

Algeria's Space Power as a Mechanism to Strengthening Border Security: A Foresight Study amid Geopolitical and Technological Transformations

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Received: 16/01/2023 ; Accepted: 20/02/2023 ; Published: 31/08/2023

Abstract

In recent decades, space power has become a major indicator of state power. Outer space has moved beyond scientific exploration and has become a strategic domain where security, military, economic, and technological interests intersect. This shift has altered the nature of national security. Satellites, remote-sensing systems, and space communications now play a central role in border protection, counterterrorism, military monitoring, disaster management, and intelligence.

Since launching its national space program, Algeria has sought to expand its space capabilities. It established the Algerian Space Agency and launched satellites for remote sensing, communications, and scientific research. These efforts strengthen national decision-making autonomy and support security and development needs.

This study examines the current state of Algerian space power and explores its future amid geopolitical and technological change. It focuses on its role in strengthening border security. The study combines descriptive-analytical and foresight approaches. It analyzes the legal and institutional framework of Algeria's space program, assesses current capabilities, and develops future scenarios for national space capacity.

The study concludes that investment in space power is no longer only a technological choice. It is a strategic requirement for stronger national security. This requires an industrial base, qualified human resources, deeper international cooperation, and an integrated national space strategy linking security, defense, development, and scientific research.

Keywords: space power; border security; Algeria; satellites; foresight studies.

Introduction

Since the end of the Cold War, the international system has undergone deep structural changes that have affected every dimension of power in international relations. Conventional military power is no longer the sole measure of a state's standing. New domains of strategic competition have emerged, especially outer space. Rapid advances in space technology have reshaped concepts of national security. Satellites, navigation systems, remote sensing, and space communications are now indispensable for crisis management, border protection, military monitoring, and operations against terrorism and organized crime.

Contemporary strategic studies show that space capabilities are no longer confined to major powers. Emerging states also pursue them because control over space-derived information and data is a key source of power in the twenty-first century. Algeria therefore developed a national space program.

This effort led to the creation of the Algerian Space Agency and the launch of several satellites for civilian and security uses. The broader aim is to reinforce national sovereignty and support sustainable development.

This study addresses a recent topic that remains underexamined in Arabic scholarship. It focuses on the link between space power and Algerian border security. Algeria has more than 6700 kilometers of land borders and faces diverse security threats in its regional environment. This raises an important question: To what extent can space technology improve surveillance and early-warning systems and help security institutions address conventional and non-conventional challenges?

Research Problem

How can Algeria's space power strengthen border security amid contemporary geopolitical and technological transformations?

This main question gives rise to the following subquestions:

- What is space power, and what place does it occupy in contemporary strategic thought?
- What is the current state of Algeria's space program, and how can its capabilities support border security?
- What are the main obstacles to build a national space power?
- What scenarios may shape the development of Algerian space power through 2030?

Research Hypotheses

- Space power is a new foundation of national security in the twenty-first century.
- Algeria's space program can improve border security management when it is linked to integrated national policies.
- The future of Algeria's space power depends on investment in scientific research and international cooperation.

Research Objectives

- To establish the concept of space power within international relations and security studies.
- To analyze the current state of Algeria's space program.
- To explain the role of space technologies in border protection.
- To explore the future of Algerian space power in light of international change.

Methodology

The study uses a descriptive-analytical approach to examine the relevant concepts and the legal and institutional framework. It also uses a foresight approach to develop a systematic view of the future of Algerian space power amid geopolitical and technological change.

Section One: Theoretical Framework of Space Power and Its Relationship to Border Security

In recent decades, outer space has become a major domain of strategic competition among states. During the Cold War, space activity was largely associated with scientific exploration. It later became a core element of comprehensive state power because it supports communications, reconnaissance, surveillance, navigation, early warning, and military operations. This change gave rise to the concept of space power. The concept now occupies a prominent place in strategic studies and international relations as a new dimension of national power.¹ The concept of border security has evolved in parallel. It no longer refers only to the military protection of land borders. It now includes space-based and digital tools, as well as artificial intelligence, to monitor land, maritime, and air domains, analyze data, and anticipate threats. The relationship between space power and border security is therefore complementary. It reflects a shift from "border guarding" to "smart border management."

