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REVIEW ARTICLE

Sustainable development in Algeria: Investigating challenges and potential pathways

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Abstract
Sustainable development has emerged as a global priority, with the aim of balancing economic growth, environmental preservation, and social equity to meet present and future needs. Algeria's reliance on fossil fuels has led to environmental degradation and economic instability exacerbated by the recent financial crisis. This study aims to investigate the constraints and strategies of sustainable development in Algeria as well as the efforts of the Algerian government to achieve sustainable development. Through an in-depth analysis of scientific publications and official texts, this research examines the country's environmental state, economic growth in the non-oil sector, and individual living environments. All of which are crucial for sustainable development. This study employs descriptive and analytical methods to asses several action plans and policies, providing a comprehensive understanding of the complexities surrounding sustainable development in Algeria. The findings of this study will shed a light on the strategies for a more diversified and environmentally conscious economy, ultimately contributing to a more stable and prosperous future for the country.

Keywords: Challenges; Potential pathways; Sustainable development; Action plan; Algeria

Introduction

Over the last two decades, the concept of sustainable development has been established by public authorities, capturing the attention of the whole world since it was mentioned at the 1972 United Nations Conference on the Environment. After years of study at the Stockholm Conference, the International Committee on Environment and Development finalized a report entitled “Our Common Future”, which saw the need to follow alternative models, causing a qualitative leap in the concept of the relationship between development on the one hand and environmental considerations. Sustainable development expresses the desire to resolve difficulties. Its objective is to maintain a certain quality of the environment and living conditions favourable to the survival of the human species for future generations without compromising that of present generations. It is an alternative to the economist's vision of development based on a belief in the unlimited availability of resources and faith in science and technology to solve all problems. By 2030, the world population will increase by three billion people, 95% of whom will be in developing countries. Food production will have to double, and waste and effluent production will increase in cities. Without sustainable practices, economic growth can lead to excessive degradation of natural and social resources. Therefore, public authorities are challenged to reconcile the contradictory pressures on natural and social resources without sacrificing economic progress.

Algeria follows a development model based on the use of fossil fuels that are limited and highly polluting. In recent years, Algeria has suffered a financial crisis due to its dependence on a single resource, whose income has dropped. This has had serious consequences for the national economy and daily lives of citizens, thus putting the future of the country in an uncertain situation. It should be noted that the number of people in the world's population will grow to 3 billion over the next 50 years by the year 2030, 95% of those in developing countries. The world will have to double its food production rate, and food, waste, and effluent generation will increase even further in cities, which is disturbing. However, when economic development is not accompanied by sustainable measures, living standards can be overexploited along with natural and social capital. Thus, public authorities are faced with the task of meeting the conflicting demands of natural and social staff without negating development (Farinet and Niang 2004).

Using the case of Algeria, research has identified that the country has adopted a development model that heavily relies on the use of fossil fuels, which are finite and environmentally unfriendly. In the recent past, Algeria has been facing certain financial problems because the country has been exploiting only one resource and the returns derived from it have reduced. This has led to a soaring national economy, coupled with a total change in the daily lives of citizens, putting the future of the country at stake. This research is part of a relatively long process of research and analysis; it relies on several academic journals that dis-cuss sustainable development in Algeria, in addition to the official papers that were read. This paper is comprised of three main sections. The first part presents the precedent principles and basic concepts of sustainable development based on a scientific literature analysis. The second part of the study considers the environmental crises and sustainable development challenges faced by Algeria. Finally, we focus on an attempt by the Algerian government to achieve sustainable development.

Key issues Algeria facing

Environmental Challenges: Algeria's dependence on fossil fuels has led to widespread pollution, resource depletion, and a vulnerability to climate change. "Without sustainable practices, economic growth can lead to excessive degradation of natural and social resources." The consequences of industrial and household waste mismanagement, soil contamination, and water scarcity have created a precarious situation for both ecosystems and human health.

Economic Instability: The overreliance on fossil fuel exports has exposed Algeria to economic shocks, particularly when global oil prices decline. This has restricted fiscal capacity to invest in non-oil sectors, resulting in unemployment and reduced purchasing power for families.

Social Inequities: The combination of poverty, illiteracy, and uneven access to resources has heightened disparities between urban and rural areas, creating barriers to equitable development.

Government's response and strategic objectives

Recognizing these interlinked challenges, the Algerian government has undertaken a series of initiatives aimed at transforming its development model. Key actions include:

Promoting Renewable Energy: Through the National Renewable Energy and Energy Efficiency Program, Algeria seeks to reduce dependency on fossil fuels and expand its renewable energy portfolio. Between 2014 and 2017, the government constructed several photovoltaic solar plants to boost clean energy capacity.

Enhancing Water Resource Management: The government has adopted a Water Sector Development Strategy for 2030, focusing on desalination, infrastructure development, and equitable water access to combat scarcity.

Fostering Sustainable Urbanization: Urban planning reforms prioritize energy efficient housing, sustainable transportation, and green building codes to address the rapid pace of urbanization.

Biodiversity and Ecosystem Conservation: Algeria has expanded its network of protected areas and launched reforestation programs to mitigate deforestation and land degradation while safeguarding biodiversity.

What Is Sustainable Development (SD)?

In 1987, the World Commission on Environment and Development adopted a definition of sustainable development that remains an international reference. Sustainable development meets the needs of the present without compromising possibilities for future generations. To meet their needs. However, the birth of this notion is linked to an awareness of planetary limits and definiteness of natural resources. In other words, it is a long-term vision that integrates ecological and environmental dimensions as well as economic, social, and human dimensions. The objective is to meet human needs without harming future generations by preserving natural resources, social equity, and economic equity (L 2021).

The Pillars of Sustainable Development

Social, economic, and environmental are the three systems of sustainable development known and acknowledged by the 1992 Rio Earth Summit. Ideally, these three (3) main pillars should be integrated. The idea is to reconcile the economic, social, and environmental dimensions to ensure sustainable viability (Godard 2015). An action could be part of sustainable development when it manages to reconcile three (3) E's: economy, equity, and the environment (Mulder 2017, SD 2019). In this spirit, sustainable development means achieving a balance between humanity and nature, the poor and rich, the present generation, and the future generations Fig. 1.

