

Towards Effective Protection of Algerian Coasts Using Artificial Intelligence: Legal Challenges and Legislative Foresight

نحو حماية فعالة للسواحل الجزائرية باستخدام الذكاء الاصطناعي: التحديات القانونية والاستشراف التشريعي

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Abstract:

This study explores the use of artificial intelligence in protecting the algerian coastlines, analyzes the current legal framework, and examines legislative prospects for ai's role in sustainable environmental protection. It concludes that ai can significantly improve coast management by addressing threats like erosion and pollution, and highlights the need to update the legal framework for effective integration of this technology into protection strategies.

Keywords : artificial intelligence, coastal protection, legal framework, coastal erosion, environmental pollution.

Introduction

The Algerian coastline is considered one of the country's most significant environmental and economic resources, extending over 1,200 kilometers and characterized by unique biological and geographical diversity. However, this coastal stretch faces multiple environmental challenges, most notably coastal erosion, pollution resulting from human activities, and climate change. In the face of these challenges, artificial intelligence emerges as an effective tool that can contribute to improving the management of coastal resources and enhancing their protection. However, achieving this requires a well-structured legal and regulatory framework that supports the use of this technology.

Study Problem: This study focuses on the effectiveness of the Algerian legal framework in protecting the coastline from increasing environmental threats, and the role of artificial intelligence in enhancing these efforts. To address this issue, the study is divided into two main sections: the first section addresses the legal framework for protecting the Algerian coastline in light of technological developments, while the second section is dedicated to exploring the prospective role of artificial intelligence in protecting the Algerian coastline.

1. The Legal Framework for Protecting the Algerian Coastline

The Algerian coastlines are among the most prominent environmental resources that require effective protection and regulation due to their significant importance in economic and social development, as well as being a vital environment facing multiple threats resulting from human activities and climate change.

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With the increasing pressure on these coastal areas, it has become essential to establish a robust legal and administrative framework to ensure the preservation of these natural resources and protect them from deterioration. In this context, Algerian legislators have adopted a range of national laws aimed at regulating the exploitation of coastlines and protecting them from risks that could impact the marine and coastal environment.

The focus has been on achieving a balance between sustainable development and environmental protection, with these regulations aiming to reduce the harmful effects of human activities, such as pollution from industries and waste, while promoting the conservation of marine biodiversity¹.

In this context, the focus will be on the legal framework for protecting the Algerian coastlines. The first section will address the national legislation related to coastal protection, covering the various laws enacted by the Algerian legislator, with special attention to the challenges faced in implementing these laws. Additionally,

The study will explore the legal and administrative mechanisms that contribute to the enforcement of these regulations, emphasizing the role of specialized bodies, such as the National Coastal Conservation Agency, and the licensing system as a tool for regulating coastal activities.

1.1 First Subtitle The Algerian legislator has placed significant emphasis on the protection of the coastlines :

recognizing them as a strategic environmental and economic resource, and a cornerstone of sustainable development. To this end, a series of laws have been enacted aimed at regulating the exploitation of the coastlines and safeguarding them from degradation, with a particular focus on addressing the negative impacts caused by human activities and climate change.

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Law No. 02-02, dated February 5, 2002,² is considered one of the most significant national legislations that established a comprehensive legal framework for the protection and enhancement of the coastline. The law aims to ensure a balance between the protection of the coastline and its sustainable utilization. It sets out key principles, such as the necessity of adopting an integrated approach to urban planning along the coast, and prohibits the establishment of polluting or environmentally destructive activities and facilities in coastal areas.

Furthermore, the law imposes restrictions on industrial, agricultural, and tourism activities, prohibiting the construction of facilities within sensitive coastal areas without prior authorization. It also emphasizes the need for conducting environmental impact assessments for any project carried out along the coastline to minimize its negative effects.³

On the other hand, Law No. 03-10, dated July 19, 2003,⁴ was issued with the aim of establishing the general principles for environmental protection in its broadest sense, including the protection of coastlines. This law outlines principles that obligate public authorities and investors to adopt measures to preserve natural resources, including coastlines.

