOINT STRATEGIC PARTNERSHIP.

Feature Index

The Huntsville Times

Where Progress...

Covers The Valley!

28 PAGES TODAY

VOL. 51, NO. 21 — CHICAGO DAILY NEWS SERVICE — HUNTSVILLE, ALABAMA, WEDNESDAY, APR. 12, 1961 — ASSOCIATED PRESS — WIREPHOTO — 45c PER WEEK

Man Enters Space

'So Close, Yet So Far,' Sighs Cape

U.S. Had Hoped For Own Launch

CAPE CANAVERAL, Fla. (AP) — The Redstone rocket which the United States had hoped would boost the first man into space stands on a launching pad here. The Soviet Union beat its firing date by at least two weeks.

"So close, yet so far," commented a technician who is helping groom the Redstone to send one of America's astronauts on a short sub-orbital flight, hopefully late this month or early in May.

"If we hadn't had those troubles last fall and on the chimp and Little Joe shots this year, we might have made it," the technician said.

"But you have to give the Russian scientists credit. They've accomplished a remarkable break-

Hobbs Admits 1944 Slaying

Soviet Officer Orbits Globe In 5-Ton Ship

Maximum Height Reached Reported As 188 Miles

MOSCOW (AP)—A Soviet astronaut has orbited the globe for more than an hour and returned safely to receive the plaudits of scientists and political leaders alike. Soviet announcement of the feat brought praise from President Kennedy and U. S. space experts left behind in the contest to put the first man into successful space flight.

By the Soviet account, Maj. Yuri Alekseyvich Gargarin, rode a five-ton spaceship once around the earth in an orbit taking an hour and 29 minutes. He was in the air a total of an hour and 48 minutes.

The whole sequence of events and the announcements relating to it raised a number of questions. The Soviet announcement said the flight took place today between 9:07 and 10:55 a.m., but some persons in Moscow's Western colony

VON BRAUN'S REACTION:

'To Keep Up, U. S. A. Must Run Like Hell'

Figure 1-1*: The Hunstville times of 12 April 1962 reports Yuri Gagarin's orbit in Space. "The United States and the Soviet Union waged the Cold War for nearly 50 years after the end of World War II". The two countries were locked in political and military tension that resulted in the space race. Source: https://airandspace.si.edu/explore/topics/war-and-conflict/cold-war.*

Since the terrestrial geopolitical realities still dominate the space policy practice, before delving into the roadmap and determinants that led and shaped the Euro – Africa collaboration in the Space sector, I briefly overview some significant moments, starting from the 50s through the 70s of the geopolitics of the outer space domain in Europe and the global context, and the process that led to a political and economic integration in Europe. A necessary recognition to understand how they evolved from the 50s to date, who are the major actors in the space arena today, what the rising conflicts, competition, and collaboration are installed between the actors, and the challenges present therein.

The chapter also presents some significant historical dynamics and legal actions between the EU and Africa that shaped and led to the joint strategic partnership on Science and Technology and the adoption of Space technologies to foster sustainable development in Africa. How did this relationship evolve to adopting the Joint Strategic Partnership (JAES) in 2007? Who were the policy actors that shaped the strategy? What were the factors, "the game changers," that induced the E.U. to seek a new strategy with Africa? These are some of the research questions this first part of the dissertation enquires. The purpose is to investigate and reflect on this transformative agenda and its potential in a context marked by asymmetries between the partners.

1.1: 1950s - 2020s: HIGHLIGHTS FROM THE BIPOLAR RACE, EU INTEGRATION, THE EUROPEAN SPACE PROGRAM, AND AFRICA

***Figure 1-2**: TIME Magazine of 04 October 1957, depicting the Race for the Moon after Russia Sputnik -1 in Outer Space*

1.1.1: 1950s-1970s: BIPOLAR COMPETITION, EU INTEGRATION

Twentieth-century technological and scientific progress has enhanced the understanding of Outer Space, which was relatively unknown.

As remembered in the introduction, in 1957, the Soviet Sputnik-1 became the first artificial satellite in Earth's orbit. The same year, Laika became the first animal to orbit the Earth. In 1961, Yuri Gagarin was the first human to enter outer Space and orbit the Earth. In 1969, the Apollo 11 crew was the first to land on the surface of the Moon (Doboš 2019: 1).

1949 witnessed the birth of the Western defense military pact, the North Atlantic Treaty Organization (NATO), which was matched in 1955 by the establishment of the Soviet-led Warsaw Pact (Treaty of Friendship, Cooperation, and Mutual Assistance) following the admission of Western Germany into NATO (*Ibidem*: 85-86).

"In the first decade of the postwar period (1945 – 1950), Italy, Western Germany, France, and the Benelux countries began the European integration. Following the tremendous events of the previous years, an interdependent space between the two European rivals (France and Germany) was set up to avoid another devastating event on the continent. The process at first called for a unification of the market connected to the production of resources that constituted the essential war-fighting material of that time—coal and steel. In 1950, the two main rivals—France and Western Germany—and Italy, Belgium, the Netherlands, and Luxembourg established the European Coal and Steel Community" (Doboš, 2019, p. 88).

In ***1957***, the Rome Treaty established new organizations aiming to deepen integration further by establishing the European Economic Community.

During the ***1970s***, "military regimes in Spain, Portugal, and Greece fell, beginning their accession to the Western community, while the United Kingdom, Ireland, and Denmark entered the EU" (Ibidem, p.86).

During the early phase of the Cold War, Space was an extension of the ideological struggles between the superpowers, and security and military concerns were predominant. For example, the first-generation satellites were dedicated to military purposes, especially espionage, and space activities were subjected to Cold War logic. By the latter part of the Cold War, scientific activities and commercial concerns (especially in communications,

as was seen in the modern space economy) had become major parts of the space arena, and today, even though space technology maintains its dual-use characteristic, "the market for military use is falling, and the market of civil use is on the rise" (Petroni, Bianchi 2016).

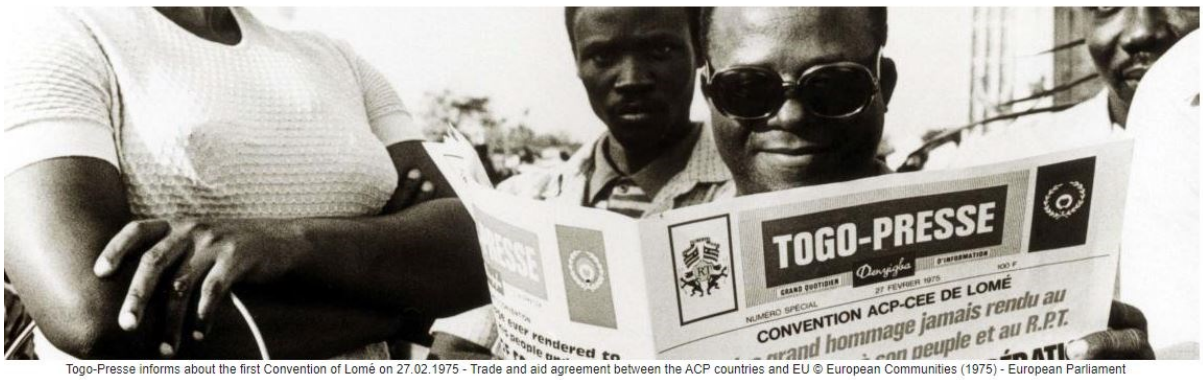
According to Hayes and Lute (2017), the period from the ***1950s to the 1970s*** was characterized by bipolar competition and the setting of political practice in the newly accessible domain. “The basic principles of space law and diplomacy were set throughout this period. Since that era, no significant amendment to the framework has occurred despite the considerable political shifts connected to the end of the Cold War and the proliferation of the actors. Space during this era held two prominent diplomatic roles—a scene of the struggle for prestige between the two superpowers and an enabler of the signing of crucial international norms” (Doboš, 2019, p.34). The Soviet Union received many ovations for its space stunts, like sending the first artificial object into the Earth's orbit (1957 Sputnik 1) and the first animal into Space (1957 dog Laika on board Sputnik 2). “The U.S. administration was forced to try something similarly daring. The prestige issue culminated in the U.S. lunar landing, placing the country as the ultimate winner in the first space race. Diplomacy in this era was thus characterized by bipolar competition with other actors playing, at best, a secondary supportive role, and the primary focus was placed on the attempt to use the space race as a propaganda tool and the development of space technologies also enabled to ease tensions caused by the uncertainty about the opponent’s strategic capabilities mainly connected to the issue of nuclear weapons and ballistic missiles—precisely their number and sophistication. Knowledge-based on satellite imagery coupled with the principle of free movement that gave both sides certainty over the regular flow of new information stabilized the mutually assured destruction system. The satellite imagery was, together with the U-2 plane pictures, for example, crucial for detecting the transport of nuclear warheads to Cuba in ***1962.*** The imagery's sophistication level has grown significantly since then” (Doboš, 2019: 40 - 41). Moreover, since the end of the Cold War, space politics underwent a complete transformation mainly due to the two main processes—actor proliferation and privatization (Petroni and Bianchi 2016). The commercialization of space activities also contributed to the proliferation of space actors, mainly due to the decreasing financing for the most prominent agencies and to the spread of new non-state actors, notably Space

X, Virgin Galactic, and many others whose objectives as private entities is the utilization of outer Space towards profit (Doboš, 2019).

The United States, following the four-decades-long Cold War competition, established itself as the sole superpower, and its space policy was primarily defined by the aim of retaining its independent and dominant strategic position.

Meanwhile, in EU–Africa relations, the Yaoundé Convention, signed in ***1963 and 1969***, gave a new rise to EU-Africa Cooperation, which evolved around the concept of association, not integration as envisaged in the declared objectives. During the next twelve to fifteen years, the six European countries of the Common market will gradually abolish all tariffs and quotas on imports from overseas territories (Hunt,1963).

However, as argued by Mangala (2013), the virtue of the reciprocal nature of the trade provisions conferred equality of status despite the asymmetrical nature of the agreement. As argued by Hunt (1963), in the twilight of the age of colonial dominance, West European countries are turning their attention inward. Weakened by generations of strife and rivalry, they have begun to seek ways to regulate common economic problems. Many projects were undertaken because of the growing European demand for raw materials, which the Common Market will boost. The Common Treaty also covered several overseas African territories of France, Belgium, and Italy.[6]



Togo-Presse informs about the first Convention of Lomé on 27.02.1975 - Trade and aid agreement between the ACP countries and EU © European Communities (1975) - European Parliament

Figure 1-3*: Trade and aid agreement between the ACP countries and EU © European Communities (1975) - European Parliament*

[6] https://archives.eui.eu/en/fonds/103221?item=UWK%2FNS%2FDOC-43

1.1.2: 1975-2000s: EU–AFRICA COOPERATION AND THE EUROPEAN SPACE AGENCY

Despite the predominance of the initial actors, the USSR and USA, since the 1960s and 70s, other actors have joined the group of countries capable of developing space assets: France, Japan, China, India, and recently many African nations.

"France, in cooperation with other Western European states, developed throughout the ***1970***s its Ariane launchers, thus directly competing with the US boosters that were, until then, the only Western space-launching capability" (Wang 2009, p. 443).

In ***1975***, the intergovernmental institution that later became the European Space Agency stemmed from" the French rocket technology and German industrial potential and, with support from the U.S. National Aeronautics and Space Administration (NASA), enabled Europe to establish a sound and sophisticated space program" (Doboš, 2019, p.2). The United Kingdom stood at the beginning of the European space efforts. "By the end of the 1950s, the kingdom began developing its domestic ballistic missile—Blue Streak- with assistance from the United States. The development of Blue Streak and the understanding of a small group of scientists regarding the importance of European space cooperation marked the beginning of the joint European space program" (Doboš, 2019, p. 92). Throughout the 1960s, European states established several organizations to conduct European space activities. In 1960, the first meetings of scientists and policymakers took place to determine the shape of the future organizational setting. In the next few years, the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO) were set up as the central institutions in the heart of the European space program (Gervas et al. 2021). However, the need to build an independent heavy launcher did not disappear. "Despite the test failure of Europa 1 in 1967, the strategic necessity of developing the European heavy booster continued. The need was directly connected to problems with the launching of the European assets on board the US boosters (such as the need to hand to the United States all data that were generated by the satellites launched from the US territory or scheduling issues)". (Krige, J., & Russo, A. 2000, p. 76).

However, Europeans failed to produce the common launcher during this first stage. In 1969, the United Kingdom abandoned ELDO; later, even Germany found it more economical to use the US launchers. "In 1973, the Europa 2 (already successfully

developed launcher ready for production) and Europa 3 (planned launcher) projects were abandoned, and ELDO dismantled itself as its last meeting took place in 1975. All the documentation and technology related to the program were transferred to the Ariane program as France appeared as the dominant force behind the common European launcher, and it not only undertook the central part of the development of the Ariane launcher itself but also built a launching site in Kourou in French Guiana. The joint European space program has since used this site. By the end of the first phase of the space age, European space programs were marked by many financial issues and technological failures". (Doboš, 2019, p.93).

This led the European partners to seek the reform of its many multifaceted and uncoordinated space institutions. The need to unify the efforts to make the European space program viable in the global competition led to the establishment of the common European Space Agency, combining the priorities of both ELDO and ESRO. The ESA Convention was agreed upon and signed in 1975.

Other European space program developments comprised space applications and science throughout this period. After initial neglect in the space applications field, Europe began to develop its capabilities in several industries. This included communication. The first European telecommunication satellite, EUTELSAT, was launched in 1983, and maritime communication satellites MARECS in 1981 and 1984.

Arising from the World Meteorological Organization's (WMO) 7th session, held in Nairobi from 6 -17 February ***1978***, African countries were urged to install at least one satellite ground station to benefit from the transmission of Meteosat. "Tanzania, for example, through the Republic of Germany in 1980, installed a ground receiving station. Together with other African countries, the Meteosat operations program would make a notable socio-economic contribution to African countries" (ESA/PB-MET 80 p.31).

For many years, ESA has activities in and with Africa. It started with the ground station for tracking the Ariane launcher in Libreville and Malindi – Kenya and satellites associated with joint projects for education. ESA's activities with Africa include various projects addressing different scopes such as space infrastructure, environment, water management, health, science, technology, and capacity building. The partners involved in the activities are the African scientific community, technical authorities, international organizations, and European NGOs (ESA/IRC, 2007, p.4). Many of these activities address Africa's development issues and find their origins in the EU or UN programs.

They consist mainly of capacity building, training, hosting students, and providing support in setting up Research and Development centers. These activities are, however, in the Agency's interest. Some related mainly educational activities are of interest to Africa.

The ***1980s*** also saw active and increased initiatives on behalf of ESA through its International Relations Advisory Committee, which, from 18 to 22 March 1985, held awareness seminars on telecommunications in Africa in Lomé – Togo. "The seminar, jointly organized by the Pan African Telecommunication Union and ESA, was attended by participants from 20 French – speaking African countries and representatives of the ITU, Eutelsat, CEC, and Euro space. During the seminar, many participants stressed the need for a decision–making structure that was genuinely African. They pointed out that the problems in African telecommunication were neither technical nor financial but rather institutional. They stressed integrating satellite communication systems into the existing and planned national networks. They deemed it necessary and urgent for the African countries to take relevant measures in selecting the optimum orbital position for the African system" (ESA/IRAC 85, p.2).

As indicated in (ESA/IRAC, 89), which shows prospects for cooperation on telecommunication in Africa, "the work that the agency is doing in the telecommunications industry is aimed at ensuring that European industry is in the best possible position to establish itself o this new market." ESA is engaged in efforts to persuade the African authorities of the benefits of carrying out rural telecommunication projects using Olympus satellite to provide an opportunity for analyzing and assessing requirements and resources needed for using satellite telecommunications technology in Africa. "These activities were the subject of exchanges of views with representatives of the African Development Bank (AfDB) and the International Telecommunication Union (ITU) in October and December 1988. Other satellites were also envisaged along the Olympus satellites, such as Eutelsat and Intelsat. Training courses were also planned for African engineers and technicians. ESTEC, ESA's Space Research and Technology Centre in the Netherlands, held a course for African engineers from 1983 to 1986" (ESA/IRAC, 89 p.2).

Further efforts have been made on the side of ESA to cultivate the AfDB as a source of information on the project in connection with using remote sensing in AfDB projects. In the meantime, while waiting for the deployment of Eutelsat, the experimental use of the

Olympus satellite for rural telecommunications in Africa could serve to strengthen the image of European technology in Africa. ESA is, thus, endeavoring to make a constructive contribution to carrying out the African telecommunication satellite program to promote the development of Africa and provide a market for the European Space. The experience of the organization and its status as a commercial European organization led many Africans to hope that the Agency would play a role in this program.

Meanwhile, the newly formed European Economic Community (EEC) was in the making. However, "the path could have been smoother due to French President Charles de Gaulle's retrogressive "Europe des *partries"* (Europe of nation states) and suspicion of passing powers to the Brussels bureaucracy. De Gaulle blocked British entry into the EEC in 1963. The EEC was eventually enlarged to nine members in 1973 and 12 in 1984. Gradually, over the years, this number increased to the present 27. At the same time, after a period of "*Euro sclerosis*" in the 1970s, in which new moves for integration were limited to direct elections to the European Parliament and the creation of a European Monetary System, more significant substance was given to the European Court of Justice (Mangala, 2013, p. 79).

The ***1980s*** were shaped by growing tensions in Eastern Europe, first in Poland, then Hungary, and in 1989 by the fall of the communist regimes all over the European part of the socialist bloc. During the mid-1990s, the EU enlarged over previously nonaligned countries, and the new millennium saw a massive eastward expansion of both the EU and NATO that penetrated even the territory of the former Soviet Union with the accession of the Baltic countries in 2004. The process is not finished, as was evident from the 2013 Croatian EU accession or the 2009 NATO expansion to the Balkan countries (Croatia, Albania), followed in the same region by Montenegro in 2017 (Ibidem: 87).

This process and the 1991 dissolution of the Soviet Union led to political shifts and rapid changes in European geopolitics. Hunt (1963) argued that "economic advances and technical achievements in one country can be nearly as provocative as direct incitements to violence. Such might be the reaction to the process in Western Europe, where economic integration leads to political consolidation; the Common Market, Euratom, and the Coal and Steel Community are all by way of preparation for a political federation in due course" (Hunt, 1963, p. 3).

How does the process of European integration affect or concern other countries? As further argued by Hunt (1963), in material terms, the influence should be good by creating

more capital for investment in economically poor countries and ensuring the expansion of markets for their exports. On the other hand, if a fresh dynamism is given to the West European economies, then the balance of economic power in the world is bound to be affected.

Although the bipolar space race is over, in the contemporary space arena, we can distinguish "the terrestrial strategic tensions connected to the rise of China, as seen in the ban on the export of most space-related technology from the United States to China and refusal to include China in the ISS project" (Doboš 2019, p.42). Further examples of these geopolitical realities that still dominate the space policy practice are the development of independent national navigation systems (e.g., Galileo), attitude to militarization and weaponization of outer Space, or strategic alliances that usually follow terrestrial diplomatic development. (Doboš, 2019, p. 44). Thus, Space diplomacy is a follow-up of terrestrial geopolitical relations and how they develop over time.

Togo-Presse informs about the first Convention of Lomé on 27.02.1975 - Trade and aid agreement between the ACP countries and EU © European Communities (1975) - European Parliament

Figure 1-4 *First Agreement Signing of Lomé Convention 1975 between the EU and ACP Countries in Togo. Source: European Parliament.*

In delving into Europe–Africa cooperation, the legal framework of the relations between both regions for decades was the ACP (Africa-Caribbean and Pacific) Partnership Agreement (Sijilmassi 2021).

However, the origins of the formal relationship between the EU and Africa go back to the creation of the European Economic Community (EEC) by the 1957 Treaty of Rome. Part IV of the treaty envisaged an association of the overseas territories of Belgium, France, the Netherlands, and Italy. Most of these overseas territories were in Africa, with 15 administered by France, two by Belgium, and one by Italy.

Nonetheless, the first Lomé Convention in February 1975 between the EU and ACP countries, upgraded four times since then, marks a significant moment in the formal relationship between Africa and the EU. The signatories at the time were the nine EEC Member States - now the EU - and 46 African, Caribbean, and Pacific countries. The Georgetown agreement officially established the ACP group in 1975, although its members had been negotiating since 1973.[7]

It was scheduled to expire in February 2020, but as negotiations on the future Agreement are ongoing, it was extended to December 2020 (Sijilmassi 2021). In addition to the institutional framework of the EU-ACP Partnership Agreements, the EU and Africa gradually started to have a direct political and cooperation dialogue within the framework of EU-Africa Summits. The main objectives of this partnership consist of "strengthening economic cooperation and promoting sustainable development, with both continents co-existing in peace, security, democracy, prosperity, solidarity, and human dignity (Ibidem) [8]. The summary of the works and results of the Lomé convention stressed the need to integrate satellite communication systems in the existing and planned national networks based on a thorough study of Horizon 2000 requirements. (ESA/IRAC/85).

The following years were marked by the dispensations of the Cotonou Partnership Agreement, with their primary focus on European development aid to Sub-Saharan Africa and preferential access to European markets for developing countries (Cherry et al. 2018, p.6). The Lomé Convention of 1975 created a significant and more equitable relationship, ending reciprocity. The Lomé convention was also an essential prerequisite for making

[7]See:https://www.europarl.europa.eu/acp/en/about/history#:~:text=The%20formal%20relationship%20between%20the%20ACP%20group%20of%20states%20and,African%2C%20Caribbean%20and%20Pacific%20countries. Last accessed: 10 October 2023.

[8] https://international-partnerships.ec.europa.eu/orphan-pages/intpa-landing-pages/about-africa-eu-partnership_en - Last accessed 10 October 2023.

the Economic Community of West African Countries (ECOWAS) seen as a means for healing the division between former French and English-speaking countries (Mangala, 2013).

As Mangala (2013) argued, Brussels was enthusiastic about supporting African integration, although often more rhetorical than practical. They eventually pledged ten percent of Lomé convention funds for regional integration. International aid during this period was mainly directed towards science and establishing new universities.

The following decade (1985 to 1995) was a significant push for EU Integration under Jacques Delors as President of the European Commission. The single market was created. "These efforts, in turn, led to the treaties of Maastricht (1992) and Amsterdam (1997), which enlarged community powers in many sectors and created new pillars of defense and foreign policy, internal security, and freedom of movement alongside the Community. The European Union was born, and the launch of the Euro – the common currency – in 1999 became one of the most decisive acts of consolidation" (Whiteman, Nagar,2009, p.21).

Moreover, the end of the Cold War in 1989 and the Civil War in Rwanda in 1994, where over 800,000 people were killed, encouraged African and European Leaders to focus on a new era of cooperation, *a pax Africana*, to embark on recent political and policy dialogue. Mangala (2013) argued that the end of the Cold War opened a new political space that pushed the E.U. and Africa to seek a "restructuration of their continent-to-continent relationship. Until 2000, EU-Africa relations were almost entirely based on development aid.

In 2018, EU28 ODA to Africa increased by 4.3%, reaching EUR 25 billion [9].

[9] See also: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_674. Last access: 24 September 2023.

Figure 1-5: *Meeting of the President of the European Commission, Ursula Von der Leyen, and President of the AU Commission Chairperson Moussa Faki Mahamat. Source: Image courtesy of Etienne Ansotte, European Union, 2019, via EC – Audiovisual Service.*

1.1.3: 2000-2022: TOWARDS A JOINT STRATEGIC EU - AFRICA PARTNERSHIP

The 1990s and the 2000s also saw the European space program's clear-cut success regarding the commercial impact of Arianespace[10] and its cornerstone missions and science programs. Additionally, Europe successfully participated in the construction of the ISS, mainly with its Columbus laboratory (ESA 2014a). The European space program throughout" the 2000s - 2010s also adapted the Soyuz launcher to follow European safety norms and the technical parameters of the Kourou site. So Soyuz has served as the European medium launcher since 2011. The ESA also constructed Vega mainly through Italian industrial and research capacity as a light launcher in 2012" (Doboš, 2019, p.102). ESA's experience with pilot projects has shown that "space-based systems can provide powerful tools for supporting Africa in reaching its development objectives. However, due to budgetary constraints, ESA's activities are limited in its technical support for implementing the EU policy vis à vis Africa" (ESA/IRC, 2007, p.9).

[10] Ariane is a continuation of the European launcher program and turned out to be very reliable and economically viable as were its predecessors. Its main economic advantage as a heavy booster launcher is that it can launch two heavy satellites to GEO at once. See: 3AF Strategy and International Affairs Commission 2008, p. 106.

Furthermore, the new strategy for Africa, adopted by European Union leaders in December 2005, whose objective is to "promote the achievement of the UN Millenium Development Goals (MDGs) in Africa, gave rise to many initiatives. The activities carried out by ESA in Africa contribute to the response, directly targeting the MDGs and improving interconnections to support the continent's economic development. The TIGER initiative launched in 2002, aimed to assist African countries in overcoming problems in collecting, analyzing, and disseminating water-related information by exploiting the advantages of Earth Observation (EO) and other space technologies. The initiative has benefitted from the association of the space and water resources related programs of UNESCO, UNECA, and Canada Space Agency. A 2005 -2007 plan was subsequently developed for the first phase and implemented with 50 research projects submitted by African research teams selected by ESA, currently receiving free EO data and training. The ESA also co-finances development and demonstration projects for an aggregated investment of more than € 6 million, focusing on specific needs and demands expressed by more than 20 different representatives of the African water sector[11].

As further stated by the ESA's International Relations Committee (IRC), "the effective implementation of the TIGER initiative in Africa and the achievement of its long-term objectives strongly depends not only on the potential of EO technology to provide accurate and timely water -related information but on several human, institutional, and technical factors that go beyond Earth Observation" (ESA/IRC, 2007, p.4).