Figure 1. The three (03) pillars of sustainable development (Author)

Various environmental risks in Algeria

Environmental threats in Algeria

Algeria's geographic size is 2,381,741 km^2, ranking second to Sudan among African countries. Algeria is in north-western Africa and has a Mediterranean Sea border with a 1200 km coastline. The Saharan Atlas divides the country into two distinct zones: a population of almost the entire population of the northern Mediterranean region; the remainder is in the south, including the Sahara, which occupies 85% of Libya. The Algerian population is estimated at 44.7 million inhabitants (2020). The capital city, Algiers, has more than 2.5 million inhabitants. The climatic areas are diverse and the climate varies from Mediterranean to Saharan. Along the Mediterranean coast, there is a hot summer that is dry and has a mild and humid winter. In the north, winter is characterized by rain, whereas summer is characterized by heat. In the south, summer is characterized by rain, whereas winter is characterized by dryness, and the climate along the coast is softened by the sea. Eastern Algeria is a rainier region than the west, and its river network is strongly subject to a seasonal regime (wadis). During the rainy period, numerous depressions (chotts) form shallow lakes (BAD) (Attalah 2018). Algeria today faces enormous environmental problems of a global nature, concerning the globe in general, the issue of the country's natural resources remains a major concern and is far from what one might expect from such an area, since they are limited and weakened by climatic conditions increasingly accelerated by anthropological actions.

Pollution caused by household waste

Waste refers to any residue from a production process, transformation, or use, any substance, any material, any product, or, more generally, any movable property abandoned, or that its holder intends to abandon (vivant 2019, BDC 2023). Algerian regulations define household and similar waste as all waste, the elimination of which is handled by local authorities directly or through approved companies (Martinez 1998, Gueye 2010). Thus, the management of household waste in Algeria is highly efficient. The quantity of waste generated annually is estimated to be 5.2 million tonnes,1.2 daily. It is of the order of 0.5 kg per inhabitant of solid waste. In large cities such as Algiers, citizens generate approximately 1.2 kg of waste per day. More than two-thirds of the urban waste generated per inhabitant per day comprises of organic elements. Fig. 2 shows the percentage distribution of household waste in trashcans. Waste is deposited in illegal landfills that do not comply with the regulations. It is often incinerated in open air. In addition, these landfills provide a suitable biotope for the proliferation of stray animals (dogs, cats, rats, flies, and mosquitoes) that are vectors of diseases.

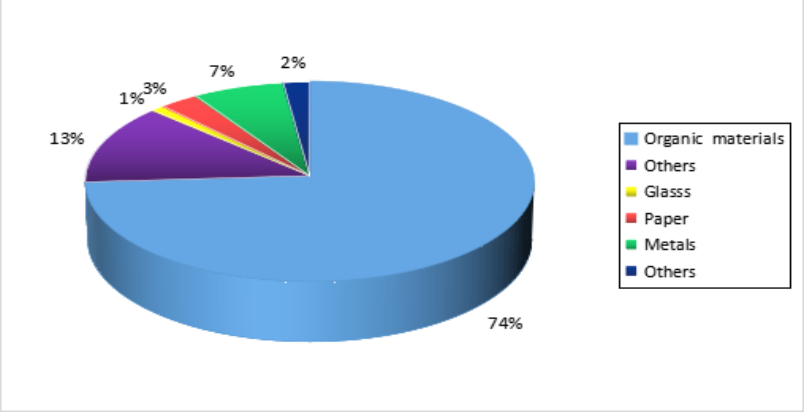

Figure 2. The average composition of household waste (PAC 2004, Medjitna 2021).

Industrial pollution

Algeria's industry has experienced sustained development in terms of its diversity and capacity Fig. 3. Steel and metallurgical industries account for half of the industrial activities. However, these issues have not been addressed in industrial processes. Before the promulgation of Law 83-18 of 1983 relating to environmental protection, industrial projects were conducted without environmental impact studies. Close to labour pools, communication routes, and amenities (Benadda 2004, Emmanuel 2004). This situation is harmful to the environment and public health.

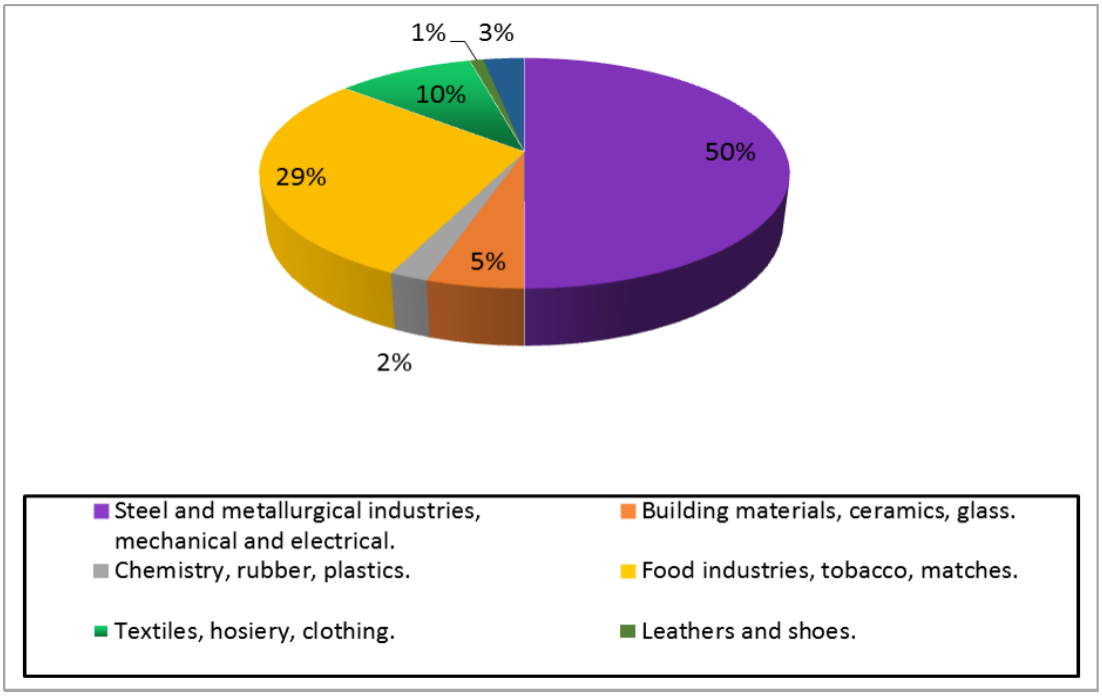

Figure 3. Waste production by major sectors of industrial activity (Mouhouche 2002, Medjitna 2021).

