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Juniperus oxycedrus forests: A Unique Ecosystem Threatened by Extinction - Case Study of the Forest of Lahwant, Tifirt N'ait Hamza Commune, Azilal Province- Morocco."

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Abstract:

This study explores the ecological significance of the Fragrant Juniper Forest ("Twalet" in Amazigh) in Lahwant, Central High Atlas. The forest plays a key role in soil protection, climate regulation, and biodiversity. Field data reveal severe degradation due to illegal logging, overgrazing, agricultural expansion, poor law enforcement, and climate change effects like drought and heat. The extinction of the local bird "Azuri," once crucial for juniper seed dispersal, has worsened natural regeneration. The study calls for legal reform, native-species reforestation, environmental education, and scientific research to preserve this vital ecosystem.

Keywords: Juniperus oxycedrus forests – Ecosystem – Degradation – Extinction – Commune of Tifirt N'ait hamza.

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غابات (توالت) العرعار الفواح نظام بيئي فريد مهدد بالاندثار –حالة غابة لحوانت بجماعة تيفرت نايت حمزة إقليم أزيلال–المغرب

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الملخص

تتناول هذه الدراسة الأهمية البيئية لغابة العرعار الفواح (توالت باللغة الأمازيغية المحلية) بمنطقة لحوانت في جماعة تيفرت نايت حمزة، إقليم أزيلال، الواقعة في الأطلس الكبير الأوسط. وتؤكد على الدور الحيوي الذي تضطلع به الغابة في حماية التربة، وتنظيم المناخ، والحفاظ على التنوع البيولوجي. وتشير الاستنتاجات المستخلصة من المسوحات الميدانية، والاستمارات المعبأة، والمقابلات المستندة إلى الدراية المحلية، إلى مظاهر تدهور مقلقة، ناجمة عن القطع العشوائي، والرعي الجائر، والتوسع الزراعي، إلى جانب ضعف تطبيق التشريعات الغابوية. كما يُعزى هذا التدهور أيضًا إلى تأثيرات التغير المناخي، خصوصًا الجفاف وارتفاع درجات الحرارة. وتوصلت الدراسة إلى أهمية طائر غراب أسود كان يعيش بالمنطقة ويُسمى بالأمازيغية المحلية "أزوري"، الذي كان يلعب دورا حاسما في نشر وحماية بذور العرعار من الإتلاف بفعل فضلاته، حيث ساهم اختفاؤه في تراجع التجدد الطبيعي لهذا النوع النباتي. وتوصي الدراسة بإصلاح قانوني عاجل، وتفعيل برامج لإعادة التشجير بالأنواع المحلية، إلى جانب رفع الوعي البيئي، ودعم البحث العلمي المخبري لهذا النوع من النبات، لضمان استدامة هذه الغابة واستقرار المنظومة البيئية بالمنطقة.

الكلمات المفاتيح: غابات العرعار الفواح – النظام البيئي – التدهور– الاندثار –جماعة تيفرت نايت حمزة.

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Introduction

Morocco places growing importance on environmental protection, with the "Green Morocco Plan" forming a cornerstone of its strategy, especially regarding forest preservation and the fight against desertification. However, these efforts face major challenges, particularly in rural and mountainous regions, where forests have suffered increasing degradation due to overexploitation by impoverished local populations, coupled with ineffective forest management policies. These policies often grant logging and charcoal production rights to large companies that employ exploitative and unsustainable methods.

The Commune of Tifirt N'ait Hamza in Azilal Province serves as a stark example of this crisis. The Tawalt forests are under severe threat due to illegal activities, including smuggling and clandestine logging, which endanger the *Juniperus oxycedrus* species. Agreements between the municipal council and forest authorities have worsened the situation, especially with the issuance of technical documents that have facilitated law violations by wood merchants, causing significant environmental harm.

The Lahwant Juniper Forest represents one of Morocco's most important ecological systems, covering approximately 10,500 hectares—making it the largest of its kind nationally. This forest is characterized by remarkable biodiversity and environmental and economic significance. *Juniperus oxycedrus* trees offer medicinal and ecological value, provide refuge for endangered species, and contribute to maintaining the local ecosystem by regulating the climate and protecting soil and water resources. Nevertheless, the forest is increasingly endangered by human pressures such as overgrazing and illegal logging, as well as natural threats like climate change, which accelerates biodiversity loss and threatens endemic montane species with extinction.

A similar pattern of degradation is also evident in other Moroccan high-altitude *Juniperus* forests. *Juniperus thurifera* L. is a cupressoid scale-leaved conifer belonging to the Cupressaceae family (Fennane et al., 1999) that exhibits significant variation in size. The tallest individuals, reaching up to 20 meters, are generally found in Spain (Blanco-Castro et al., 1997), while the largest in terms of basal circumference—reaching up to 16 meters—are found in Morocco (Emberger, 1938). This species has experienced a marked regression in its geographic distribution.

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This degradation is clearly observed in *Juniperus thurifera* trees in the high mountains of Oukaïmeden, Azzaden, Aït Bouguemmez, and Jbel Bou Iblane, where only dead trunks remain standing (Benabid, 2000). All these factors have led to a significant decline in the distribution area of *J. thurifera* stands. According to Emberger (1938), the surface occupied by these formations was more than 50,000 hectares. Boudy (1958) estimated the area at 31,000 hectares, while Barbero et al. (1990) reported a reduction to 21,000 hectares in 1990, estimating the potential surface for this species at about 300,000 hectares, representing a regression of more than 90%. Hence, it is unsurprising that *J. thurifera* is destined to disappear in the coming decades (Benabid, 2000).