The law includes provisions that require stakeholders to establish national and regional plans to protect the coastlines from pollution, particularly that resulting from industrial activities and liquid waste. It also introduces the principle of environmental responsibility, which holds those responsible for pollution accountable for rectifying the damage caused to the coastline, either through the removal of pollutants or the rehabilitation of damaged areas. Furthermore, the law established regulatory frameworks for controlling the methods and processes of transporting hazardous and specific waste through the issuance of Executive Decree No. 04/409, dated December 14, 2004, which defines the procedures for the transport of special and hazardous

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waste.⁵ This provision implicitly strengthens the management and transport of hazardous and specific waste, thus mitigating the risk of environmental pollution, including that of the coastline.⁶

Law No. 01-19⁷ establishes a legal framework for waste management, aiming to reduce its negative impact on the environment, including the coastlines. This law sets clear principles for organizing waste collection, treatment, and disposal in an environmentally sound manner.

It emphasizes the need to provide special means for transporting hazardous waste and preventing its leakage into coastal or marine areas. In addition, the law stipulates the establishment of specialized centers for treating industrial and liquid waste, which are among the main causes of pollution along the coastal strip.

In addition to the aforementioned legislation, there are other laws that indirectly contribute to the protection of the coastal environment. For example, Law No. 04-07 dated August 14, 2004,⁸ related to fishing, regulates the exploitation of marine resources in a way that ensures the preservation of ecological balance. Law No. 05-12, dated August 4, 2005,⁹ related to water resources, is a key reference for regulating the exploitation of water resources and preventing pollution caused by the leakage of chemicals into beaches and seas. Furthermore, the Algerian legislator has enacted a crucial decree to address the waste generated by industrial facilities located near the coast through Executive Decree No. 06/141,¹⁰ which regulates the maximum allowable values for industrial liquid discharges. This decree aims to reduce pollution from industrial liquid discharges, which is vital for protecting the coasts from pollution caused by industrial activities. Industrial liquid discharges, which may contain toxic and polluting substances, pose a significant threat to coastal ecosystems, including soil and marine waters.¹¹

By imposing maximum limits for industrial liquid discharges, the decree helps reduce the negative impacts of these discharges on the marine environment and Algerian coastlines, contributing to the preservation of the coastal ecosystem's balance and protection from pollution. This decree represents an important step in strengthening the legal framework for the protection of Algeria's coasts, complementing other measures aimed at combating pollution and developing sustainable strategies for protecting coastal natural resources. It can also be noted that this decree enhances the ability of relevant authorities to monitor industrial discharges and ensure compliance with the established limits, which is crucial for safeguarding the Algerian coasts from environmental degradation.

Despite the existence of these laws, their practical application faces multiple challenges, notably the lack of coordination among the responsible authorities, as well as insufficient material and human resources allocated for monitoring activities affecting the coastal environment. Furthermore, the insufficient awareness among economic actors regarding the importance of complying with these regulations is a significant barrier to achieving the desired objectives.

In conclusion, the Algerian legal framework clearly focuses on coastal protection through specialized and supporting legislation, striving to achieve a balance between the exploitation and preservation of coastal resources. However, the challenges associated with enforcement require further efforts to enhance oversight and ensure strict application of the law.

1.2 Second Subtitle: The Legal and Administrative Mechanisms for Implementing These Legislations

To ensure the effective implementation of coastal protection legislation, the Algerian legislator has taken multiple steps, including the establishment of specialized bodies and institutions and the introduction of legal mechanisms that guarantee environmental protection of the coasts, limiting degradation caused by increasing human activities. These steps reflect the state's awareness of the importance of coasts as a vital part of the natural, economic, and social environment.

The National Coastal Conservation is one of the most important bodies established under Executive Decree No. 04-113, dated April 13, 2004,¹² to enhance coastal protection and value it

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as part of Algeria's natural and environmental heritage. This conservation body is tasked with formulating and implementing comprehensive strategies for coastal protection in coordination with relevant authorities.

It is responsible for preparing national and regional programs aimed at protecting coastal biodiversity by regulating human activities in coastal areas and ensuring their alignment with environmental preservation requirements. The conservation body is also concerned with monitoring industrial, tourist, and agricultural activities that could pose a threat to coastal ecosystems, offering preventive and corrective solutions to reduce environmental damage.

In addition, the conservation body issues periodic reports on the state of the coasts and the level of pollution, based on field data and scientific analyses, providing recommendations to address discovered environmental issues. These reports serve as a crucial reference for policymakers and executive bodies in making decisions based on accurate information.

The role of the conservation body is not limited to executive actions and monitoring but extends to promoting environmental awareness among citizens through awareness campaigns that highlight the importance of coasts and their role in achieving sustainable development. The conservation body also encourages the involvement of civil society in coastal protection programs, based on the principle that environmental protection is a collective responsibility requiring active participation from all segments of society.¹³

The licensing system also includes strict conditions for issuing licenses, such as the necessity to adhere to the general principles of environmental protection, the use of eco-friendly technologies that reduce pollution emissions, and the commitment to ensuring that marine ecosystems are not harmed. The licenses also involve continuous monitoring of the approved activities to ensure compliance with the specified environmental conditions.