In addition, industrial activities produce toxic waste that can be recovered and stored with inefficiencies. They were evaluated in 1994 at approximately 185,000 tons per year, and the same study evaluated 344,000 tons of hazardous and toxic waste, including 90% in the Wilayas of Annaba and Tlemcen. In addition, all the hazardous waste produced is often stored in makeshift dumps under deplorable conditions. A large portion of this waste is found in nature, with all the risks of soil and water resource pollution. The Ghazaouet zinc electrolysis complex is expected to produce 40,000 tons of zinc, 90,000 tons of Sulfuric Acid (H_2SO_4), and 150 tons of cadmium per year. This is the origin of the significant release of heavy metals into the environment (Kehila 2006, Medjitna 2021) The analysis carried out in the region of Ghazaouet by the world organization "Greenpeace" on September 9, 1991, showed that lead, cadmium, mercury, zinc, and copper are found in more or less high concentrations, causing pollution of the soil and significant marine pollution.

Contamination of water resources

Water, an increasingly rare natural resource, is a part of the heritage of a nation in a specific way and the heritage of humanity in general. In Algeria, the issue of water resources remains a major concern because 95 % of the

territory has an arid climate, aggravated by the risk of pollution, which renders the few resources available to the country unusable (Mouhouche 2002, Kehila 2006). Indeed, if water management is well controlled in the coming years, the water problem will be seen from the perspective of its quality and not just its quantity (Guouas 2002, Abdelaguerfi 2003). Cases of severe surface and groundwater pollution have been recorded throughout national territory. A study conducted by ANRH showed that industrial solid waste is generally disposed of along with household waste, making a significant contribution to the pollution of mobilization works, groundwater, and soil.

Soil contamination

It may also be regarded as a decline in the quality of soil due to anthropogenic utilization of the territory (Guassart 2001, RAC 2006). In Algeria, the issue of soil degradation is reported, which shows that it impacts a considerable portion of the agricultural lands as well as the steppe rangelands. It includes chemical, physical, and biological degradation, such as reduction in fertility, decline in aggregate stability, and salinity. Land degradation is widely used as an indicator of sustainability, as visual evidence of environmental degradation, and diminishing biological diversity (Kehila 2006, RAC 2006). For a long time, soil has played an important role in major biogeochemical cycles and the fate of polluting substances. It accumulates and provides plants and animals with most elements essential to life (air, water, natural elements, nutrients, etc.). In addition to its food function, soil can also constitute an effective environmental filter by purifying the water passing through it with various pollutants that can contaminate the food chain and groundwater. This complex environment raises important questions regarding its ability to retain elements, such as heavy metals.

There was, in fact, no beneficial legal regime for soil protection, but it was considered that the earth absorbed and "digested" everything (Catherine 1997, CNES 2000).

a. Either the critical load is exceeded or the soil no longer plays a buffering role so that pollutants penetrate the water table and rivers.
b. Pollutants accumulate in the soil to the point where a change in physical, chemical, and/or biological conditions results in their transfer.

Algeria's journey toward sustainable development

Algeria's approach to sustainable development has evolved significantly over the decades owing to its unique socioeconomic and environmental challenges. Below is the detailed historical context.

Post-independence industrialization (1960s–1980s)

Since its independence in 1962, Algeria has undergone many significant sociological, political and economic structural transformations. A development model based on socialism was immediately put in place with a desire to quickly achieve industrialization and an economic model close to that of Eastern European countries. This was able to see the light of the day and at one time gave the illusion that the country was on the right track only thanks to the hydrocarbon sector, the growth of which was conceived as a means of achieving rapid development through a heavy industrialization strategy. The oil counter-shock of 1986 and the debt crisis of the 1980s showed the limits of such a strategy as well as the fragility of the economy and its dependence on hydrocarbons.

Environmental Awareness and Legislative Foundations (1990s)

In June 1992, the government passed the Environmental Protection Act (1993) in Rio de Janeiro, Brazil. The United Nations Conference on Environment and Development (known as the Earth Summit) adopted a declaration that advanced the concept of the rights and responsibilities of countries in the environmental field. The Rio

Declaration on Environment and Development reflects two major concerns that emerged during the 20-year interval between the two conferences: the deterioration of the environment, including its capacity to sustain life, and the increasingly evident interdependence between long-term economic progress and the need for environmental protection. This era was marked by increasing efforts to align policies with international environmental standards.

National Strategies and Integration of Sustainability (2000s)

Since the 2000s, the state has decided to react and invest in sustainable development in order to end the process of environmental degradation. This desire is also a consequence of the commitments made by Algeria to the international community, which requires, in particular, the translation of the binding provisions of the international conventions and protocols to which the country has adhered into its national legislation. The realization of this intention was initially achieved by the adoption of the National Environmental Strategy (SNE 2001-2011). The two main tools of this strategy are the law on the protection of the environment and sustainable development promulgated in 2001 and the national action plan for the environment and sustainable development, PNAE-DD (MATE, 2002).