Subsection One: The Concept of Space Power and Its Development in Strategic Thought

First: The Concept of Space Power

Space power is a relatively recent concept in strategic studies. It emerged from the rapid growth of civilian and military uses of outer space and the resulting changes in the international balance of power.

Everett Dolman defines space power as a state's capacity to use outer space to protect its national interests, strengthen its security, and pursue political, economic, and military objectives.²

This definition shows that space power is not limited to owning satellites. It includes the capacity to design, manufacture, launch, operate, and protect them. It also includes the use of space-derived data in strategic decision-making.

Joan Johnson-Freese views space power as a component of comprehensive national power. It gives the state an informational advantage in security, defense, economics, and communications. This makes it a decisive element of the contemporary strategic environment.³

Taken together, these definitions present space power as a state's ability to employ space capabilities in pursuit of strategic objectives. Such power strengthens the state's international position and improves the performance of its security and development systems.

Second: The Development of the Concept of Space Power

The origins of space power are associated with the Soviet Union's launch of Sputnik 1 in 1957. This event marked a turning point in international relations by extending Soviet-American competition from land, sea, and air into outer space. Initial attention centered on military applications, particularly reconnaissance, communications, and early warning. After the Cold War, space activity expanded to economic, environmental, and scientific uses. At the start of the twenty-first century, strategic thought increasingly treated space as a fifth operational domain alongside land, sea, air, and cyberspace. Many states consequently created independent military space commands and incorporated space security into defense strategies.⁴ Space power thus evolved from the possession of technology into an integrated system of space industry, scientific research, human expertise, legal rules, and international partnerships.

Third: Space Power in International Relations Theory

Several theories explain the growing interest in space power. From a realist perspective, it is a natural extension of military power. States seek strategic superiority and try to prevent rivals from controlling vital domains. Space thus becomes part of the balance of power.

Liberal theory treats space as a domain for international cooperation. Agreements, joint projects, and technology exchange can strengthen collective security and reduce the risk of conflict.

Constructivism views space power as a product of scientific and technological development and of socially constructed ideas about security and threats. The importance of space changes as ideas, identities, and interests within the international system evolve.

Space power cannot therefore be understood from a purely military perspective. It must be analyzed through the interaction of political, legal, technological, and economic factors. This makes it a multidimensional concept.

Subsection Two: The Relationship between Space Power and Border Security amid Contemporary Security Transformations

Changes in the international security environment have redefined border security. It is no longer limited to protecting state boundaries through conventional military means. It now depends on an

integrated system for early warning, reconnaissance, data analysis, and risk management. Space capabilities have therefore become central to border protection. International experience shows that satellites can monitor vast border regions, track illicit activity, and deliver timely information to decision-makers.⁵ Border security has moved from physical protection to smart border management. Satellites now work with artificial intelligence, drones, biometric systems, and secure communications networks in an advanced border-management system.

First: Security Applications of Satellites in Border Management

Satellites form the backbone of modern border-surveillance systems. They provide high-resolution imagery, track geographic changes, and monitor movement across desert, maritime, and mountainous areas that conventional means cannot easily cover. States use these capabilities to:

- Monitor land and maritime borders continuously.
- Identify routes used for smuggling and irregular migration.
- Track the movements of armed groups and terrorist organizations.
- Monitor critical infrastructure near borders.
- Support search-and-rescue operations in remote areas.
- Provide accurate data for managing natural disasters and fires that may affect the security of border regions.⁶

These applications can operate around the clock and cover wide areas quickly. They give decision-makers a comprehensive view of the security environment.

Second: Space Power as a Tool for Early Warning and Decision-Making

Early-warning systems are among the most important security uses of space technology. They detect initial indicators before threats become actual dangers. These systems combine satellite imagery with intelligence, digital maps, and geographic information systems. This integration supports pattern analysis and the anticipation of unusual movements.