The first attempt to give a new strategic dimension to the global partnership between the two regions was at the E.U. – Africa Summit held in Cairo in 2000. As argued by J. Mangala, the framework adopted in Cairo was timid, considering the stated ambition to elevate the relationship to a strategic level, and more importantly, it lacked a credible operational structure (Mangala, 2013). The relationship took a new turn under the British Presidency of the E.U. in 2007. Under Prime Minister Tony Blair, the Commission's recommendation report in fields such as Economy, Security, and Education, established as priorities in response to some of the needs of Africa, were incorporated into the Resolutions of the G8 Summit held in Gleneagles – Scotland- with the recommendation for a massive doubling of international aid to 50 billion dollars by 2010 (Adebajo, Whiteman, 2013). During his tenure at the E.U. presidency, Blair was concerned about

[11] See: https://www.tiger.esa.int/ . Last accessed 09 November 2023

Africa. He elaborated a new strategy for Africa entitled "*The E.U. and Africa: Towards a Strategic Partnership to Develop a Comprehensive, Integrated and Extended Term Framework for Guiding Europe's Relations with Africa*[12]*."*

Meanwhile, in 2007, the Cotonou agreement saw the fragmenting of Africa, the Caribbean, and the Pacific (ACP) unity in the Economic Partnership Agreement (EPA). Discussions on the new Economic Partnership Agreements (EPA) between Europe and different African regions were thriving, preparing the way for a relationship focusing more on reciprocity in African and European commitments (Cherry et al. 2018).

According to the EU Commission (2007), "the end of the agreement is the opportunity to rejuvenate the EU's relationship with its ACP partners, considering the current global context. Since the 1950s, Africa has undergone significant institutional, economic, and political transformations that, in recent years, "*have diminished the prevailing Afro-pessimism that prevailed after the post-Cold War era.*" The establishment of the African Union (AU) in 2002 and the New Partnership for Africa's Development (NEPAD) are some examples of how Africa's institutional capacity and its position at the international level have increased positively and significantly (Iftode 2012).

Furthermore, a wide range of reforms at the domestic level undertaken by various governments has improved the economic outlook for the continent. Since 2002, Africa's annual economic growth rate has averaged four percent. African economies, however, remain resilient amid multiple shocks. These shocks have reduced the continent's GDP growth from 4.8 percent in 2021 to 3.8 percent in 2022. However, African economies remain resilient, with average growth projected to stabilize at 4.1 percent in 2023–24 (African Development Bank 2023).

The second Summit, held in the second half of 2007 under the Portuguese Presidency, sought to overcome the traditional door-recipient relationship that has often guided European interventions in its former colonies. That year also saw the signing of the Treaty of the European Union, also known as the Treaty of Lisbon, where the Africa–EU STI partnership is included among the treaty's articles to strengthen the EU's scientific and technological bases towards a European Research Area. The Summit outlined the policy

[12] European Union Committee (2006), *The EU and Africa: Towards a Strategic Partnership*. Vol.1 – report. authority pf the House of Lords, London - HL Paper 206-I. available at https://publications.parliament.uk/pa/ld200506/ldselect/ldeucom/206/206i.pdf . Last accessed 23 September 2023

and governance framework for the joint strategic partnership and envisaged a shared vision of principles, objectives, and priorities (European Commission 2007).

The action plan underlined in the second Summit in Lisbon initiated the cooperation between Africa and the EU on the utilization of EO systems to respond to global challenges in managing the environment, mitigating climate change, and a partnership to confirm the commitment to avail European infrastructure and facilities, under the Copernicus program to Africa, Caribbean, and Pacific (ACP) countries. Since then, the collaboration has resulted in long-term programs such as the Global Monitoring for Environment and Security, Africa-GMES, AFRICA, and AU-EU Space Earth Observation.[13]

In May 2007, the European Space Policy was adopted by the EU and the ESA Council and provided in chapter 6.3 ("international Relations"),

"*Europe will assess opportunities for cooperation according to their contribution to EU external policies, particularly sustainable development, cooperation with developed countries, stability and humanitarian aid, with particular focus on Africa and the European neighborhood."* The strategy of the Agency underlines the importance that all space-related activities find the basis in sound cooperation between Europe and Africa*"* (ESA/IRC, 2007 p.3).

Among the fundamental commitments of the EU – Africa Strategy was the attainment of the Millennium Development Goals (MDGs) by 2015, strengthening investments, growth, and prosperity through Regional Integration, and promoting good governance and human rights. Various actors within the EU and AU were engaged within these priority outlines, including the EU-AU Commissions, EU-AU ministerial councils, Parliament, and Civil society organizations. (Whiteman, Nagar 2009).

According to Mangala (2013), adopting the Joint Africa-EU Strategy (JAES) and its first action Plan at the Lisbon Summit represented a significant moment in the historical relations between the E.U. and Africa. This, he argued, is due to the recognition by the E.U. of Africa's growing importance in the global arena. The demand for Africa's energy and other natural resources by China, India, Brazil, and other emerging countries is increasing, and they are turning to Africa to meet their energy and mineral resource needs.

[13] See: (https://au.int/GMESAfrica/background. An initiative to confirm the commitment to avail European infrastructure and facilities under the Copernicus program to Africa. Last accessed: 02 October 2023.

In particular, the harsh competition pursued by these emerging economies has emerged as a game changer. China – Africa trade since 2000 has doubled in nominal terms every three years, whereas Europe's trade with Africa has declined in the last two decades. In 2009, China surpassed the United States to become Africa's largest trade partner (Mangala 2010). Furthermore, social and demographic factors contribute to a shift to a strategic view of Africa. The continent hosts a growing young population – a trend contrasting with most E.U. countries. By 2050, Africa's share of the global population will exceed that of China or India. The JAES, according to Mangala, represents an attempt to reinvent the relationship considering the changing environment outlined above. Operationally, they represent an attempt to respond to some of the challenges in this dissertation and to overcome one of the major criticisms of E.U.–Africa relations, which is the existence of fragmented frameworks coupled with the lack of policy coherence and coordination (Mangala 2013).

Ursula Von de Leyen expressed this willingness to implement a new strategic partnership during her first official visit as the President of the E.U. Commission at the African Union (AU) headquarters in 2019.

"*It has been less than a week since the European Commission took office. And here I am, in the heart of the African continent. I have chosen Africa for my very first visit outside of Europe. I hope my presence at the African Union can send a strong political message because the African continent and the African Union matter to the European Union and the European Commission. For my first visit, I have chosen the continent hosting the world's fastest-growing economies—a continent with immense ambition and aspirations but also with vast needs. And I have chosen the African Union's headquarters – the home of all African people, from Cairo to the Cape. For us, for the European Union, you are more than just a neighbor. Both our Unions are. Both our Unions are built on a dream – a dream of peace and a dream of economic prosperity in our continents*[14]*. Therefore, it is of utmost importance that – I also think that our founders – both in Africa and Europe – knew that only unity could make our continents strong in a changing world. The African Union is a partner I count on, and I look forward to working within the spirit of a true partnership of equals" (*European Commission 2019).

[14] https://www.politico.eu/article/into-africa-von-der-leyen-visit-kicks-off-geopolitical-commission/ - Last accessed 02 October 2023.

A year later, she further underlined, in a statement of 9 March 2020, "*Both continents can build a more prosperous, more peaceful and more sustainable future for all*." This vision for future Africa –EU is represented in the joint communication document "*Towards a Comprehensive Strategy with Africa and Supported by the Council Decisions,*" which also outlines the partnership for Space cooperation[15]. Europe's role as a historical provider of space-based technologies and services to Africa, European efforts to provide Africa with information and data products from Earth observation platforms, and perhaps ambitions to safeguard and expand this role further cemented the inclusion of Space in this framework.

The high-level forum Summit held in Lisbon by the Portuguese Presidency of the Council in 2021 recommended the closer integration of observations from Space with data from other sectors and complete socio-economic value chains re-enforcing links with the private sector. The inclusion of Science and Technology in the Joint Africa -EU Strategy (JAES), in part, reflected the global consensus at that time that capacity in Science and Technology(S&T) was essential to economic competitiveness, sustainable development, and poverty reduction (Cherry et al. 2018).

The policy context informed the inclusion of Science, Technology, and Information (STI) in the joint strategy focused on narrowing the digital divide between the two continents. The World Summit on Sustainable Development, held in 2002 in Johannesburg, South Africa, recognized in its implementation plan that Science can be an instrument for development. In this sense, the ACP Group of States and the EU convened a dedicated forum on research for sustainable development to consider appropriate investments from the EDF to build STI capacity in ACP countries." This theme would subsequently receive regular consideration under the JAES (Cherry et al. 2018).

The emergence in 2006–2007 of Africa's Science and Technology Consolidated Plan of Action can also be seen, in the broader context, as another component of this global consensus, giving practical issue to Africa's high-level objective of building strong S&T constituencies for socio-economic transformation (Cherry et al. 2018).

The kick-off meeting in Entebbe, Uganda, in 2008 brought together the network of 18 partner organizations, mainly national science authorities and universities from across

[15] See: https://www.europarl.europa.eu/legislative-train/theme-a-stronger-europe-in-the-world/file-towards-a-comprehensive-strategy-with-africa. Last accessed: 02 October 2023.

Africa and Europe. It began a long-term Africa–Europe partnership, forging new working relationships and exploring new ideas[16].

After five years, CAAST-Net gave way at the end of 2012 to CAASTNet Plus with an expanded consortium of 25 partners, still mainly national science authorities, collectively pursuing the same purpose, particularly concerning the global societal challenges of climate change, food security, and health. More closely aligned to the interests and needs of a formal Africa–EU partnership in science, technology, and innovation (STI), the new project also offered a platform for stakeholders to share opinions and experiences of Africa–Europe collaboration with the partnership's governance structure, the EU–Africa high-level policy dialogue (HLPD) on STI[17]. For an entire decade (2008–2017), the CAAST-Net and CAAST-Net Plus projects became bywords for Africa–Europe collaboration, reinforcing the landscape, bringing together research and policy actors from the two regions to engage on topics of mutual interest and to conduct analytical work to advance the practice of cooperation (Cherry et al.2018).

The convening in Abidjan during November 2017 of the fifth Africa–EU Summit of Heads of State and Government provides an appropriate moment to reflect on the achievements of bi-regional cooperation between Africa and Europe in Science, Technology, and Innovation (STI) over the past decade (*Ibidem*)[18].

In Abidjan, at the 2017 Summit of Heads of State and Government, Africa and Europe will recommit to the JAES and the bi-regional STI partnership it includes. It is opportune to ask if the drivers, which informed cooperation in 2007, still apply and how they may have evolved. Profound economic, political, environmental, and social changes in Africa and Europe, alongside the international agreements and frameworks responding to these changes, such as the United Nations 2030 Agenda, provide a rapidly evolving context for Africa–EU relations, for the JAES and the cross-cutting STI partnership. Africa and Europe certainly have much to gain from increased political and economic ties (European Commission 2017; Cherry et al. 2018).

[16] See: CAAST Net Plus Was a consortium of 25 African and European-based public research, funding and policy making organisations focused on how to strengthen cooperation on science, technology and innovation as a means to tackle key global challenges, including climate change – available at : https://unepccc.org/project/caast-net-plus/. Last accessed 02 October 2023.

[17] . "Africa-Europe Research and Innovation Cooperation: Global Challenges, Bi-regional Responses." 2018, https://doi.org/10.1007/978-3-319-69929-5.

[18] See also: https://cordis.europa.eu/project/id/311806. Last accessed: 02 October 2023.

The STI partnership between Africa and Europe, in this sense, cannot be considered in isolation from more comprehensive political relations between the two regions, given the dominant role of the institutions of the African Union (AU) and the EU (and, to some extent, their member states) in promoting this cooperation (Cherry et al. 2018). As further argued by the authors, although not an explicit driver at the outset, over time, both the African and European sides saw, in the inclusion of STI in the JAES framework, potential for science diplomacy: the STI partnership reinforcing the bi-regional relationship via influence in other policy spheres. This contribution would include safeguarding and expanding a historic trading partnership, although as the complex EPA negotiations in years to come would show, the two sides would harbor different ambitions, with Africa, for example, seeking greater access to the European agricultural market, and with Europe seeking to expand its presence in the African services sector (*Ibidem*).

For example, the global security context and Africa's role as a partner for Europe in the space sector were also seen as potential beneficiary spheres, at least from the European side, from investment in bi-regional STI cooperation. Given the strategic significance and continued dominance of development cooperation as the focus of Africa–EU relations, the African and European sides also harbored ambitions for the bi-regional STI partnership to influence this domain.

From an African perspective, there was a strong demand for the partnership to contribute to STI capacity building on the continent. While shared by the European side, the perspective was perhaps nuanced by a desire to see a new dimension added to the historic Africa–EU development cooperation relationship that would ensure greater efficiency and deliver a more significant impact (*Ibidem*).

As part of the portfolio of science diplomacy objectives, it was also foreseen that the bi-regional STI partnership would contribute to strengthening the AU–EU institutional partnership. As with capacity building, the institutional partnership objective was shared by both sides, perhaps from slightly different perspectives. From a political angle, the EC could leverage STI cooperation to develop a privileged relationship with the new AUC. At the same time, the partnership with the EU also provided the AU with opportunities to build its influence within the continental STI landscape (Cherry, du Toit 2018).

The last EU – AU Commission to Commission meeting in Ethiopia in 2020 enhanced a renewed partnership cooperation with Africa on sustainable and inclusive development. The document "Towards a Strategic Cooperation with Africa" (European Commission

2020), prepared and announced by the Commission, proposes five thematic areas of cooperation:

(1) *"A partnership for green transition and energy access; (2) a partnership for digital transformation; (3) a partnership for sustainable growth and jobs; (4) a partnership for peace and governance; and (5) a partnership 'to ensure a balanced, coherent, and comprehensive approach to migration and mobility".*

(2) *The proposed strategy also features a transversal action to strengthen multilateralism in deepening the EU-Africa alliance in international fora. (*EUR - LEX -Europa*)*[19]

Space data and technology were also part of the comprehensive strategy. In December 2020, the EU and the AU signed a Memorandum of Understanding (MoU) to strengthen regional space cooperation. The MoU defined a framework for cooperation on many aspects of the space sector, including space policy and governance, research and innovation, Earth observation, climate change, and disaster management.

In its 30 June 2020 conclusions, the Council approved the joint communication as 'an excellent basis for initiating a new ambitious partnership with Africa.' (European Commission 2020). On the proposed strategy, the European Parliament adopted its Resolution on 21 March 2021. The Resolution highlights "*the need to adapt the partnership in the light of coronavirus impacts, which risk widening inequalities, increasing food insecurity and poverty, and aggravating insecurity in Africa. It calls for closer cooperation in key areas, such as security, agriculture, and health, to better anticipate future health crises. It insists that the future relationship must move away from a donor-recipient dynamic and give African countries the means to achieve sustainable development through fair and ethical trade*" (*Ibidem).*

The Resolution further states that the EP regrets that the migration issue has dominated EU-Africa relations. It suggests that a renewed partnership helps devise a fair migration policy, tackling the root causes of migration and better delivering an effective visa and legal migration policy. The partnership should support the increased mobilization of domestic resources in Africa, notably through the fight against corruption and tax evasion (*Ibidem*).

[19] See: EUR-Lex. https://eur-lex.europa.eu/. Last accessed 02 October 2023.

The Resolution highlighted the need for a new budgetary instrument for external action to dedicate adequate resources, notably to climate objectives. It points out that many Member States have yet to reach the 0.7 % gross national income (GNI) target for Official Development Assistance (ODA) and that some have even decreased their ODA (EPRS 2022).

At the last EU-AU Summit, which took place in Brussels on the 21 and 22 of February 2022, the Head of State and Government of the Member States of the African Union (AU) and the European Union committed to a joint Vision for 2030 and an EU pledge of 150 billion for 2021 – 2027 that will support the common ambition for 2030 and AU Agenda 2063 [20].

The briefing document by the EP, published in February 2022, updated the EU's approach to a new partnership with Africa, stating that "*they still have to find common ground on migration, security management, and fundamental values."*[21] The gaps and overlaps of the current variable-geometry partnerships challenge the comprehensiveness of the proposed strategy[22]. "*The coronavirus outbreak delayed the adoption of a common strategy. At the same time, it highlighted the need to strengthen the links between the two continents to tackle the most urgent global issues. Measures to fight the current pandemic and to prevent future ones have reframed the priorities and will give new impetus to partnerships in areas such as health, the fight against climate change, and promoting digital transformation*" (EPRS 2022b).

As underlined by the Commission's Joint Communication with the EU Parliament and the Council, the African continent's economic expansion has the potential to accelerate and drive broader social and human development with new opportunities arising from the digital transformation, the demographic dividend, low-cost renewable energy, the green transition and a low-carbon, blue and circular economy (European Commission 2020).

The STI partnership has enjoyed substantial acclaim over the ten years of its bi-regional relationship, and it is considered a flagship of the cooperation in terms of political impact in strengthening inter-institutional cooperation between the AUC and the EC. STI

[20] See: https://www.consilium.europa.eu/media/54412/final_declaration-en.pdf. Last accessed: 02 October 2023.

[21] See: https://epthinktank.eu/2022/02/17/understanding-the-eus-approach-to-a-new-partnership-with-africa/ - Last accessed 02 October 2023.

[22]See:https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698905. Last accessed: 02 October 2023.

cooperation during JAES has served Africa's human capital development and other capacity-building objectives well, with a range of student training and mobility programs launched under the Erasmus and ACP instruments. The bi-regional partnership has also seen valued investment in developing Africa's high-speed research networking capacity, a critical research infrastructure requirement.

The ten-year course of the JAES science partnership has accumulated an “expansive portfolio of associated African–EU cooperation initiatives “around scientific and technological research and innovation (R&I), particularly with a development focus” (Cherry et al. 2018, p.26). At the same time, however, the additional bi-regional cooperation opportunities “afforded to Africa by the Tokyo International Conference for Africa's Development or by the Forum on China–Africa Cooperation (FOCAC) adjust Africa's perspective on JAES. Indeed, China is a dominant trade and investment partner for Africa, and a more substantial analysis might consider how the STI component of JAES compares to that of the FOCAC” (Ibidem, p.16).

In a world where multilateralism and solidarity are precious commodities, Africa–Europe bi-regional cooperation continues to matter “because of its cross-cutting impact and strategic significance should play an ever more central role in this broad political relationship. Africa and Europe should aim to harness this potential, to advance cooperation, is required, as provided for the bi-regional partnership” (Ibidem, p.18).

1.2: 2013: TOWARDS AU AGENDA 2063: DEVELOPMENT CHALLENGES AND THE AFRICAN SPACE POLICY AND STRATEGY

Where is Africa, and what has the African Union (AU) done so far in the race to utilize space for development is discussed in this section. The African Union Agenda 2063 and one of its key programs, Africa Outer Space, are presented. Also, the chapter will briefly discuss some significant development challenges facing the continent and its institutions.

1.2.1: AFRICA DEVELOPMENT CHALLENGES

This literature review analyzes and considers academic work on some of Africa's significant development challenges and the efforts of the African Union in obtaining inclusive and sustainable development through Agenda 2063, Its Master plan for transforming the continent's future as a global player by 2063. As I am elaborating on this dissertation, the live count of the African population provided by Worldometer [23] is over 1 billion 460 million people. The current population of Africa is 1,477,556 79 as of 14 September 2023, estimates.

According to the United Nations Economic Commission for Africa (UNECA), the population of Africa increased from 478 million in 1980 to about 1.2 billion in 2016, and it is projected to reach 2.5 billion by 2050. The countries that experienced significant population growth were Nigeria, South Africa, Ethiopia, Kenya, Egypt, and Algeria, among others (UNECA, 2016).

1. Estimated mid-year population by major area and region, 2020 and 2021

	Population (in thousands)	
	2020	2021
WORLD	7 840 953	7 909 295
AFRICA	1 360 677	1 393 676
Eastern Africa	449 292	461 142
Middle Africa	184 570	190 268
Northern Africa	251 418	255 738
Southern Africa	67 272	67 985
Western Africa	408 125	418 544

Table 1-1 *The population estimates for 2020 -2021 for the world and the United Nations Population Division produces Africa. Source: ttps://unstats.un.org/unsd/demographicsocial/products/vitstats/sets/Series_A_2023.pdf.*

Africa is three times the size of Europe. Home to 54 sovereign states, it is one of the world's fastest-growing middle classes and economies. The African Union (AU) is the most important organization on the continent, including all 54 countries. It comprises eight Intergovernmental Regional Economic Cooperation Organizations (RECs), constituting the "building blocks" of the Union. "The RECs are thus key organs of the AU. They are the Arab Maghreb Union (UMA), the Common Market for Eastern and Southern Africa (COMESA), the Community of Sahel-Saharan States (CEN-SAD), the East African Community (EAC), the Economic Community of Central African States

[23] See: https://www.worldometers.info/world-population/africa-population/. Last accessed: 14 September 2023.

(ECCAS), the Economic Community of West African States (ECOWAS), the Intergovernmental Authority on Development (IGAD), and the Southern African Development Community (SADC)" (Froehlich, Siebrits, 2019, p. 10).

At least each of these RECs has a national space agency. Thus, "since they are, in effect, the implementing arm of the African Union" and the building blocks of its economic integration, building a broader continental "appetite" for space collaboration and integration through the RECs" seems a road the Union must consider (Ibidem, p.12).

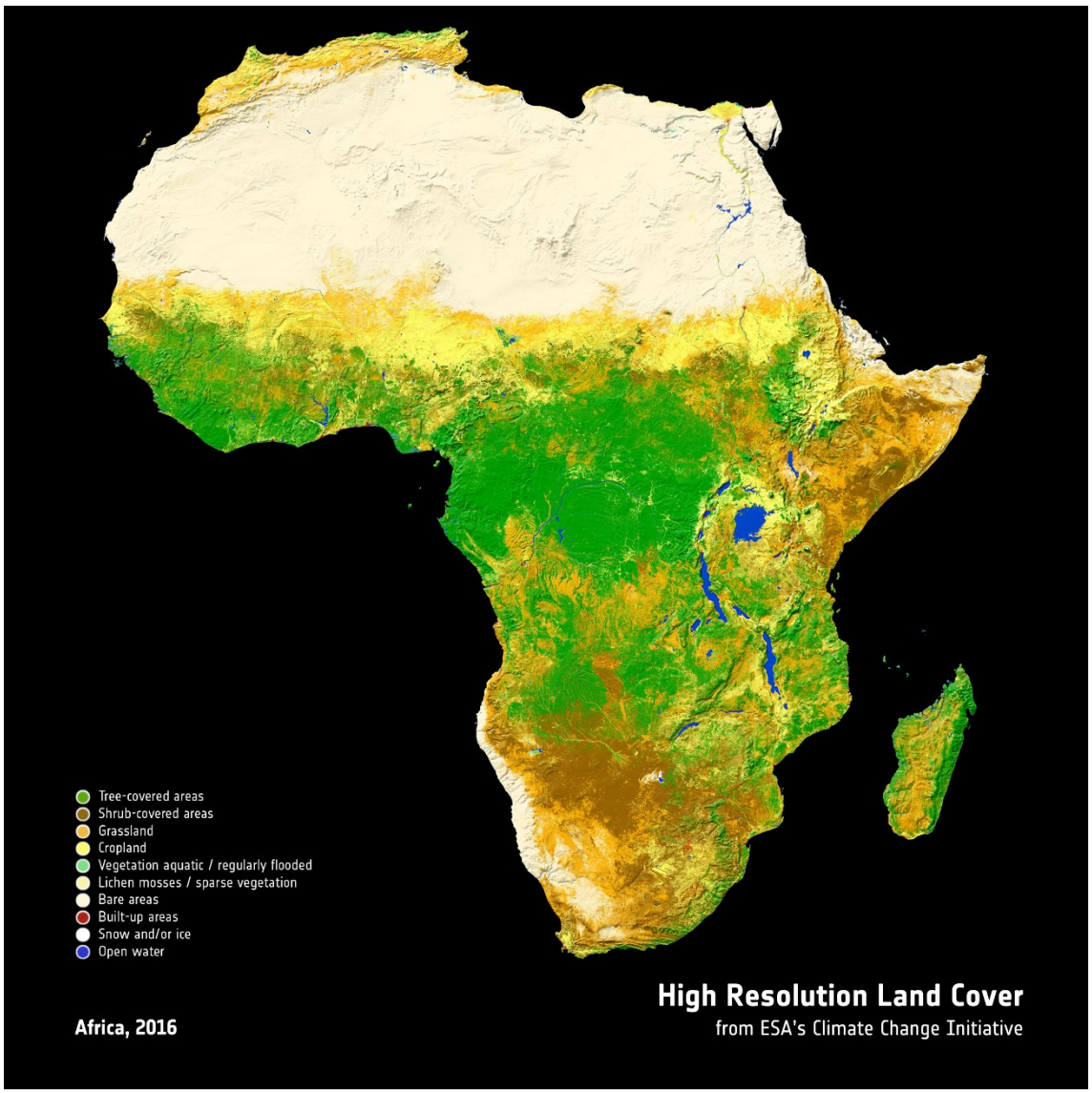


Figure 1-6: *depicts Africa's land coverage and highlights the natural environments across the continent. At 20 m resolution, this land cover classification map of Africa was created using 180,000 Copernicus Sentinel-2A images captured between December 2015 and December 2016. Land-cover mapping breaks down the different types of material on Earth's surface. This information is important for understanding changes in land use, modeling climate change extent and impacts, conserving biodiversity, and managing*

natural resources. Source: European Space Agency. https://www.esa.int/esearch?q=africa+and+europe+land+cover .

Despite its vast resources, the continent is still home to many poor. It hosts over 350 million people living below the poverty index, and almost thirty-six of the world's most fragile economies are in Africa.[24] Due to domestic and external shocks, the economic and social situation remains weak and vulnerable. "Investment remains subdued, limiting efforts to diversify economic structures and boost growth. Therefore, Sub-Saharan African countries face significant challenges: increasing growth, reducing poverty, and integrating themselves into the world economy (IMF, 2000).

"Despite noteworthy progress in governance and democratization across the continent, many political challenges still confront African countries and threaten socio-economic development and progress in sectors, including space. Many countries, such as Somalia, the Central African Republic, Burundi, and South Sudan, are still politically fragile" (Froehlich, Siebrits, 2019, p. 19).

According to Transparency International's 2023 Corruption Perceptions Index, on a scale of 0–100 (0 being highly corrupt and 100 being very clean), the best-performing country with the highest index of 89 was Danmark, with the worst, Somalia placing 180th with an index score of 9. The best-performing African countries were Botswana, Rwanda, Mauritius, and Namibia[25]. Less than ten African countries scored more than 50, meaning corruption remains a serious issue for African public opinion (CPI 2022).