Accelerating Environmental Reforms (2010s–Present)

Renewable Energies Development

While the share of RE in Algeria's energy mix is negligible today, policies and support mechanisms (with/without feed-in tariffs) have been increasingly established to develop RE. In 2020, Algeria created the Ministry of Energy Transition and Renewable Energy (RE) to set out an ambitious roadmap. The "National Program for the Development of Renewable Energies" aims to achieve a 30% RE contribution in the energy mix by 2035. The ministry aims to develop 1000 MW of electricity from solar power plants spread across 11 sites in the first phase, focusing primarily on solar projects. The target for the long run is placing 15,000 MW by using 2035. Algeria released its first renewable energy plan in 2011, targeting the installation of 22 gigawatts (40 percent of its generation capacity) of renewable energy sources by 2030. Rather, today, Algeria produces a mere 411 MW of renewables. However, officials said the new strategy described here should help revive efforts to get more than 1 gigawatt of solar power up and running by the end of year-end and a further 13 gigawatts in line by 2030.

The hydrogen development in Algeria

Transporting 20 years-old notion of solar north Africa to Europe, the DESERTEC project1 envisaged transmitting solar electricity from the MENA region to Europe using high-voltage direct current transmission in its original conception (EcoMENA 2023). Nevertheless, this ambitious project has suffered from partial abandonment because of difficulties in establishing electricity infrastructure for intercontinental links. On the contrary, increasing interest in the alternative pathway of solar-to-hydrogen energy conversion for its export has arisen (Cherigui, Mahmah et al. 2009).

Sustainable development constraints in Algeria

Algeria is currently led by a development model based essentially on limited natural wealth, ecologically very polluting, and an unfair sharing of wealth as well as the financial crisis that the entire country is facing generated by this dependence on a single resource whose income has fallen in recent years. This has had drastic consequences for the national economy and impacted the daily lives of citizens, thus putting the country's future

in an uncertain situation (CI Faurie 2003). In light of this, Algeria attempted to overcome some of these obstacles (Ramade 2000).

1) Lack of integration in productive sectors.
2) The increase in unemployment and the deterioration of income and purchasing power for families.
3) The weakness of the agricultural and industrial base and the absence of a solid strategy.
4) Absence of material and moral incentives in the area of budgetary expenditure.
5) The problem of poverty and the increase in illiteracy.
6) Lack of effective economic institutions, competition, lack of efficiency, lack of specialization in vital areas, and lack of supportive policy (Kehila 2001, MATE 2002).
7) Money supply, which corresponds to the quantity of currency circulating in the Algerian economy, reached 19,918.39 billion dinars at the end of October, compared to 17,659.64 billion dinars at the end of December 2020. This growth is mainly due to the increase in the aggregate (coins and notes in current accounts, assets immediately usable as means of payment) by 16.41%, going from 11,901.82 billion dinars at the end of December 2020 to 13,854.50 billion dinars by the end of October 2021 (Khababa 2009, Benali 2017).
8) Term deposits increased by 5.32%, reaching 6,063.89 billion dinars at the end of October 2021, compared to 5,757.82 billion dinars at the end of December 2020 (BOA 2021, Mesbahi 2021). The evolution of demand deposits at the end of October 2021 was marked by a strong growth of approximately 23.54%, going from 4,210.00 billion dinars by the end of 2020 to 5,201.23 billion dinars by the end of October 2021. The increase in demand deposits is mainly due to the growth in demand deposits in Sonatrach (Nassim 2019).
9) A stronger than expected fall in energy prices could reduce authorities' ability to support the dinar, thereby posing an upside risk to inflation forecasts.
10) According to the World Bank, the Algerian multidimensional poverty rate has increased from 2.1% to 1.4% between 2013 and 2019. “Algeria's 1.4% MPR is better than its regional neighbours: Egypt (5.2%), Iraq (8.6%), Morocco (6.1%), but not Tunisia, with a comparably better low rate of 0.8%) (Bank 2021)”
11) The MPI has shown that the most disadvantaged areas of the country have been cut off, even though there are some differences. The Central Highlands, the Hauts Plateaux-Ouest, and the South Region, with recent poverty rates of 4.4%, 2.6%, and 2.3%, respectively, underwent a remarkable improvement in poverty, but still remained behind the other four Algerian regions. In light of this, if we distillate the differences between urban and rural areas, we see that the poverty rate in 2019 was four times higher in rural areas than urban ones. There were no significant differences between the two survey cycles for men and women (Mesikh 2014, Bank 2021).

National context and strategy

The effects of climate change on natural and human systems are now clearly perceptible, and recurrently lead to climatic anomalies and extreme phenomena. These changes are inevitable in the scientific community. Algeria is located in an area that is particularly vulnerable to climate change. Estimates from the Intergovernmental Panel on Climate Change (IPCC) predicted a rise in temperature of approximately 2°C, drop in precipitation, and increase in the frequency of extreme events. While the country is already faced with a deficit in its water balance and sometimes a degradation of ecosystems, the analysis of vulnerability to climate change conducted on a national scale has highlighted the threats facing Algeria in the face of climate change. These include:

1) The reduction in agricultural production is leading to a risk of food insecurity given the strong dependence of Algerian agriculture on rainfall.
2) The limitation in quantity and quality of natural resources and the increase in water stress.
3) The degradation of coastal areas, with a potential rise in sea levels and destruction of fishing activities.

4) The resilience and adaptation capacity of forests, which have diminished and caused a major disruption of biodiversity.
5) Natural hazards such as earthquakes, floods, landslide phenomena, rising groundwater from desert palm groves, wind sand, etc.
6) Technological tools that threaten inhabited areas, in particular gas and hydrocarbon exploitation sites as well as energy product processing facilities (CDER 2015, RNVA 2019).

Faced with these challenges, which compromise sustainable development, Algeria decided in line with the 2030 Agenda to adopt a strategic policy aimed at:
1) The integration of climate change into policies and strategies at all levels.
2) Improving education and raising awareness about adaptation to climate change and mitigation of its impacts.
3) Strengthening resilience to climatic hazards and related natural disasters.