The role of satellites is no longer limited to data collection. They also support strategic decision-making by providing accurate and timely information. This improves crisis management and shortens response times.⁷

Third: Integration of Space Power and Artificial Intelligence

The digital revolution has transformed the use of space-derived data. Vast volumes of imagery and information require intelligent tools for rapid and efficient analysis. Artificial intelligence can interpret satellite imagery and help anticipate security risks. Its main applications include:

- Automated analysis of satellite imagery.
- Detection of suspicious movements in border areas.
- Forecasting routes of irregular migration.
- Support for early-warning systems.
- Better allocation of security resources along borders.

This integration enables a shift from responding to threats to anticipating them.

Fourth: Analytical Perspective

The importance of space power lies not in the possession of satellites alone. It lies in the ability to convert space-derived data into strategic knowledge for decision-making. A state that owns a satellite but lacks advanced analysis centers, qualified personnel, and an appropriate legal and regulatory framework cannot fully use its space capabilities. The effectiveness of space power is therefore

measured by the state's ability to integrate space technology with artificial intelligence, geographic information systems, intelligence analysis, and security institutions under a unified national strategy.

Subsection Three: The International Legal Framework Governing Outer Space and Its Implications for Border Security

The rapid development of space activity since the mid-twentieth century created a need for an international legal framework. Its purpose is to regulate the use of outer space and prevent it from becoming an arena of open military conflict. After the launch of the first satellites, the international community recognized that outer space was not an extension of national territory. It was an international domain governed by specific rules. These rules seek to balance freedom of exploration and peaceful use with the maintenance of international peace and security. This process produced an integrated legal system known as international space law. It now provides the main framework for the space activities of states and international organizations.⁸

This legal system is especially relevant to border security. Most tools used for border surveillance and crisis management depend directly on satellites, remote sensing, and space communications. Compliance with international legal rules is therefore essential to their lawful use.

First: The Concept of International Space Law

International space law comprises the international legal rules that govern the exploration and use of outer space. It defines the rights and obligations of states and regulates legal responsibility arising from civilian, commercial, scientific, and security-related space activities. This field developed as space activity expanded after the 1950s. It is now one of the most dynamic branches of international law.

Space law rests on several core principles. Outer space must be free for exploration and use for the benefit of all humanity. Neither outer space nor celestial bodies may be subject to national appropriation. Space must be used for peaceful purposes. States also bear international responsibility for national space activities, whether carried out by public authorities or private entities.⁹

Bin Cheng argues that international space law is a natural extension of public international law. It nonetheless has distinctive features because outer space is not subject to the sovereignty of any state. This condition required new legal rules that differ from those applied on land, at sea, or in the air.¹⁰

Second: Legal Principles Governing the Use of Outer Space

The 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, commonly known as the Outer Space Treaty, forms the legal foundation of international space law. It established principles that continue to govern space activity.

1. Freedom to Explore and Use Outer Space

Article I of the treaty states that outer space is open to all states without discrimination. States may explore and use it for the benefit of all humanity, subject to international law. This principle seeks to prevent a limited group of states from monopolizing space and to ensure broad access to scientific and technological progress.

2. Non-appropriation

Article II provides that no state may claim sovereignty over any part of outer space, the Moon, or other celestial bodies through occupation, use, or any other means. This principle is a defining feature of the legal regime governing outer space.

3. Peaceful Use

The Outer Space Treaty does not prohibit every military use of space. It does prohibit placing weapons of mass destruction in orbit or on celestial bodies. It also requires the Moon and other celestial bodies to be used for peaceful purposes. This principle has generated extensive legal debate about the lawfulness of non-offensive military satellite uses, including reconnaissance, communications, and navigation.¹¹

4. International Responsibility

States bear international responsibility for all space activities conducted under their jurisdiction, including activities carried out by private companies or non-governmental organizations. They must therefore establish effective legislative and supervisory frameworks to ensure that national actors comply with international law.

Third: Implications of International Space Law for Border Security

The development of international space law has provided a lawful basis for the use of satellites in border security, provided that international legal principles are respected. Remote sensing, space communications, and satellite navigation have become important tools for monitoring land, maritime, and air borders. They also help detect illicit activity at an early stage and coordinate rescue and relief operations.