Urgent and effective interventions are necessary to protect and restore this unique forest. Its conservation should become a national priority to ensure biodiversity preservation and sustainable livelihoods for local communities, who depend on forest resources for medicinal plants and ecotourism. If degradation continues, the region risks increased poverty, rural exodus, and the loss of a natural buffer against climate change within an already fragile ecosystem prone to drought and soil erosion. Forests in this region are essential for maintaining environmental, economic, and social balance (Elabbadi Mohamed, 2014).

Problem Statement

The main issue concerning the degradation of Juniperus oxycedrus forests is: "How can we address the accelerating degradation of Juniperus oxycedrus forests in the Lahwant area of the Commune of Tifirt N'ait hamza, knowing that it is Morocco's environmental heritage? Under pressure from human activities, including the use of wood and leaves for medicinal and other purposes such as fuelwood and ornamental plant in landscaping, what sustainable strategies can be deployed to preserve and rehabilitate these forests before they reach the brink of extinction ?"

- **Potential Hypotheses for the Research Problem:**

1-Hypothesis One : Unsustainable human activities (such as overgrazing and illegal logging) are the primary factors contributing to the degradation of Juniperus oxycedrus forests.

2-Hypothesis Two : Climate changes, such as drought and altered precipitation patterns, contribute to the accelerated degradation of these forests and limit their ability to regenerate.

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3-Hypothesis Three : The lack of effective environmental strategies and the absence of strict enforcement of laws promote illegal activities that lead to forest degradation.

4-Hypothesis Four : The degradation of Juniperus oxycedrus forests directly impacts biodiversity and leads to the extinction of certain plant and animal species.

- **Research Objectives**

The objectives of this study are as follows **:**

❖ Diagnosing the Environmental **Situation :** To assess the environmental conditions in the studied area and highlight the various threats to the sustainability of Juniperus oxycedrus forests in the study area, as well as to explore viable ways to preserve them and ensure their continuity.

❖ Enriching National and Local Knowledge : To contribute to the national and local **repository** of pivotal geographical topics and open avenues for researching and discussing new issues concerning the development and decline of Juniperus oxycedrus forests and their implications for local development.

❖ Formulating Effective Solutions **:** To develop effective solutions so as to overcome some of the constraints and threats Juniperus oxycedrus forests face in Morocco in general, and in the Lahwant area of the Commune of Tifirt N'ait hamza in the Azilal Province of the Central High Atlas in particular.

1- Importance of The Research Study

The significance of this study lies in its focus on one of the most prominent fundamental issues, namely the degradation of Juniperus oxycedrus forests, by examining the natural and human causes threatening this forest area at both scientific and practical levels. This research can be seen as a positive initiative towards this forest in the Azilal region, as it has long been neglected and deprived from adequate attention in specialized studies, unlike several similar areas in the High and Middle Atlas Mountains.

Furthermore, the importance of this study is highlighted by its role in addressing various issues within the study area, such as the transformations of the components of the forest environment and the strong connections of the local population to it within the economic, social, and environmental inter-connected framework.

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2- Key Concepts

The degradation of Juniperus oxycedrus forests is a complex issue that requires an understanding of several key concepts that help clarify its causes and impacts. Below are the main factors associated with the degradation of these forests :

- **Vegetation :** Refers to all the plants covering the earth's surface in a specific area. The degradation of forests means a decrease in the density and diversity of vegetation, leading to negative environmental impacts such as loss of biodiversity.
- **Overgrazing** : Occurs when the number of livestock exceeds the land's carrying capacity, leading to soil erosion and hindering the natural regeneration of trees and plants. Overgrazing is a major factor in the degradation of Juniperus oxycedrus forests.
- **Illegal Logging :** Refers to the excessive and illegal cutting down of trees without replanting them. Illegal logging is one of the biggest threats to Juniperus oxycedrus forests as it restricts their ability to regenerate.
- **Climate Change :** Refers to long-term changes in climate, including rising temperatures, altered precipitation patterns, and drought. These changes have a negative effect on the growth of Juniperus oxycedrus trees and hence reduce their resilience to environmental pressures.
- **Biodiversity :** Refers to the variety of living organisms, including plants and animals, in a specific area. The degradation of Juniperus oxycedrus forests is a direct threat to biodiversity due to the loss of habitats for many living organisms and species**.**

3 - Methodology Adopted in the Research

Two approaches were used in studying and analyzing the research.

- **Documentary Method** : This approach involved reviewing a set of documents and studies that dealt with the topic of the study in its multiple dimensions. It included development projects and programs that were planned in mountainous areas, particularly those related to the management and exploitation of forested areas relevant to the study.
- **Descriptive Method :** This method focuses on tracking the studied problem in the field and extracting its cognitive and procedural components. It involved monitoring the extent of degradation and decline of the forest area

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and the preservation of the Juniperus oxycedrus tree that characterizes the region.

☞ **Field Study :** The field research formed the essential methodological pillar for studying the topic. We relied on data collected through field questionnaires to highlight the nature of the ongoing exploitation and to determine the perceptions of the local population regarding the management practices implemented and the future of Juniperus oxycedrus forests. Additionally, oral interviews were conducted with whoever might be concerned in the area including the local community, civil society, association members, and public officials.

☞ **Use of a Household Questionnaire:**

A household questionnaire was used with the aim of identifying the most significant factors threatening the degradation of the studied forest area, through the direct collection of field data from the local population in the region.

☞ **Technical Aspect:**

The technical aspect concerns providing the necessary analytical tools to understand the studied phenomena in a systematic scientific manner. Topographic maps and Geographic Information Systems (GIS) were utilized to accurately process spatial data, alongside the use of (SPSS) software to input and analyze the questionnaire results. This integrated methodology contributes to organizing and objectively interpreting the data, thereby enhancing the scientific credibility of the findings and conclusions.

☞ **Study Sample and Method of Selection:**

The study relied on a sampling method known as cluster sampling, which is a type of probabilistic random sampling. In this approach, everyone in the population has a known and non-zero chance of being selected in the sample. The term "random" does not imply arbitrary selection but rather refers to the equal opportunity given to all units or elements of the phenomenon studied to be included in the sample.