Adaptation of town planning

To prevent natural and technological hazards, urbanization programs in line with the spirit of urban planning instruments (the master plan for development, urban planning, and land use plans) are undertaken by considering the results of periodic geotechnical and vulnerability studies. These instruments set the fundamental orientations for the development of the territories concerned and determine the planning forecasts and rules. Specifically, they defined the conditions for development and construction to prevent natural and technological risks. Furthermore, more than three million buildings erected since 2000 have provided facade walls that are systematically made of double partitions of baked clay bricks (thermally efficient materials), and their terrace roofs are insulated with polystyrene. These measures aim to reduce energy consumption in homes to cope with climate change and limit atmospheric carbon dioxide emissions. The ministries in charge of housing and energy jointly initiated a project of 600 high energy performance housing units located in 11 wilayas representing all climatic zones in the country. Other actions are being undertaken and are expected to be generalized, such as the use of materials that allow for better energy efficiency, the use of low energy lamps in all new housing programs, the introduction of renewable energies in buildings, and the use of photovoltaics for public lighting.

Resilience to flood and forest fire risks

In 2016, the government adopted a national flood control strategy. It comprises of five main axes which are given below:
Improving knowledge of the risk of flooding and strengthening awareness of these risks.
1) Reducing vulnerability.
2) Review of Flood Protection Structure Planning.
3) Sustainable territorial development.
4) The water resource sector plays an essential role in promoting institutional cooperation and coordination.
This strategy is broken down into an interministerial plan aimed mainly at ensuring the safety of people in areas exposed to flooding, particularly through the construction of flood control dams to dissipate floods, the establishment of early warning systems for floods (Sidi Bel Abbes, Skikda, and El Harrach), the development of wadis, and the protection of towns and urban agglomerations. At the regional level, each hydrographic region has a water resource development master plan that defines strategic choices to ensure the prevention and management of risks linked to exceptional natural phenomena such as drought and floods. Furthermore, in the field of the protection of national forest heritage, a certain number of awareness raising actions and preventive work were

carried out by the forest administration and other organizations traditionally involved in the related system before the launch of each forest protection campaign against fires.
The Forest Sector Strategy for 2035 supports actions related to the mitigation and adaptation to climate change, particularly in terms of in situ and ex situ conservation. Algeria has made efforts to safeguard and extend the network of protected areas, in particular the National Parks, increasing from 165,361 ha to 194,932 ha in 2019. These ecosystems protect forest and plant cover in a manner that contributes to carbon sequestration. In addition, operational committees are set up at the level of each layout as well as at the level of daïras and communes. Their role is to coordinate intersect oral control operations in accordance with the forest fire plan approved by territorially competent "Wali". Local residents' committees have also been established to strengthen the organizational systems of local authorities (CDER 2015).

Encourage energy efficiency measures

The government has decided to integrate the energy efficiency component into the management of the activities of the Sonatrach oil group, following a diagnostic program for industrial units to bring installations up to standards in terms of energy efficiency. This decision is part of a series of measures, identified by the IPCC, to combat climate change. Furthermore, as electricity production is primarily based on natural gas, the Sonelgaz Group has contributed to GHG mitigation efforts for several decades. The development of the electricity production capacity of the group was based on the development of combined cycle, solar, and wind power plants. The Sonelgaz group determined actions aimed at further reducing the emissions from old power plants. These actions are in addition to the positive impacts of efforts to rejuvenate the production fleets. The conversion of diesel power plants into natural gas in localities covered by the national gasification program is also planned.

Reduce flares and greenhouse gas (GHG) emissions

The oil group Sonatrach continues to implement its program to eliminate flared gas. In addition to the government's introduction of a tax for flaring associated gases, several actions and projects have been implemented for this purpose, such as gas compression and reinjection facilities, 32 flared gas recovery projects, and one CO_2 sequestration project. These actions have enabled considerable reduction in Greenhouse Gas (GHG) emissions. Thus, since 1973, the flaring rate decreased from 78.6% in 1970 to 8% in 2016. This reduction effort will continue and be supported through the registration and implementation of new gas recovery projects in oil installations. And gas industries to reduce the rate of gas flaring to less than 1%, as provided for in Algeria's Nationally Determined Contribution (CDER 2015).

Achievements and level of achievement of the objective

Rehabilitate and safeguard terrestrial ecosystems and enhance their services

In 2016, Algeria established a forest sector development strategy for 2035, which is structured around three main axes, in this case sustainable management of forest heritage, defence, and conservation. Land restoration, conservation of floristic and faunal genetic resources with a view to their sustainable use and development, and the development and promotion of ecosystem goods and services within the framework of sustainable socioeconomic development. In this context, a forest heritage rehabilitation program, covering 39 wilayas, was implemented. It consists of the implementation of actions intended mainly for the restoration (renovation and reconstitution) and protection of forest stands.
As part of the sustainable use of freshwater ecosystems, the fishing sector implements actions linked to:

1) Raising awareness of the benefits of integrating fish farming into agriculture in terms of job creation, diversification of production and income, and soil fertilization through the use of water from fish farming.
2) Launch of pilot projects in aquaponics and above ground aquaculture associated with plant production on an experimental basis.
3) Increasing production through the exploitation of other underground water potentials (drilling), particularly in arid and semi-arid zones, and significant potential of operating dam sites.

As part of ecosystem protection, Algeria has made sustained efforts to classify spaces as protected areas that extend over a total area of 219,332 ha. The national network of protected areas thus includes ten national parks (Taza, Gouraya, Djurdjura, Belezma, Djebel Aissa, Tlemcen, Theniet El Had, Chréa, El Kala, BaborTababort, classified in 2019), five cultural parks (Tassili n'Ajjer, Ahaggar, Saharan Atlas, Touat Gourara, and Tindouf), one nature reserve (Cap Lindles), and four hunting reserves (Djelfa, Mascara, Tlemcen, and Zéralda), whose missions are the rehabilitation, multiplication, and development of native wildlife. Internationally, eight protected areas are classified as biosphere reserves within the framework of the Man and Biosphere Program (MAB/UNESCO), covering a total area of 14,191,883 ha, and 50 wetlands are classified on the Ramsar list (Ramsar 2022). International importance over an area of 2,981,421 ha and 21 Important Plant Areas in the Southern and Eastern Mediterranean: Priority Sites for Conservation (Concept of the International Union for Conservation of Nature (IUCN)) over an area of 2,611 ha (2016). Since the launch of the PNR in 2000, 809,877 ha of plantations have been planted, of which 485,225 ha are forest. These plantations account for 64% of the PNR objective, which aims to reach 1,245,900 ha by 2020. However, these plantations have enabled the reconstitution of heritage sites degraded by various factors, including repeated fires, grazing, and land clearing (IUCN).