[24] See: https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty-turning-corner-pandemic-2021 -last accessed 04 November 2023

[25]See: https://www.transparency.org/en/cpi/2022 . Last accessed 04 November 2023

Corruption Perceptions	World Economics Corruption Index (0-100)	World Economics Corruption Grade A-E
Botswana	66.7	B
Rwanda	56.7	B
Mauritius	55.6	B
Namibia	54.4	B
Benin	47.8	B
Ghana	47.8	C
Senegal	47.8	C
South Africa	47.8	C
Burkina Faso	46.7	C
Tunisia	44.4	C

Table 1-2 *shows the corruption perception index for the first ten African countries in 2022. Source: https://www.worldeconomics.com/Indicator-Data/Corruption/Corruption-Perceptions-Index.aspx.*

Much progress must still be made regarding the rule of law, civil rights, and the political process.

Several factors hinder economic development, including weak infrastructure, lack of productive capital, and low-value chain integration. Infrastructure is essential to Africa's development and growth and vastly insufficient to date: 43% electricity coverage, 43% access to an all-season road, 40% access to improved sanitation, etc.

The infrastructure investment need for sub-Saharan is estimated to have a financing gap of USD 93 bn per year by 2025, 1/3rd of which is dedicated to maintenance and 2/3rd to new constructions. (Africa Economic Outlook, 2018).

In terms of economic activities, the predominant sector is the tertiary sector. While much of African GDP is generated by services, most people are still employed and dependent on agriculture.

The main exports are, however, dominated by primary agricultural products (with mining, oil and petroleum, fish, and farming goods being the main exports of 50 states), with the accompanying vulnerability to unstable commodity prices.

The results of an empirical analysis of the factors affecting economic growth in sub-Saharan Africa by IMF staff affirms that ″economic growth rates are still not high enough

to make a real dent in the pervasive poverty and enable these countries to catch up with other developing nations. What is needed is a sustained and substantial increase in real per capita GDP growth rates in these countries, coupled with significant improvements in social conditions" (IMF, 2000).

GDP PPP Estimates:	2022 Estimate Billions, Int$	2030 Estimate Billions, Int$	Percentage Growth 2022-2030	World Economics Data Quality Rating (A-E)
Nigeria	$2,024	$2,089	22.6%	E
Egypt	$2,012	$2,086	38.2%	D
South Africa	$1,174	$1,176	13.4%	B
Algeria	$589	$605	18.5%	B
Ethiopia	$446	$473	82.1%	E
Morocco	$418	$430	37.5%	C
Angola	$393	$407	9.9%	E
Kenya	$390	$410	53.0%	C
Sudan	$326	$330	12.3%	E
Ghana	$290	$294	38.5%	C
Tanzania	$265	$278	54.0%	D

Table 1-3 *Africa GDP growth 2023 – source: https://www.worldeconomics.com/Indicator-Data*

An enduring theme of Africa's development is its unevenness. "Africa is a continent of immense diversity and presents enormous opportunities and potential. According to the World Bank's Country and Lending Groups classification, which purely considers gross national income (GNI) per capita, calculated using the World Bank's Atlas method, Of the 54 countries in Africa (excluding Western Sahara), only one—Seychelles—falls into the high-income category. Eight are upper-middle-income, 18 are lower-middle-income, and the remaining 27 fall into the low-income category" (Froehlich et al. 2019: 41).
The HDI reveals that human development is one of Africa's most significant challenges. According to the United Nations Human Development Program (UNDP), "The ongoing Covid-19 pandemic, having driven reversals in human development in almost every country, continues to spin off variants unpredictably. War in Ukraine and elsewhere has

created more human suffering. Record-breaking temperatures, fires, storms, and floods sound the alarm of planetary systems increasingly out of whack. Together, they are fuelling a global cost-living crisis, painting a picture of uncertain times and unsettled lives." UNDP, report 2021-2022.

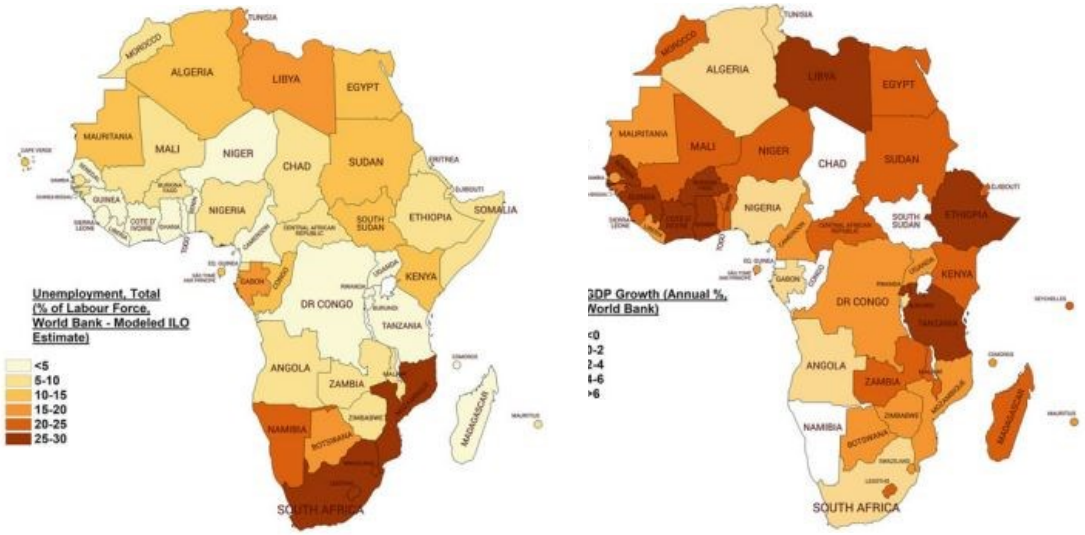


Figure 1-7 *Unemployment rate. Total of Labour force, and GDP Annual growth of Africa. Source: World Bank.*

The United Nations Human Development Index program (HDI), a summary measure of average achievement in key dimensions of human development, also provides insight into the development and well-being of the African population. According to the latest report, No African country ranks above the first fifty countries. The Seychelles has the highest African rank of 63rd out of 188 countries, followed by Mauritius at 64th. Fourteen states fall into the medium human development category. All remaining 36 countries are characterized by low human development. UNDP (Human Development Report 2021 – 2022).

Poverty-related causes, conflicts, and governance issues also challenge the Region's growth. As with many parts of the world, the continent also faces the consequences of climate change and environmental degradation. “The immense diversity in linguistic, cultural, and political arenas, as well as the significant differences in technological capabilities and economic and industrial levels between countries, are also challenges facing the continent” (Froehlich et al. 2019, p.8).

Concerning governance, challenges revolve around issues of a democratic process, institutional capacity, and accountability. Many Researchers and policy analysts argue that weak institutions, corruption, and lack of accountability contribute to Africa's governance challenges. These challenges are particularly evident in the conflicts, instability, and human rights abuses that plague the continent. One study notes the need for governance structures that are participatory, inclusive, accountable, and transparent if the continent is to become peaceful and prosperous (Ayeni & Mabvurira, 2019).

The challenges to social justice include inequality, poverty, and discrimination. These challenges are often interconnected and can further exacerbate the continent's governance and economic development challenges. Due to social justice challenges, significant barriers to accessing basic needs like Education, health, and infrastructure remain. Researchers argue that addressing social justice challenges such as poverty, inequality, and discrimination requires concerted efforts by governments, international organizations, civil society, and other stakeholders across the continent (Ekeanyanwu & Ndukwe, 2019). For an insight into inequality, the World Bank Gini data indicates a broad Gini spectrum in Africa, with Algeria being the most equal country and South Africa among the most unequal. Greater inequality has also been associated with increased crime rates and greater political inequality, where a small, wealthy minority wields disproportionate political power.

Peace and security are other political arenas where many challenges remain. Seven of the UN's current 14 peacekeeping operations are active in Africa (Froehlich et al. 2019).

Other significant challenges facing the continent are linked to security challenges. They include terrorism, organized crime, and transnational threats. These challenges pose significant threats to regional and global security and can undermine economic and social development. The Region has been the scene of many internal conflicts since the early 1990s, with complex origins and complex issues at stake (OECD, 2012).

Some researchers argue that these conflicts persist because governments have difficulty imposing their authority on the countries they are responsible for.

External factors contributing to regional instability should also be remembered, especially foreign interference. Africa is rich in natural resources such as oil, gas, iron, phosphate, copper, tin, and uranium, coveted by the Western powers and China, who are confronting each other more and more openly for control over these resources. Foreign countries do not hesitate to manipulate local players to secure their influence in the region, to exploit

these natural riches, or to prevent others from getting their hands on them. These external rivalries do much to fuel local conflicts (OECD 2012).

One study argues that addressing Africa's security challenges requires sustained cooperation among the affected countries, international organizations such as the African Union and the United Nations, and regional stakeholders (Shinn & Minter, 2018).

Figures

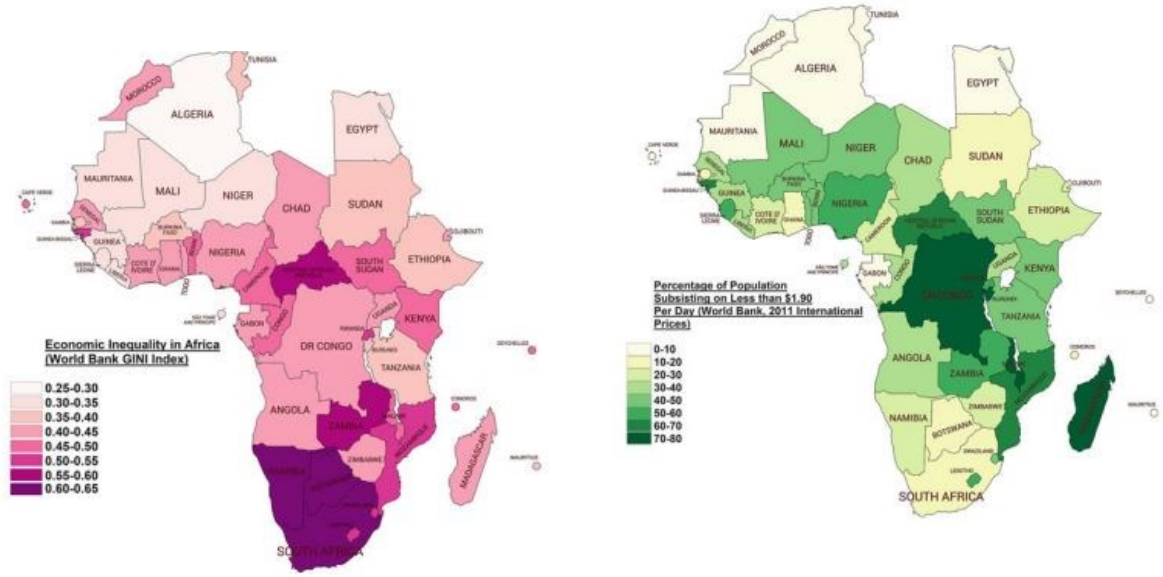


Figure 1-8 *Economic Inequality in Africa. Percentage of the Population subsisting on less than $ 1.90. Source World Bank.*

1.2.2: THE AGENDA 2063 AND THE OUTER SPACE PROGRAM

While socio-economic and political challenges remain relevant on the continent's agenda. Although arguably passive, its leaders have slowly been active in facing the challenge therein. One of the core concepts used to express Africa's hope for the future and a driver of change is that of an "*African Renaissance*," which aims to build a golden age of Africa's social, economic, and political institutions creating through good governance and improved state-society relations by 2063.

The African Union (AU) Agenda 2063 is the core policy document on a continental level that will guide Africa towards a sustainable development future, in line with the United Nations Sustainable Development Goals (SDGs 2030) (Froehlich et al. 2019).

It encapsulates Africa's future aspirations and identifies key programs to boost its economic growth and development. Among these programs is the Africa Outer Space Strategy Program, which aims to strengthen Africa's use of space to bolster its development in agriculture, disaster management, remote sensing, climate forecasting, banking and finance, defense, and security.[26]

The agenda embodies Africa's aspiration for a better, sustainable future and identifies essential flagship programs to boost growth and development. It aims to achieve these objectives through a ten-year implementation period at continental, regional, and national levels (NEPAD 2022). The top ten issues in Agenda 2063 are women, peace, youth, technology, trade, gender, education, governance, infrastructure, and inclusiveness.

Among the identified 12 flagship programs is the Africa Outer Space Program, which aims to strengthen Space's use to reinforce development in all fields, including climate, agriculture, disaster management, banking and finance, defense, and security, and to address the specific challenges and needs of African nations. [27]

*"*It encapsulates the recognition that African development is critically dependent on outer Space and space technology. Moreover, it contends that space technology products are no longer a matter of luxury; access to space technology and products must be sped up. Satellite technology is more accessible than ever to African countries" (Froehlich, Siebrits,2019, p.35).

[26]See: https://au.int/en/agenda2063/flagship-projects. Last accessed: 05 October 2023.
[27] See: https://au.int/en/agenda2063/overview. Last accessed: 19 March 2023

The Program refers to the collective efforts of African countries to develop their capabilities in space exploration, satellite technology, and applications of space science and technology for socio-economic development.

The space strategy was built on five core principles.

(1) "development of the services and products required to respond effectively to the socio-economic needs of the continent."

(2) "development of the indigenous capacity to operate and maintain core space capabilities."

(3) "development of an industrial capability that can transform innovative ideas from research and development into the public and commercial sectors";

(4) coordination of space activities across member states and regions to minimize duplication but maintain sufficient critical mass.

*(5) fostering international cooperation within Africa and the rest of the world to realize the space sector's entire value proposition"(*AUC, 2019*).*

Earth observation, Navigation and positioning, satellite communications, and space science are the four key space technologies and applications highlighted for their value to Africa's socio-economic development (Gairiseb 2020). The strategy also recognizes that to actualize these specific technical interventions, supporting programs such as Infrastructure, industrial involvement, and international partnerships are required, focusing on human capital and generating and promoting space awareness[28].

Over time, the African space program has evolved significantly. Historically, African countries have focused on basic satellite technology, remote sensing, and communication systems. However, there has been a noticeable shift towards more ambitious projects and collaborations in recent years.

One of the notable developments is the establishment of the African Union's African Space Policy and Strategy, adopted in 2016. This policy framework aims to guide African countries in developing their space programs, promoting regional cooperation, and leveraging space science and technology for various sectors such as agriculture, weather forecasting, telecommunication, and natural resources management. The Continental Space Agency headquarters is in Egypt (NEPAD 2022).

[28]See: https://archives.au.int/handle/123456789/9989 - Last accessed 04 November 2023. Last accessed: 23 October 2023.

The recognition by the AU of the importance of Space and the laying out of why Africa needs to take part in the space economy and what it needs to do to get there is so important. For this reason, adopting the African Space Policy and Strategy (ASPS) in 2016 by the African Union Heads of State and Government, drawn up by the African Union Working Group on Space, was such an important milestone for the space sector on the continent. The Science, Technology, and Innovation Strategy for Africa 2024 (STISA) was also encapsulated (Africa Union Commission 2014). Implementation of the first set of flagship programs under STISA occurred between 2015 and 2017.

The second set of flagship programs under STISA was implemented between 2018 and 2020.

As with the Agenda 2063, 10-year implementation plan, STISA-2024 is actualized on continental, regional, and national levels. At the continental level, the African Union Commission (AUC), NEPAD Agency, and their partners advocate and create awareness, mobilize necessary institutional, human, and financial resources, track progress, and monitor implementation; at the Regional level, the RECs and "regional research institutions, networks, and partners leverage the strategy in designing and coordinating initiatives"; and, at the national level, where STISA is incorporated within the development plans of the various African states[29].

What is, however, significant about STISA-2024 is that it recognizes space and space technology as critical to Africa's development. Specifically, it states, under priority area 4 *("Protection of our Space"*), that "Earth Observation and Monitoring of Africa's abundant natural resources, including minerals, and biodiversity (and associated indigenous knowledge), are essential for conserving the welfare of current and future generations. (Africa Union Commission 2014).

Furthermore, numerous African nations have launched satellites or are involved in regional satellite projects. For instance, South Africa successfully launched its first satellite, SunSat-1, in 1999. Since then, other countries such as Nigeria, Egypt, Ghana, Algeria, and Kenya have also launched their satellites.

Intra-African collaboration is another significant aspect of the evolution of the African space program. The African Union, through its African Space Agency initiative, aims to

[29] See: https://au.int/documents/20200625/science-technology-and-innovation-strategy-africa-2024. Last accessed 27 October 2023.

facilitate cooperation among African countries in the space sector. This kind of collaboration is a relatively new phenomenon due to the relatively recent establishment of African space agencies or government space offices, which are essential drivers for cooperation.

Additionally, regional organizations such as the "African Regional Centre for Space Science and Technology Education - (ARCSSTEE) and the Regional Centre for Training in Aerospace Surveys (RECTAS) have played crucial roles in capacity building and training.[30] Currently, 11 African countries are members of RECTAS—Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, and Senegal" (Idowu et al. 2012).

Many space collaboration initiatives have been started among African countries. Among these initiatives is RASCOM, the first pan-African space initiative, established in 1992. It focused on the African telecommunications arena, which involved 50 African countries. RASCOM's mission is to design, implement, operate, and maintain the space segment of the African telecommunications satellite system and translate into services and tools for African integration all the opportunities satellites provide by linking it, where necessary, with any other appropriate technology. [31]

The African Resource Management Satellite Constellation (ARMS-C) is a multilateral satellite project focused on African needs. This collaborative initiative between four countries—Algeria, Kenya, Nigeria, and South Africa—was initially conceived around 2003. The Nigerian contribution is NigeriaSat-2, launched in 2011, making it the first satellite in the African Resource Management (ARM) constellation. (Froehlich et al. 2019, p.107).

Another initiative is The African Leadership Conference (ALC) on Space Science and Technology for Sustainable Development, formally established in 2005 by the governments of Algeria, Kenya, Nigeria, and South Africa[32]. The goals of the ALC are to raise awareness among African leaders of the importance of space science and technology and provide a regular forum for information exchange among African countries regarding their space activities (*Ibidem*).

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[30] See: African Regional Institute for Geospatial Science and Technology: https://afrigist.org. Last accessed: 23 September 2023

[31] See: http://www.rascom.org/index.php?langue_id=2. Last accessed: 19 September 2023.

[32] See: Regional Centre for Mapping of Resources for Development, http://www.rcmrd.org/archives/380-rcmrd-attends-the-6th-afri can-leadership-conference-in-Egypt. Last accessed: 19 September 2023.

The Square Kilometre Array (SKA)[33] is another significant project that represents the goal of 12 member states and over 100 organizations from about 20 countries to build the world's largest radio telescope with an eventual collecting area of over one square kilometer. The SKA thus represents an international partnership both globally and within Africa, and while it promises to increase our knowledge on a range of topics, including insight into the formation and evolution of the first stars and galaxies after the Big Bang, the role of cosmic magnetism, the nature of gravity, and possibly even life beyond Earth, and lucrative opportunities for local industry (Labate et al. 2019).

One significant international project in Africa is Kenya's "*Luigi Broglio Space Centre"* (LBSC). The LBSC has been operated by Italy (initially through the San Marco Project Research Centre, CRSPM, and was managed by the University of Rome La Sapienza until the end of 2003, after that by the Italian Space Agency, (ASI) following renewable intergovernmental agreements with Kenya since the early 1960s. While Italy delineates the programs, supplies equipment, and hires local Kenyan employees, Kenya rents out the territory used by the LBSC to Italy. These agreements allow for launch activities, data acquisition from satellites, remote sensing, and training activities in Kenya and Italy (Gariseb, 2020).

"Twenty-seven launches, most of which were sounding rockets but nine of which were for satellites, were made between 1964 and 1988, with a 100% success rate for the nine satellites (four Italian, four American, and one British), including the notable NASA satellite named *Uhuru*, launched on Kenya's independence anniversary in 1970" (Floritsch, Siebrits, 2019, p.185).

The latest agreement was signed between Italy and Kenya in 2016, renewing the Luigi Broglio Space Centre Agreement, with the inclusion of five implementation protocols: "Support to the Kenyan National Space Agency, establishing a Regional Centre for the Observation of the Earth, access to Earth Observation Data and Scientific Data, Training and Educational Activities, and Telemedicine.[34]

The International Centre for Space Education in Africa is a recent initiative by the International Astronautical Federation, Kenya Ministry of Defense, and Italian Space

[33] See: https://www.eoportal.org/other-space-activities/ska-1. Last accessed: 23 September 2023.

[34] See: Agenzia Spaziale Italiana, "'Luigi Broglio' Space Center. https://www.esteri.it/en/sala_stampa/archivionotizie/approfondimenti/2016/10/diplomazia-e-hi-tech-italia-e-kenya-2/ -Last accessed 23 September 2023.

Agency to “prepare African students and trainees to become Africa’s space leaders and foster regional and international cooperation.” It is open to all African countries and aims to have its first space course by the end of 2018. It is based at Luigi Broglio Space Centre (LBSC) in Malindi” (Ibidem, p. 186).

While progress has been made, it's important to note that the African space program still faces several challenges. Some obstacles include limited financial resources, lack of infrastructure, and the brain drain of skilled personnel to other countries. Nonetheless, there is a growing recognition of the importance of space science and technology for Africa's development, and efforts are being made to address these challenges.

Figure 1-9 *Member states of the African Union Space Working Group. African Union, “The African Union Working Group on Space Meeting” Press release No 137/2013, August 26, 2013, https://au.int/sites/default/files/newsevents/pressreleases/27555-pr-pr_137-au_working_ group_on_space_meeting.pdf.*

Regarding Africa's overall expenditure on Space, costs are split between governments, private investors, and external actors, with roughly 62% of satellites fully funded by governments, as are most astronomical observatories, ground stations, and sounding

rocket launch sites (Froehlich et al. 2019, Oyewole 2017). Algeria, Egypt, Nigeria, and South Africa, which have the most advanced space programs on the continent, spend less than 1% of their GDP on R&D, with Africa having the lowest ratio of R&D to GDP in the world. (Abdulai, Abdul-Fatahi, et al. 2019).

In 2023, African countries allocated USD 425.01 million to fund space activities, representing a 14.96% and 18.77% decrease compared to the revised budgets of 2022 and 2021, respectively. The African space economy "is projected to grow by 16.16% to USD 22.64 billion by 2026."[35]

According to Euroconsult[36] data, Nigeria spent $61 million. More recent figures related to satellite spending are reported as follows: Ghana spent $500,000 on its first satellite in 2017, while "the government allocated GHC $38.5 million ($10 million) to nuclear and space science technology in 2015 as it aims to further space education and benefit from its satellite imagery"[37].

Kenya's satellite cost "about $1.2 million"; Nigeria "built capacities in satellite design and manufacturing spending over $500 million on satellite projects since 2003".[38]

1.3: 2000-2023: THE STATE OF THE ART OF EU – AFRICA SPACE

In the area of Space, DG DEFIS of the EU Commission[39] is leading the EU Space Program, "consisting mainly of the European Earth Observation (Copernicus), the European Global Navigation Satellite System (Galileo), the European Geostationary Navigation Overlay Service (EGNOS), the European Union Governmental Satellite Communications (GOVSATCOM)" and Space Situational Awareness (SSA)[40]. The

[35] See: New Space Africa Conference: https://www.satellitetoday.com/event/newspace-africa-conference-2/. Last accessed: 19 September 2023.

[36] See: https://www.euroconsult-ec.com/in-the-news/3/. Last accessed: 19 September 2023

[37] https://africanews.space/over-3-billion-have-been-spent-on-space-projects-in-africa-since-1998/

[38] Over $3 billion have been spent on space projects in Africa since 1998 - Space in Africa. See: https://africanews.space/over-3-billion-have-been-spent-on-space-projects-in-africa-since-1998. Last accessed: 19 September 2023.

[40] See also: https://www.euspa.europa.eu/about/about-euspa/partners. Last accessed: 02 October 2023.

Directorate-General for Defense, Industry, and Space reports to the Commissioner for Internal Market"[41].

The Space Program Regulation defines the roles and responsibilities of each partner. The European Union Agency for the Space Program (EUSPA)[42] "provides safe and secure European satellite navigation services, promotes the commercialization of Galileo, EGNOS, and Copernicus data and services, and coordinates the EU's forthcoming governmental satellite communications program, GOVSATCOM. EUSPA is responsible for the security accreditation of all the EU Space Program components"[43].

The European Space Agency (ESA) is an intergovernmental organization "with extensive expertise in the space domain that concluded a Framework Agreement with the European Community in 2004 ('2004 Framework Agreement')"[44]. The agency is the most important partner in implementing the European Space program. The European Space Agency (ESA) "is responsible for system design, procurement of the system infrastructure (Space and ground) and preparing the future evolutions of the system."[45]

The agency also provides technical support to developing African countries based on EGNOS technology and Galileo satellites for extended benefits for airports, airlines, and passengers.

The ESA also co-sponsors the Farming by Satellite contest, a competition for students and young people across Europe and Africa focused on using Galileo/EGNOS and Copernicus to improve agriculture and reduce its environmental impact., and a tandem of European and African scientists to exchange best practices and knowledge. These projects focus mainly on food and water security, including projects to monitor crop stress in arid and drought-prone regions to forecast crop yield and manage precious water resources. These are among the Case Studies presented in the second part of the dissertation.

Another significant program is the ESA's Science for Society program, which works with the African Union Commission on many research and development projects based on satellite data to develop innovative, open-source applications adapted to African-specific

[41] See: https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/defence-industry-and-space_en. And: https://commissioners.ec.europa.eu/thierry-breton_en. Last accessed: 02 October 2023.

[42] See: https://www.euspa.europa.eu/about/about-euspa/partners#. Last accessed: 02 October 2023

[43] See: https://www.4rfv.com/8R23WGL5FXS3/507/thales-alenia-space-wins-4year-maintenance-contract-for-europe39s-egnos-satellite-navigation-system.htm. Last accessed 02 October 2023

[44] See: https://www.euspa.europa.eu/about/about-euspa/partners. Last accessed 02 October 2023

[45] See note n.12.

challenges. These challenges are underlined in the Africa Union Agenda 2063[46] –Africa's blueprint and master plan for transforming Africa into a global powerhouse of the future is "to prioritize inclusive social and economic development, continental and regional integration, democratic governance, and peace and security, amongst other issues aimed at repositioning Africa to becoming a dominant player in the global arena [47]. The primary objectives for space development are broadly set as space exploration, economics, international cooperation, and inspiration for future generations (ESA 2014d, p. 7).