Random sampling also requires the existence of a sampling frame. Unlike non-probability sampling, this method allows for the assessment of the accuracy of the results, as it not only enables the estimation of population parameters but also allows the measurement of the potential error resulting from studying a sample instead of the entire population.

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Based on this methodology, cluster sampling was adopted by dividing the study population into groups (clusters) according to a specific characteristic, like stratified sampling. Some of these clusters were then randomly selected to form the study sample, followed by simple random sampling of individuals within each selected cluster. The study area was divided into **fiv**e douars, representing the statistical population on which this research is based, in accordance with the administrative division of the Tifirt N'ait hamza rural commune, Province Azilal Morocco.

The sample was selected from this population with a particular focus on individuals closely connected to the forest areas in the region — specifically, farmers who are directly experiencing the issue under investigation. A 10% sample was drawn from the total number of farmers, estimated at 800 individuals**.**

Accordingly, the following procedure was adopted to determine the sample size

$$\text{Sample size} = \frac{\text{Total population of the study}}{100} \times \text{Percentage \%}$$

$$\text{i.e.,} \quad 10 \times \frac{800}{100} = 80$$

Table N° 1 : Sample Framework of Respondents by Douar

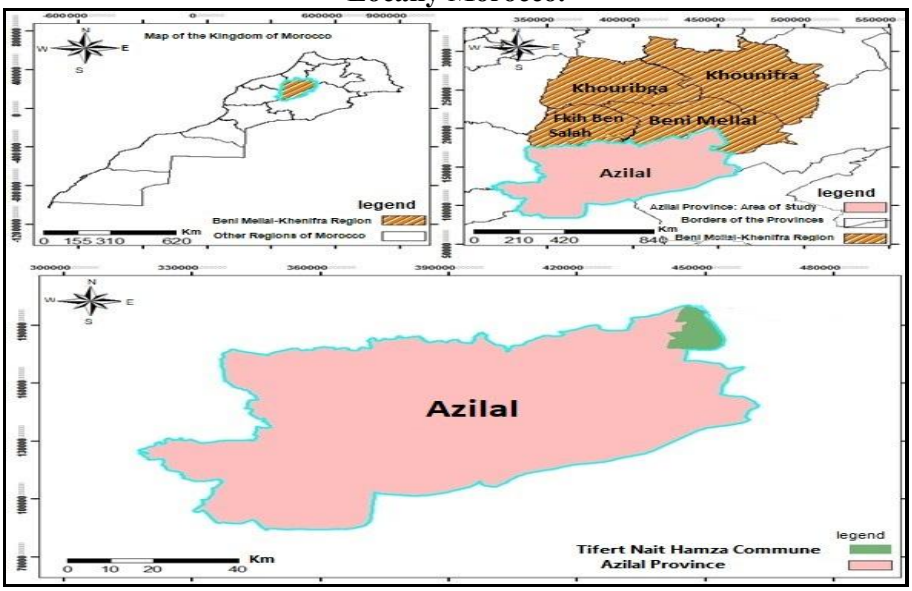
Total number of individuals in the sample	Douars	The number of individuals in the sample from each douar	Percentage
80	Ait mandid	20	25%
	Ait mnessef	20	25%
	Ait brdahem	20	25%
	Ait gairou	20	25%
Total %			**100%**

Source : Researchers' work

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Figure N° 1 : Map : Study Area : Its Localization Nationally, Regionally, and Locally Morocco.



Source: Prepared by the researchers

4- The natural and administrative delineation of the forest area

* Field of study & Its location

The subject of study area is in the Middle Atlas, situated between the latitudes (32°10‘) and (32°23‘) north of the equator and the longitudes (32°10‘) and (6°0‘) west of Greenwich. It precisely lies at the eastern end of the Azilal Atlas, in the heart of the Middle Atlas. It is bordered by a series of topographical units. To the south, is the "Iguil n Mouriq" ridge, and to the east, the "Aghbala and Tizi N'Sli" heights while to the north, the "Tazmout Aghbala" ridge, and to the west, the area overlooks the Tagleft plains. Thus, what characterizes the area is its mountainous nature and rugged terrain, with elevations reaching up to approximately 2100 meters.

5- The Climatic Conditions of the Thuriferous Juniper Forest in the Lahwant Site, Tifirt N'Aït Hamza Commune

According to Table (2), the Lhawant depression, located within the territorial jurisdiction of the Tifirt N’Aït Hamza commune—and considered one of the largest national sites hosting dense populations of thuriferous juniper

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(Juniperus thurifera) —shows Emberger's pluviometric quotient (Q2) values ranging from 40 to 80.

Annual precipitation levels in this area range between 300 and 800 mm, while minimum temperatures can drop to around -7°C during the winter season.

These climatic parameters reflect a cold to very cold winter, classifying the region within the semi-arid to sub-humid bioclimatic zone.

More broadly, Juniperus thurifera stands in the Central High Atlas, particularly in the Azilal Province, are primarily distributed across medium- to high-altitude mountainous zones, which are marked by very low temperatures and bioclimatic stages ranging from cold to very cold semi-arid, and from cold to very cold sub-humid.

These characteristics are consistent with the findings of Peyre (1983), who noted that the distribution of Juniperus thurifera across several Moroccan regions—particularly in the Central and Eastern Middle Atlas and the High Atlas—is confined to cold interior zones located at medium to high elevations, which correspond to upper semi-arid to upper sub-humid bioclimates, and align with the supra-montane and Oro-Mediterranean vegetation stages.