The security use of space technology nevertheless raises several legal issues. These include data protection, respect for state sovereignty, limits on the collection of space-derived information, and the lawfulness of using satellite imagery in security and military operations. Recent scholarship therefore calls for more precise legal rules that can keep pace with rapid technological change while balancing security needs with respect for international law.

The authors argue that international space law will become increasingly important. It will regulate not only conventional space activity but also emerging issues such as space-based artificial intelligence, small satellites, and the cybersecurity of space infrastructure. Updating the international legal framework is therefore urgent if outer space is to remain safe, sustainable, and peaceful.

Section Two: The Current State of Algeria's Space Power and Its Role in Strengthening Border Security

1. Algerian Satellites and Their Role in Strengthening Border Security

Satellite technology has advanced substantially in recent decades and has become a major strategic instrument for national security and border management. Satellites no longer serve only to collect geographic information or provide communications. They are now integral to intelligence, surveillance, reconnaissance, and early-warning systems. This development has reinforced their place within comprehensive national power. Algeria has accordingly developed a national space system based on multipurpose satellites. The system supports economic development while strengthening security and defense capabilities.¹²

This system is especially important because of Algeria's geography. Its long land borders cross varied desert and mountainous terrain, where conventional surveillance is insufficient. Satellites provide an effective means of continuous monitoring, support security decisions, and improve border management.

First: Algeria's Satellite System

Since the beginning of its space program, Algeria has developed a diverse group of satellites with different technical functions and missions.

Alsat-1 was Algeria's first satellite. It was launched in 2002 through international cooperation for disaster monitoring. Although intended mainly for civilian applications, it gave Algeria valuable experience in satellite operations and image analysis. Its data supported mapping, environmental monitoring, and the observation of fires and floods.¹³

Alsat-2A and Alsat-2B marked a significant advance in remote sensing because they could capture high-resolution satellite imagery. They supported land monitoring, digital mapping, urban planning, and environmental observation. Their data can also serve security applications.

In 2017, Algeria launched Alcomsat-1, its first national communications satellite. It provides television broadcasting, government communications, distance education, and connectivity in remote areas. It also strengthened the state's autonomy in strategic communications and reduced reliance on foreign space services.

These satellites reflect the gradual development of Algeria's space capabilities. The program has moved from acquiring technology toward expanding applications and developing space infrastructure.

Table 1. Algerian Satellites and Their Main Uses

Satellite	Launch year	Satellite type	Primary mission	Security applications
Alsat-1	2002	Remote sensing	Earth, environmental, and disaster monitoring	Mapping, border-area monitoring, and disaster management
Alsat-2A	2010	High-resolution remote sensing	High-resolution space imaging	Border monitoring, movement detection, and military-map updates
Alsat-2B	2016	High-resolution remote sensing	Space imaging and monitoring	Geospatial intelligence and monitoring of illicit activity
Alcomsat-1	2017	Communications	Satellite communications and broadcasting	Secure government communications and command-and-control support during crises
Alsat-1B	2016	Remote sensing	Imaging and natural-resource monitoring	Satellite imagery for environmental and security monitoring
Alsat-1N	2016	University and experimental satellite	Scientific research and training	Development of national expertise in space technology

Source: Prepared by **Merabet Bochra** using data from the Algerian Space Agency (ASAL) and reports of the National Space Program, 2022.

Second: Security Applications of Satellites in Border Protection

Satellites support border security by monitoring large areas continuously and producing accurate data for threat analysis and decision-making. Their main applications are as follows:

First, continuous monitoring of land borders. Satellite imagery can detect movement in remote desert and mountainous areas. It can therefore reveal unauthorized routes used for smuggling or irregular migration.

Second, maritime-border surveillance. Satellites can track vessel movements, detect illicit activities, and support the protection of maritime areas and natural resources.¹⁴

Third, support for counterterrorism and operations against organized crime. Satellite imagery helps locate suspicious activity, analyze changes on the ground, and support security planning.