Thus, space sector cooperation is part of the broader EU-Africa Partnership, which outlines the areas of collaboration between the two regions.

The EU supports Africa through the African Union and Regional Economic Communities (REC), significantly shaping the African space sector. The cooperation includes supporting African countries' participation in global space programs, promoting the transfer of technology and knowledge-sharing, funding research and development, and supporting the development of space-related infrastructure, such as Earth observation systems. The EU also provided financial assistance to African countries under the African Space Program since 2010, the year it was launched, to promote the development of space activities in Africa, enhance African countries' capacity in the space sector, and support the implementation of the African Space Policy and Strategy adopted by the African Union in 2016.

The state of the art of the EU-Africa space program from 2000 to 2023 can be described as a period of active collaboration, with the objectives of promoting sustainable development, reducing the digital divide, and addressing various socio-economic challenges in Africa by applying space technology. The key developments have been in the Establishment of Cooperation Frameworks, as of 2007, where ESA and the EU signed an agreement to enhance collaboration in space activities, including Earth observation, satellite telecommunications, space science, and satellite navigation[48]. Also, the joint EU

[46] See: https://au.int/en/agenda2063/overview. Last accessed: 05 October 2023.

[47] See: https://thebftonline.com/2021/05/28/the-future-of-work-capsules-making-africa-resilient-to-create-more-jobs-post-covid-19/. Last accessed: 05 October 2023.

[48] See: European Space Agency. (2007). Cooperation Agreement between the European Space Agency and the African Union Commission. Available at: https://www.esa.int/About_Us/Business_with_ESA/How_to_do/Space_ESA_and_EU_sign_cooperation_agreement. Last accessed 23 October 2023

– Africa Strategic partnership was launched in the same year, emphasizing space as a priority to strengthen Africa's capacity and integration in the global space arena[49].

The Sentinel satellites, developed under the European Commission's Copernicus program, have provided Africa with free and open Earth Observation (EO) data, supporting various applications such as monitoring deforestation, desertification, agriculture, and water resources[50]. "The Copernicus Sentinels are a fleet of dedicated EU-owned satellites designed to deliver the wealth of data and imagery that are central to the European Union's Copernicus environmental program." The European Commission leads and coordinates this program "to improve the management of the environment, safeguarding lives every day. ESA oversees the space component and is responsible for developing the family of Copernicus Sentinel satellites on behalf of the European Union and ensuring the data flow for the Copernicus services". The operations of the Copernicus Sentinels have been entrusted to ESA and EUMETSAT[51].

The African Monitoring of the Environment for Sustainable Development (AMESD) program, implemented from 2006 to 2011, aimed to enhance African countries' capacity to utilize satellite data for environmental monitoring and natural resource management (Rooyen, 2011). The African Resource Management Satellites (ARMS) initiative, proposed in 2018, focuses on developing regional satellite communications systems to support various applications, including telemedicine, e-learning, and disaster management [52]

The *AfricaConnec*t project, funded by the European Commission, aimed to connect African research and education institutions to European research networks through dedicated high-capacity satellite links, thereby reducing the digital divide[53].

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[49] See: Joint Africa-EU Strategy. (2007). Joint Africa-EU Strategic Partnership - Action Plan 2011-2013. Available at: https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/EN/foraff/125769.pdf - last accessed 23 October 2023

[50] See: European Space Agency. (2021). Copernicus in Africa. Available at: https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_in_Africa - last accessed 23 October 2023.

[51]See: https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Space_for_Earth/Africa/(archive)/image . Last accessed: 05 October 2023.

[52] See: https://www.adaptation-undp.org/partners/african-monitoring-environment-sustainable-development-amesd. Last accessed: 23 October 2023.

[53] See: European Commission. (2022). EU External Actions – Africa Connect: A high-capacity Internet network for research and education in Africa. Available at: https://ec.europa.eu/europeaid/node/56268. Last accessed: 23 October 2023

In Space Science and Education, the European African Network for Earth System Science (Euro-AFRI-ESS) promotes collaboration between European and African research institutions in Earth system science, facilitating joint research and knowledge exchange. The Training Centre in Communication, developed through the African Leadership in Space and Astronomy project, aims to provide training and education in space science and technology to young African professionals.

Some significant space applications for socio-economic development have also been developed to foster solutions for sustainable development. Among these applications is the European Space Solutions for Sustainable Development in Africa (EU-ESF) program, launched in 2017, which supports African entrepreneurs and startups in developing innovative space-based applications to tackle development challenges, such as agriculture, healthcare, and urban planning and the EU-Africa High-Level Policy Dialogue on Science, Technology, and Innovation which aims to foster policy dialogues between the European Union and African countries to identify areas of cooperation and develop joint initiatives to exploit space technology for socio-economic development[54].

The European Commission, in addressing its space policy, sees outer space as an asset that helps the EU to pass some of its policy priorities. These include a push for a more profound and fairer internal market with a strengthened industrial base (European Commission 2015). Additionally, the EU understands the need for the development of the independent space program as an asset for the implementation of policies in areas that include jobs and industrial growth, the meeting of key challenges in industrial competitiveness, technological innovation, research, space security, space exploration, international cooperation, and investment in the future (European Commission 2016).

[54] See: UNESCO-IAU. (2017). African Leadership in Space and Astronomy (ALSAH). Available at: http://www.alsa.africa/. Last accessed 23 October 2023

1.3.1: 2013-2023: THE STATE OF THE ART OF THE AFRICA SPACE PROGRAM

To monitor and operationalize the goals and targets of Agenda 2063, the African Union Commission (AUC, 2015) prepared a ten-year implementation Plan to form the basis over the medium term for the preparation of development plans in the individual AU states, RECs, and AU organs. They serve to identify the goals and priority areas based on the current development situation on the continent; provide a vision or snapshot of what the continent will look like at the end of the ten years; provide outlines of the targets and indicative strategies, key process actions, and milestones on national, regional, and continental level; identify financing needs and implementation arrangements to ensure financing; provide recommendations on partnerships; provide for monitoring and evaluation; and identify key stakeholders and their roles and the principles to guide the stakeholders.

The first ten-year plan of Agenda 2063 – covers a period from 2013 to 2023 and includes all flagship programs. According to the last report, one of the most significant progresses in implementing the AU flagship projects was achieved with the operationalization of the African Continental Free Trade Area (AfCFTA). Currently, "54 AU Member States have signed the AfCFTA Agreement, 42 Member States have ratified it, and 39 have deposited their instruments of ratification"[55].

Progress is seen in implementing the Pan African E-Network, which aims to establish policies and strategies to create transformative e-applications and services in Africa. Further progress was also made in implementing the Single African Air Transport Market (SAATM), which aims to strengthen intra-regional connectivity between the capital cities of African countries and ensure the availability of a single unified air transport market in Africa. Thirty-five AU Member States, which constitute 89% of intra-Africa air traffic, have signed the solemn commitment to support the full operationalization. (NEPAD 2022).

The state of the art of the African space program varies between countries. Some nations have significantly progressed in developing their space capabilities, while others are still

[55] See: The African Union Agenda 2063 - The Ghana Report. https://www.theghanareport.com/the-african-union-agenda-2063/. Last accessed: 05 October 2023.

in the early stages. South Africa, Nigeria, and Egypt are among the more advanced countries in satellite technology and space-related ventures.

Nigeria has made substantial progress with its National Space Research and Development Agency (NASRDA) and has successfully launched multiple satellites, including NigeriaSat-1 and NigeriaSat-2. Nigeria's first communication satellite has been operational since 2011 and should deorbit after 2021. NASRDA has been actively involved in remote sensing, communication, and satellite technology development. (source). South Africa, for example, is home to the South African National Space Agency (SANSA), which coordinates the country's space activities. South Africa's EO-Sat1 should be launched in late 2021 or 2022. They have partnered with international space agencies, launched satellites, and are actively engaged in research and development in various space science and technology areas.

Similarly, Egypt has made notable advancements, researching and launching satellites like EgyptSat-1 and EgyptSat-2. They aim to expand their space capabilities further by promoting collaboration with international partners.

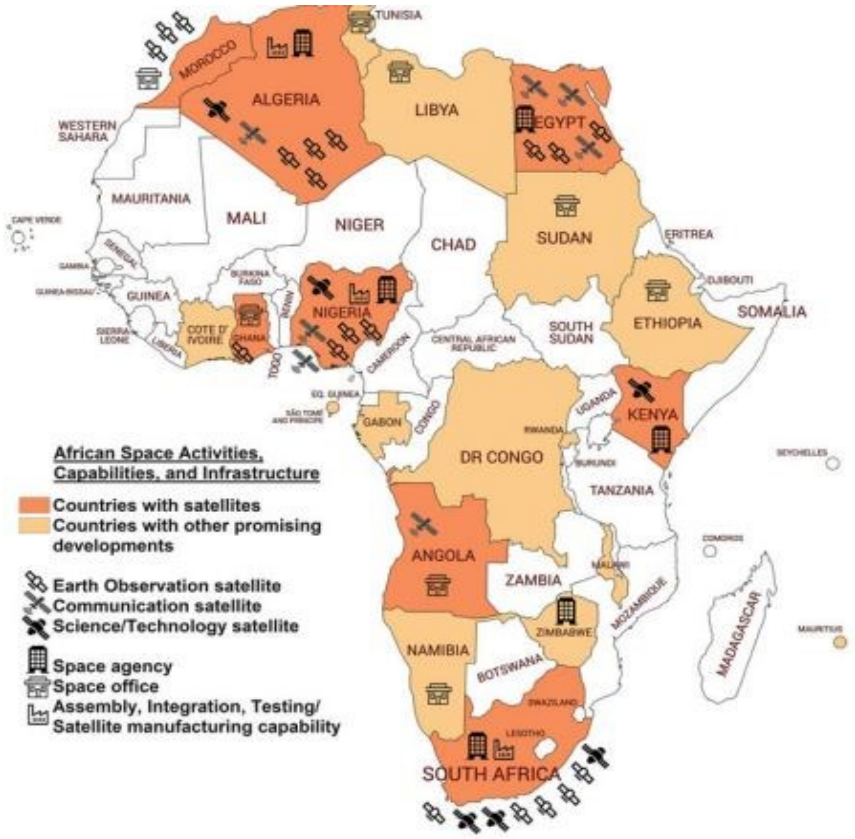

Figure 1-10 *provides the state of the art of the space capabilities of African countries. Source: Floriestch et al. 2019.*

In the second continental progress report (2022) on the implementation of Agenda 2063, prepared by the African Union Commission (AUC) and the African Union Development Agency-NEPAD (AUDANEPAD)[56], policy organs of the African Union were tasked to coordinate and prepare continental-level biennial performance reports to track progress made towards the goals and targets of Agenda 2063.

In the report, new developments in satellite technologies are foreseen to facilitate greater access to these technologies and products in African countries. (NEPAD, 2022). Furthermore, the structure and cost implication of the African Space Agency (AfSA) have been reviewed by the Permanent Representatives Committee (PRC) Sub-Committee on Structural Reforms. This is expected to lead to the adoption of the Africa Outer Space Strategy structure. The African Earth Observation (EO) system has been strengthened to improve the management of the environment through the Global Monitoring for the Environment and Security (GMES) & Africa program. Furthermore, a comprehensive study on the African Private Sector in Earth Observation, Geospatial, and allied technologies and a gap analysis study on Navigation and positioning were carried out to develop operational programs.[57]

The Challenges, however, as recognized by the African Union Development Agency, are due to delays in considering the structural and financial implications of the African Space Agency.

The foreseen future steps in the implementation of the flagship program are to mobilize resources for launching and implementing the African Space Agency and Support Member States, RECs, and other institutions to operationalize the African Space Agency, including capacity building in areas such as earth observation; satellite communication, Navigation and positioning, and space science and astronomy, as articulated in the African Space Policy and Strategy.[58]

Education and capacity building led to four portals to improve data access and knowledge management. An environmental scan has been done to identify the common or cross-cutting areas among the four space segments: Satellite Communication, Navigation and Positioning, Astronomy, and Space Sciences. Furthermore, mechanisms for synergies

[56] See: https://au.int/en/documents/20220210/second-continental-report-implementation-agenda-2063. Last accessed: 04 November 2023

[57] See: AfCFTA – AU WATCH. https://www.au-watch.org/afcfta. Last accessed: 04 November 2023

[58] See: https://www.nepad.org/agenda-2063/flagship-project/african-outer-space-programme. Last accessed: 04 November 2023

among the space segments have been proposed based on the findings of baseline studies. At least 2,000 people have been trained in Earth Observation, Satellite Communication, Navigation and Positioning, Space Science and Astronomy, and Space Regulatory Regimes. (NEPAD, 2022).

The continent still needs to structure a space agency or joint space programs at the continental level. Investments thus remain predominantly at the country level. However, in 2013, the African Union adopted the Africa Agenda 2063, where the Science, Technology, and Innovation Strategy for Africa (STISA) was defined to address development challenges. Acknowledging that Space could play a critical role, an African Outer Space program was initiated, followed by an African Space Policy, the African Space Strategy, and finally 2018, an African Space Agency (AfSA), with its headquarters in Egypt. The primary role of AfSA is to "*promote, advise and coordinate the implementation of programs and activities approved by the African Space Council*." (EU Global Space Report, 2022, p.21).

Among the intra-African collaborative initiatives on Space, The Africa Resource Management Constellation (ARMC) is a cooperation project initiated in 2004 and revived in 2018 between Algeria, Kenya, Nigeria, and South Africa. It aims to launch a constellation of four Earth Observation satellites and share the data collected to assess and monitor Africa's natural resources. It is under the leadership of SANSA, the South African Space Agency. Each of the four countries is supposed to send a satellite. (EU Global Space, 2022).

In 2021, the EU unlocked several funding programs to develop the usage of satellite technologies in Space, including GMES, a program of the African Union (AU) and the European Union whose objective is to address global challenges and promote sustainable development with an EU-AU cooperation based on the data from the Copernicus program. Free Copernicus images for different applications, including food security or GMES systems, are also provided.

Concerning GNSS, Africa does not have any regional GNSS system. One satellite-based augmentation system (SBAS) relies on European EGNOS technology. It covers most of Africa and the Indian Ocean and is mainly used for aviation.

ASECNA SBAS “was developed as part of the "SBAS for Africa & Indian Ocean" program to provide navigation services in the aviation sector. The system is based on the technology developed for EGNOS.[59]

Figure 1-11 *Member states of ASECNA. Source ESA.int.*

ASECNA provides air navigation services within an airspace of 16.5 million sq. km, divided into six flight information regions covering its Member States Benin, Burkina Faso, Cameroon, Central African Republic, Comoros, Congo, Côte d’Ivoire, France,

[59] See: SBAS for Aviation Opens over Africa and Indian Ocean - Inside GNSS - Global Navigation Satellite Systems Engineering, Policy, and Design. See: https://insidegnss.com/sbas-for-aviation-opens-over-africa-and-indian-ocean/. Last accessed: 04 November 2023

Gabon, Guinea Bissau, Equatorial Guinea, Madagascar, Mali, Mauritania, Niger, Senegal, Chad and Togo.[60]

In June 2021, ASECNA, together with Nigeria-based satcom operator NIGCOMSAT and Europe-based Thales Alenia Space, conducted a first board test of rotorcraft to validate the progress of the navigation data.

ASECNA SBAS is expected to be operational in 2024. Respectively, EUR 25 m over three years for the Global Monitoring for Environment and Security (GMES & Africa) program, supplying Earth Observation data for the Copernicus program, and over EUR 4.5 m over four years to continue the Satellite Navigation in Africa support program for air navigation, developing GNSS and implementing EGNOS across Africa.

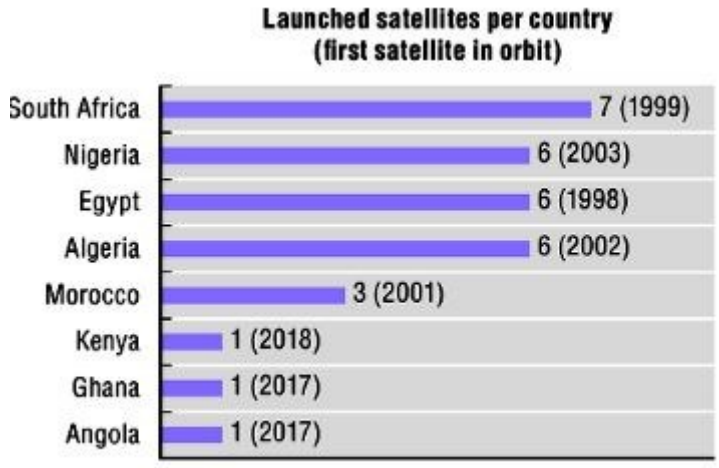

Table 1-4 - *The number of Satellites launched by African countries since 1999. Source* Froehlich*, Siebrits, 2019.*

Only some countries have observation satellites beyond nanosatellites and university projects. For most of the applications, data from foreign satellites is used. The largest African EO satellites include South Africa's military Kondor-E, NigeriaSat-2, and Sudan's SRSS-1 (Tsehaie Woldai, 2020).

The most advanced countries are South Africa and Nigeria. For example, South Africa is responsible for setting up the data infrastructure for the Africa Resource Management Constellation (ARMC) project. Downstream, most EO applications rely on foreign/international organizations. Besides South Africa and Nigeria, whether

[60] See https://www.esa.int/Applications/Navigation/EGNOS_technology_for_Africa_ESA_signs_deal_with_ASECNA . Last accessed: 03 November 2023.

governments or private entities could develop such applications is still being determined. (EU Global Action on Space, 2022).

Concerning satellite communication systems, there are few mature African Satcom projects beyond CubeSats and technology demonstrators. All large-scale projects rely on foreign (often Chinese) satellite technology. One example of Chinese penetration in space in Africa is the NigComSat-1R, developed, built, and launched by the China Great Wall Industry Corporation. The Chinese Shenzhen Aerospace Oriental Red Sea Satellite Company developed SUDASAT-1. The Ethiopian GEO satellite was ordered from the Chinese Rocket Company in 2020; CongoSat-1 (GEO), ordered by DR Congo from the CAST1) in 2012, is currently on hold. Applications range from mainstream communication to development-critical tasks like telemedicine, education, and rural connectivity. (EU Global Action on Space, (2022).

On Access to Space: no realistic ambition, besides Nigeria aiming to develop a launch vehicle, with limited milestones reached. On Science & exploration, participation of several countries in the Square Kilometer Array (SKA) project); Africa also wishes to develop partnerships in science payloads. Concerning human spaceflight, there is no realistic ambition besides Nigeria's aim to launch its first crew mission by 2030. (EU Global Action on Space, 2022).

Figure 1-12*: Signing of Agreement between ESA and ASECNA*

CHAPTER 2: EXPLORING THE POTENTIALS AND OVERCOMING CHALLENGES IN EU -AFRICA SPACE ECONOMY

Figure 2-1: Source:
https://www.esa.int/ESA_Multimedia/Videos/2015/12/Space_Economy

2.1: EXPLORING THE POTENTIALS OF THE SPACE ECONOMY

The history of space travel has brought humanity many social benefits, such as skills in human-robot cooperation, implantable heart monitors, improved solar panels, light-based cancer therapy, and research on human aging based on experiments in weightlessness, among many others (ISECG 2013).

Over the past decade, many countries and enterprises have been involved in space activities. The services deriving from them are increasingly important to society. Infrastructures such as telecommunication and increasing commercial digital applications now depend on space technologies. As the economy's digitalization increases, the exploitation of satellite data and signals is playing an increasing role in generating value for the global economy.

Satellite data has indeed become central and pervasive in everyday life, being widely employed in all modes of transport (road, aviation, maritime, etc.), fleet management,

high-precision and consumer applications, provision of time information in critical national infrastructures as well as scientific applications such as measuring the impact of space weather on the Earth, of earthquakes and climate change on human communities (Baumgart et al. 2021). With the ongoing digital transformation and upcoming mega-constellations of satellites whose objectives, among others, is to bring the internet for all, it will be possible to connect the over 3.6 billion who have no access to the web, as mentioned by the UN Study, I reported in the introduction.

Agriculture and forestry also make great use of satellite data, not only for farmers themselves (e.g., soil quality, crop growth) but also for the control of illegal activities in mining, fishery, and subsidy frauds. Another commercial utilization arises from satellite imagery in mineral exploitation and resource management. "Satellites with the ability to photograph specific geographical areas under different light specters can provide data that can be processed into geologically valuable images. These images may be further distributed to help with mineral discovery and mining rationalization. Additionally, modern complex construction projects utilize satellite imagery to map vast and critically important (e.g., nuclear power plants) construction sites and assess environmental damage or hazards to the area" (Doboš 2019, p.64).

In its 2023 Spin-off report, NASA mentions technologies developed for space travel, industry, and utilization and adopted on Earth in health and medicine, transportation, public safety, consumer goods, energy and environment, information technology, and industrial productivity. This is an impressive list of the most important spin-offs from the Apollo mission. Each of these categories provides particular fields in which space technology helps. They include cloud -computing, kidney dialysis, 3D endoscope, precision eye measurements to robots tough enough to withstand the harsh marine environment, ventilators that were designed to meet the immediate needs of the pandemic., ionospheric mapping software, water mapping technology, magnetic fluids for speakers, Landsat imagery, and many more [61].

The crucial role of space assets can also be manifested in climate change monitoring, which can be very effectively done from orbits as the temperature measurements on the global level or coverage of the decrease of ice coverage in polar areas are best done from the high-ground perspective. Another notable example of using space assets in social

[61] See: https://technology.nasa.gov/NASA-Spinoff-2023. Last accessed: 23 September 2023.

development is their impact on natural catastrophe mitigation. First, the space weather satellites and connected weather forecast systems provide up-to-date data about the progress of possible calamities. The precision and amount of meteorological data available from a combination of weather satellites and ground stations is historically unprecedented and mitigates many risks connected to predictable weather changes. It can, for example, help affected areas prepare for the impact of massive storms. A combination of satellite imagery (which regions are accessible) with navigational services (knowing one's position) enables rescuers to be more effective (Doboš 2019). The utilization of space technologies creates many spin-offs that aid the progress of contemporary terrestrial technological development. "These benefits can be divided into direct (scientific knowledge, innovation, the creation of markets, inspiration for people, or treaties signed) and indirect (improvements in the economy, healthcare, environmental quality, security, or philosophy)" (ISECG 2013, 6).

As evident from this small and limited segment, the economic and social importance of outer space research and development is enormous (Doboš 2019, 64).

As defined by the OECD, the space economy is all "activities and the use of resources that create and provide value and benefits to human beings in *exploring, understanding, managing, and utilizing space"* (OECD 2012). It, therefore, "includes all public and private actors involved in developing, providing, and using space-related products and services, ranging from research and development, the manufacture and use of space infrastructure (ground stations, launch vehicles, and satellites) to space-enabled applications (navigation equipment, satellite phones, meteorological services"), and the scientific knowledge generated by such activities. The space economy goes well beyond the space sector since it also comprises the increasingly pervasive and continually changing impacts (quantitative and qualitative) of space-derived products, services, and knowledge on the economy and society (OECD, 2012b).

Space activities can be divided into upstream activities (satellites and launch vehicles) and downstream (applications and services based on spatial and infrastructural data). Another important subdivision element to better understand the dimension of the space economy on a mid-long-term vision is to consider those space activities done in Space to assist exploration missions and services in orbit, that is, *Space for Space* activities and those activities that use data and space infrastructures to contribute to alleviating the quality of life on Earth that *is Space for Earth* (Di Pippo 2022).

One common theme in the literature is the significant economic potential of the space industry. Some scholars argue that space exploration can lead to the development of new technologies that benefit numerous sectors, including transportation, medicine, and communication. Others point to the opportunity for space-based businesses to contribute to Earth's economic growth by providing new products and services (Di Pippo 2022). Despite inflation and other factors, the space economy grew from a revised estimate of $505 billion in 2021. According to the Quarterly Report of the Space Foundation, in 2023, the global value of space activities amounted to 547 billion dollars, an increase of 260 billion dollars in the past decade[62].

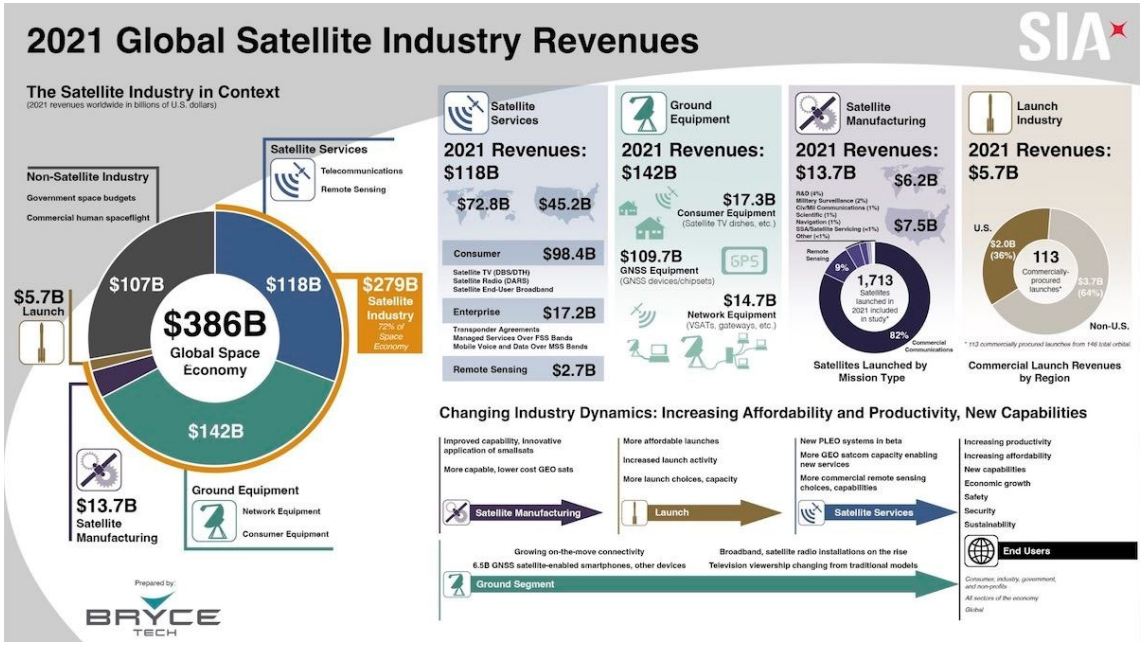

Figure 2-1 *2021. Global Satellite Industry Revenue. Source Geo Spatial World. Net*

"The satellite industry ($279 billion) and the non-satellite industry ($107 billion), with the latter consisting almost entirely of government budgets ($82.9 billion) plus a small ($1.1 billion) commercial human spaceflight segment. The most significant segment of the satellite industry is made up of television services ($97.7 billion), followed by satellite ground equipment ($60.8 billion) and GNSS chipsets and related technology ($52.6

[62] See: Space Foundation, "the space report 2023", available at: https://www.thespacereport.org/?taxonomy=topic&term=economy-interactive-tables-and-charts. Last accessed: 05 October 2023.

billion). Fixed satellite service made up a further $17.4 billion, followed by satellite manufacturing ($13.4 billion), launch services ($5.5 billion), satellite radio ($5 billion), mobile satellite service ($3.6 billion), and broadband and commercial remote sensing (both $2 billion). The non-satellite industry can be broken down into US government spending ($47.5 billion) and non-US government spending ($35.4 billion), with China and Europe dominating this category" (Froehlich, Siebrits, 2019, p. 80).