Despite the effectiveness of the licensing system in regulating coastal activities, its implementation faces significant challenges. One of the most prominent challenges is the lack of human and technical resources, as some relevant authorities suffer from a shortage of qualified staff and the necessary equipment to effectively monitor coastal activities. Additionally, there is a lack of environmental awareness, as the importance of complying with environmental legislation remains low among some investors and project implementers, leading to increased violations. Some entities seek to implement development projects that could negatively impact the coastal environment under the pretext of achieving economic gains.

To address these challenges, it is essential to strengthen monitoring mechanisms and provide the necessary resources to the authorities responsible for monitoring coastal activities. Furthermore, awareness campaigns should be intensified to raise citizens' and investors' understanding of the importance of adhering to environmental regulations. Moreover, the licensing system can be developed by adopting digital technologies that facilitate the licensing process and improve the efficiency of detecting violations..¹⁴

2. Envisioning the Role of Artificial Intelligence in Protecting Algerian Coasts

The Algerian coasts, stretching along a vast expanse of the Mediterranean Sea, face increasing environmental challenges due to climate change, industrial pollution, and unregulated urban expansion. As these challenges grow, the importance of leveraging modern technology, particularly artificial intelligence, has emerged as an effective tool for protecting this vital natural resource. Artificial intelligence is an advanced means capable of providing innovative solutions to environmental problems by collecting data, analyzing it accurately, and making decisions based on future predictions.

In this context, this section discusses the possibilities offered by artificial intelligence to address the environmental challenges facing Algerian coasts, focusing on its ability to provide

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proactive and effective solutions. The section also addresses the legislative foresight of AI's role in coastal protection, as integrating artificial intelligence into the legal framework is a crucial step to ensure the sustainability of the coastal environment and protect it from degradation caused by human activities or natural phenomena.

2.1 First Subtitle: The Potential of Artificial Intelligence in Addressing Environmental Challenges

Artificial intelligence is considered one of the effective tools in addressing environmental challenges, as it contributes to improving environmental sustainability through various applications. AI enables the processing of vast amounts of environmental data, helping to gain a deeper understanding of climate changes and accurately identifying pollution sources. Through modeling and predictions, AI aids in optimizing the use of natural resources, such as water and energy, reducing waste, and enhancing efficiency. Additionally, AI can improve the efficiency of renewable energy technologies, such as solar and wind power, by predicting weather conditions and optimizing operations and maintenance.

AI also helps in improving waste collection and sorting processes, contributing to higher recycling rates and reduced pollution. However, despite the benefits of AI, its use requires significant energy and storage resources, which could lead to increased energy consumption and carbon emissions if not used sustainably. Therefore, it is essential to adopt strategies that ensure AI is utilized in ways that protect the environment and support sustainable development.¹⁵

Coastal areas are vital regions that combine rich biodiversity with various human activities, making them vulnerable to a range of natural disasters such as floods, storms, and coastal erosion. In this context, artificial intelligence (AI) is considered a powerful tool in predicting and managing these disasters effectively.

AI contributes to analyzing large volumes of environmental data, such as satellite images, weather data, and water levels, to identify patterns and trends that may indicate impending coastal disasters. For example, machine learning techniques can be used to predict the paths of tropical storms or potential floods, enabling early preventive actions.¹⁶

After a disaster occurs, AI helps in quickly and efficiently assessing damages by analyzing aerial images and field data. This analysis contributes to identifying the most affected areas and guiding relief teams and resources accurately, thus accelerating response and recovery efforts.

AI is also used to monitor changes in coastal lines and analyze factors affecting erosion, such as wave movement, tides, and human activities. Through these analyses, effective strategies can be developed to protect coasts, such as designing marine barriers or restoring coastal ecosystems. Despite its significant benefits, the use of AI in managing coastal disasters faces challenges, including a lack of high-quality data, the complexity of environmental models, and the need for cooperation among various stakeholders. Nevertheless, these challenges provide opportunities to develop new technologies and enhance collaboration between scientists, engineers, and decision-makers, ultimately contributing to improved coastal disaster management strategies.¹⁷

It is certain that artificial intelligence represents a significant transformation in supporting sustainable environmental decision-making. It opens the door to achieving positive changes and greater sustainability in various aspects of environmental life. AI allows us to harness its advanced capabilities in conducting accurate simulations, analyzing large volumes of data with high efficiency, and building advanced forecasting models.