Fourth, disaster and crisis management. Satellite data help assess the effects of floods, fires, and earthquakes. They can identify affected areas and guide relief and rescue operations. These functions indirectly support stability in border regions.¹⁵

Fifth, the creation of accurate geospatial databases. These databases support security and military institutions, long-term planning, and resource management.

These applications reduce reliance on conventional monitoring methods. They also provide timely information that can be integrated with artificial intelligence and geographic information systems. This improves the efficiency of border management.

Authors' Analysis

An assessment of Algeria's satellite system should not focus only on the number of satellites launched. It should examine the strategic value that the system creates for the state. Genuine space power exists when space-derived data become usable information for security planning and decision-making. It also requires integration into a national network that includes security and defense institutions, universities, research centers, and industry. The future of Algerian space power therefore depends on moving beyond satellite ownership toward an integrated space system. Such a system must include manufacturing, scientific research, software, data analysis, and continuous training. This transition would strengthen national decision-making autonomy and improve border security in a changing threat environment.

Subsection Three: Challenges and Future Prospects for the Development of Algeria's Space Power

Algeria's space program has progressed markedly over the past two decades. Rapid changes in the global space sector nevertheless create new challenges that require a long-term strategic vision. Competition now extends beyond satellite ownership. It includes space industries, technological innovation, artificial intelligence, cyber capabilities, and big-data management. It also requires international partnerships that facilitate technology transfer while strengthening national autonomy. Assessing the future of Algerian space power therefore requires an analysis of these challenges and of possible development paths consistent with border-security needs.¹⁶

First: Technological Challenges

Advanced technology is the foundation of modern space power. Achieving a high level of capability requires major investment in scientific research, space engineering, artificial intelligence, and the production of precision electronic components.

Algeria faces the challenge of a limited space-industrial base. A substantial share of its space technology still depends on external cooperation. Technological autonomy is therefore a strategic objective. It requires domestic industrial development and specialized centers for the design, manufacture, and testing of space systems. Rapid advances in small satellites, including CubeSats, and low Earth orbit (LEO) systems create an additional need for adaptation. Otherwise, the technological gap between Algeria and leading space powers may widen.

Second: Economic Challenges

Space activity requires substantial long-term financing because research, development, satellite design, launch, operation, and maintenance are expensive.

Investment in space requires considerable financial resources, but it can also produce major economic and strategic returns. It can develop national industries, create highly skilled employment, improve natural-resource management, support food security, and expand digital services. Algeria should therefore diversify funding for space projects, encourage public-private partnerships, and support space-technology start-ups. These measures can help sustain the national space program.

Third: Legal and Institutional Challenges

National space legislation is essential to effective space power. It regulates space activity, protects data, encourages investment, and assigns legal responsibilities. Algeria must therefore continue to develop the legal framework for its space sector in accordance with United Nations treaties on outer space.

The success of a space program also depends on coordination among national institutions. These include defense, interior, higher education, scientific research, telecommunications, and industry authorities. An integrated institutional approach is therefore necessary.

Fourth: Geopolitical Challenges

Competition among major powers in outer space is intensifying. Space has become a domain of strategic, economic, and technological rivalry and a modern dimension of deterrence.

This trend has created challenges related to the militarization of space, cyberattacks on space infrastructure, and growing reliance on satellites in military and intelligence operations. Middle powers must therefore adopt balanced space policies. Such policies should build national capability, support international cooperation, and respect international space law. This approach can preserve decision-making autonomy and avoid costly involvement in space arms races.

Section Three: A Foresight Model for Developing Algerian Space Power to Strengthen Border Security

Technological change and new forms of security threat are transforming the international system. States have consequently reassessed the tools used to protect national security. Border security no longer depends only on conventional means. It increasingly relies on space technology, artificial intelligence, and big-data analysis within an integrated border-management system.

Recent strategic literature shows that investment in the space sector produces more than scientific gains. It can strengthen sovereignty, support the economy, and improve the performance of security and military institutions. This section proposes an analytical model for assessing the role of space power in border security. It also examines the future of Algeria's space program in light of international change.

Subsection One: A Proposed Smart Space Power Model for Strengthening Border Security

Integrated Smart Space Power Model for Border Security

The model consists of six interrelated dimensions. The authors regard them as essential to any national policy that uses space capabilities for border protection.