It is worth noting that the values of Emberger's pluviometric quotient (Q2) were calculated using the formula developed by botanist Louis Emberger (Emberger, 1931), designed to characterize Mediterranean climate types, particularly in North Africa (Gaussen, 1954 ; Quézel, 1979). This bioclimatic index expresses the relationship between annual precipitation and the mean maximum and minimum temperatures, adjusted by the absolute thermal amplitude (M − m). It is calculated using the following formula :

$Q_2 = 2000 \times P / (M + m + 546.4) \times (M - m))$

Where :

P : annual precipitation (in mm)

M : maximum temperature of the hottest month (July)

m : minimum temperature of the coldest month (January)

Perature of the warmest month (C°) P: The minimum temperature of the coldest month (C°)

Q2: The rainfall

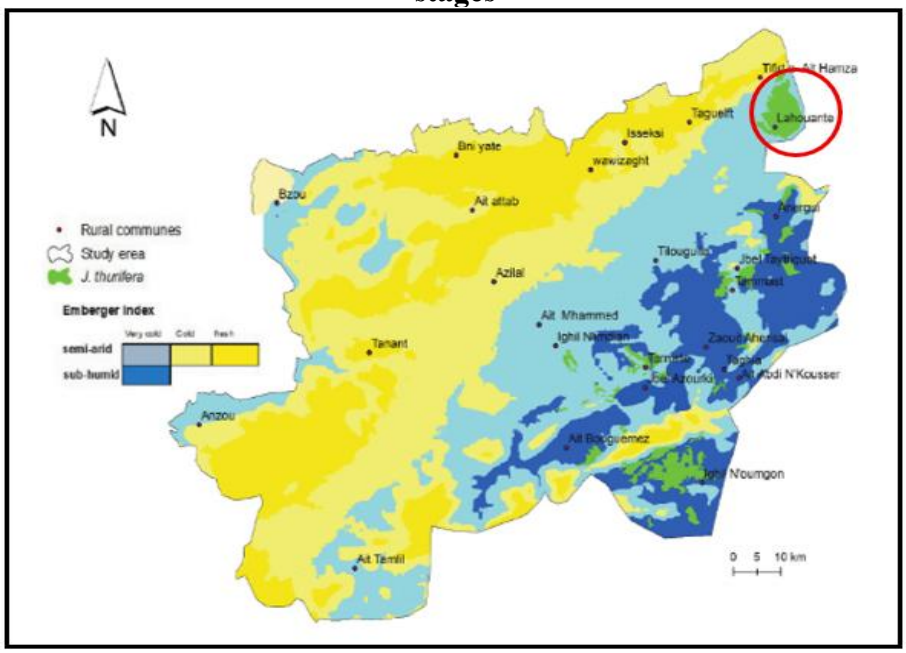
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Table N° 2: Ecological characteristics and Coordinates of the study sites

Site	laltitude	longitude	Altitude (m)	M C°	M C°	P mm	Q2	Bioclimats
Tifirt N'ait hamza	32°18' 41" N	05°57' 32" W	1800-2200	38.4	-0.2	531.7	46.60	Semi-arid – cold
Zaouit Ahnssal	31°45' 11" N	06°05' 02" W	1600-2800	30.6	-4.2	568.9	57.11	Humid-cold
Anrgui	32°01' 01" N	05°57' 39" W	1600-2600	36.1	-3.6	465.37	41.20	Semi-arid-Very cold

Quotient of Emberger

Figure N° 2 : Map "Distribution of *J. thurifera* according to bioclimatic stages

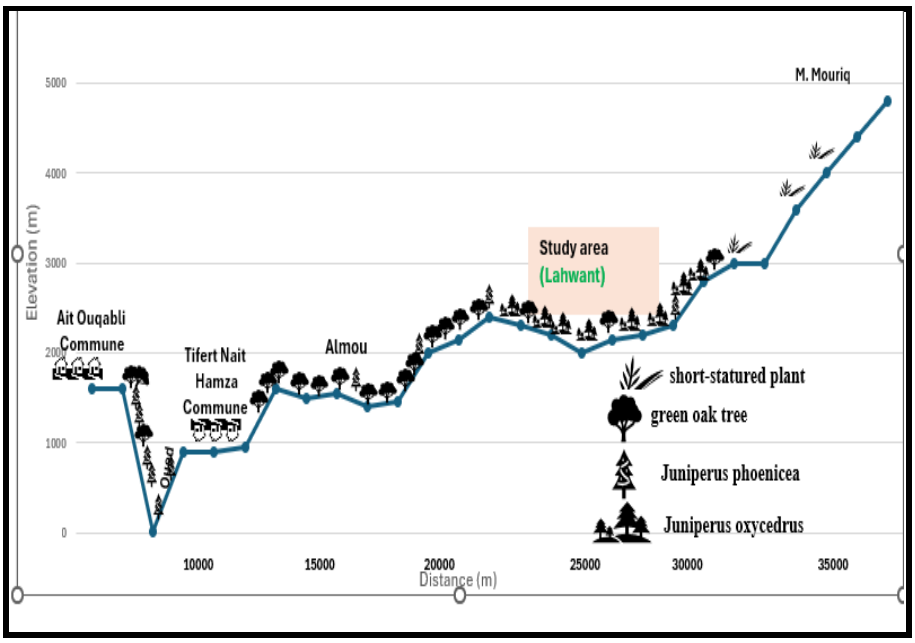


The **Source :** Abdelaziz Moujane, A. A., et al. (2023): Geographical distribution of the Thuriferous juniper (Juniperus thurifera L.) and the influencing factors in the Atlas Mountains of Azilal (Central High Atlas, Morocco),

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Figure N° 3 : Phototopographical profile of the tifirt N'aih hamsa commune



Source : Prepared by the researchers

6- Characteristics of the Fragrant Juniper (Tawalt)

The fragrant juniper tree thrives at high elevations and in deep, cold valleys. Juniper typically forms stands that are often dense and suitable. The forests of fragrant junipers can consist of pure or mixed stands with green oak, depending on elevation and location on the slopes (TTOBA - PROCES VERBAL D'AMENAGEMENT- JUIN 2007). These forests are characterized by the following :

6.1. Physiological Characteristics :

The fragrant juniper (Juniperus thurifera) is a unique tree distinguished by its aromatic properties. This tree produces concentrated resin that is distributed throughout various parts of its vegetative structure, including the roots, trunk, and leaves. This resin is responsible for the strong scent emitted by the tree, setting fragrant juniper apart from other plants. This aroma serves as an ecological communication method, allowing the tree to be identified even from a distance.

