HOW CAN REMOTE SENSING TECHNOLOGY HELP AFRICA'S FUTURE CHALLENGES?

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Abstract

Remote sensing technology, which uses satellites and sensors to observe the Earth from space, has become indispensable for monitoring environmental changes. This work examines the multiple applications of remote sensing, spanning vegetation mapping, urban planning, and disaster management, crucial for promoting environmental stewardship and sustainable resource management. As the world faces growing challenges, remote sensing emerges as a vital tool to address future environmental and socio-economic complexities in all continents. Thus, remote sensing, understood as an instrumental means for effective environmental management and optimization of resources, can be an important tool also in Africa on the path towards sustainable development, monitoring UN SDGs and fostering environmental resilience on the continent. and beyond.

Keywords: Remote sensing, Earth observation, Copernicus program, Africa.

Introduction

Spaceborne and airborne remote sensing is a powerful technique that allows the observation and the analysis of the Earth from space or their using satellites, airborne platforms, and the sensors they carry. Through these sensors, it becomes possible to obtain valuable information about the environment and how it changes over time. Indeed, remote sensing captures data using hardware that record the electromagnetic radiation reflected or emitted by

the Earth's surface. After these data are processed and converted into images, they can be interpreted to provide maps that help us understand spatial patterns, temporal trends, and environmental phenomena [1]. In this sense, remote sensing plays a crucial role in various scientific and application areas, e.g., vegetation mapping, urban cartography, archaeology, flood risk assessment, and forest monitoring. Additionally, it contributes to meteorology, oceanography, pollution measurement, and climate predictions. By leveraging data from satellites, we gain a global and periodic view of our planet, enabling informed decision-making and environmental stewardship. The continuous advancement in remote sensing technology enhances our understanding of Earth's dynamics and contributes to sustainable resource management [2-12].

Earth monitoring through remote sensing involves measuring physical variables of a given area without direct contact with the observed elements. This field has witnessed remarkable growth in both data quantity and quality. In fact, the volume of remote sensing data has surged exponentially. Advances in satellite technology, airborne sensors, and ground-based instruments have led to an unprecedented influx of information [13]. These data are collected from a range of diverse sensors: radars, radiometers, spectrometers, and cameras capture data across various spatial-temporal resolutions and wavelengths [14]. Recently, drones, both aerial and underwater, contribute to this data explosion by providing localized observations.

It is crucial these data to be open to contribute to solve the challenges of the next generations. The Copernicus program exemplifies the vital importance of providing free and open-access data [15]. By offering unrestricted access to its wealth of Earth observation data and services, Copernicus has democratized access to crucial information on our planet's environment, weather patterns, and natural resources. This unrestricted access enables governments, researchers, businesses, and individuals worldwide to harness this data for a wide array of applications, ranging from disaster management and climate change mitigation to urban planning and agriculture. By eliminating barriers to access, Copernicus facilitates innovation and collaboration, empowering diverse stakeholders to address pressing global challenges collec-

tively. Moreover, the free availability of Copernicus data ensures that even resource-constrained regions and communities can benefit from the insights provided, fostering equitable development and resilience in the face of environmental changes. Overall, Copernicus underscores the transformative potential of free data in driving positive societal impact and scientific advancement on a global scale [16].

Through this double reflection on remote sensing technology and the wide availability of large amounts of data, in this contribution we try to answer a crucial question: how can remote sensing technology help Africa's future challenges?

Methodology

To answer this question, we first identify five lines of action and then the problems associated with each of them. From that point, we identify the capacity of remote sensing technology to help address each of the specific problems associated with each axis.

Indeed, both in general and in the context of the African continent, remote sensing has multiple applications that can contribute to its development and improve the quality of life of its inhabitants. These are represented in Figure 1 where the five lines of action mentioned above are named.

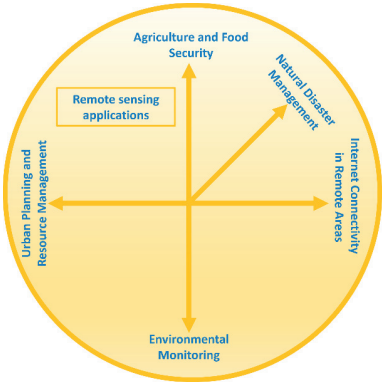

Figure 1: Remote sensing applications chart to contribute to development.

		Remote Sensing Contribution		
Axe	**Problem**	**High**	**Medium**	**Low**
Environmental Monitoring [1-3]	Climate change	x		
	Water stress	x		
	Rising temperatures and drought	x		
	Pollution and deforestation:	x		
	Poor waste management and overpopulation		x	
Agriculture and Food Security [4,5]	Climate change and agricultural adaptation	x		
	Malnutrition and inequalities			x
	Agricultural productivity and population growth		x	
	Urbanization and loss of agricultural land	x		
	Access to markets and supply chains			x
Natural Disaster Management [6-9]	Floods	x		
	Climate change and rising temperatures	x		
	Desertification and drought	x		
	Insufficient response and preparation			x
	Forced displacement and vulnerability		x	
Urban Planning and Resource Management [10-12]	Accelerated Urban Growth	x		
	Insufficient Infrastructure		x	
	City and Territory Management		x	
	Impact of Climate Change	x		

Table 1: Evaluation of a priori impact of remote sensing technology contribution to different problems.

Table 1 identifies various specific problems associated with each of the five main lines of action. The a priori impact of the contributions from remote sensing technology to help solve these problems is scored. The score was determined through a bibliographic review of the scientific literature.

In view of Table 1, remote sensing allows monitoring and evaluating the state of the environment in Africa. Changes in vegetation, deforestation, desertification, and water quality can be detected

using satellite images. Moreover, agriculture and food security issues can be addressed using remote sensing data to help farmers optimize their use of resources, to predict their harvests, and to monitor crop health. This is also crucial to ensure food security. In terms of natural disaster management, satellites can provide real-time information on floods, droughts, forest fires and other natural disasters. This helps response planning and impact mitigation. Finally, these technologies contribute to urban planning as well as resource management by assisting in urban sustainable planning, evaluating the urban consumption of natural resources, and monitoring city expansion in 2D and 3D.

Conclusions

Remote sensing technology has emerged as a transformative tool for monitoring and managing Earth's resources. Africa can use it to address critical challenges. By providing detailed observations from space, remote sensing helps in environmental monitoring to track changes such as deforestation, desertification and water quality, helping farmers optimize resource use and ensure food security, offering real-time data to plan and mitigate the impact of disasters, or supporting the management of urban growth and the related consumption of natural resources.

The availability of free, up-to-date, open access big data, such as those provided by the European Copernicus program, exemplifies the power of remote sensing to democratize information, fostering global collaboration and innovation. As Africa faces future challenges, remote sensing is presented as a fundamental ally in sustainable development and environmental management.

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