First: The Space Dimension

This dimension provides the technical foundation of the model. It includes:

- Remote-sensing satellites.
- Communications satellites.
- Satellite-navigation systems.
- Ground control stations.
- Data-reception centers.

These components provide the primary information needed to monitor borders and manage land and maritime domains.

Second: The Technological Dimension

Satellites alone cannot provide security. Space-derived data must be converted into accurate and usable information.

This dimension includes:

- Artificial intelligence.
- Big data.
- Geographic information systems (GIS).
- Cloud computing.
- Machine learning.

These tools help identify unusual patterns and anticipate threats before they materialize.

Third: The Security Dimension

This dimension measures the state's ability to use space-derived information to:

- Combat terrorism.
- Combat organized crime.
- Address irregular migration.
- Combat arms and drug trafficking.
- Protect maritime borders.
- Protect critical infrastructure.

This dimension represents the ultimate objective of the space system.

Fourth: The Institutional Dimension

The effectiveness of space power depends on coordination among national institutions.

This dimension includes:

- The Algerian Space Agency.
- Defense institutions.
- Security services.
- Universities.
- Research centers.
- The industrial sector.

Stronger institutional integration increases the effectiveness of border-security management.

Fifth: The Legal Dimension

A successful space policy requires a clear legal framework governing:

- The use of space-derived data.

- Cybersecurity.
- Information protection.
- Legal responsibility.
- International cooperation.
- Investment in the space sector.

Updating national legislation is among the most important requirements for the development of space power.

Sixth: The Geopolitical Dimension

A state's geography and its regional and international environment directly shape the nature of its space program.

This dimension includes:

- The nature of regional threats.
- Competition among major powers.
- International cooperation.
- Regional security.
- The global space race.

The authors argue that neglecting this dimension produces space programs detached from strategic realities.

Subsection Two: Future Scenarios for the Development of Algerian Space Power through 2030

Foresight studies are important methodological tools in political science and strategic studies. They do not seek to predict the future with certainty. Instead, they identify possible trajectories by analyzing current trends and key variables. Foresight is especially important to space power because innovation is rapid, international competition is intensifying, and new applications are emerging in artificial intelligence, quantum computing, and small satellites. States therefore need long-term strategic visions that prepare them for future challenges.¹⁷

The study proposes three main scenarios for the future of Algerian space power through 2030:

First: The Status Quo Scenario

This scenario assumes that current policies continue without major changes to the structure of the space sector or to investment levels. Algeria would continue to launch satellites periodically. It would also remain dependent on international partnerships for design, launch, and some technical applications, while domestic manufacturing stayed limited. This scenario would preserve existing achievements, but it would not deliver full technological autonomy. It would also restrict Algeria's ability to keep pace with rapid changes in the global space sector.

From a security perspective, satellites would continue to support border surveillance. The response to new threats would nevertheless remain dependent on external capabilities in some technical areas.

Second: The Evolution Scenario

This scenario calls for greater investment in scientific research and stronger training programs for engineers and researchers. It also expands cooperation among universities, research centers, and industrial institutions.

It further assumes the creation of national incubators for space innovation and support for start-ups that develop applications based on space-derived data and artificial intelligence.¹⁸

Under this scenario, Algeria would increase its national contribution to satellite design, space-data analysis, and specialized software. Coordination between the space agency and security institutions would also improve.

These developments would strengthen border security by providing more accurate information, shortening response times, and improving risk anticipation.

Third: The Strategic Leadership Scenario

This is the most ambitious scenario. It calls for a comprehensive national space strategy through 2030 and treats the space sector as a driver of development, innovation, and national security.

This scenario assumes the achievement of several strategic objectives:

- Establish an integrated national space industry.
- Manufacture a high proportion of satellite components domestically.
- Establish a national center for space-based artificial intelligence.
- Develop advanced systems for satellite-image analysis.
- Create a national geospatial database based on space-derived data.
- Strengthen cooperation with international space agencies.
- Integrate the private sector into space industries.
- Develop specialized university programs in space engineering and space policy.