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6.2. Scent as an Ecological Tool :

When passing near the mountainous areas where Juniper grows, especially at altitudes ranging from 1600 to 2000 meters, one can notice the fragrant resin filling the air. This is quite common when trekking or hiking in nature nearby. As one travels across dense forests with a diverse plant composition or just approaches the area, they will begin to sense the strong aroma of Juniper's resin, and hence its identification without the need for direct visual contact.

6.3. Nature's Message : "I Am Here " :

Metaphorically, this powerful scent resembles a brief auditory message sent by the tree to passersby, as if it were saying, "I am here." This distinctive fragrance makes the tree clearly recognizable in its natural environment, to the extent that it has become part of the cultural consciousness of certain local populations. In Amazigh regions, for instance, the male fragrant juniper tree is referred to as "Awal" (meaning "speech" or "word" in Amazigh), while the female tree is called "Tawalt." This nomenclature carries connotations of communication, as the scent of the tree is viewed as a clear signal of its presence in nature.

6.4. Cultural and Heritage Value:

The fragrant juniper tree holds a special place in local culture, particularly in North Africa. It is considered a symbol of the relationship between humans and nature and is viewed as a source of beauty and utility. The Amazigh names "Awal" and "Tawalt" reflect this close bond between humans and the environment, as the value of the tree extends beyond its physical properties to encompass its cultural and heritage significance.

7- Origin of the Name "Tawalt" in Amazigh:

The designation of the fragrant juniper as "Tawalt" in the Amazigh language is not arbitrary ; it stems from a set of physiological characteristics associated with this tree, alongside a correlation between these characteristics and local Amazigh terminology. In the local Amazigh lexicon, feminine names are formed by adding the letter "t" at the beginning and end of a word. Based on this linguistic rule, the female fragrant juniper tree in the Ait Sekhaman region of Azilal is called "Tawalt." In contrast, the male tree is referred to as "Awal," a term used by some tribes in areas like Ourika, Tchka, and Zawiyat Ahnaslal. Moreover, the word "Awal" in the Amazigh language designates "speech." This leads to the question : How is the connection made between the word "Awal," denoting speech, and the male

Fragrant juniper tree ?

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This connection can be explained through the strong fragrance that characterizes the male tree, which can be viewed as a form of natural "communication" sent by the tree, as if it were "speaking" to its surrounding environment, thus clarifying the choice of the name "Awal" for the male tree.
It is noteworthy that the fragrant juniper belongs to the gymnosperms, which possess two types of reproductive systems (Ait Hamdi Abdelluh & Nachouane Hazim, 2021).

Hermaphroditic : Where the tree bears both male and female cones simultaneously, as seen in some species like the Aleppo pine.

Dioecious : Where there are distinct male and female trees, as in the case of fragrant juniper. In this species, the male tree produces pollen, while the female tree bears cones. This means there exists a male tree and a female tree, and reproduction occurs between fragrant juniper trees (Juniperus thurifera) through a sexual reproduction system that involves male and female plants. The male tree produces pollen, which are the male gametes, while the female tree produces cones that contain seeds, which are the female gametes.

In spring, the male trees begin producing pollen, which appears in the form of small cones that open to release pollen. The pollen is carried from the male trees to the female trees by the wind, as fragrant juniper is one of the plants that rely on wind for pollination, allowing the pollen to travel considerable distances.

Upon reaching the female cones, the pollen adheres to the female reproductive organs within the cones. Pollination occurs when the pollen fertilizes the eggs present in the cones, leading to the development of fertilized eggs into seeds. This process takes several months, and typically, female trees produce seeds that are ready for growth in the following fall or spring.

The seeds are surrounded by a sweet and attractive substance, which helps attract animals. When these animals consume the seeds, they aid in their dispersal in nature through their droppings, contributing to the distribution of fragrant juniper into new areas.

This reproductive process is crucial for maintaining biodiversity and the distribution of trees in their natural habitats, thereby contributing to the sustainability of this unique ecosystem.

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Table N° 3 : Complete Identification Card of the Fragrant Juniper

Category	Details
Division	Seedlants
Group	Gymnosperms
Family	Cupressaceae
Genus	Juniperus
Species	Juniperus thurifera
Common Name (Global)	Fragrant Juniper
French Name	le jenevrier thurifère
Arabic Name	العرعار الفواح
Amazigh Name	Tawalt (ⵜⴰⵍⵍⵓⵜ)

Source: Researcher's Contribution

8- Ecological Characteristics and Functions of the Fragrant Juniper Forest in the "Lahwant" Area, Tifirt N'ait hamza, Azilal Province

The fragrant juniper forests serve as a reservoir for unique animals and plant genes within the juniper ecosystem. They play a significant role in regulating water flow, preserving soil, and protecting the soil and infrastructure from erosion. In addition, the forests have a determining role in combating river sedimentation and their ability to mitigate the effects of drought.

8.1 Ecological Characteristics

The fragrant juniper (Juniperus thurifera) is found in mountainous regions characterized by a semi-arid to semi-humid climate, occasionally reaching humid conditions, with winters ranging from cold to severely cold. The tree thrives at altitudes between 1600 and 3400 meters, often appearing as solitary trees that can reach heights exceeding 18 meters. Notably, its growth is not significantly affected by the physical or chemical properties of the soil.