Thus, it is not a question of plantations extending the wooded cover but of the densification and rehabilitation of existing woodlands. Thus, the forest area can be considered unchanged until the commitment of the new National Forest Inventory (CDER 2015). The achievements recorded by Algeria has also affected the level of safeguarding sites that are important for terrestrial biodiversity. Hence, with reference to international indicators, the proportion of sites that are important for terrestrial biodiversity and are located in protected areas increased from 24.6% in 2000 to 38.8% in 2018. The same is true for sites that are important for freshwater biodiversity, the proportion of which increased from 15% in 2000 to 49.0% in 2018 (CDER 2015).

Ensuring sustainable forest management

To ensure sustainable forest management, Algeria has identified and implemented the following actions:

1) Nearly 173,000 ha of forests have benefited from development studies with a target of 1,540,000 ha by 2030, which largely include restoration aspects sustainable.
2) A palliative measure was put in place in the absence of forest management studies through the adoption of simple management plans. This process resulted in the validation of five simple management plans covering an area of 7,269 ha, and eight simple management plans covering 10,619 ha are being validated.
3) Capacity building for forest administration field managers in the development of simple management plans in a ‘training through action’ mode.

However, establishing a consensus indicator for sustainable forest management is difficult. The United Nations recommends the use of four sub-indicators, each of which refers to a particular dimension of National Forestry Strategy. The international database reveals a non-decrease in these sub-indicators over the last decade, which would be a sign of forest management with a view toward sustainable development, although progress is slow and sometimes insignificant. It should be noted, however, that these indicators seem insufficient because they do not take into account, in particular, forest fires, which affect the increase in the area of forests. However, since

2000, Algeria has recorded 491,000 ha of land covered by fires (CDER 2015). Furthermore, these indicators do not consider the obsolescence of forest management.

Combat land degradation and desertification

A vast treatment program for 107 watersheds upstream of hydraulic structures is underway as a part of a policy to combat water erosion and soil conservation. This intervention plans to cover a territory of nearly 5.6 million hectares across 30 wilayas and 747 municipalities. Currently, 66 watersheds are being treated by essentially carrying out a volume of 1,300,000 m^3 of soil defence and restoration work (torrential correction, fixing of banks, stone lines, and low walls) and planting 89,000 ha, with a rate of progress of 84% in 2018. Another result to be achieved is the reduction of desertification and restoration of soils and degraded lands in pastoral regions (CDER 2015). To this end, the action plan was implemented and concerned 30 Wilayas and 723 municipalities, which has enabled the following achievements:

1) **Development and protection of ecosystems**: Nearly 31,900 ha of forest plants and 22,800 ha of fruit plants have been planted to maintain wooded spaces. Protection of economic infrastructure and agricultural land against silting. Therefore, 4,100 ha of threatened dunes were fixed at the level of the green dam area. Likewise, more than 2,600 ha has been developed, supplemented by water and soil conservation work by carrying out approximately 1.2 million m^3 of torrential correction, as well as 1,200 ha of bank fixation (CDER 2015).
2) **Pastoral development:** To improve fodder potential and regenerate natural resources, intervention in alfa layers and rangelands combined pastoral plantations on nearly 14,900 ha and fencing on 72,000 ha (CDER 2015).
3) **Improving the living conditions of populations:** More than 7,300 km of rural access roads have been built and 5,000 renewable energy kits have been developed with the aim of reducing pressure on natural resources as a source of energy (firewood in particular).
4) **Treatment (fixing) of the dune cordon of the Green Dam:** Between 2016 and 2017, 87 ha was treated for a target of 56,000 ha at the level of the Green Dam area, that is, a progress rate of 3% (CDER 2015).

Preserving and enhancing biodiversity and protecting areas essential for biodiversity

An important aspect of the forest sector's strategy is the creation of new protected areas. The establishment of protected areas is an important mechanism for safeguarding certain remarkable sites, including mountains and mountain ecosystems. Stems from a decline in biodiversity. The objective of 2030 is to have 13 sites between national parks and nature reserves for a total area of 1,283,480 ha, including five new sites to be classified as protected areas containing floristic and faunal genetic resources in view of their rational use and development. In addition to the eight national parks with areas of 165,361 ha, an effort to classify two new sites was recorded in January 2019 (Babor-Tababort National Park and Cap Lindles), bringing the total PA surface area to 194,932 ha. It should also be noted that four protected areas (Mazafran, Réghaia, Zemmouri, and the Chenoua protected area) were classified in accordance with Law No. 02-02 of February 5, 2002, relating to the protection and development of the coastline (PCAA 2005). There is a direct correlation between the vegetation cover of mountains and their capacity to fully play a role in the ecosystem. Therefore, the vegetation cover index of mountainous areas can provide an adequate measure of the conservation status of mountain ecosystems. Both climate change and deforestation can increase habitat vulnerability to shelter biodiversity. The overexploitation of the seas further accentuates this risk. Assessment of the state of biodiversity in the country using the Red List index necessitates a checklist of flora and fauna where the state is of concern. Endangerment status based on the classification made by the IUCN (International Union for Conservation of Nature). Information on the availability and quantity of

wild fauna and flora is scarce, given the lack of a national census, which is an important step for updating the data and introducing relevant conservation measures (CDER 2015).
Concerning access and benefit sharing (APA), in an inter-sectoral approach, the forest administration conducted a project in 2016 concerning 'The establishment of a national, legal, and institutional framework on access and use of genetic resources as well as the fair and equitable sharing of benefits arising from the use and knowledge of genetic resources in compliance with the Convention of Biological Diversity (CBD) and the Nagoya Protocol in Algeria. Another aspect of wildlife protection is anti-poaching and the fight against illicit trade in live animals through, among others, enforcement of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), which Algeria ratified in 1982. In addition, within the context of the program of Integrated Monitoring and Assessment of the Mediterranean Sea and its coastal zone launched by the Barcelona Convention for the protection. In the Mediterranean region, there is a national monitoring program for non-indigenous marine species (ENI) in Algeria. This program led to the production of a list of non-native marine organisms and a plan to monitor them.