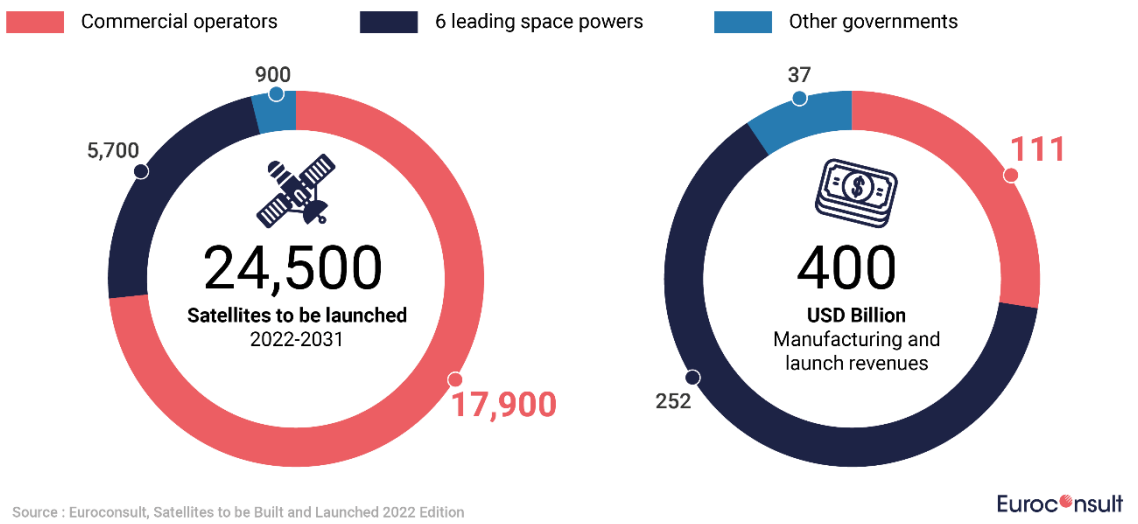

Figure 2-2 *Number of Satellites to be built and launched by 2022. Manufacturing and launch revenues. Source: Euroconsult (2022).*

Satellite navigation and telecommunication remain the central pillars, amounting to 50% to 41%, based essentially on business-to-consumer applications (B2C). Earth Observation contributes about 5% to the total value. (Euroconsult 2021). Research, also published in 2020 by the Institute for Defense Analyses, indicates a projection that the value of the space economy will amount to 1.400 billion dollars by 2040 (Crane et al. 2020). The Bank of America's Meryl Linch expects the space economy to grow at least 2.7 trillion in the next three decades (Kavanagh 2019)[63].

[63] See also: Michael Sheetz, "The space industry will be worth nearly $3 trillion in 30 years, Bank of America predicts," CNBC, 31 October 2017. Available at: https://www.cnbc.com/2017/10/31/the-space-indus try-will-be-worth-nearly-3-trillion-in-30-years-bank-of-america-predicts.html. Last accessed: 16 September 2023.

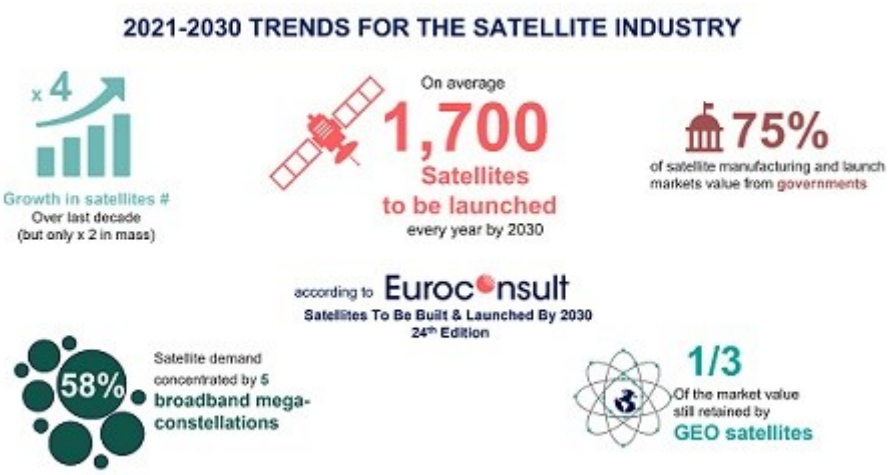

Figure 2-3 : *2021 – 2030 trends for the satellite industry. Source: Euroconsult (2022***)**

As argued by Simonetta di Pippo, the space sector is undergoing a profound transformation in the various segments of the value chain. This is because space technology has become more accessible to private actors. Lowering entry barriers in space activities has increased the benefits of using space data and infrastructure (Di Pippo, 2022). Furthermore, the deployment of mega-constellations for satellite broadband in the low-earth orbit and the involvement of ICT enterprises in the sector exemplify how significant optimism has been placed on its market prospects. The demand from the transportation sector will drive the industry, the Internet of Things (IoT), and artificial intelligence, among others. Since the first satellite for operative telecommunication, IntelSat-1 was launched in 1965, more than 80 countries have registered a satellite in orbit today. In the early 2000s, more than 30 new space agencies or offices were established on all six continents and in high- and lower-income economies (UNOOSA 2018).

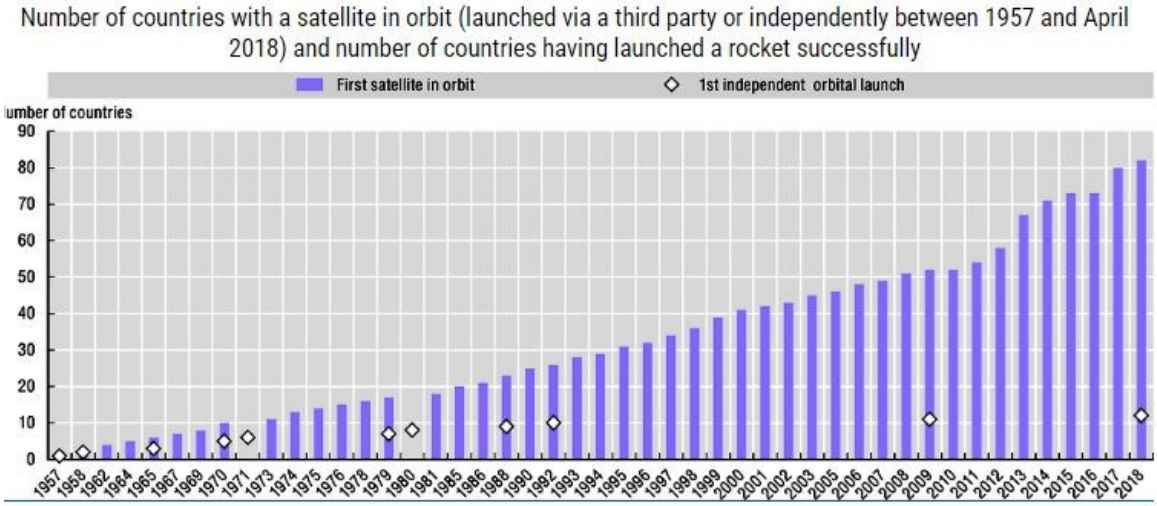

Table 2-1 *Provides the total of countries with a satellite in orbit since 1957. Source: OECD 2019.*

Commercial and private actors play an increasing role in shaping the future of space utilization. The growth in relevance is evident from the fact that 76% of space economy revenue is now generated by commercial activity. The entrance of commercial actors into the space economy was initially motivated by the vision of inventing cheaper means to reach terrestrial orbits compared to the state-owned capabilities and to decrease the price of space-based services. The actors' proliferation was also connected to the process of privatization of the space systems that took place in the 1980s. Commercial actors thus did not only emerge in the economic fields but also overtook more complex supply and explorational functions (Doboš, 2019).

Private space commercial activities not only encompass operating the satellites in their orbit (provision of telecommunications, imagery services, navigation, etc.). Other activities comprise manufacturing such satellites or their parts/equipment/research tools, launching the cargo to orbit (usually provided by state actors with essential service providers consisting of Russia, ESA (through Arianespace), the United States, or China, but with growing private competition), and provisioning of terrestrial support for space-based assets. "The current spread of private space launch capabilities (most notably related to SpaceX's Falcons) is once again challenging and supplementing the state capabilities.

Besides space launches, private actors appeared dramatically in almost all other space industries and fields. Among these, we can mention satellite manufacturing with

companies like Boeing, Lockheed Martins, or Alcatel. Also, many commercial cyber actors exploit synergies created in cooperation with space capabilities. Companies like Google or Microsoft cooperate with actors like Virgin Galactic or Bigelow Aerospace to provide services such as Google Maps" (Doboš 2019, p. 71).

Private actors are now involved in all parts of commercial space utilization, and the most important may have the potential to overcome states in their impact on future activities in outer space. For example, SpaceX, founded in 2002 by billionaire Elon Musk, is probably the most developed private space actor, operating three space vehicles and employing over 4000 people. The company aims not only to provide supplies that were associated exclusively with state actors in the past. One example is the Dragon capsule, which has provided payload for the International Space Station (ISS) since its first arrival in May 2012. (ISECG 2013, p. 11) but also finances research of the new capacities to reach Mars. The company has been recently authorized by the US Federal Commission on Communications to provide broadband Satellite services. Starlink, the mega constellation of satellites developed by the company, will launch satellites that can provide internet everywhere in the coming years. A total of 11,943 satellites are said to be launched by 2027.

Meanwhile, Elon Musk is working on Starlink2.0. A constellation of 30,000 big and powerful satellites will provide services to households and navigation services for automobiles, planes, ships, Etc. SpaceX remains the only private company to reach LEO and safely return the vehicle to Earth.

The company's progress surpasses most national space programs, and its rapid technological progress establishes it as one of the leaders of space technology progress. Space-related markets comprise space-based operations (remote sensing, navigation, weather forecasting, or communication) and terrestrial industries connected to developing and manufacturing satellites and launch vehicles. Furthermore, the new set of actors trying to create new space markets is pushing into the front seats with the capability to establish a new stage of human spaceflight. In this age, innovation and "space stunts" such as lunar landing will not be driven by states (e.g., SpaceX's goal of the piloted mission to Mars). Many new information technology companies take advantage of space capabilities to present their customers with products like Google Maps or meteorological radar services (Doboš 2019, p.79)

From “the geoeconomic perspective, some of the most exciting and important locations and objects in outer space are those with large deposits of natural or energy resources. There is a possibility that given the lack of atmosphere, the lunar surface might hide some massive alien body that hit its surface and remained in reasonably compact shape as to provide, in case it is composed of rare minerals, substantial economic benefit” (Wingo 2009, 162).

“Outer space holds the potential to become Earth’s ultimate source of plentiful rare minerals, ores, and energy resources. The “Blue Planet’s” neighborhood is full of smaller bodies, some rich in materials like PGMs, gold, or other valuable metals and ores. Furthermore, outer space may give us the ultimate solution for our planet's energy needs. Two primary proposed paths to reach such a goal are He-3-based nuclear fusion and space-generated solar power beamed to Earth.

Despite the many issues connected with their utilization, both technologies hold some future potential. Outer space has many riches and is a generator of human progress and spin-off technologies that will return benefits of multiplied value to Earth. The current socioeconomic utilization of outer space is more important than many realize, even though it is still in its infancy. Therefore, no matter how high space's economic and social importance is, the future impact will be much more massive (Doboš, 2019, p.80).

As further argued by Doboš (2019), however, there’s an issue connected to satellite operations primarily aiming at civil, benign, and beneficial activities: their inherent dual-use nature. “The same technologies used for social and commercial activities are also potential military assets. Satellites can be used as a space weapon; the same reconnaissance technology providing information about forest fires can spy on an opponent’s army capabilities. Following the same logic, the same system navigating machinery on large agricultural plants can guide missiles on their target” (Doboš, 2019, p.64).

The space sector will be the future game changer. Developing economies can take advantage of this opportunity by creating close partnerships with European Institutions to address sustainable growth based on space technologies. With the ongoing digital transformation changing governance, businesses, and way of living at an accelerated pace, adopting efficient technology such as the Global Navigation Satellite System

(GNSS) and Earth Observation System (EOS)[64] will be the key to taking advantage of these opportunities.

2.2: OVERCOMING DEVELOPMENT CHALLENGES IN EU – AFRICA SPACE

According to recent World Bank estimates, on our planet, about 9.2% of the world's population, over 719 million people, live on a daily income of less than $ 2.15. In contrast, one in five persons in developing regions still live on less than US 1.25 per day, and globally, over 20,000 children die each day from poverty-related causes. (World Bank, 2021).

These figures, among many others, reflect and amplify existing social, cultural, and economic inequalities in our society. For these reasons, in 2015, at a plenary session in New York, the UN General Assembly approved the 2030 Agenda for Sustainable Development, which calls for action for people, the planet, and prosperity. The agenda identified 17 objectives, with 169 sub-objectives and over 241 indicators. The sectors for intervention range from eradicating poverty to obtaining gender equality, from reducing inequality to health and societal well-being (UN SDGs, 2015).

This chapter overviews the identified 17 objectives and their related challenges. Historical milestones and a literature review of the SDGs are also provided. Research Questions connect: How can Space technologies and satellite data contribute to achieving these goals?

“Sustainable development is an organizing principle that aims to meet human development goals while *enabling natural systems to provide necessary natural resources and ecosystem services to humans*." (Robert et al., 2005).

The concept gained momentum in 1972 with the UN Conference on the Human Environment (Nations Conference on the Human Environment, 1972) held in Stockholm-Sweden, and in 1987 when the Brundtland report was published, which defined sustainable development as "development that meets the needs of the present generation

[64] See: https://eos.com. Last accessed: 06 October 2023.

without compromising the ability of future generations to meet their own needs" (UN 1987).

However, the Roadmap to develop the SDGs began in 2012 with the United Nations Conference on Sustainable Development (Rio+20). They evolved for several years through consultations and negotiations involving various countries, international organizations, civil society groups, and other stakeholders.

Milestones moments to the SDGs were the Millenium Development goals set in the year 2000, which also represented one of the largest gatherings of World leaders in history. On that occasion, nations committed to a new global partnership to enhance human development by "setting out a series of time-bound targets with a deadline of 2015, which became known as the Millennium Development Goals (MDGs)".

The Addis Ababa Action Agenda 2015 focused mainly on the theme of finance for development, and the COP21 Paris Agreement (United Nations, 2015) focused on climate change (Neves, 2018).

Although significant progress was made in addressing extreme poverty, hunger, and environmental sustainability, some MDGs still needed to catch up. Therefore, in 2013, the United Nations General Assembly established an Open Working Group (OWG) of 70 member states to develop a set of SDGs.

The OWG met thirteen times between 2013 and 2014, and in July 2014, it released a proposal for 17 goals and 169 targets, which were discussed in a series of intergovernmental negotiations.

The identified 17 goals and 169 targets are “viewed as integrated, indivisible, and collectively devoted "to pursuing global development and "win-win" cooperation, which can bring huge gains to all countries and all parts of the world. The Goals and targets resulted from over two years of intensive public consultation and engagement with civil society and other stakeholders worldwide, which paid particular attention to the voices of the poorest and most vulnerable” (UNOOSA, 2018:7).

In September 2015, the United Nations General Assembly formally adopted the 2030 Agenda for Sustainable Development, including the 17 SDGs and 169 targets.

Since then, the SDGs have been incorporated into various national development plans, and progress toward achieving them is monitored through the global indicator framework developed by the UN Statistical Commission.

The signing countries also established the High-Level Political Forum on Sustainable Development (HLPFSD) to boost efforts to achieve the goals. These high-level representatives of governments and stakeholders meet every four years to review progress, examine obstacles, exchange best practices, and recommend new actions to achieve the 2030 Agenda. (UN General Assembly Resolutions 67/290 and 70/299)[65].

The first SDGs Summit was held on the 24th and 25th of September 2019. It resulted in adopting a political declaration in which world leaders called for accelerated action to deliver the SDGs by 2030.

September 2023 is scheduled to hold the second Summit for the HLPF to convene under the UN General Assembly at the level of Heads of State and Governments. As stated by the Secretary General of the UN, "*At the mid-way point of the 2030 Agenda for Sustainable Development, it is time to face the facts because, without a surge in commitment, solidarity, and transformative action, we will miss the headline targets of the 2030 Agenda to end poverty, reduce inequality and protect the environment* "(2023-04 SG Letter to All Heads of State and Government).

The identified 17 objectives and related development challenges, particularly significant for the EU and Africa, are briefly introduced below. According to the UNDP, these objectives and challenges are integrated; they recognize that an action in one area will affect outcomes in others. Most importantly, the development concept must build an equilibrium between economic, social, and environmental sustainability.

The identified 17 objectives and challenges are as follows:

End poverty in all its forms and everywhere.

According to the Sustainable Development Goals report prepared by the UN Statistics Department, if current trends continue, by 2030, 575 million people will still live in extreme poverty, and only one-third of countries will have halved their national poverty levels.

2. ***End hunger, achieve food security, improve nutrition, and promote sustainable agriculture.***

[65] Review of the implementation of General Assembly resolution 67/290 on the High-Level Political Forum on Sustainable Development, resolution 70/299 on the follow-up and review of the 2030 Agenda for Sustainable Development at the global level and resolution 72/305 on the strengthening of the Economic and Social Council : draft resolution / submitted by the President of the General Assembly- Available at: https://digitallibrary.un.org/record/3874826 - Last accessed 08 November 2023

Up to date, more than 600 million people worldwide are projected to face starvation in 2030. 1 in 3 people worldwide struggle with food insecurity, while high food prices continue to plague many nations.

3. ***Ensure healthy lives and promote well-being for all at all ages***.

Notable improvements have been made globally to improve health outcomes. However, 25 million children still miss crucial routine immunization, and Malaria cases have surged worldwide.

4. ***Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.***

Still, according to the UN statistics division, the world needs to catch up in achieving quality education. Without additional measures by 2030, 84 million children and youth will be out of school, and only 1 in 6 countries will achieve the universal secondary education target.

5. ***Achieve gender equality and empower all women and girls***.

It will take over 300 years to end child marriage and 140 years to achieve equal workplace representation.

6. ***Ensure availability and sustainable management of water and sanitation for all***.

Safe drinking water, sanitation, and hygiene are still out of reach for billions of people, and 81% of species dependent on inland and wetlands have declined since 1970, according to the same sources.

7. ***Ensure access to affordable, reliable, sustainable, and modern energy for all***.

Today, 675 million people still have no access to electricity, and 4 in 5 people are in Sub-Saharan Africa. With ongoing trends and declining international public financing, 1 in 4 people will still use unsafe and inefficient cooking systems by 2030.

8. ***Promote sustained, inclusive, sustainable economic growth, full and productive employment, and decent work.***

A related issue to these goals is that 1 in 4 young people need to be in Education, employment, or training, and young women, according to the report, are twice to be in this situation.

9. ***Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation***.

10. ***Reduce inequality within and among countries***.

Between 1990 and 2019, the income differences between countries decreased by 37%. However, globally, women are twice as likely as men to report experiencing discrimination based on their sex.

11. ***Make cities and human settlements inclusive, safe, resilient, and sustainable***.

In 2020, 1.1 billion urban residents live in slums, and 2 billion more are expected in the next thirty years. Globally, 3 in 4 cities have less than 20% of their area dedicated to public spaces and streets. (SDG reports 2023).

12. ***Ensure sustainable consumption and production patterns***.

According to UN Statistics, Higher-income countries leave a larger environmental footprint than lower-income countries; on average, each person wastes 120 kilograms of food annually.

13. ***Take urgent action to combat climate change and its impacts***.

According to UN Statistics, the world temperature will exceed 1.5 centigrade and 2.5 centigrade by 2100. The world needs deep, rapid, and sustained GHG emission reductions by 43% by 2030 and net zero by 2050 to reverse climate change and its impacts.

14. ***Conserve and sustainably use the oceans, seas, and marine resources for sustainable development***.

Coastal eutrophication, ocean warming, plastic pollution, overfishing, and ocean acidification are only a few of the ocean's emergencies, which call for urgent actions to safeguard our ecosystem.

15. ***Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and biodiversity loss.***

One hundred million hectares of productive land is degraded yearly, and the world is facing the most significant species extinction since the dinosaur era.

16. ***Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.***

17. ***Partnership for the goals.***

One hundred eight million people have been forcibly displaced worldwide as of 2022, and nearly 200 thousand trafficking victims were detected worldwide, according to the IOM report in 2022. There is also a steep rise in conflict-related civilian deaths, with an over 50% surge in 2022, fueled by the Ukraine war.

(https://unstats.un.org/sdgs/report/2023/).

Figure 2-4 *UNSDGs 2030 Source https://unstats.un.org/sdgs/report/2023/.*

The 17 interlinked global goals address the world's most pressing social, economic, and environmental challenges. They aim to achieve a sustainable and equitable world by 2030 to end poverty, promote economic growth, reduce inequality, combat climate change, and ensure universal access to fundamental rights such as Education, health care, and clean water and sanitation. The 17 goals are interconnected, and progress toward achieving one goal can positively impact others. UNDP (2015). The SDGs aim to create a more collective, inclusive, and sustainable world, leaving no one behind in pursuing a better future. (https://www.undp.org/sustainable-development-goals).

Several literature reviews have been conducted on the SDGs, covering their origins, implementation, monitoring, and impact evaluation. (Boar, Bashida, Marimon, 2020).

Neves (2018) developed a literature review based on the relationship between Sustainable development goals and partnership and how they could be implemented to achieve the goals.

On the importance of partnership in achieving the goals, as also remarked by Ms. Simonetta Di Pippo, ex-director at the United Nations Outer Space Agency,

"*Partnerships are key to achieving the SDGs, especially at a time when we frequently hear the phrase "you have to do more with less" which, by definition, requires innovation and new approaches*[66]. " According to her, the demanding goals set out by this agenda can only be reached with a concerted effort by institutions and will require using the right tools.

In his foreword note to the joint study of the GSA and UNOOSA in supporting the SDGs, Carlo des Doirdes, the executive director at that time, enhanced the importance of GNSS and EO data in creating new solutions that will help achieve the SDGs. From precision farming to smart cities, intelligent modes of transportation and mobility, infrastructure monitoring, etc.

Nonetheless, critics were also moved to the SDGs and how they could affect the paradigm of development and cooperation. Hickel (2015) stated that the SDGs were unfeasibly expensive at the cost of over 2-3 trillion per year, covered too much ground and that GDP growth is all that ultimately matters, bluewashing, and that the SDGs were inadequate and dangerous as it needed to deep structural changes.

Thomas Pogge (2016) also affirmed that the SDGs were a statement of aspirations, and they failed to reflect the root causes of poverty and ignored the structural reforms needed at the national and international levels.

Other critics (Kumar, 2017) also perceived the goals as too complex, that the whole approach was a fruitless exercise, and that it would be hard to create accountability around them.

These reviews provide valuable insights into the strengths and weaknesses of the SDGs and offer recommendations for improving their effectiveness. They also highlight the need for increased collaboration between stakeholders, more substantial data collection and analysis, and a focus on addressing inequality and promoting social inclusion to achieve the SDGs. (UNOOSA, 2018).

[66] See: https://www.spacefordevelopment.org/library/european-global-navigation-satellite-system-and-copernicus-supporting-the-sustainable-development-goals/. Last accessed 23 September 2023

CHALLENGE	LINK TO THE SPACE2030 AGENDA
Food security	**Overarching objective 1** **Action 1.7:** Strengthen the contribution of space technologies and their applications to sustainable fisheries management, agriculture, food safety and security, and nutrition.
Water management	**Overarching objective 2** **Action 2.2:** Promote the use of space technologies and their applications to enhance scientific knowledge of the natural environment, including oceans and seas, mountainous regions, water cycles and resources, forestry, biodiversity, desertification and land degradation, as well as urbanization, with a view to contributing to the preservation of the natural environment, sustainable resource management and the protection of ecosystems.
Environmental and climate change	**Overarching objective 1** **Action 1.1:** Promote the use of space-based solutions in global efforts to ensure sustainable forest and ocean economies. **Overarching objective 2** **Action 2.2:** Promote the use of space technologies and their applications to enhance scientific knowledge of the natural environment, including oceans and seas, mountainous regions, water cycles and resources, forestry, biodiversity, desertification and land degradation, as well as urbanization, with a view to contributing to the preservation of the natural environment, sustainable resource management and the protection of ecosystems **Action 2.3:** Strengthen the use of integrated space applications to facilitate the observation of the climate and the assessment of disaster risks, improve early warning disaster systems and provide data for the indicators used to track progress in the implementation of the 2030 Agenda for Sustainable Development, the Sendai Framework and commitments by States parties to the Paris Agreement. **Action 2.4:** Advance the role of space technologies in highlighting, analysing and addressing climate change and facilitating the transition to low-emission societies, and promote international collaboration in that regard, in line with existing and recognized international mechanisms and organizations.
Disaster management and emergency response	**Overarching objective 2** **Action 2.5:** Promote the use of space-based technologies in all phases of the disaster management cycle, applicable to both natural and man-made disasters, including prevention, mitigation, preparedness, response, recovery, reconstruction and rehabilitation; monitor and assess elements such as exposure, hazards, disaster risk and damage in different regions of the world; and promote the sharing of disaster monitoring data.
Urbanization	**Overarching objective 2** **Action 2.6:** Strengthen the use of space technologies and their applications to support the development of socially and environmentally sustainable human settlements and infrastructure, both urban and rural; improve livelihoods; study urbanization and migration patterns; and monitor cultural heritage sites and contribute to their preservation
Migration	**Overarching objective 2** **Action 2.7:** Strengthen the use of space technologies and their applications to support the development of socially and environmentally sustainable human settlements and infrastructure, both urban and rural; improve livelihoods; study urbanization and migration patterns; and monitor cultural heritage sites and contribute to their preservation.
Energy	**Overarching objective 2** **Action 2.4:** Advance the role of space technologies in highlighting, analysing and addressing climate change and facilitating the transition to low-emission societies, and promote international collaboration in that regard, in line with existing and recognized international mechanisms and organizations.
Health	**Overarching objective 2** **Action 2.6:** Strengthen space-related cooperation in support of global health; improve the use and application of space medicine, science and technology, innovations in the global health domain, cooperation and the sharing of information and tools to improve the timeliness and effectiveness of public health and health-care interventions; and enhance capacity-building in space medicine, science and technology.