Oceanic influences are important climatic factors that significantly impact the distribution of the fragrant juniper. This tree tends to avoid these influences, preferring protected areas such as closed valleys (Cuvettes) or sunny slopes, particularly on southern-facing aspects known as "Asamer" in Amazigh. In contrast, it avoids northern-facing slopes (Varsant Nord), which are characterized by constant shade and referred to as "Amalou" in Amazigh.

In addition to its presence in mountainous areas and avoidance of oceanic influences, the fragrant juniper plays a vital environmental role in protecting

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soil from erosion and enhancing its cohesion, particularly in regions susceptible to erosion due to heavy rainfall. It is also an important source of biodiversity, providing habitat for numerous plant and animal species that depend on this natural habitat for survival.

Figures N° 4 : Juniper Tree (Tawalt) in the Study Area



The image documents a Juniperus thurifera tree in a very good state of growth. It serves as a living example of a healthy forest cover in the Central High Atlas region, specifically in lahwant, Tifirt N'Aït Hamza municipality, Azilal Province, Morocco. The image shows a large tree with a dense, spherical crown extending widely in a horizontal direction, with a relatively short trunk, reflecting more lateral than vertical growth—a characteristic feature of old trees of this species.

Source: Taken by colleague Khalla Oalijan in the Fawah juniper forest in the "Lahwant" area, under the jurisdiction of the Tifirt N'ait hamza commune in the Azilal province Morocco on 25/06/2025.

The Fawah tree also contributes to the local economy, as it provides raw materials such as wood for furniture manufacturing and heating, making it an important resource for local populations.

Table N° 4 : Various Secondary Forest Plant Formations Accompanying and Associated with Juniper in the Study Area

Name in English	Name in Amazigh	Name in French
□ Juniperus oxycedrus	**tiqi** ⵜⵉⵇⵉ	Juniperus oxycedrus
□ Juniperus phoenicea	**Kizou** ⴽⵉⵣⵓ	Juniperus Phoenicia
□ Alyssum spinosum	**ifsi** ⵉⴼⵙⵉ	Alyssum spinosum
□ Astragalus ibrahimianus	**Tichet** ⵜⵛⵔⵜ	Astragalus ibrahimianus
□ Carmenis scariosa	**Tafsit** ⵜⴰⴼⵙⵜ	Armenis scariosa
□ Holm oak (Quercus ilex)	tasafte ⵜⴰⵙⴰⴼⵜ	Quercus ilex
□ Aleppo pine (Pinus halepensis)	**tayda** ⵜⴰⵢⴷⴰ	Pin d'Alep

The source is field research.

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8.2 Usefulness of the Fawah Forest

8.2.1. Economic Level :

The Fawah forest in the "lahwant" area of the Tifirt N'ait hamza commune, Azilal province, provides a vital source of fodder, which is almost the primary food for livestock, especially during winter when snow covers the area and roads-whether paved or not- become inaccessible. This situation pushes herders to trim and cut branches from the Fawah trees to feed their livestock. Due to the lack of alternative energy sources, the local population relies on gathering firewood from the forest to be used for heating and cooking, particularly "Tawalt" wood, known for its quality and durability, making it desirable for various uses such as roofing buildings and making furniture. Additionally, the density of trees in this area provides an ideal environment for wildlife to thrive such as birds and wild animals. These are needed in hunting ; so, the abundance of games benefits the region and its population thanks to the revenues gained from hunting activities.

8.2.2. Ecological Level :

The "Lahwant" forest plays a vital role in carbon storage, enhancing its biomass and providing an ecological niche for various species of birds and animals. Thus, the forest becomes a haven for these creatures, significantly contributing to the preservation of biodiversity in the area. In addition, this forest is a major source of wildlife, as the neighboring areas rely on it as a reservoir For these natural resources.

In addition to its role in carbon storage and biodiversity preservation, the "Lahwant" forest contributes to local ecological balance by regulating the climate, stabilizing the soil, and preventing erosion. The forest is also an essential part of the ecosystem that supports human activities such as agriculture and grazing, providing important natural resources for the local population. Moreover, the forest represents a part of the natural and cultural heritage of the region, which enhances its importance in preserving the sustainability of natural resources and sustainable development for future generations.

8.2.3. Recreation and Leisure Level :

The recreational and leisure function is nearly non-existent or even absent, due to two main reasons. The first is that residents do not pay sufficient attention to recreational areas due to the widespread poverty and social vulnerability. These difficult economic conditions prevent many individuals

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from allocating time or resources for leisure activities, which negatively impacts their mental and social health.

The second reason is the lack of accessible means which further complicates reaching these ecological sites. Recreation in such places requires appropriate infrastructure, such as roads and public transportation, which often suffers from neglect. Consequently, the lack of recreational facilities not only deteriorates the quality of life for residents but also leads to widespread frustration and a sense of disconnection from nature, exacerbating social and psychological issues in affected communities. Therefore, it is crucial to improve economic conditions and provide access to natural sites in the Lahwant area of the Tifirt N'ait hamza commune, specifically the Fawah forest, to enhance recreation and leisure, thereby improving overall quality of life.

8.2.4. Medical Uses :

In recent years, the dry distillation method was used to extract certain perfumes and tar, known in Amazigh as 'Lkdam' or 'Oudi Nlghman', from the wood of the Fawah tree. This tar resembles juniper oil and is used in veterinary medicine to treat deep and superficial wounds, as it is effective as a disinfectant that eliminates germs and contributes to wound healing (Cicatrisant) due to its antibacterial properties (Antiseptique).

Additionally, the tar is used as an insecticide and antiparasitic (Antiparasitaire), making it important for animal care. Due to the limited availability of veterinary medications at the time, residents would clean the fur of their goat herds using this tar, earning it the nickname 'Shampoing de Chèvre'.