Sustainable development and energy issues

It is now imperative both for oil producing countries and for oil consumers, as well as for global companies, to turn to alternative energy sources, with the conviction that fossil fuels, and more especially oil, are exhaustible energies on the one hand, and that it is the main factor in the increase in greenhouse gas emissions, and more particularly carbon dioxide, which further accentuates global warming, which induces sudden climatic disturbances that harm humanity (Cherif 2021). Today, with the substantial growth in internal energy consumption (+14%/year for electricity and 7%/year for natural gas), this energy model, which is based on an energy mix of 98% fossil fuels (30% oil and 68% gas), cannot be sustainable, and risks become completely irreducible in the near future if we do not react (Hadjam 2020). To resolve this problem, the government launched the National Renewable Energy and Energy Efficiency Program in 2011, elevated to the rank of national priority in 2016, but has not been followed by any tangible progress on the ground. A total capacity of 343 MW is provided by approximately 20 photovoltaic solar power plants built between 2014 and 2017 in the South and Hauts-Plateaux (Bounab 2020). According to an activity report carried out by the Renewable Energy Commission, the installed capacity of this type of energy in Algeria since 2010 has been approximately 400 MW. "The achievements of installed capacities in renewable energies between 2010 and 2019 are estimated at 390, or 1.8% of the 22,000 MW of the total capacity to be deployed by 2030. A simple comparison between the installed capacities for the production of electricity from gas and those based on renewable resources over the last decade highlights, that between 2010 and 2019. These installed mainly in the form of gas turbines practically doubled going from almost 11,000 MW in 2011 to almost 21,000 MW in 2019. That shows that all the priorities have been granted to the development of power production from natural gas during the last decade", contrary to the ambitious discourse on the preponderant place to be given to renewable energy (Nichane 2015).

Sustainable development and water management

Algeria is among the countries classified in the category of countries poor in water resources, with a water endowment of 600 m^3 per inhabitant per year. This is explained by the extent of the Algerian territory, covering 2,381,741 km^2, the majority of which (87%) are deserts where precipitation is almost zero. Ninety% of the surface water is located in the Tell region, which covers approximately 4% of the territory and is home to 65% of the country's population, estimated at 40 million inhabitants in 2016 (Nichane 2015). Algeria is subject to unfavourable physical and hydroclimatic conditions owing to its geographical location in arid and semi-arid zones. For several decades, Algeria has suffered from climatic hazards, including chronic droughts, shortages,

and devastating floods, in addition to demographic and economic growth, with an increasing need for drinking, industrial, and agricultural water. The contribution of runoff to the surface water systematically decreased. Flows that are too low have the impact of insufficient filling of the existing dams (Nichane 2015).

To address this situation, the state has adopted a water sector development strategy for 2030 with the following main objectives:

1) Satisfy, quantitatively and qualitatively, the water demand of the entire Algerian population.
2) Ensure the availability of water for productive activities.
3) Preserve the living environment of citizens, water resources, and the environment.

This strategy is structured around the National Water Plan (PNE), Regional Water Resources Development Master Plans (PDARE), and National Sanitation Development Plan (SNDA). These strategic planning instruments set objectives and programs in terms of water access for different uses, sanitation, and resource preservation. The principle of sustainable development is enshrined in the main legal texts and instructions concerning land use planning, environmental protection, and the management and mobilization of water resources. The new Algerian Constitution of 2016 devotes through Article 19 the rational use of natural resources as well as their preservation for the benefit of future generations (Law No. 05-12 of August 4, 2005, relating to water completely reviews Algerian legislation in this area, with a view to implementing strategic management tools for the integrated management of water resources within the framework of sustainable development) (Hamiti 2021). During the period 2000-16 to a budgetary envelope of more than 50 billion USD for the implementation of a very ambitious development program, which was translated by the improvement in national indicators in terms of water resources.

Algeria has been set to mobilize water resources through the implementation of:

1) 80 dams with a storage capacity of more than 8.3 billion m^3, to which must be added five (05) dams currently under construction with an additional capacity of 300 million m^3.
2) 2,800 boreholes managed by Algérien Des Eaux (ADE) to strengthen and secure the drinking water supply, particularly for secondary towns and scattered areas, with a production capacity of more than 3,200,000 m^3/j.
3) Eleven large seawater desalination units, managed by dedicated project companies, with a drinking water production capacity of 2.1 million m^3/day, and four (04) units in the production stage project: two of 300,000 m^3/d each, one of 70,000 m^3/d and another 50,000 m^3/d.
4) 27 demineralization stations, in order to guarantee that available and quality drinking water meets current standards, particularly for the benefit of the populations of the localities of the "Wilayas" in the south of the country.
5) 21 major transfer and supply systems between the geographical areas of the country, to consolidate the principles of equity and universality of access to water to a total length exceeding 4000 km and a daily capacity of 2.9 million m^3 intended for the drinking water supply of 15 million inhabitants.
6) 127,000 km of the length of its drinking water supply and distribution network, whereas it did not exceed 55,000 km in 2001, making it possible to densify the network of the national drinking water network and reach homes located particularly in scattered areas or far from urban centres.
7) 14,365 reservoirs and water towers make it possible to mobilize 9 million m^3, thus ensuring regular availability of drinking water to populations.