Table 2-2 *Selected African challenges and their link to Space and UNSDGS 2030. Source: UNOOSA, 2023. p. 10*

CHAPTER 3: RESEARCH QUESTIONS AND CASE STUDIES

3.1: THE RESEARCH QUESTIONS AND METHODOLOGY

The Research Questions and the methodological approach reflect the research arguments presented in the literature review in the first chapter of this dissertation. Research questions were drawn from other pieces of research and reports from the United Nations and European and African Institutions on these topics.

THE RESEARCH QUESTIONS

My interest and curiosity in exploring the potential benefits of the Space economy on society grows as I research the topic. The vastity, complexity, and interdependent nature of the topic raises questions that cannot be answered in this single dissertation, given the time at my disposal and the efforts to research thoroughly in relevant archives, interview experts, and perhaps travel to Space centers and laboratories where the Space assets are put to work for the benefit of society.

Research questions, however, revolve around these complex and interdependent topics and constitute, perhaps, research questions for future studies.

Thus, as demonstrated through the literature on the potentialities of the Space Economy, space technologies can contribute to societal well-being by accelerating economic growth and development. These activities are pushing forward economic growth on a global scale, and there is no doubt they can accelerate sustainable socio-economic growth while acting as a flywheel for innovation. A sector, therefore, in rapid expansion, with enormous perspectives for future growth. On the other hand, however, Africa remains one of the most challenged regions to meet sustainable development.

Despite its vast resources, the African continent faces many complex and multifaceted challenges, including high levels of poverty, inequality, security, unemployment, health, and governance issues. It is still home to many poor and hosts over 350 million people living below the poverty index and almost thirty-six of the world's most fragile economies.

Given the premises of the space industry as demonstrated through the literature review, Can the Space Economy be a flywheel or a shortcut route to overcome global challenges

and accelerate growth in Africa? If yes, can the EU – Africa partnership unlock these potentials?

What are the strengths, weaknesses, opportunities, and threats in the partnership and their respective Space arena, and what are the possible policy recommendations to overcome the challenges in the EU- Africa Space Partnership?

Research Questions for future studies:

Since both continents share common interests, as expressed by the President of the Commission, Ursula Von der Leyen, the research questions that arise, and perhaps constitute research questions for future studies, are linked to the development and promotion of space-based applications that can address common challenges such as climate change, migration, food security, terrorism, etc.

Will including Science and technology in the Joint EU -Africa Strategic partnership generate potential for Science Diplomacy?

What are the potential political, economic, and social impacts of EU-Africa cooperation in the space economy, and how can they be measured and evaluated?

METHODOLOGY

A mixed methodological approach is adopted to explore the research topics and corroborate the research questions. A qualitative methodology was also utilized due to the interdisciplinarity of the arguments being treated in this dissertation. To comprehensively understand the present and future potentials and challenges of Europe and African Space, I identified two case studies successfully implemented using the European programs Galileo and Copernicus. They are linked to selected UNSDGs that are particularly significant for Africa. (SDGs, 1, 11, 17). They represent best practices where Space economy endeavors have supported global challenges as specified in the UNSDGs 2030 and the Africa Agenda 2063.

Key facts on the economic and space sectors of three African countries, Nigeria, Ghana, and Kenya, are also provided. The reason for selecting these countries is, first, based on my linkage and curiosity to explore the current state of their space arena and the possible impacts of the Space economy on their society. Secondly, they are considered emerging "middle powers" in international relations literature. They are States that are neither great nor small in terms of global power, capacity, and influence and demonstrate a propensity

to promote cohesion and stability in the world system (Jordaan, 2003). In the literature, various frameworks are employed to facilitate the analysis of national space capabilities. These countries certainly fall in “third tier countries according to their space capabilities compared to first and second-tier countries such as the USA or Brazil, but they place a strong emphasis on the socio-economic benefits of space technology and are firmly in favor of driving regional and continental efforts to create space institutions and structures in Africa while taking a leading or dominant position in these” (Froehlich et al. 2019, p.177).

Lastly, they can bridge Africa and Outer Space, contributing to achieving active participation of most African states in the Space Arena. They are stable countries with growing economies that emphasize the socio-economic benefits of space technology (*Ibidem*).

Thorough Research at the Historical Archives of the European Union and Field visits at the European Space Agency in Frascati, Rome, and the Centre for Remote Sensing and GeoSpatial Information Services (CeRGIS) at the University of Ghana gave me a unique opportunity to see my eyes Space technologies, how they work, the expertise and know-how that revolves around this industry and the benefits they bring to our society.

Pictures from these visits are presented in annexes to the dissertation.

3.2: PRESENTATION OF THE CASE STUDIES

The European Space Agency (ESA) provides technical support to developing African countries based on EGNOS technology and Galileo satellites for extended benefits for airports, airlines, and passengers. Also, through the EU's Copernicus Program, satellite data from the family of Sentinels allows African institutions free and open access to data to develop applications to monitor lakes, prepare adaptation measures for agriculture, and monitor biodiversity. “The Copernicus Sentinels are a fleet of dedicated EU-owned satellites designed to deliver the wealth of data and imagery that are central to the European Union's Copernicus environmental program.”

The European Commission leads and coordinates this program to improve the management of the environment, safeguarding lives every day. ESA oversees the space component and is responsible for developing the family of Copernicus Sentinel satellites on behalf of the European Union and ensuring the data flow for the Copernicus services.

At the same time, the operations of the Copernicus Sentinels have been entrusted to ESA and EUMETSAT.[67]

A brief overview of the EU Flagship Space components and programs: Galileo and Copernicus and their services to European citizens, and their contribution to achieving the SDGs are presented below:

3.2.1: BRIEF OVERVIEW OF EU SPACE COMPONENTS: GALILEO AND COPERNICUS

THE GALILEO PROGRAM

Global Navigation Satellite System (GNSS) is the term used for a satellite navigation system with worldwide coverage. They consist of three components: a space segment, which comprises a satellite constellation; a ground segment to control and monitor the space segment; and the end user receivers. They are a network of satellites that includes infrastructures that allow users "to determine their position, velocity, and local time by processing signals from satellites in Space. "These signals are provided by various satellite positioning systems, including global constellations and Satellite-Based Augmentation Systems (SBAS)," that allow compatible GNSS receivers to compute position estimates with improved accuracy concerning the accuracy computed with GNSS stand-alone and associated integrity warnings" (UNOOSA, 2018, p.11).

The European Geostationary Navigation Overlay Service (EGNOS) is Europe's regional satellite-based augmentation system that is used to improve the performance of GNSSs. The system started its initial operations in July 2009 and obtained certification for safety-of-life applications in March 2011. EGNOS has been deployed to provide safety-of-life navigation services to aviation, maritime, and land-based users over most of Europe since GNSS systems alone do not meet the necessary operational requirements set by the civil aviation authorities.

Galileo is Europe's global navigation satellite system, providing a highly accurate, guaranteed international positioning service under civilian control. Their services have a

[67] See: https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Space_for_Earth/Africa/(archive)/image . Last accessed: 08 October 2023.

significant favorable impact on many European services and users. (UNOOSA, 2018, P.15). Governance over the project is divided among the European Commission, ESA, and GSA. The first tests began in 2005, and the first navigational satellites were launched in 2011. Currently, Galileo's system consists of 28 satellites. Initial services became available in December 2016[68].

Once fully operational, Galileo will comprise 30 MEO satellites with terrestrial infrastructure spread around the globe with primary bases in German Oberpfaffenhofen (Galileo Control Centre), Swedish Kiruna, and Kourou in French Guiana (tracking and telecommand centers). Galileo enhances the accuracy of the position computed by multi-constellation receivers and supports Search and Rescue operations. Its operational capacity is scheduled for 2025 when the satellite constellation will be complete, and the range of services will be fully provided. “The Galileo constellation will comprise 30 satellites spread evenly around three circular orbital planes with semi-axes about 23,222 km above the Earth's surface. The system's orbit and signal accuracy are controlled by a ground segment consisting of two Galileo Control Centres (GCC) in Oberpfaffenhofen, Germany, and Fucino, Italy” (Dobos,2019, p.113).

As a further specificity, Galileo provides a global Search and Rescue (SAR) function based on the operational Cospas-Sarsat system. Satellites are, therefore, equipped with a transponder, which can transfer the distress signals from the user transmitters to regional rescue coordination centers, which will then initiate the rescue operation. “At the same time, the system will send a response signal to the user, informing him that his situation has been detected and that help is on the way. This latter feature is new and is considered a significant upgrade compared to the existing system, which does not provide user feedback.

The system can operate on several levels—free navigation opened to any compatible system, paid commercial high data flow service, search and rescue service, and critical information sharing with member states as well as Frontex mission and third countries that sign an agreement with the project government” (Doboš 2019, p 115). Galileo thus plays a crucial role in the commercial development of outer space by providing reliable navigational information to businesses with the potential to generate some extra funding by providing its paid services. Furthermore, it strengthens the international standing of

[68] See: https://www.esa.int/Applications/Navigation/Galileo/What_is_Galileo. Last accessed: 05/10/2023

the European space program by providing critical data to non-European partners and establishing strategic independence in the maritime services that will enhance the European terrestrial strategic options. Galileo thus operates on multiple levels similar to other navigational systems.

Currently, “four operational SBAS are operating in different regions: the Wide-area Augmentation System of the United States (WAAS, North America), the European Geostationary Navigation Overlay Service (EGNOS, Europe), the Japanese Multifunctional Transport Satellite (MTSAT) SBAS (MSAS, Japan) and the Indian GPS Aided Geo Augmented Navigation (GAGAN, India); and another three in various phases of development: the Russian System of Differential Correction and Monitoring (SDCM, Russian Federation), the Korean Augmentation Satellite System (KASS, Republic of Korea) and the Satellite Navigation Augmentation System (SNASS, China)” (UNOOSA,2018, p.15).

Among the global constellations, “the United States Global Positioning System, managed by the Department of Defense, has been operational since 1995, and the Russian Federation Global Navigation Satellite System (GLONASS) has been operating since 2011. Galileo, the European GNSS, is currently under deployment, along with the BeiDou Navigation Satellite System (BDS), the Chinese Navigation system” (UNOOSA, 2018, p.10).

Figure 3-1 *Agriculture machinery using GNSS Galileo technology for precision agriculture.*

THE COPERNICUS PROGRAM

Copernicus is the EO and monitoring program of the European Union, funded by the European Commission. It primarily builds on data collected from Earth Observation (EO) satellites. “The Copernicus services transform this wealth of satellite and in situ data into value-added information by processing and analyzing it, integrating it with other sources, and validating the results. With more than 8 petabytes per year, Copernicus is the third largest data provider in the world. No previous EO initiative has ever provided such a volume and diversity of data at such an impressive rate” (UNOOSA, 2018, p.26).

Formerly known as GMES, the terrestrial observation system was established as a response to the commitments made by the EU in the Kyoto Protocol—the second critical strategic space-based system based by the ESA, also a system complementary to Galileo (Dobos, 2019, p. 103). Copernicus’ usefulness also lies in other fields like agriculture, fisheries, transport, regional development, or development aid. It is comprised of three components: space (provided by the ESA, EU member states, and EUMETSAT in cooperation with the United States, Russia, and South Africa), in situ (terrestrial), and

provided by many facilities. The data provided is free of access and can support European and international efforts to identify and respond to global challenges such as climate change, land management, resource management, pollution, and many other environmental challenges.

The Copernicus space component comprises the "Sentinels," a series of EU-owned satellites operated by the ESA, which also acts as the overall system architect of the space component and ensures its technical coordination, and the “Contributing Missions” who provide Copernicus with complementary data collected through synthetic aperture radars, optical sensors, altimetry systems, radiometers, and spectrometers. Thanks to various technologies such as “radars and multispectral imaging instruments for land, ocean, and atmospheric monitoring.” This group of Satellites enables a set of Earth Observations to provide weather forecasts all day and night, land monitoring, and emergency management. Sentinel-1A and 1B, launched in 2014 and 2016, provide all-weather, day, and night radar imagery for land and ocean monitoring. The twin Sentinels 2B -2B, later launched in 2016 and 2017, are polar-orbiting missions that provide multispectral high-resolution imaging for land monitoring and emergency management[69].

These Sentinels and Contribution missions, which are more than 40, have an independent ground segment linked together to form the Copernicus ground segment system. The space data access system streamlines the data flows from the various ground segments to the users. By processing and analyzing the data, integrating them with other sources, and validating the results, the Copernicus service transforms satellite data into value-added information that can be made comparable, ensuring the monitoring of changes over time The operational implementation of Copernicus in services such as Climate Change, Land Monitoring, environment, emergency management, and security benefits a wide range of domains such as urban planning, civil protection, public health, the environment, tourism, renewable energies, development and cooperation, and many more. (UNOOSA, 2018, p. 27).

The European agencies involved are the “European Environment Agency (EEA), “the European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union (FRONTEX), Management Board Decision 03/2014 adopting practical arrangements regarding public access to the

[69] See: http://www.seso.com/sentinel-1a/. Last accessed: 05 October 2023.

documents of the European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union (Frontex)"[70], the European Maritime Safety Agency (EMSA) and the European Satellite Centre (SatCen). Other competent organizations involved are the European Centre for Medium-Range Weather Forecasts (ECMWF) and Mercator Océan" (UNOOSA, 2018, p.28).

3.2.2: CASE STUDY 1: GALILEO AND COPERNICUS SUPPORT THE SUSTAINABLE DEVELOPMENT GOALS

For the dissertation, three SDGs are analyzed in detail as essential goals that can foster growth and sustainable development in Europe and Africa. The role of EGNSS and EO in supporting each goal is also analyzed and presented.

UNSDG 1 – END POVERTY; UNSDG – 2 - Zero Hunger

Objectives one and two are linked to the same challenges and are briefly presented below:

SDG 1 - Calls for ending poverty in all its forms by 2030. It aims to ensure that the poor and vulnerable access essential services, provide social protection, "and support people harmed by climate-related extreme events and other economic, social, and environmental shocks and disasters[71].

SDG 2 "aims to end hunger and all forms of malnutrition. It also commits to universal access to safe, nutritious, and sufficient food at all times of the year[72]. This will require sustainable food production systems and resilient agricultural practices, equal access to

[70] See: https://prd.frontex.europa.eu/document/management-board-decision-03-2014-adopting-practical-arrangements-regarding-public-access-to-the-documents-of-the-european-agency-for-the-management-of-operational-cooperation-at-the-external-borders/. Last accessed 04 November 2023

[71] See: https://sdgs.un.org/goals/goal1 - Last accessed 04 November 2023.

[72] See: https://sdgs.un.org/goals/goal2 Last accessed 04 November 2023

land, technology, and markets, and international cooperation on investments in infrastructure and technology to boost agricultural productivity" (UNOOSA, 2018).

Five hundred million small farms worldwide provide up to 80% of food consumed in a large part of the developing world. Poor nutrition causes nearly half (45 percent) of deaths in children under 5 – 3.1 million annually. One in nine people (795 million) are undernourished today, lacking regular access to adequate dietary energy.

"The fight against hunger has progressed over the past 15 years. Globally, the prevalence of hunger has declined from 15 percent from 2000 to 2002 to 11 percent, according to figures from 2014 to 2016". However, more than 790 million people worldwide still lack regular access to adequate dietary energy. If current trends continue, the zero-hunger target will be largely missed by 2030.[73]

Moreover, more than 800 million people live on less than $1.25 a day globally, meaning that one in five people in developing regions lives on less than $1.25 daily. Moreover, 18,000 children still die each day from poverty-related causes. Poverty levels have dropped by over half in the last decades, but most are still struggling for basic needs and human rights. According to many UN and international research reports, Sub-Saharan Africa and Southeast Asia are the most affected regions.

In addition, new threats are coming from internal and external conflicts, such as the ongoing Ukraine–Russia conflict with threats on food security, coup d'états in Sub-Saharan Africa, etc. Eradicating poverty in all forms remains one of humanity's most significant challenges.

As space technologies are a crucial asset contributing to the achievement of SDG 1, their contribution is linked to a subset (five out of a total of seven) of the SDG 1 targets,

By 2030, eradicate extreme poverty for "everyone everywhere, currently measured as people living on less than $1.25 daily".

By 2030, reduce at least half the proportion of men, women, and children of all ages living in poverty in all its dimensions according to national definitions.

Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030, achieve substantial coverage of people experiencing poverty and the vulnerable.

[73] See: https://sdgs.un.org/goals/goal2. Last accessed 04 November 2023.

Ensure significant mobilization of resources from various sources, including through enhanced development cooperation, to provide adequate and predictable means for developing countries, particularly least developed countries, to implement programs and policies to end poverty in all its dimensions.

Create sound "national, regional, and international policy frameworks based on pro-poor and gender-sensitive development strategies to support accelerated investment in poverty "eradication actions" (UNOOSA, 2018, p. 49).

GOAL 17– PARTNERSHIP

Partnership for the Goals. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

A successful sustainable development agenda requires partnerships between governments, the private sector, and civil society. These inclusive partnerships, built upon principles and values, a shared vision, and shared goals that place people and the planet at the center, are needed at the global, regional, national, and local levels (UNOOSA, 2018, p.88).

"Urgent action is needed to mobilize, redirect, and unlock the transformative power of trillions of private resources to deliver sustainable development objectives. Long-term investments, including foreign direct investment, are needed in critical sectors, especially developing countries. "Review and monitoring frameworks, regulations, and incentive structures that enable such investments must be retooled to attract investments and reinforce sustainable development[74]."

The European Union and Africa have engaged in a long-standing partnership (GMES and Africa) to foster the development of EO applications tailored to African needs and to strengthen the capacity of African public and private institutions to use EO data and information for sustainable development purposes. GMES and Africa rely mainly on the

[74] See: https://gsan.essex.ac.uk/sustainable-development-goals/partnerships-for-the-goals/. Last accessed 23 October 2023

expertise, technology, data, and information offered by the Copernicus program. Additionally, the GSA signed an MoU with UNOOSA, establishing a partnership to cooperate on themes linked to satellite navigation, including pilot projects and educational activities.

The targets where EGNSS and Copernicus can better contribute within SDG 17 are:

17.6 Enhance North-South, South-South, and triangular regional and international cooperation on and access to Science, technology, and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism

17.7 Promote the development, transfer, dissemination, and diffusion of environmentally sound technologies to developing countries on favorable terms, including concessional and preferential terms, as mutually agreed.

17.8 Fully operationalize the technology bank and Science, technology, and innovation capacity-building mechanism for least developed countries by 2017 and enhance enabling technology, mainly information and communications technology.

17.9 Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through North-South, South-South, and triangular cooperation.

17.18 By 2030, enhance capacity-building support to developing countries, including least developed countries and small island developing States, to significantly increase the availability of high-quality, timely, and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location, and other characteristics relevant in national contexts (Ibidem, p.89).

To effectively contribute and benefit from space and the space economy, the European GNSS Agency and UNOOSA signed a Memorandum of Understanding (MoU) in July 2016 to develop activities, including educational activities and everyday awareness-raising actions. The MoU follows the line established in the European Parliament resolution of 8 June 2016 (2016/2731(RSP)). Paragraphs 9 and 26 of this resolution read as follows:

"9. *Supports the development of integrated applications using EGNOS/Galileo and Copernicus. […]*

26. Encourages the Commission to investigate opportunities for deploying European GNSS and Copernicus in the Union's neighborhood and development policy and negotiations on cooperation with non-EU countries and international organizations;"

The European Union's infrastructure deployment and market uptake efforts have launched EGNOS, Galileo, and Copernicus operational services. These services support a continuously increasing number of users in many different market application domains, from transport-related services including aviation, road, maritime, and rail) and consumer solutions to professional applications, for example, agriculture, construction, and infrastructure monitoring (UNOOSA, 2018, p.1).

The United Nations Office for Outer Space Affairs (UNOOSA) has recognized how essential space technologies can contribute to obtaining all the 17 SDGs. The 17 interlinked global goals address the world's most pressing social, economic, and environmental challenges. They aim to achieve a sustainable and equitable world by 2030 to end poverty, promote economic growth, reduce inequality, combat climate change, and ensure universal access to fundamental rights such as education, health care, and clean Water and sanitation. The 17 goals are interconnected, and progress toward achieving one goal can positively impact others. The SDGs aim to create a more collective, inclusive, and sustainable world, leaving no one behind in pursuing a better future.

The study, in collaboration with the European Union Agency for the Space Program (EUSPA)[75] , systematically analyzed the 169 sub-objectives of the 2030 Agenda by using the European program Galileo - the European global satellite-based navigation system for geolocalisation and precise navigation and Copernicus (Earth Observation) [76].

According to this study, 40% of these sub-objectives (65 out of 169) strongly depend on space activities. The SDGs and 17 objectives could only be achieved if the states utilize research and space technology to reach sustainable development goals and as a flywheel and accelerator for growth[77]. As further noted by the report, additional value can be generated by using the two space technologies in synergy. GNSS applications such as urban planning, traffic management, or high-precision agriculture can be complemented

[75] See: www.euspa.europa.eu

[76] See: www.copernicus.eu/en

[77] UNOOSA, European Global Navigation Satellite System and Copernicus: Supporting the Sustainable Development Goals. Building Blocks towards the 2030 Agenda, Vienna 2018. See: https://www.spacefordevelopment.org/library/european-global-navigation-satellite-system-and-copernicus-supporting-the-sustainable-development-goals/. Last accessed: 04/ 11/2023.

by imagery and, for example, soil moisture data from EO. The maturity and diversity of systems and data availability allow unprecedented potential for combining the two technologies, GNSS and EO, unleashing integrated applications that were impossible years ago. (UNOOSA, 2018 -P10).

Space technologies are integral to achieving the SDGs because they strongly emphasize data acquisition and their link to geolocalisation to monitor and measure environmental and demographic indicators and targets.

On top of this, a GNSS-based tracking system can inform farmers about the condition of cattle and pasture. Understanding animal behavior and environmental interactions can optimize livestock management and grazing environments. The University of New England (UNE) developed GNSS-based tracking technology to remotely monitor the condition of cattle and pastures. The UNE tracking system can send notifications to farmers, warning them that their stock is running out of feed or overgrazing a paddock. As the animals start to run out of food in the paddock, their behavior changes. By monitoring this, the system informs the farmers when cattle are stressed and pastures are degraded. Similarly, within the EU-funded project, E-track, an animal-tracking and analysis tool for sophisticated behavioral research on wild and domestic animals, has been developed using EGNOS corrections to enhance GPS accuracy[78].

Improving food security through satellite technology: Accurate and timely information on agricultural production helps farming communities make informed decisions to achieve sustained growth in agricultural activity. This information is essential in enabling early warning of harvest shortfalls, increasing crop production, and ensuring agricultural sustainability. An example of using EO data in agricultural monitoring is “remote sensing- based information and insurance for crops in emerging countries” (RIICE), a public-private partnership aiming to reduce the vulnerability of smallholder rice farmers in low-income countries. This program seeks to use remote sensing technologies to map and observe rice growth in selected areas. Sentinel-1A’s national-scale data is used in this project to monitor seven countries' rice crops. [79]

Lastly, the Farming by Satellite contest, a competition for students and young people across Europe and Africa, focused on using Galileo/EGNOS and Copernicus to improve

[78]See: http://www.project-e-track.eu/ - Last accessed 12 August 2023.
[79]See: https://www.asean-agrifood.org/projects/riice/ Last accessed 12 August 2023

agriculture and reduce its environmental impact. Each edition has a special Africa Prize, which has a double benefit for the regional participants: it rewards tailored solutions for agriculture and creates additional future employment possibilities for the young talents participating.[80]

3.2.3: CASE STUDY 2: USE OF COPERNICUS FOR URBAN HOUSING DENSITY ANALYSIS

UNDSDGs 11 – SUSTAINABLE CITIES AND COMMUNITIES

Goal 11 – Sustainable Cities and Communities Make cities and human settlements inclusive, safe, resilient, and sustainable.

More than half of the world's population lives in cities, an equivalent of 3.5 billion people. They are hubs for culture, social development, productivity, etc. "Common urban challenges include congestion, lack of funds to provide essential services, a shortage of adequate housing, and declining infrastructure. By 2030, it is projected that 6 out of 10 people will be urban dwellers. In 2014, around half the global urban population was exposed to air pollution levels at least 2.5 times higher than the maximum standards set by the World Health Organization". The world's cities occupy just 3 percent of the Earth's land but account for 60-80 percent of energy consumption and 75 percent of carbon emissions. Lighting, for example, can account for up to 40 percent of a city's energy consumption. As a result, city administrations and other agencies operating large streetlight networks are continuously looking to enhance the overall system's efficiency. Moreover, Rapid urbanization is exerting pressure on freshwater supplies, sewage, the living environment, and public health. Policymakers can tackle the challenges cities face in ways that allow them to continue to thrive and grow while improving resource use and reducing pollution and poverty.[81] The targets that can be are as follows:

"By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated, and sustainable human settlement planning and management in all countries. 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural Heritage".