Artificial intelligence can provide strong signals and precise evidence, contributing to making sustainable and innovative environmental decisions. This power can be used to improve environmental policies, develop effective measures such as implementing waste management strategies and planning sustainable cities. It can also play a major role in evaluating the impact of

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environmental projects and predicting climate changes, thus contributing to informed strategic decisions based on data and evidence.¹⁸

It is worth noting that artificial intelligence can significantly contribute to the development of new technologies that play a vital role in environmental conservation and achieving sustainable development. These technologies can be harnessed to improve various environmental sectors, starting with the development of clean and sustainable energy systems. AI can enhance energy efficiency by monitoring patterns and systems of energy usage and analyzing consumption data, which helps reduce waste and achieve more efficient consumption. Additionally, these technologies can foster innovations in renewable energy technologies such as solar and wind energy by optimizing system design and analyzing weather and production data for more accurate and efficient results.

Furthermore, artificial intelligence can be relied upon to improve recycling and waste disposal processes. By using intelligent classification technologies, recyclable materials can be sorted and the most suitable ones for reuse identified more quickly and accurately, which helps reduce waste and minimize raw material loss. AI can also analyze consumption behaviors and identify the most sustainable patterns, contributing to the widespread adoption of recycling practices. These technologies represent a step toward achieving tangible progress in environmental sustainability and improving resource efficiency, ultimately reducing negative environmental impacts.

2.2 Second Subtitle: Legislative Foresight for the Role of Artificial Intelligence

Sustainable development is considered a fundamental element in the Algerian Constitution, emphasizing its importance and environmental protection in several constitutional articles, both explicitly and implicitly. The Algerian Constitution aligns with the country's international commitments in the field of environmental conservation and the balance between economic and social development and environmental protection. The state seeks to improve the quality of life for both current and future generations by promoting sustainable development, preserving natural resources, safeguarding environmental heritage, and protecting the coastlines.

Sustainable development occupies a prominent legal status in the Algerian legal system, as it is intrinsically linked to a range of related laws, including those specifically for coastal protection. This close connection demonstrates the evolution and advancement of the concept of sustainable development to the highest level, explaining its inclusion in the Algerian Constitution, which is considered the supreme law of the country. Furthermore, the Algerian environmental law is referred to as "the law concerning environmental protection within the framework of sustainable development." Additionally, Algeria adopts international commitments in the field of sustainable development, most notably the United Nations 2030 Agenda for Sustainable Development.¹⁹

These principles reflect a commitment to sustainable environmental practices, leveraging modern technology to achieve these goals. Among these principles is the principle of substitution and integration, which calls for the development of technologies that contribute to environmental protection and the sustainability of resources.

The precautionary principle reflects the focus on using technology to prevent pollution and potential environmental damage, while the principle of caution emphasizes the positive interaction between technology and the environment. The "polluter pays" principle stresses the need to hold those responsible for pollution accountable and encourages them to adopt technologies that minimize environmental impact. Finally, the principle of information and participation highlights the importance of engaging the public and using technology to raise environmental awareness and foster participation in decision-making processes, underscoring Algeria's comprehensive commitment to sustainable development in its legislation.²⁰

These principles aim to integrate technological advancement with the forward-looking vision of law, creating a clear balance between science and technology on one hand, and the

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environment on the other, within the framework of sustainable development. Upon closely examining the concept of biodiversity conservation, we find that this principle is closely related to biology, as well as precise sciences and microscopy. This connection indicates a continuous and noticeable evolution in the study of environmental phenomena, with an ongoing need to monitor this progress using available technology, including artificial intelligence applications. The development of these applications demonstrates the ability to address growing technological challenges, such as sensing techniques, monitoring, precise imaging, and data analysis.

In this context, the principle of non-degradation of natural resources can be seen as a complementary effort aimed at improving the efficiency of renewable energy use while preserving environmental resources for future generations. This includes adopting clean energy as a suitable alternative to conventional fuels like petroleum and natural gas, which lies at the core of understanding sustainable development.

The principle of substitution refers to replacing activities and industries that have a negative environmental impact with other activities that enhance sustainable development, even if the economic cost of doing so is higher. Achieving this goal requires the use of artificial intelligence technologies in fields such as recycling, promoting the green economy, and relying on sustainable and environmentally friendly energy sources.