In this way, the Fawah tree contributed to providing some veterinary medicines, reflecting the importance of natural plants in traditional medicine and their role in promoting animal health. This traditional use demonstrates how communities rely on local resources to meet their health needs, contributing to the sustainability of traditional veterinary practices.

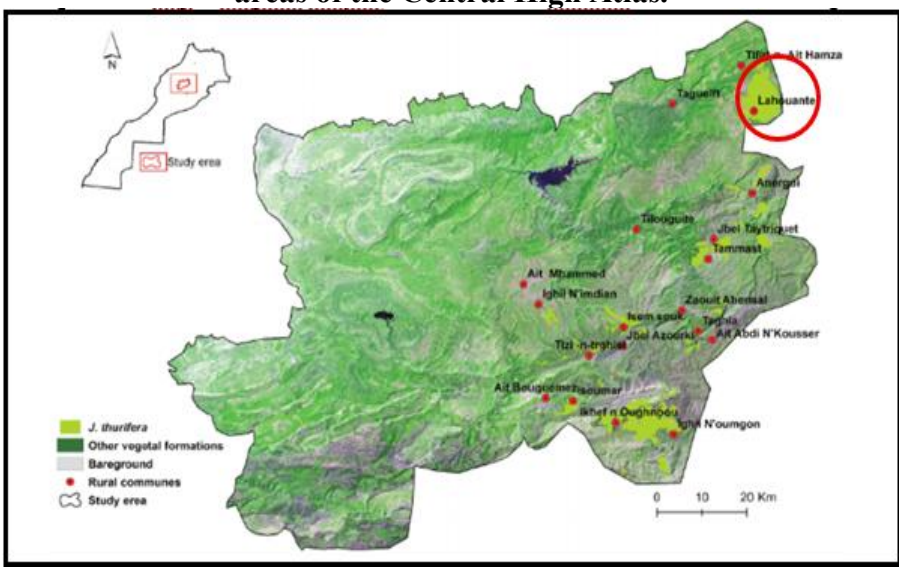
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Table N° 5 : Types of Junipers in the Study Area

Name in Amazigh	Name in Arabic	Name in French	Name in English
Kizou ⵅⵉⵣⵓ	العرعار الأحمر-	Genevrier rouge	-Red Juniper
tiqi ⵜⵉⵇⵉ	العرعار الشوكي-	Genevrier oxycedre	-Prickly Juniper (Juniperus oxycedrus)
Tawal ⵜⴰⵡⴰⵍⵜ	العرعار الفواح-	Genevrier thurifere	Incense Juniper (Juniperus thurifera)

The source is field research.

Figure N° 5: Map of *Juniperus thurifera* distribution in the mountain areas of the Central High Atlas.



The source : Abdelaziz Moujane, A. A., et al.(2023): Geographical distribution of the Thuriferous juniper (Juniperus thurifera L.) and the influencing factors in the Atlas Mountains of Azilal (Central High Atlas, Morocco.

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9- Signs of Environmental Imbalance Due to the Degradation of the Fawah Juniper Forest in the Study Area

Because of its critical function in controlling the climate, preserving the soil, and promoting biodiversity, the fragrant juniper forest is one of the significant ecosystems that help to maintain ecological equilibrium. However, human activities like overgrazing, excessive logging, and unsustainable resource extraction are causing this natural environment to deteriorate more and more. The soil is prone to erosion and runoff, endangering the sustainability of the entire ecosystem, and these detrimental changes result in the loss of ecological balance, which impacts the living things that rely on this habitat. The following are symptoms of losing balance :

Animals in the Tifirt N'ait hamza community are affected by the loss of biodiversity.

There is a serious risk from the juniper forest deterioration in the Tifirt N'ait hamza community.

9.1. Loss of Biodiversity and Impact on Fauna in the Tifirt N'ait hamza Commune :

The degradation of juniper forests in the Tifirt N'ait hamza commune poses a significant threat to biodiversity loss, as the destruction of these forests leads to the loss of habitats for many different species (Bahou Abdelaziz, & Hanane Benaissa, 30Oct 2022) , increasing the risk of extinction for endangered species. This directly affects food chains, as species that rely on each other for sustenance are disrupted, resulting in disturbances within the ecosystem. Furthermore, the juniper forest is home to a diverse array of animals and plants in the study area, and the loss of these habitats means that these species will face difficulties in survival. In the worst-case scenario, some species may reach the brink of extinction, while others may be forced to alter their migration patterns due to the loss of their traditional habitats. Therefore, preserving these forests is not only essential for maintaining biodiversity but also for ensuring the continuity of the ecosystem in this natural environment in the Lahwant area of the Tifirt N'ait hamza commune.

9.2. Degradation of Soil and Water Quality :

The deforestation and excessive logging of trees have significantly impacted soil stability, leading to increased erosion and nutrient loss. Moreover, the degradation of this forest in the study area can result in water source pollution due to the runoff of pollutants from degraded areas.

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9.3. Effects on the Local Climate :

The Fawah juniper forest plays an important role in regulating the local climate ; thus, its degradation can lead to increased temperatures and greater fluctuations in humidity. Additionally, its degradation results in higher carbon emissions due to tree decay, contributing to the intensification of the greenhouse effect.

10- Economic and Social Impacts of the Loss of the Juniper Forest in the Tifirt N'ait hamza Commune

The Fawah juniper forest in the Tifirt N'ait hamza commune is a vital source of natural resources, as many residents in the area rely on this forest to secure their basic needs for food, medicine, and raw materials. This ecosystem plays an important role in supporting the livelihoods of local communities, and therefore, the loss of these natural resources will have significant economic and social repercussions.