Under this scenario, space power would become a pillar of national security. It would directly support border surveillance, natural-resource management, disaster response, the digital economy, and Algeria's international standing.

Table 2. Comparison of Future Scenarios

Indicator	Status Quo Scenario	Evolution Scenario	Strategic Leadership Scenario
Investment	Limited	Moderate	High
Scientific research	Gradual progress	Developed	Advanced
Domestic manufacturing	Limited	Moderate	High
Artificial intelligence	Partial use	Broad use	Full integration

Indicator	Status Quo Scenario	Evolution Scenario	Strategic Leadership Scenario
Border security	Limited improvement	Substantial improvement	Integrated smart system
International cooperation	High dependence	Balanced	Strategic partnerships
Space autonomy	Low	Moderate	High

Source: Prepared by Merabet Bochra.

Subsection Three: Strategic Recommendations for Developing Algerian Space Power and Strengthening Its Role in Border Security

International trends show that space capability has become an important measure of comprehensive state power. Space technology offers advanced applications in security, defense, and development. Achieving these benefits requires an integrated strategic vision that combines technological development, institutional reform, investment in human capital, and legal modernization. Based on the assessment of Algeria's space program and its challenges, the study proposes practical recommendations to strengthen Algeria's position in the space domain and support its border-security system.

First: Adopt a Comprehensive National Space Strategy

Algeria needs a national space strategy extending through 2030. It should define clear objectives, measurable performance indicators, and investment priorities in remote sensing, space communications, artificial intelligence, cybersecurity, and space industries. The strategy should align with national-security and sustainable-development goals. It should also be reviewed regularly in response to international change.

Second: Develop the National Space Industry

A national space industry is essential to building space power. It can reduce technological dependence and create value for the national economy. Algeria should therefore:

- Promote the domestic manufacture of space components.
- Establish specialized industrial clusters.
- Support start-ups in space technology.
- Strengthen partnerships between universities and industry.
- Use international cooperation to facilitate technology transfer.

Third: Invest in Scientific Research and Human Resources

Human expertise is the foundation of every successful space program. Algeria should expand training in space engineering, artificial intelligence, satellite-image analysis, robotics, and cybersecurity. It should also establish specialized national centers for space research and link them to security and economic institutions. This would help ensure that scientific research addresses practical needs.

Fourth: Integrate Artificial Intelligence into Space Applications

Space-derived data have become vast and complex. Artificial intelligence is therefore a necessity rather than an option. Algeria should develop machine-learning platforms for satellite-image analysis that can:

- Detect unusual movements.
- Anticipate security risks.
- Improve border management.
- Support decision-making.
- Improve the effectiveness of early warning.

Fifth: Strengthen the Cybersecurity of the Space System

Space infrastructure is increasingly vulnerable to cyberattacks. Algeria should therefore:

- Establish a national center for the protection of space systems.
- Develop cybersecurity protocols.
- Train specialized teams in space cyber defense.
- Protect ground-control stations and databases.

Sixth: Expand International Cooperation

International cooperation is a major factor in the success of space programs. It supports technology transfer, joint projects, and professional development. Algeria should therefore:

- Strengthen cooperation with the United Nations Office for Outer Space Affairs (UNOOSA).
- Expand partnerships with international space agencies.
- Participate in multilateral scientific programs.
- Promote exchanges among experts and researchers.

Seventh: Apply Space Power to Border Security

The authors argue that effective use of space power for border protection requires an integrated national system comprising:

- Remote-sensing satellites.
- Centers for satellite-image analysis.
- Artificial-intelligence systems for threat anticipation.
- Unified geospatial databases.
- Direct links between the space agency and security and military institutions.

Eighth: The Proposed Strategic Vision

The authors propose that Algerian space policy in the next phase rest on five main pillars:

1. Technological autonomy.
2. Innovation and scientific research.
3. Institutional integration.
4. Balanced international partnerships.
5. The use of space technology to serve security and development.

Conclusion

Rapid advances in space technology have reshaped concepts of power in international relations. Conventional military capability alone is no longer sufficient to guarantee national security. Space power has become a core component of comprehensive state power. Satellites, remote sensing, space communications, and artificial intelligence have transformed border management, threat monitoring, and security decision-making.