Finally, the principle of "polluter pays" is closely linked to economics and taxation, often aiming to direct resources toward scientific research and technological development that contribute to improving the environment and innovating alternatives that support sustainable development.

It seems that the Algerian legislator has demonstrated a distinctive forward-looking vision regarding modern technologies and their role in environmental protection while ensuring the achievement of sustainable development. Legal guidelines emphasize the importance of the precautionary principle, as well as the rectification of environmental damage using advanced and modern technologies, while also taking the economic aspect into account. The laws also require all individuals who may cause harm to the environment to consider the interests of others before taking any action.

This approach reflects that the law opens up many opportunities to benefit from the latest available technologies, such as artificial intelligence and other innovations, with the goal of preserving the environment and ensuring sustainable development. This direction can be seen as a clear expression of the forward-looking vision adopted by the Algerian legislator, where the laws grant a central role to modern technology as a powerful tool that helps achieve a balance between economic development and environmental protection.

The necessity of applying the precautionary principle as an effective means of preventing serious environmental harm also emerges. This principle reflects careful thinking in confronting environmental risks that may not yet be proven based on current knowledge and technology. The precautionary principle is mentioned in Law No. 03-10, where the phrase "serious environmental damage that has not been proven based on current knowledge and technology" highlights the importance of utilizing advanced tools and technologies to activate this principle. This includes considering all potential environmental impacts that current scientific knowledge may not be able to address. This approach presents a completely different perspective from the precautionary principle, which focuses on addressing already confirmed environmental damage that requires the application of modern technology to rectify.²¹

Based on Law No. 03-10 related to environmental protection within the framework of sustainable development, which relies on eight fundamental principles, including the precautionary principle and the preventive action principle, the first principle focuses on taking preventive measures before any potential environmental harm occurs, even in the absence of conclusive scientific evidence to prove it. The second principle, known as the preventive action

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principle, emphasizes the priority of correcting environmental damage at the source. It encourages taking necessary steps to reduce known and expected environmental harm at the source by assessing risks and implementing appropriate measures to mitigate them.

In the context of using technology to achieve the precautionary and preventive principles, there is an urgent need to think deeply about how to achieve a balance between economic development and environmental preservation. Moving forward in this direction requires the adoption of innovative strategies, including the development and use of modern technologies such as geographic information systems and remote sensing. These technologies contribute to improving environmental productivity and reducing negative environmental impacts by accurately identifying and monitoring pollution sources, which allows for the implementation of effective measures to reduce these impacts and maintain air and water quality.

Moreover, these technologies can play a crucial role in analyzing the environmental impact of development projects and directing investments toward environmentally sustainable options. Relying on advanced technology can significantly contribute to achieving sustainable economic development while simultaneously preserving the environment and natural resources to ensure their sustainability for future generations.²²

As a result of the above, the precautionary principle and the preventive action principle intersect in the necessity of leveraging current advancements in modern technology to protect the environment and enhance sustainable development, as stated in Article 3 of Law No. 03-10.

Preventive legal frameworks aim to protect the environment and public health from the negative effects of technology. They regulate and monitor expected technological activities and provide preventive measures that reduce environmental and health impacts. These frameworks also aim to encourage the sustainable use of technology and ensure that institutions and companies adhere to stringent environmental standards.

One point that can be highlighted within the preventive legal frameworks related to environmental protection and sustainable development concerning potential technological hazards is the fact that the effects of technical specifications on environmental protection from the risks of industrial activities have undergone comprehensive studies and evaluations by environmental law experts. Furthermore, it is clear that there is a distinction between the concepts of risk assessment and impact study, which opens the door for discussing diversity and integration in this context.²³

Through the use of artificial intelligence, environmental data can be analyzed and pollution and environmental changes can be monitored with high accuracy and efficiency. By collecting data from multiple sources, such as satellites, drones, and smart sensor networks, AI enables the rapid and effective detection of air and water pollution, as well as changes in ecosystems. When we are able to identify these issues early on, it becomes possible to take effective actions to protect the environment through strategic foresight and the use of available data within specific algorithms. This allows decision-makers to obtain the expected results within the set timeframe based on selected options.

AI can also play an important role in improving the management of natural resources such as water, energy, forests, and oases. Through data analysis and the use of intelligent models, the efficiency of resource use can be improved, and conservation strategies can be directed more effectively. This contributes to providing a more accurate strategic vision aimed at maintaining environmental balance and protecting sensitive areas, such as oases, from pollution and erosion, ensuring a healthy and sustainable future.