[80] See: https://www.euspa.europa.eu/farming-satellite-launches-ideas-competition. Last accessed: 21 October 2023

11.5 “By 2030, significantly reduce the number of deaths and the number of people affected by disasters and substantially decrease the direct economic losses relative to the global gross domestic product caused by disasters, including water-related disasters, focusing on protecting people experiencing poverty and people in vulnerable situations.
11.6 By 2030, reduce cities' adverse per capita environmental impact by paying particular attention to air quality and municipal and other waste management”.
11.7 By 2030, provide universal access to safe, inclusive, accessible, green, and public spaces, particularly for women and children, older persons, and persons with disabilities.
11. a Support positive economic, social, and environmental links between urban, peri-urban, and rural areas by strengthening national and regional development planning
11. b “By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation, and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels”.
To make cities and human settlements inclusive, safe, resilient, and sustainable. By 2030, almost 60% of the world's population will be living in Urban areas, and 95% of the Urban expansion in the coming decades will occur in developing countries. While occupying, on average, 3% of the Earth's surface, cities are responsible for 60 – 80% of energy consumption and 75% of carbon emissions. Rapid urbanization severely pressures water supplies, sanitation, the environment, and public health. The challenge the urban environment poses includes issues such as traffic, lack of funds to subsidize essential services, scarcity of adequate housing, and deteriorating infrastructures. Lighting can account for up to 40 percent of a city's energy consumption. As a result, city administrations and other agencies operating large streetlight networks are continuously looking to enhance the overall system's efficiency.
Consequently, the public outdoor lighting market is adopting light-emitting diode (LED) streetlights that can be networked with communications to become "smart streetlights." Within smart lighting technology, new streetlights are equipped with low-cost GNSS receivers and connected to a mesh radio network that relays their data to a Cloud Gate Gateway device for review and analysis in a centralized location. In this way, defective lamps communicate their status in real-time and can be precisely located for replacement, improving the maintenance process and reducing maintenance costs by up to 30 percent.

EGNSS has also proved very important when mapping disaster areas accessed by rescue teams with extreme precision, avoiding the need to survey the same area twice. The satellite images provided by Copernicus could help monitor the risk of a disaster and reduce the economic loss and the number of deaths and missing persons if it occurs. Satellite data from both programs are beneficial to supporting, planning, and monitoring "migration and mobility of people, either in the case of human migration between different areas of the world or mobility within urban centers."

Earth Observation (EO) and Global Navigation Satellite System (GNSS) help with urban mapping and infrastructure monitoring, particularly for planning and managing city services and structures, traffic optimization, energy consumption reduction, mobility improvement, land register management, air quality monitoring, emergency and disaster management, and municipal waste management.

Rapid urbanization is also exerting pressure on freshwater supplies, sewage, the living environment, and public health, and rapid urban population growth can hinder the execution of any well-thought-out urban plan. To ensure citizens' well-being and productivity, the necessary infrastructure and services, such as water supply, housing, and sanitation facilities, must be set up. It is, therefore, crucial to have a timely understanding of and monitor changes in urban density to help policymakers react promptly to any sudden change in urban dynamics and make the best decision regarding the allocation of resources. This is especially true in developing countries, where urbanization is increasing.

In this regard, the Centre for Remote Sensing and Geographic Information Services (CERSGIS)[82] in Ghana implemented a project that used EO Sentinel-2 imagery to map the urban housing density in Accra (Ghana). By observing similar spectral reflections exhibited by pixels in the images, they identified three urban density levels in built-up areas: high, medium, and low. The project developed a Geographic Information System database of the country's planned urban infrastructure. The Centre also provides GIS and Remote Sensing services using Geospatial technologies to provide decision support and planning tools for sustainable social and economic development to the Government of Ghana, NGOs, Research Institutions, and the Private Sector. They also offer services in the development of Spatial Data Infrastructure, Satellite Image processing, Spatial

[82] See: https://cersgis.org/team/ . Last accessed: 23 September 2023

Database development, and Web-based applications for spatial land use/land cover mapping and planning, desertification, flood hazard mapping, spatial modeling, vulnerability assessment, and capacity enhancement programs in Geographic Information System development. [83]

An electric scooter sharing service for sustainable urban mobility Vehicle sharing services benefit from GNSS information to track the vehicles, which are widely distributed across the city. In the case of "floating sharing," where cars are not parked in specific stations, GNSS is the primary source of information for users to locate the vehicle. It also enhances the system's security by alerting people about unexpected movements and tracking a car in the event of theft. G-MOTIT is a European-funded project that has developed an electric scooter-sharing service to solve urban mobility problems in major European metropolitan areas. "It allows users to reserve a scooter with their smartphone, receive a notification with the position of the assigned vehicle, drive it, and drop it off wherever they want. The service aims to enhance vehicle positioning performance by developing and integrating EGNSS-based location technology, which is key to the service's success".[84]

"*TehnoGIS*[85] is an independent start-up delivering geo-referenced data using EGNOS, Galileo, and Copernicus data in complementarity with other sensors (IMU, UAV, etc.) to provide affordable solutions to farmers, as well as to city and land administrators, and other users." Project portfolios range from determining flood areas and conducting preparatory studies for new infrastructure (highways, railways, etc.) in Eastern Europe to 3D modeling for Western European city planners and building companies.

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[83]See: http://cersgis.org/ . Last accessed: 12August 2023.
[84] See: http://gmotit.pildo.com/. Last accessed: 12 August 2023.
[85] See: http://www.tehnogis.ro/index.php/ro/ Last accessed: 12 August 2023.

CHAPTER 4: EURO-AFRICA SPACE: A SWOT ANALYSIS

A SWOT analysis proves to be a helpful method for understanding the potential of the African space and comparing the present and future. This analysis comprises a comprehensive set of present and prospects for their economy and society. They focus on the current capabilities, the opportunities and threats, and the potential for future development. The issues covered are the economy, technological capacities, socioeconomic situation, relation with key powers, stability, the level of corruption, regional dynamics, youth potential, untapped resources, investment, threats to stability, or a lack of needed reforms.

This section explores the prospects of the European space program and the African Space arena, combining the SWOT analysis with the division of outer space activities.

4.1: EUROPEAN SPACE: A SWOT ANALYSIS

STRENGTHS

The European space industry has all the necessary technological capabilities and know-how to produce rocket launchers and satellites. The cooperation of ESA with other space agencies enables the agency to utilize the tracking stations in places like Poker Flat and Goldstone in the United States, Hartebeesthoek in South Africa, Usuda and Masuda in Japan, and Canberra in Australia. However, with its Kourou launch site, French Guiana is the most important of these overseas territories regarding spaceflight. Located about five north of the equator, it provides launched rockets with almost the maximum possible additional velocity created by the spin of the Earth.

Furthermore, the setting up of Galileo and Copernicus is giving strategic independence to Europe. Galileo provides Europeans with their navigational system, while Copernicus aims to improve climate change mitigation strategies. EUMETSAT is a leading meteorological data provider, and EADS Astrium is a leading partner in space technology development. All these programs have significant social and economic benefits. The ESA Technology and Transfer program aims to commercialize space technologies in terrestrial and commercial applications (ESA 2015b). The cooperative nature of the European

program in the current setting of outer space geopolitics also proves to be a crucial asset for the possible future development of outer space activities.

In space security, the ESA is highly active in the issue of orbital debris mitigation. Its Clean Space initiative, coupled with parts of the proposed Code of Conduct and projects like *e.deorbit,* aims to secure the environment for future space utilization. Europe, thus, might stand at the center of the future of space security provision.

Moving to the military-diplomatic sphere, we can see strengths mainly in the soft power part of this domain. As for space law, even though European states and agencies only had a limited influence on the development of the current outer space regime, which was mainly established by the two Cold War superpowers, they prepared the possibly most important amendment of space law in the past decades—the Code of Conduct. Reacting to the new developments and threats to the outer space environment, the EU and ESA are trying to gain broad support for their proposed set of non-binding rules and norms that have the potential to secure outer space for the time to come. The European plan is perceived as more sincere than the Sino-Russian, or any potential US, version. This also sheds light on the issue of the role of Europe in the field of space diplomacy. Thanks to its primarily nonmilitary nature, the EU and ESA cooperate with all major space agencies worldwide. An example is the undertaking relations with Africa on Space issues.

WEAKNESS

The European space program lacks independent launch capabilities apart from those of French Guiana. In case of problems on the site or conflicts in that territory, Europe has no other alternatives.

In the arena of space diplomacy, Europe lacks a robust single voice. Its fragmented political structure weakens its international position and affects its effectiveness and financing as the projects usually lack proper support.

Europe is also little visible in mitigating the Sino-US space confrontation that can endanger European space utilization, lacking a credible hard power segment and relying on its diplomatic strength. This cooperative central position must be used to decrease international tensions in the space arena.

Another weakness of Europe is the lack of private space companies like SpaceX or Virgin Galactic. Europe needs more space entrepreneurs' space to fully profit from the

privatization of Space economic activities and stay at the forefront of future technological development together with the US commercial sector.

OPPORTUNITIES

Opportunities for the future of the European space program lie in developing the new launchers Ariane 6 and Vega C. Ariane 6 is Europe's next heavyweight launcher that will replace Ariane 5. "*Vega C is an enhanced version of the lightweight Vega*" with increased power and capacity. "In parallel to preparing a new generation of launchers, ESA is also working on its first reusable spacecraft, *SpaceRider*, that will fly on top of a Vega C. They should keep the European launcher industry at the top of the global technological and commercial ladder. [86]

Good relations with most space-faring nations should enable the European space program to use cooperative projects. The ESA's focus on space exploration is at the forefront of the efforts to develop new technologies potentially useful for further developing the European space industry. At the diplomatic stage, the ESA should use its potential to become the center of international space cooperation. Europe holds the potential to become a central negotiator in outer space geopolitical disputes and diplomatic efforts, as its nature is so far less aggressive and less concerned about a hard power than terrestrial geopolitics and diplomacy are. In the economic domain, the potential of European space companies is enormous due to the industrial application of their technologies and space projects. The opportunities in the social development aspect of space travel will drive start-up companies in the space sector. If Arianespace wants to compete with SpaceX, the new launchers under development must be able to continue the commercialization of space efforts and competitiveness of its space launchers.

THREATS

The main threats to the future of the European space program come from international and internal instability. A continuing deterioration of West-Russia relations might lead to losing access to Russian launch sites and space technologies crucial for some parts of the European space program.

[86] See: https://www.esa.int/ESA_Multimedia/Transmissions/2019/06/Ariane_6_and_Vega_C_new_generation_of_European_Launch_Vehicles -last accessed 14 October 2023.

In the case of significant internal problems, these might be followed by the disappearance or radical decrease of the importance of common frameworks manifested by the existence of the EU and ESA. The space program would suffer in this turn of events as no single European state can maintain competitive space technologies or programs. In the diplomatic field, the main troubles for Europe would arise if the tensions among the space-faring powers worsened. "Although the transatlantic ties will probably remain strong, a hostile position of China and Russia would hamper the significant cooperative efforts. It would leave the European soft power of little use. In space warfare, the European military capabilities are virtually nonexistent. The civilian nature of the space program thus only might make sense as long as the technological development forbids the effective conduct of space warfare" (Doboš, 2019, p. 123).

"Another potential threat is the disregard for mining opportunities on celestial bodies. If any hostile actor acts fast enough and decisively, it might successfully prevent Europe from enjoying the spoils of the space "Gold Rush." Europeans, thus, should stay focused on these commercial and seemingly far-fetched goals by engaging in them to prevent the nationalization of space resources and the denial of access to places like the Moon by any single space-faring actor. The future of Europe's space program is thus mainly threatened by its indecisiveness and slow reaction, a potential hostility within international relations in general and toward European proposals in particular, space war or widespread ASAT testing, a crumbling of the European project in general, a lack of funding by states that will not see the outer space as an urgent priority, and potential hostile moves by more hard power-oriented actors that might deny Europe the freedom of operation in the outer space domain." (Doboš 2019, p.124).

STRENGTHS:	**WEAKNESS:**
Launch site, launch, and industrial capabilities, diplomatic and scientific cooperation, space regime proposal, debris mitigation projects, the establishment of the strategic infrastructure, commercialization	Only one launch site, lack of human launch capabilities, insufficient strategic infrastructure (mainly SSA), disunity, lack of familiar solid voice, budgetary issues, lack of credible hard power segment, comparatively less progressive NewSpace sector

OPPORTUNITIES:	THREATS:
New launchers, good relations, cooperative nature, potential to become the heart of the future space regime, new strategic infrastructure, technological spin-off, commercial power, space mining	Internal fragmentation, the rise of international tensions, lack of hard power, rapid rise of space debris, loss of international credibility, loss of financing, slow innovation and commercial progress, indecisiveness

Table 4-1 *Summarizes the SWOT analysis of the EU Space.*

4.2: AFRICAN SPACE: KEY FACTS ON ECONOMIC AND SPACE SECTOR. COUNTRY OVERVIEW: NIGERIA, KENYA, GHANA.

This section presents the three identified African Space players with their related space capabilities. These specified countries are Nigeria, Ghana, and Kenya.

Their choice is because they "are States that are neither great nor small in terms of international power, capacity, and influence and demonstrate a propensity to promote cohesion and stability in the world system" (Jordaan 2003).

Nigeria, Ghana, and Kenya are among the leading States with Space Capability in Africa and are also leading their respective Regional Economic groupings. They are much more in favor of Regional Cooperation and integration, advocate for international law and other space organizations, and have ratified UN treaties on outer Space. (Froehlich et al. 2019).

Furthermore, these countries "place a strong emphasis on the socio-economic benefits of space technology, and lastly, they can be a bridge between Africa and Outer Space, contributing to achieving active participation of most African states in the Space Arena. (*Ibidem*).

4.2.1: REPUBLIC OF NIGERIA

KEY FACTS ON ECONOMIC AND SPACE SECTORS

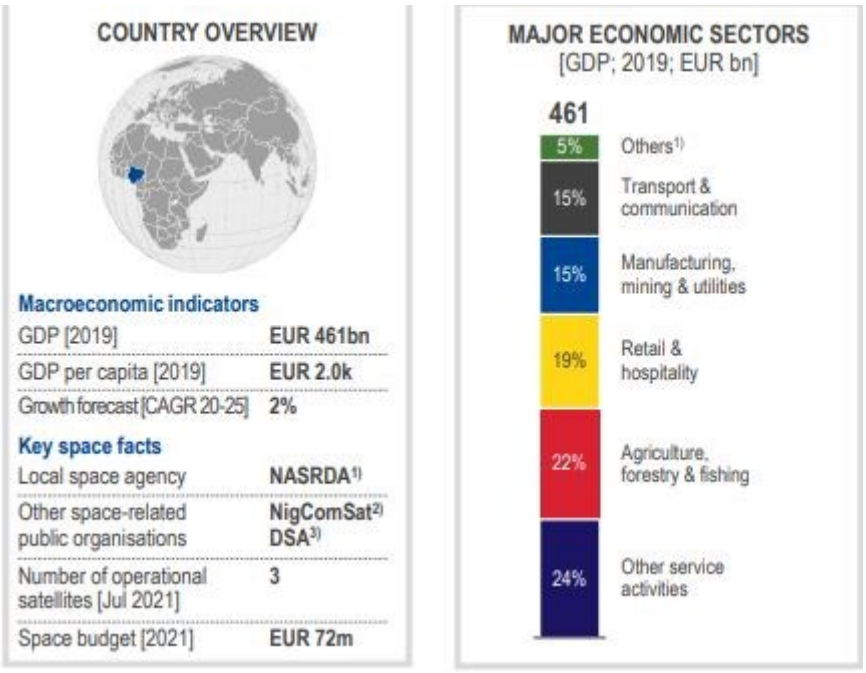

Figure 4-1: *Key economic sectors and space facts in Nigeria. Source EU Global action on Space*

Nigeria was among the first African nations to develop a space program. Its ambitions were started in 1976. The country has owned six satellites since 2003 and has founded the National Space Research and Development Agency as part of the Federal Ministry of Science and Technology. To date, 3 out of these six satellites remain active.

Nigeria's space strategy was formulated in 2005 by NASRDA. It comprised a 25-year road map with three main objectives. Produce a Nigerian astronaut by 2015, launch a Nigerian-manufactured satellite by 2018, and launch a Nigerian-made satellite from a Nigerian launch site on a Nigerian-manufactured launch vehicle by 2025.

As of today, only objective two have been partially successful. Nigeria Sat-2 was the first satellite to be built entirely by African engineers. As for the objective one, it has been postponed to 2030. Objective 3 is far from reality regarding the launch vehicle besides

operating rocket testing facilities. NASRDA is currently developing a new strategy that is set to be published [87]

The country has two main ground stations—the National Center for Remote Sensing and Satellite Technology and Development. In 2008, Nigeria established NigNet (Nigerian GNSS Reference Network)[88]. Today, Nigeria operates nearly 20 GNSS ground stations, serving as the country's fiducial geodetic network. (Beger, 2019). To support education, NASDRA has recently created the Institute of Space Science and Engineering (2017) as part of the African University of Science and Technology in Abuja to domesticate the training of engineers and scientists for the Nigerian space program[89].

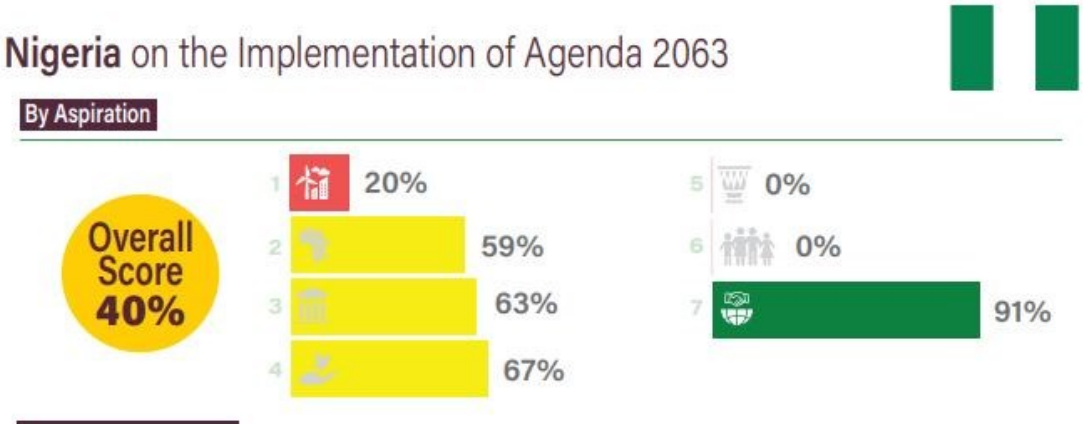

Table 4-2 : *Nigeria implementing Agenda 2063, as of 2022. Source African Union Commission*

[87] See: https://africanews.space/investing-in-the-final-frontier-nigerias-2023-space-budgetary-allocations/. Last accessed 05 November 2023

[88] See: https://www.nasrdacbss.com/. Last accessed 05 November 2023

[89] See: https://africanews.space/nigeria-collaborates-with-china-to-commence-the-crop-watch-programme-in-nigeria/. Last accessed: 05 November 2023.

4.2.2: REPUBLIC OF KENYA

KEY FACTS ON ECONOMIC AND SPACE SECTORS

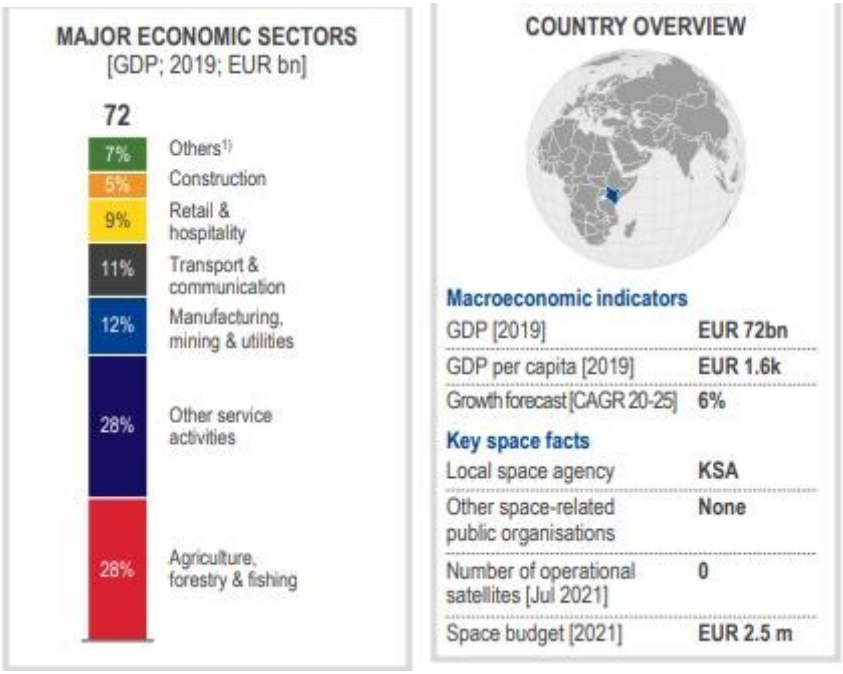

Figure 4-2 *Country Overview and Major Economic sectors in Kenya, 2022. Source EU Space report*

"Kenya's economy relies heavily on Agriculture, like many African countries. It accounts for approximately 28% of the GDP and employs two-thirds of its population. The country is also experiencing rapid population growth. As a result, large areas of high agricultural potential are decreasing in size, affecting food production. Kenya's economy strongly relies on forestry and fishing. However, these resources are endangered because of overexploitation and pollution. For example, overfishing, illegal fishing from foreign boats, and water pollution threaten lakes and ocean resources. On fishery, 'Agriculture, Fisheries and Food Authority' and the Ministry of Fisheries Development have taken measures to prevent overexploitation. Satellite-based monitoring can give the means to enforce these measures, for example, by detecting boats in restricted areas or vessels emitting pollution in protected zones. On forestry, the Forest Preservation Program (FPP) of the Kenya Forest Service (KSF) plans to monitor and mitigate deforestation and forest degradation. This plan includes as a first step: "Harnessing and utilization of archived and fresh imagery acquired from earth observation satellite sources and from forest inventory

and ground-truthing field activities to develop national forest resource map" (EU Global Action on Space, 2022, p. 26).

1964, Kenya opened the San Marco Space Centre, a satellite launch and tracking base, collaborating with Sapienza University of Rome (Italy) and NASA. It is the main space asset of the Kenyan Space program, which the country exploits with the Italian Space Agency.

The centre was renamed *Centro spaziale Luigi Broglio* in 2004. It was replaced in 2017 by the Kenya Space Agency (KSA). Ground operations of the center are still active, primarily for NASA and ESA's satellite communications and tracking. Kenya's first satellite, 1KUNS-PF, was launched in 2018 from the ISS.[90] It was a CubeSat developed in 2015 and assembled by the University of Nairobi with the technical support of the JAXA, Sapienza University of Rome, and Italian companies. It orbited in 2020. *(Ibidem*).

"The center's activities include telemetry tracking and control of satellites, support of ESA with launchers, and support of Chinese missions[91]. Kenya also participates in the Africa Regional Data Cube (ARDC) platform, which contains 17 years of satellite imagery and is currently available for Kenya, Ghana, Senegal, Sierra Leone, and Tanzania. It monitors forest cover, land change, water quality, illegal mining, etc. Kenya plans to develop a space weather monitoring network to provide real-time space weather monitoring to mitigate events affecting communications navigation. It also plans to expand the Global Learning & Observations to Benefit the Environment (*GLOBE*) project, promoting the uptake of space-related subjects. It connects stakeholders from the public and private sectors" (EU Global Action on Space, 2022, p.25).

Italian nanosatellites and mini-rockets launching from high-altitude balloons – expected late 2021 (EU Global Action on Space, 2022).

[90] See: https://africanews.space/kenya-to-launch-first-satellite-in-april/. Last accessed: November 5, 2023

[91] See: https://africanews.space/nigeria-collaborates-with-china-to-commence-the-crop-watch-programme-in-nigeria/. Last accessed: Last accessed: November 5, 2023.

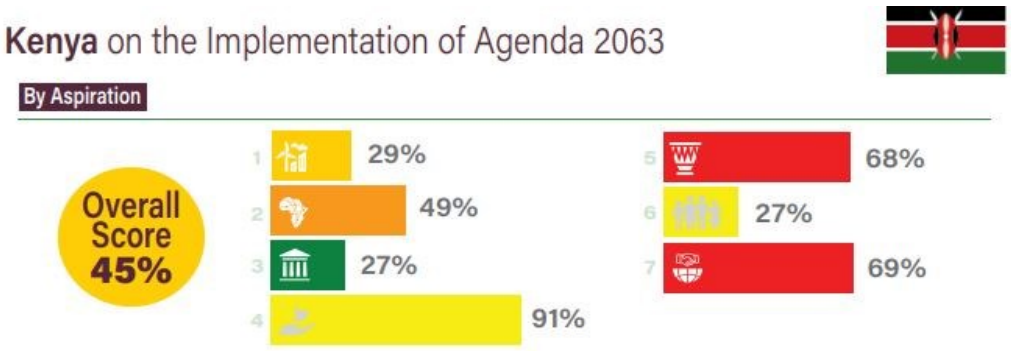

Table 4-3 *Kenya on the implementation of Agenda 2063. Source African Union Commission*

4.2.3: REPUBLIC OF GHANA

KEY FACTS ON ECONOMIC AND SPACE SECTORS

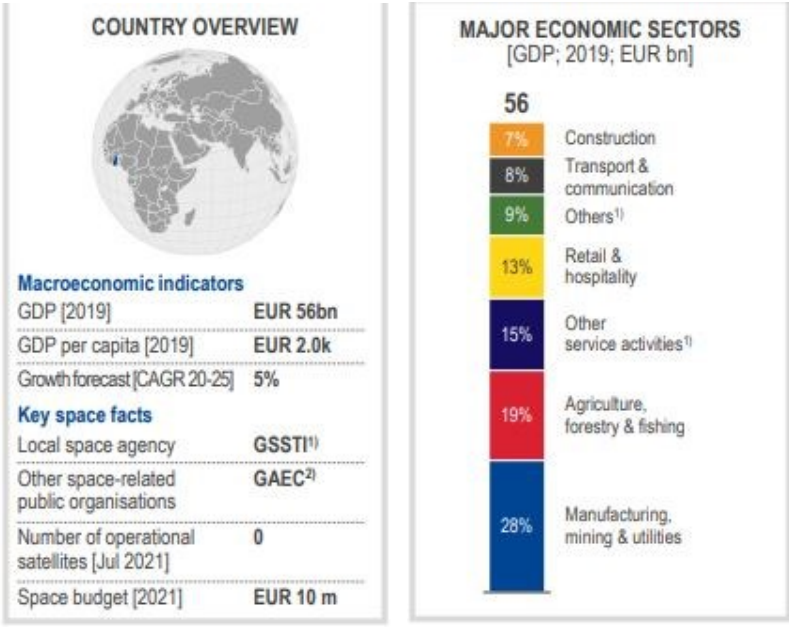

Figure 4-3 *Key economic sectors and space facts in Ghana. 2019. Source Eu Space Report.*

Ghana currently does not have a national space policy. In 2017, Ghana launched its first EO satellite, GhanaSat-1, via SpaceX's Falcon 9 rocket from the Kennedy Space Center to the International Space Station. It was deployed into orbit using the Japanese Kibō CubeSat deployment module. Three students from the private All Nations University College (ANUC) built the satellite in cooperation with the Japanese BIRDS-1 program.