The study finds that Algeria's space program has developed substantially since the Algerian Space Agency was established. Algeria has built an institutional and technical base that supports the use of space applications in border security, disaster management, digital mapping, and communications. Current international transformations nevertheless require a more advanced phase. Algeria must develop a national space industry, strengthen scientific research, and integrate artificial intelligence across space applications.

The study also shows that border security no longer depends only on conventional means. It is an integrated system that combines space technology, intelligent data analysis, institutional coordination, legal rules, and international cooperation. The study therefore proposes an analytical model that links space power to border security. This model can support future assessments of space policy.

The future of Algerian space power depends on a balance among three priorities: developing national capabilities, remaining open to international cooperation, and building a national innovation system that can produce knowledge and technology. Success in these areas would strengthen Algeria's regional and international position and improve its capacity to address emerging security challenges.

Findings

The study produced the following main findings:

1. Space power has become a core component of comprehensive national power in the twenty-first century.
2. Satellites strengthen border security through continuous monitoring, early warning, and support for decision-making.
3. Algeria has established a national space program with important capabilities in remote sensing and space communications.
4. The national space industry requires further development to achieve greater technological autonomy.
5. Artificial intelligence and big-data analysis will shape the future of space applications for border security.
6. International cooperation is essential to technology transfer and the development of national expertise.
7. The legal and institutional framework must be updated to keep pace with rapid change in the space domain.
8. Investment in scientific research and human resources is essential to sustainable space power.
9. The proposed analytical model can be developed further in future studies that measure state readiness to use space power for border security.

Recommendations

In light of these findings, the study recommends the following:

- Prepare a long-term national space strategy through 2030.
- Increase expenditure on research in space science and technology.
- Support a national space industry and reduce dependence on foreign technology.
- Expand training programs for engineers and researchers in space-related disciplines.

- Integrate artificial-intelligence applications into the analysis of space-derived data.
- Establish a national center specializing in space-based geospatial intelligence.
- Develop the legal framework governing space activity in accordance with international law.
- Expand cooperation with international space agencies and organizations.
- Strengthen partnerships among universities, research centers, industrial institutions, and security bodies.
- Support foresight research on space security, cybersecurity, and the space economy.

Notes

¹ Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), pp. 1-18.

² *Ibid.*, pp. 7-10.

³ Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), pp. 15-31.

⁴ John J. Klein, *Space Warfare: Strategy, Principles and Policy* (London: Routledge, 2006), pp. 33-59.

⁵ Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), pp. 45-63.

⁶ Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), pp. 89-118.

⁷ John J. Klein, *Space Warfare: Strategy, Principles and Policy* (London: Routledge, 2006), pp. 74-103.

⁸ United Nations, *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 1967.

⁹ Frans G. von der Dunk, *Handbook of Space Law* (Cheltenham: Edward Elgar Publishing, 2015), pp. 45-79.

¹⁰ Bin Cheng, *Studies in International Space Law* (Oxford: Clarendon Press, 1997), pp. 215-248.

¹¹ Malcolm N. Shaw, *International Law*, 9th ed. (Cambridge: Cambridge University Press, 2021), pp. 690-705.

¹² Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), pp. 84-103.

¹³ Algerian Space Agency, *Algerian Satellites: Missions and Applications* (Algiers, 2022), pp. 18-47.

¹⁴ Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), pp. 120-149.

¹⁵ Frans G. von der Dunk, *Handbook of Space Law* (Cheltenham: Edward Elgar Publishing, 2015), pp. 312-339.

¹⁶ Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), pp. 239-260.

¹⁷ Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), pp. 233-256.

¹⁸ Michel Godet, *Creating Futures: Scenario Planning as a Strategic Management Tool* (London: Economica, 2006), pp. 120-151.

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International Treaties and Documents

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967).

Convention on International Liability for Damage Caused by Space Objects (1972).

Convention on Registration of Objects Launched into Outer Space (1975).

Documents of the United Nations Office for Outer Space Affairs (UNOOSA).