Furthermore, strategic foresight based on AI technologies linked to environmental sciences and their branches seeks to understand future challenges that the environment may face. Given the complexity of the factors affecting it, collecting data in a scientifically and statistically accurate manner is essential for making the right strategic decisions that ensure the preservation and sustainability of the environment.²⁴

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The current environmental challenges go beyond a variety of sustainability issues, such as climate change, air and water pollution, biodiversity loss, and the depletion of natural resources. Therefore, we must be prepared with a sustainable vision for the future, based on accurate and reliable information to understand the causes and potential effects of these challenges.

To achieve this goal, scientists and experts in the fields of environment and sustainability must work together to unify standards and develop standardized methods for data collection and analysis. Modern technologies, such as geographic information systems and remote sensing, can be utilized to identify pollution sources and estimate their environmental impact. These technologies can also be used to monitor air and water quality, assess changes in landscapes, and manage waste accumulation effectively.

Currently, there is a focus on using traditional technologies and reducing reliance on AI applications as more effective solutions to address environmental challenges and ensure sustainable development. Over-reliance on technology can exacerbate environmental and social problems, as it increases the consumption of natural resources and contributes to environmental damage. Instead, innovative solutions should be sought, based on sustainable traditional practices that maintain a balance between the economy, the environment, and society. Thus, it becomes essential to avoid excessive use of AI applications and find ways to reduce resource consumption, enhance environmental awareness, and support sustainable development through simpler and more effective methods.

In this context, the importance of modern technologies lies in providing solutions to improve the efficiency of environmental processes. AI contributes to accurately monitoring and analyzing pollution and environmental changes. Data is collected from diverse sources such as satellites, unmanned aerial vehicles, and smart sensor networks, which help in tracking air and water pollution and identifying changes in ecosystems. However, caution must be exercised in using these technologies to avoid potential negative environmental impacts, especially concerning increased energy consumption or the depletion of non-renewable resources.

Amid this rapid technological transformation, scientists and specialists should tackle environmental challenges through collaboration and the unification of standards for environmental data collection and analysis. Modern technologies, such as GIS and remote sensing, can be used to monitor air and water quality and estimate the effects of pollution on the environment. These technologies allow for proactive measures to reduce environmental impacts and ensure the sustainability of natural resources.

As for coastal areas, they represent one of the most fragile environments, exposed to significant environmental pressures. Coastal regions face pollution and erosion due to human activities and climate change, necessitating special protection. In this regard, AI technologies can contribute to monitoring marine pollution and identifying areas most affected by desertification and erosion, providing precise data that helps in making sustainable environmental decisions. Furthermore, these technologies can assist in improving strategies for managing coastal resources, such as freshwater and marine energy, more efficiently.

However, it is important to emphasize the need to adopt sustainable solutions for protecting coastal areas without overusing technology. Local environmental awareness should be raised, and simple and effective technologies, such as planting erosion-resistant plants and using natural materials to protect coasts from erosion, should be applied. Governments and local communities must collaborate to protect coastal areas by implementing environmental policies aimed at reducing pollution and safeguarding these vital coastal environments from the effects of climate change and urban expansion.²⁵

4. CONCLUSION

The protection of Algerian coastlines, in light of increasing environmental challenges, requires multi-dimensional strategies. Artificial intelligence (AI) is considered one of the

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promising tools that could bring about a transformative shift in how these challenges are addressed. To achieve this, it is imperative to develop the current legal framework to be more responsive to technological advancements and forward-thinking, thereby contributing to sustainable development and the safeguarding of strategic environmental resources.

Findings:

- The study has demonstrated that AI can significantly contribute to predicting natural disasters, such as floods and storms, by analyzing environmental data and forecasting future weather conditions.
- AI can enhance the management of coastal resources by monitoring environmental changes and offering sustainable solutions for the preservation of biodiversity and natural resources.
- AI plays a critical role in developing effective strategies for climate change adaptation by analyzing climate data and providing evidence-based recommendations.

Recommendations:

- Update environmental legislation to include the use of AI technologies in monitoring and managing coastal areas, ensuring the protection of privacy and personal data.
- Support scientific research in the field of AI and its environmental applications through funding research projects and providing the necessary resources.
- Provide training programs for human resources in the field of AI and its environmental applications to ensure the effective and sustainable use of modern technologies.
- Strengthen collaboration with international organizations and research bodies to exchange knowledge and expertise in the use of AI for coastal protection.
- Organize awareness campaigns to educate the public about the importance of utilizing AI in protecting coastlines and encourage community participation in environmental initiatives.

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