The CubeSat weighs around 1kg and is equipped with low- and high-resolution cameras to survey Ghana's coastal borders for mapping and educational purposes. It de-orbited in 2019 as the last of the BIRDS-1 satellites.

Based on the success of Ghana Sat-1, the government stated its desire to launch Ghana Sat-2 to contribute, among others, to detecting illegal mining activities (especially gold), monitoring oil spills, improving weather forecasts to support agriculture, deforestation surveillance, and natural disaster prevention/ monitoring (e.g., forest fires). Apart from its satellite program,

Ghana has ventured into other spaces. In 2012, works began transforming the 32-meter antenna of a satellite earth station operated by Vodafone into a radio astronomy observatory.

In 2019, “Ghana expressed interest in becoming the host country of the African Space Agency, which the African Union initiated in 2017. However, Ghana entered its bid late and was not considered in the selection process, seeing Egypt emerge as the winner. The country joined in 2013 the Committee on the Peaceful Uses of Outer Space (COPUOS) and signed the Outer Space Treaty (1976), Rescue Agreement (1968), and Liability Convention (1972). Ghana's space budget stagnated over the last three years at around EUR 10m” (EU Global Action on Space, 2022, p.31).

Ghana has recently approved a Policy to Leverage Space Science and Technology for Sustainable Development. The country has recognized that the Ministry, departments, and agencies lack access to space data or underestimate the contribution of space data in aiding development. “The Ministry of Environment, Science, Technology, and Innovation (MESTI) acknowledges the lack of coordination “in the way MDAs access data from entities that provide space data, and we do not even consider value for money.[92]”

The ministry is, therefore, actively collaborating with pertinent government ministries and the private sector to harness the potential of space technology. Their collective goal is to restructure the Ghana Space Science and Technology Institute (GSSTI) into a space agency. Though the government had halted establishing new agencies due to the financial

[92]"Ghana: GHANA Confirm Lifting of Ban on PLASTIC." MENA Report, vol., no., 2015, p. n/a.

implications, it was important to consider the establishment of the space agency as an exceptional case.[93]

The agriculture sector employs almost 50 percent of the population, and the country is focused on modernizing the sector. A particular focus lies on agro-processing to achieve higher productivity and create added-value jobs. The European Union supports local authorities via the EU–Ghana Agricultural Program (EU-GAP). The country would benefit from modernizing its agricultural sector through precision farming or satellite imagery (crop monitoring, nutrient management, etc. Illegal fishery costs Ghana an estimated USD 100m each year. The government is encouraged to react and take measures to rectify the situation. Using Sentinel data to control the fishing activity, Vessel tracking, and solutions using "Integrated System for Surveillance of Illegal, Unlicensed and Unreported Fishing" can be used. Ghana lost more than 50% of its original forest areas to agricultural land usage. The government seeks to rehabilitate degraded reserves by planting fast-growing species, conserving, and using sustainable resource usage practices. Illegal small-scale mining, called *galamsey* ("gather and sell"), represents around 70% of the total small-scale mining sector. By using chemicals, *galamsey* causes great harm to the ecosystem, threatening local agriculture (e.g., cocoa) and causing state revenue losses of USD 2.3 billion (2016). High-resolution EO imagery coupled with change detection algorithms offers the ability to combat illegal mining sites" (EU Global action on Space, 2022, p.30)

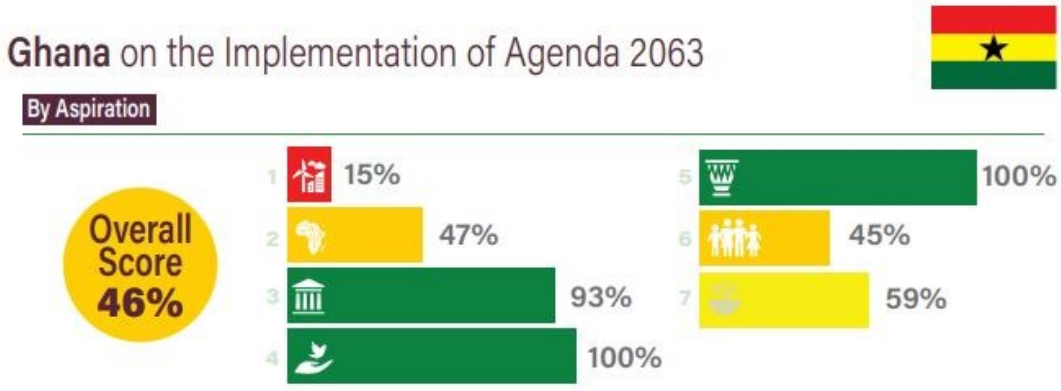

Table 4-4: *Ghana on the Implementation of Agenda 2063, as of 2022. Source African Union Commission.*

[93] See: https://africanews.space/ghana-approves-policy-to-leverage-space-science-and-technology-for-sustainable-development/. Last accessed 26 October 2023

4.3: AFRICA SPACE: A SWOT ANALYSIS

STRENGTHS

Africa has started to tackle its food security problem. Earth Observation programs within the continent are working on decision support and geo-information for agriculture. The Nigerian government, for example, is trying to move its dependency on oil and gas exports by focusing on agriculture and ICT. On this latter, the second pillar of the plan focuses on socio-economic improvements in housing and infrastructure through ICT. The country is also currently developing its launcher. However, the technological gap is still substantial, and external assistance will be required to continue the program. Satellite-based monitoring solutions could help mitigate the problem of terrorism and security challenges in oil spills in the Delta Region.

In Kenya, Earth Observation is already being used to monitor agriculture. For example, the ESA Food Security Thematic Exploitation Platform has already provided information on soil moisture through Copernicus Sentinel-2. The country is also building a satellite for the Africa Resource Management Constellation (ARMC).

Ghana plans to invest in aviation using the SBAS system, which could rely on EGNOS technology. Many infrastructure projects are related to transportation. Capitalizing on the work done on ASECNA SBAS, the Ghana Civil Aviation Authority (GCAA) would be a natural candidate to benefit from the augmentation system, considering the country's geographical position. In addition, a third port in Keta is planned to relieve pressure on existing ports. It could be a candidate for satellite systems (e.g., IoT solutions to track ship optimization of port operations thanks to connected containers (Euro Space Report, 2022).

WEAKNESS

According to the EU Space Report, administrative and policy compliance requirements are the main weaknesses hindering the growth of Africa's space sector and cooperation with European counterparts. Administrative processes are still reported to be complex and inefficient, and due to the poor state of the public education system, skilled labor is difficult to find in many scientific and technical sectors. Moreover, most space agencies have limited experience in satellite data management.

Corruption is also reported as one of the administrative challenges. Nigeria, Ghana, and Kenya score 149/180 124/180 on Transparency International's Corruption Perceptions Index for 2022, respectively (Transparency International Index, 2022). Corruption increases the cost of doing business in Africa for foreign investors and industrial players. Foreign companies face lengthy administrative processes and delays in issuing necessary business licenses, constituting a brake for foreign investments. Country bilateral agreements can also take a few years before ratification, e.g., the agreement with Italy on the Broglio space center was finalized in 2016 but ratified by the Kenyan parliament in 2020.

Lack of private sector participation, despite the efforts of the African Space strategy to establish a basic space infrastructure and commercialization of communication and EO data.

African countries also lack experience in satellite design and manufacturing and have limited funding. In Ghana, data infrastructure and know-how are nonexistent and require a foreign partner to be developed. Furthermore, Africa's significant linguistic, industrial, and economic differences present a challenge as it attempts to foster cooperation. The challenge of increasing and broadening the participation of African countries since it "is still a very long way away from having representation from all 54 African countries", partly due to expensive intra-African travel costs and linguistic barriers. (Martinez, 2012). Moreover, to grow and create jobs, economies rely on an attractive business environment, which is also a prerequisite for foreign investment and are also crucial for businesses in the space sector. Unfortunately, Africa performs very poorly. Only one country makes the top 25 for ease of business, Mauritius, which is at 25th overall. only seven others make the top 100— Morocco at 69th, Kenya at 80th, Botswana at 81st, South Africa at 82nd, Zambia at 85th, Tunisia at 89th, and Seychelles at 95th. Of the remaining 45 countries, 18 rank between 100 and 149; the remaining 27 fall between 150 and 190. (World Bank, 2022).

The budget allocation for space activities in Africa is significantly lower than that of ESA or NASA.

OPPORTUNITIES

The main opportunities in Africa’s Space Sector have been identified in Satellite provision and infrastructural monitoring. Agriculture and natural resources exploitation

are also opportunities for EU – ---Africa Space. The ICT sector has significant potential due to sizeable domestic demand with unsatisfied needs.

“The market opportunities with the highest potential are expected to be in agriculture, emergency response, transportation, infrastructure monitoring, and Satellite provision.”

In Nigeria, for example, the main opportunities for space-related activities are in satellite system provision for industries such as defense, agriculture, and infrastructure. The country’s ambition is to develop NigeriaSat-2 and NigeriaSat-X locally. It will likely require external support and can dedicate a significant budget. Kenya intends to build a satellite Imagery Analysis Portal and participate in the Africa Regional Data Cube (ARDC).

In Ghana, transportation and logistics activity is growing and modernizing. Therefore, Satellite-based tracking represents an opportunity. The country is looking to develop new satellites and has to rely on foreign partners. However, the potential remains limited because Japan is already a significant partner, and Ghana’s space budget is limited.

Agriculture is a key sector of sub-Saharan Africa. It represents over 20% of its GDP and employs over 60% of the population. However, agriculture is mainly traditional and under-productive. It is estimated that production could be doubled thanks to yield improvement methods. African agriculture is also highly vulnerable to shocks (e.g., drought floods).

Agriculture & natural resources exploitation represents 28% of Kenya's GDP. Agriculture modernization and protection of natural resources (e.g., monitoring illegal fishing) are critical to Kenya's economy. The country is already investing in associated downstream solutions.

Agriculture, forestry, and fishing represent 20% of Ghana’s GDP and profoundly needs modernization. Illegal exploitation of forests, halieutic resources, and mines cost several billion euros to the country every year. The government is already receiving the EU’s help and is willing to invest in mitigating these issues.

A few international satellite-based initiatives are already in place to anticipate such events. Agriculture is one of the promising markets in terms of the impact of Copernicus. Urban monitoring products are expected to benefit from the high growth of smart city

markets; hence, the influence of Copernicus should continue to increase[94]. The market is experiencing rapid development with the emergence of private and public Space players and new business models. New space players are, for example, emerging in the EO imagery market, using constellations of small satellites and lower launcher costs, therefore providing EO imagery data at more competitive prices than traditional space players (UNOOSA, 2018)[95].

In 2020, the revenues of the European EO economy (upstream and downstream segment) were valued between 2.5 billion and 5 billion. (EUSPA Market Report, 2022). The market perspective in the coming decades is expected to expand. Furthermore, the variety of EO data can create more commercial opportunities across other markets, such as Agriculture and urban monitoring, which are the two focus areas of this dissertation.

THREATS

Threats in EU -Africa Space are linked to security issues. Terrorist threat risk is reported to be high in Nigeria and Kenya. Nigeria needs defense and security applications due to the presence of terrorist groups such as Boko Haram, which operates in the North East of the Country. A constant security issue has claimed the lives of thousands of people and displaced more than 2.5 million people have been killed, and 2,5 million have been displaced. The oil-rich Niger Delta faces immense problems caused by oil theft and spills. Theft is estimated to cost the country USD 2.8 billion annually, while up to 400k barrels per day are lost to spills. In Kenya, near the Somalian border, the presence of Islamist grouping as Al-Shabaab represents a threat to the security of Kenya and nearby countries. EO satellites have provided data for these issues in the past, supporting relevant institutions with satellite imagery to track insurgent troop movements or oil spills (EU Global Action on Space, 2022, p.26).

Another significant threat to EU African space development is represented by Chinese Influence. China is Ghana's, and many African countries are the main commercial partners, the first import and export partners. Additionally, there is significant Chinese immigration, with the Chinese population in Ghana estimated between 7 and 30k people.

[94] See: Copernicus market report_11_2016 | PPT, available at: https://pt.slideshare.net/NEOCdotSpace/copernicus-market-report112016. Last accessed: 06 October 2023.

[95] See also: https://www.copernicus.eu/en. Last accessed: O6 October 2023.

China has contributed to the completion of several infrastructure projects (e.g., Bui hydropower station by Sinohydro Corporation, Sunon Asogli thermal plant operated by Shenzhen Energy Group, and other gas, telecommunications, and water supply projects. Nigeria is also one of the primary beneficiaries of Chinese foreign direct investment (FDI) as part of the Belt and Road Initiative. It holds an equity stake in Nigeria Communication Satellite Limited (NigSatCom Ltd).

Furthermore, in Africa, public opinion does not consistently perceive space and space-related activities, which perceives few tangible benefits to the people.

STRENGTH	***WEAKNESS***
Many Africa countries are moving their dependency on oil and gas exports by focusing on agriculture and ICT. Africa has started to tackle its food security problem. Earth Observation programs within the continent are working on decision support and geo-information for agriculture. Earth Observation is already being used to monitor agriculture. Ghana plans to invest in aviation using the SBAS system, which could rely on EGNOS technology.	administrative and policy compliance requirements are the main weaknesses hindering the growth of Africa's space sector and cooperation with European counterparts. Corruption is also reported as one of the administrative challenges. Lack of experience in satellite design and manufacturing and limited funding. Africa's significant linguistic, industrial, and economic differences present a challenge as it attempts to foster cooperation. The budget allocation for space activities in Africa is significantly lower than that of ESA or NASA.
OPPORTUNITIES	***THREATS***
Satellite provision and infrastructural monitoring. Agriculture and natural resources exploitation. The ICT sector has significant potential due to sizeable domestic demand with unsatisfied needs. The market opportunities with the highest potential are expected to be in agriculture, emergency response, transportation,	Security issues, mainly terrorism. Another significant threat to EU African space development is represented by Chinese Influence. In Africa, public opinion does not consistently perceive space and space-related activities, which perceives few tangible benefits to the people.

infrastructure monitoring, and Satellite provision.	

Table 4-5 *Summarizes the SWOT analysis of the Africa Space arena.*

CHAPTER 5: CONCLUSIONS

Space and space technologies significantly improved the quality of life on Earth and will undoubtedly continue to do so in the coming decades. Communication satellites today allow people living in remote areas to communicate and enroll in free online courses. Remote sensing satellites, as do weather satellites, may improve the early warning mechanisms in case of approaching natural disasters. Satellite imagery helps farmers increase their yields and protect their soil. Nonetheless, these spin-off technologies and know-how improve people's everyday lives worldwide.

Given the premises of the space industry, as widely demonstrated throughout the dissertation and the literature review, will the Space Economy be a flywheel or a shortcut route to overcome global challenges and accelerate growth in Africa? If yes, can the EU – Africa partnership unlock this potential?

What are the present and prospects of this partnership, and what are the possible policy recommendations to overcome the challenges in the Euro-African space? Above all, what will be the socio-economic perspectives of both continents in the coming decades, let's say by 2030? Given the emergence of new space players such as China and India, will the partnership hold?

The dissertation's conclusion attempts to answer the research questions above, constituting new research topics for future studies.

It is difficult to predict with certainty what the European – African joint strategic partnership will look like in the coming future, be it 2030 or 2063, as they are long-term projections. However, several key factors could significantly impact both continents' development. Firstly, Africa's population is expected to grow and surpass 2 billion by 2050. (United Nations, World Population Prospects 2022). This demographic dividend could provide a significant labor force and consumer market if adequately managed. Many African countries have experienced significant economic growth over the past decades, and this trend could continue. Increased connectivity and technological access can drive innovation, entrepreneurship, and economic development. Expanding internet

penetration and investment in research and development can enhance Africa's socio-economic prospects. Efforts towards regional integration, such as the African Continental Free Trade Area, can boost intra-African trade, investment, and economic cooperation, leading to shared socio-economic benefits. And lastly, there is growing recognition of the importance of sustainable development in Africa, including climate change, environmental conservation, and inclusive growth. If these challenges are addressed effectively, it could contribute to socio-economic progress.

The state-of-the-art analysis of the African space arena to date reports that new developments in satellite technologies are foreseen to facilitate greater access to these technologies and products in African countries. However, barriers to entry into space activities are still substantial for African countries as they are associated with high fixed costs, administrative, corruption, and many other conditions that reduce private sector incentives for investing in research and development.

Of course, these potential factors are contingent on various challenges addressed in this dissertation, including poverty, governance, political stability, and infrastructure development. Ultimately, Africa's socio-economic prospects in 2030 or 2063 will depend on the actions taken by governments, regional institutions, and the international community to support the continent's development.

Furthermore, our planet hosts almost 800 million people living under a poverty level estimated at 1,90 dollars per day. Three hundred fifty million are in Africa. It implies a lack of access to food, potable water, health, hygiene, etc.

Some programs on the continent have already been set up and could be further stimulated thanks to the increased use of satellite data.

The UNOOSA research in cooperation with the European Union Space Agency presented in the case studies affirms that 65 of the 169 sub-objectives of the SDGs can only be achieved through space technologies. The United Nations Sustainable Development Goals (UNSDGs 2030), Objective one of the SDGS, calls for ending poverty. All forms of poverty, fighting hunger, reaching security nutrition, better nutrition, and promoting sustainable agriculture. This is an objective and significant challenge for the AU agenda for 2063. Agriculture is central to this objective, and the market opportunities with the highest potential in the Space economy are expected to be in agriculture, emergency response, transportation, and infrastructure monitoring. Many space applications can play a significant role in reaching objective 1. Earth Observation

from Space helps collect the necessary information regarding the quantity of artificial light during the night, the extension of vegetation, and many more. Planning interventions to fight poverty will be possible by combining spatial data with poverty indicators.

Also, from Space, it will be possible to increase productivity by estimating crop yields, evaluating the need for water, optimizing pesticides, and estimating the sustainability of cultivation activities in targeted areas. GNSS and EO Systems can also provide precise and real-time information on weather patterns, soil moisture content, vegetation health, and crop yield estimation. This information can help farmers make better decisions related to crop management, soil preparation, irrigation, and fertilization, resulting in increased crop production and income. Solutions integrating GNSS and EO data can achieve yield increases above 10 percent while reducing inputs such as fuel and fertilizers. They also provide disaster assessment and recovery information to humanitarian organizations, emergency relief workers, and government agencies. This information can help them reach affected areas faster, distribute aid more effectively, and ensure people receive the help they need more time (UNOOSA, 2018). Concerning Infrastructure development, GNSS and EO systems can provide location information for various infrastructure projects such as roads, bridges, and buildings. This information can help governments and private sector investors make well-informed decisions, reduce investment risks, and ensure efficient allocation of resources.

From the SWOT analysis performed on the European Space arena, the cornerstones of the European space strategy lie in maintaining its cooperative nature, increasing strategic independence, commercialization, and participation in new frontier projects. Cooperation thus lies at the center of the European space efforts (Doboš, 2019).

Joint efforts can lead to enhanced scientific research and knowledge sharing, enabling more accurate and comprehensive insights into various fields such as climate change, natural resource management, and disaster management. Additionally, technological collaboration can foster the development of advanced satellite systems, telecommunications networks, and remote sensing tools, empowering both regions to address their shared challenges effectively. Using space-inspired technologies can bolster economic growth by providing innovative agriculture, transportation, and healthcare solutions.

However, the Euro-Africa Space cooperation also faces several issues and challenges that must be addressed. Firstly, there is a significant imbalance in technological capabilities

and resources between Europe and Africa, making it essential to ensure equitable access to space-related infrastructure and data. Furthermore, legal and regulatory frameworks should be harmonized to facilitate smooth cooperation and address data sharing, security, and intellectual property rights concerns. Mobility and capacity-building initiatives are required to bridge the skill gaps and promote knowledge exchange. Moreover, financial barriers and limited funding resources can hinder the realization of collaborative space projects, necessitating increased investment and support from governments, international organizations, and the private sector.

Other issues and challenges also originate from the historical evolution of the geopolitical space domain since the twentieth century. One issue receiving increasing attention is connected to Space law, the problem of state licensing and control over launches into outer space. The state control of space assets in the SpaceX or Virgin Galactic era is becoming increasingly obsolete. Also, the rapid expansion of the private actors' abilities and the number of services they provide will probably force the international community to adjust the legal framework to accommodate their needs and concerns. "Problematic issues are identified as space domain delimitation, mineral extraction, weaponization of outer space, issues related to the common heritage of humanity principle, and non-offensive military use of outer space" (Doboš, 2019, p.39).

Mangala (2013) observed that implications from the Joint EU -Africa Strategy (JAES) in interregional relations can be followed on various levels. They may lead to joint policies and approaches, in contrast to the pre-Lisbon era, where policies were formulated unilaterally on the part of the EU. The significant challenges, however, will be how to implement the agenda of JAES without undermining the independence of continental decision-making and African initiatives.

The next important space power is China. "Since the beginning of the 1990s, the Chinese space program has made a significant leap forward, manifested by the 2003 crewed mission. The Chinese space program is nationalistic and focused on hard power strategic logic to challenge the US hegemony even if this struggle brings a potentially armed conflict" (Doboš, 2019, p.127). Europe lacks a credible connection to China. The rapid Chinese technological development and strategic priorities are mainly incompatible with European ones. China has surpassed Europe and the US as Africa's commercial partner.

India is the fourth largest non-European space actor. “The Indian space program is, unlike the Chinese one, primarily peaceful and socially oriented but is similarly intimately connected with Russia” (Doboš, 2019, p. 128).

Europe should continue this cooperation and incorporate India as another potentially significant cooperative actor into its major space initiatives. Countries that should not be overlooked include Japan, Canada, and Brazil. “Europe should open its space cooperation and diplomacy to an extensive array of actors to help establish a framework that will mitigate aggressive space projects represented mainly by China, Russia, and the United States nowadays. Europe's central role in space cooperation must be supported by its technological development, credibility, and openness. It must also maintain the essential strategic independence crucial to establishing a firm basis for its soft power” (Doboš, 2019, p. 128). The United States provides Europe with a credible defense framework via the NATO presence. The US military collaboration with some of the most influential European states is well established. “Europe mustn't lose the US hard power support if any major international crisis unfolds. Given the sheer scale of the US space program, it suits Europe well to have the United States as its ally despite many problems in their mutual relationship. These two can cooperate on many space projects. Europe may influence US policymakers to accept some limitations on the military uses of outer space (e.g., Code of Conduct) while using the potential availability of critical US space strategic assets” (Doboš, 2019, p.127).

Concerning policies and a roadmap of actions to be taken, there is a need to bring stakeholders and policymakers together to discuss and analyze efficient public policies relating to geospatial information and data and the opportunities inherent in the space economy.

To realize the full potential of the Euro-Africa Space collaboration, policymakers and stakeholders must take specific measures. Firstly, formulating a comprehensive space policy framework at both regional and national levels will provide a roadmap for future initiatives. This should involve the establishment of joint forums, such as the Euro-Africa Space Agency, to facilitate regular interactions, knowledge sharing, and coordination. Furthermore, investments in education, skill development, and research infrastructure must be prioritized to ensure mutual capacity-building. Increased funding opportunities and incentives for public-private partnerships should be explored to accelerate technological advancements and commercialization of space-based services.

Furthermore, there's a need to intensify the exchange of knowledge and best practices between developed and developing economies on space technologies to facilitate a common understanding of how to maximize geospatial, ICT, and Internet-related opportunities in Africa and address the risks and challenges that may arise.

The space sector will be the future game changer, and developing economies can take advantage of this opportunity by creating tight partnerships with European Institutions to address sustainable growth based on space technologies. With the ongoing digital transformation changing governance, businesses, and way of living at an accelerated pace, adopting efficient technology such as the Global Navigation Satellite System (GNSS) and Earth Observation System (EOS) will be the key to taking advantage of these opportunities. The next generation of communication services, for example, 5G, will rely on a harmonious integration of networks, driving a convergence of fixed and mobile services, including Satcom services.

The Euro-Africa Space collaboration is a valuable opportunity to leverage space science and technology to benefit both regions. By addressing the challenges and implementing the recommended policy measures, Europe and Africa can foster an inclusive, balanced, and sustainable partnership, ensuring mutual benefits in space exploration and utilization.

In conclusion, the Euro-Africa Space collaboration holds immense potential for exploring and utilizing outer space to benefit both regions. This dissertation has shed light on the various aspects of this cooperation, including its historical background, current initiatives, and potential avenues for future collaborations. Integrating Euro-Africa Space endeavors can contribute significantly to both regions' scientific advancements, technological innovation, economic growth, and societal benefits.

As Nelson Mandela stated in the opening citation, our long walk has not ended. Africa is rising, and its people and ambitions are on the move. The time is now to make the necessary efforts through space to overcome the enduring challenges.

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