Sustainable development and urbanization

Algeria has been through the process of adopting urbanization at an accelerated rate in the last two decades. The results from the general population and housing censuses in 1998 and 2008 represent Chantiers, which urbanized 58.3%, then 65.7%, an urbanization rate that has been estimated to be around 70%, including 751 urban settlements in which there is a constellation of urban areas. Of these, 279 are cities with at least 20,000 inhabitants (RNVA 2019). This rapid and continuous expansion poses significant challenges. It contributes to infrastructure congestion, housing and transport tensions, increased fuel consumption, and atmospheric pollution. Thus, the evolution of the number of households and the rate of urbanization by 2030 will generate annual housing needs of between 230,000 and 260,000 housing units, without counting the necessary operations to renew existing assets, particularly those built before 1962 (RNVA 2019). The consequences of this urbanization can be even more damaging given that several regions of Algeria with a high urban concentration are vulnerable and particularly exposed to major risks (earthquakes, floods, landslides, etc.) Finally, climate change, whether driven by natural or anthropogenic factors, accelerates people's and cities' exposure to natural disasters.

The government is fully aware of the problems faced by the people and has committed to the implementation of an urbanization programme aimed at improving urban living spaces and cities. The goals of this study are as follows:

1) Increased availability of high-quality housing at a lower price and improved basic services, especially transportation services in urban places.
2) A national urban policy that promotes a quality living environment for citizens.
3) Organized and controlled urbanization, including rebalancing at the national level of the urban framework.
4) Strengthening the resilience of urban spaces to natural disaster risks.
5) Reduce the negative environmental impacts of cities.

The government's efforts are also aimed at raising awareness and supporting industrial companies in respecting the national legislative and regulatory framework relating to environmental protection and the abandonment of manufacturing processes that are polluting or dangerous for health and safety environments (RNVA 2019).

Conclusion

It is necessary to write a long book to deal with the subject as complex and fascinating as the Algerian approach to sustainable development. Many things have not been covered in this article, but the essentials will have been mentioned in the sense that it has been highlighted that sustainable development in Algeria has not yet set a precedent, but that sustainable development believes it is possible, provided a certain amount of knowledge, from which we note that Algeria faces several constraints and challenges such as environmental pollution, economic growth rate, inflation, unemployment, and poverty. In the presence of inappropriate incentives, the pressures exerted on natural heritage by economic activities risk compromising its capacity for regeneration, thereby causing irreversible effects. Algeria has adopted a sustainable development strategy centered on the integration of the principle of environmental sustainability into various economic and social development programs by improving sustainable growth and reducing poverty at the lowest levels. However, Algeria continues to achieve its desired sustainable development objective. Therefore, as much to be gained for the North as for the South by submitting sustainable development to other reading grids, to other types of cultures, visions of the world as by confining it to an ethnicity that is for the moment largely Western, in the modern sense of the term and not of its past origin. A nation like Algeria, precisely geographically and culturally more Western than one would like to believe, like all the countries of North Africa, which is at the geographical and cultural crossroads between the majorities of the cultures of the world, could prove to be a formidable laboratory to attempt such an experiment.

Things seem to evolve in a direction that is difficult to determine for the moment. This means that everything is still possible for the moment, the fact is that, whatever happens, sustainable development cannot be invited to Algeria without having taken up the challenge of reconciling Algerian society with a notion as modern as it is traditional, that of the common good, and public space. More than ever, Algerian sustainable development must be involved in a work of mediation and reconciliation that is both original and inventive between Algerians, their ancestral local cultures, as well as their national identity, and of course, the spirit of a century that will surely see ecology take an increasingly important place in national and international political squares. For sustainable development, Algeria will have to commit itself to the path of this new modernity, which is as much linked to the past and the present as to the future.

Policy recommendations for Algeria

This review discusses several strategies, policies, and actions implemented by Algeria to address the challenges of sustainable development. However, it lacks a consolidated section with clear evidence-based policy recommendations that can address the gaps in current approaches. The policy recommendations are as follows:

Diversification of economic models

- The transition from fossil-fuel dependency to a more diversified economy by promoting sectors such as renewable energy, technology, and sustainable tourism.
- Establish financial incentives, such as tax benefits or subsidies, for industries investing in sustainable practices.
- Improve business management (particularly in environmental terms); transform or close the most polluting and financially least viable public companies.

Therefore, investing in environmental pros is economically profitable and facilitates Algeria's integration into the market economy.

Renewable energy expansion

- Accelerate the implementation of the National Renewable Energy and Energy Efficiency Program by setting measurable targets, increasing funding, and fostering public-private partnerships.
- Invest decentralized renewable energy projects in rural and underdeveloped regions to ensure equitable access to clean energy.

Integrated waste management

- Develop and enforce stricter regulations on waste disposal and recycling.
- Introduce community-based waste segregation and composting programs to reduce the burden on urban landfills.

Water resource management

- Desalination and water reuse projects should be expanded to address water scarcity.
- A detailed water resource assessment should be carried out in the High-Plateaux regions, with a view to rebalancing land use.
- Strengthening the capacities of the Hydrographic Basin Agencies, and carrying out major training programs in the areas of water management and sanitation for the Algerian Water Authority, National Sanitation Organization, and municipalities. The tariff instrument also constitutes a powerful conservation tool affecting both demand (behavior) and supply (cost coverage), and the completion of the tariff study and its gradual implementation also constitute a decisive aspect of a new policy.

Sustainable urbanization

- Promote green building codes and sustainable urban planning practices, incorporating Renewable energy, and efficient water use in housing projects.
- Develop public transportation networks to reduce emissions and ease urban congestion.

Capacity building and awareness

- Introduce educational campaigns emphasizing the importance of sustainability at schools, Universities and workplaces.
- Train local authorities and community leaders in implementing and monitoring sustainability initiatives.
- Instead of using old paradigm of agri-food self-sufficiency and achieve food security objectives through high value-added agricultural production, a sustainable irrigation policy, trade, and improving the rate of import coverage by exports.

Biodiversity protection

- Increased funding for the conservation of protected areas, national parks, and biodiversity hotspots.
- Formulated a legal framework for the participation of the local and riverside populations and other partners in projects related to the conservation of natural capital.
- Reduce waste production and introduce integrated waste management, both at institutional and financial levels.
- Improve the legal, institutional and environmental management frameworks, strengthen anti-poaching laws and promote community-driven wildlife conservation programs.

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