10.1. Importance of the Forest as a Resource :

☞ **Food :** Many residents depend on the plants and herbs that grow in the juniper forest as a food source, whether through foraging or cultivation. Any deterioration of the forest directly impacts the availability of these resources.

☞ **Medicine :** The forest contains numerous medicinal herbs used in traditional medicine, and their loss poses a risk to community health, making it difficult to find alternatives for these herbs.

10.2. Impact on Livelihoods :

Loss of Economic Returns : Local communities rely on economic activities associated with the forest, such as gathering firewood and forest products. The loss of these resources leads to a reduction in job opportunities and an increase in unemployment rates in the area.

10.3. Impact on Income Sources :

Many residents consider the forest a source of income through the sale of natural products. The deterioration of resources results in decreased economic returns for the residents, negatively affecting their standard of living.

10.4. Social Effects :

☞ **Change in Lifestyle**: With the decline in resources, residents may be forced to alter their lifestyles, impacting their cultural habits and traditions associated with the forest.

☞ **Social Conflicts:** The scarcity of resources may lead to disputes among local communities over forest usage rights, increasing social tensions.

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Figures N° 6 and 7 illustrate the extent of degradation of the *Juniperus thurifera* forest in the study area



These two images show the Fragrant Juniper Forest in the Lahwant area, within the Tifirt N'ait Hamza commune, Azilal Province, Morocco, in a distressing and alarming state of deterioration that evokes concern and sorrow. The signs of environmental degradation are clear, resulting from the interplay of human and natural factors that have led to this deplorable situation threatening the existence of this valuable forest. This deterioration poses a real threat to the ecological balance and the local communities that depend on it, requiring urgent intervention by the relevant authorities to save whatever can still be salvaged from this forest.

This painful reality has compelled me to undertake this humble study as a cry and a call to officials and decision-makers to take effective and sustainable measures to curb this environmental disaster before it is too late, and to work on protecting and preserving the forest in general, and the Fragrant Juniper Forest in particular, to ensure its continuity and the well-being of future generations.

The source : Captured by the researcher on June 25, 2025.

11- Main Causes of the Degradation of the Juniperus thurifera Forest in the Study Area

The Juniperus thurifera forests are experiencing increasing degradation due to various human and natural factors:

11.1. Human Factors :

The Fawah juniper forests are vital ecosystems that contribute to maintaining environmental balance and biodiversity. However, these forests are encountering growing threats due to various human activities, raising concerns about their future and sustainability. Through fieldwork (the questionnaire) directed at the local population regarding the status of the Fawah juniper forest in the Lahwant area of the Tifirt N'ait hamza commune, a random sample of 80 individuals was selected. This sample included various categories in terms of gender, age, and educational level, aiming to gather insights from each category about the Fawah forest. The results were as follows:

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Table N° 6 : The Most Threatening Activities to the Fawah Forest

Activity Type	Frequency	%
Overgrazing	29	36.25%
Theft of wood and cutting for the expansion of agricultural land at the expense of the Fawah forest	03	3.75%
Exploitation of Fawah wood for cooking and heating	10	12.50%
Selling the Fawah forest to contractors and forestry developers in an exploitative manner	28	35%
Exposure to fires	02	2.50%
Lack of law enforcement against offenders	08	10%
Total	80	100%

Source : Analysis of field survey results, June 2025.

Based on the results of the field survey, as shown in Table N° 6, it has been confirmed beyond any doubt that the Juniperus thurifera Forest in the study area is facing serious threats due to various Human factors as follows :

11.1.1. Human Factors

The Juniperus thurifera forests are vital ecosystems that contribute to maintaining ecological balance and biodiversity. However, these forests face growing threats from multiple human factors, raising concerns about their future and sustainability. Through fieldwork (the questionnaire) directed at the local population regarding the condition of the Juniperus thurifera forest in the "Lahwant" area of the Tifirt Naït Hamza commune, a sample of 80 individuals was randomly selected, encompassing various demographics in terms of gender, age, and educational level, to gather perceptions from each category about the forest. The results are as follows :

11.1.2. Overgrazing

Although grazing is a traditional activity relied upon by local populations, its unsustainable continuation threatens the natural resources these communities depend on. The fieldwork findings, as shown in Table N° 6, reveal that 36.25% of respondents believe that unregulated and excessive grazing leads to the destruction of young plants and inhibits tree regeneration, gradually depleting the vegetation cover, especially during the last seven years. (2018-2024), during which Morocco, particularly the study area, has experienced climatic fluctuations resulting in weakened and erratic rainfall, alongside a complete absence of snowfall. It is noted that Juniperus thurifera trees grow

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slowly and cannot withstand excessive consumption of young plants and buds, leading to a gradual erosion of their forest. As vegetation erodes, the soil becomes exposed and vulnerable to erosion factors, especially rain and wind, increasing the risk of environmental degradation. Additionally, overgrazing affects soil cohesion and exacerbates its exposure to erosion and degradation.

11.1.3. Illegal Tree Cutting

The wood of Juniperus thurifera is a traditional source of firewood in the Tifirt Naït Hamza commune, located in a mountainous area characterized by severe cold in winter, with temperatures ranging from 5 to 8 degrees Celsius during rainy months. This harsh weather compels some individuals to illegally cut trees to obtain fuel or wood for construction. Such exploitative practices contribute to the reduction of the forest area and diminish its ability to regenerate naturally. According to the results from the field research questionnaire, as illustrated in Table N° 6, 12.50% of respondents confirmed the contribution of exploiting Juniperus thurifera wood for cooking and heating to the degradation of this forest.

11.1.4. Human-Caused Fires, Whether Intentional or Negligent

Fires, whether due to negligence or intentional acts, are considered a factor with minimal impact on the Juniperus thurifera forest in the study area. The forest experiences at least one fire every ten years, as demonstrated by the field research results, where the percentage of respondents reporting the impact of fires on the Juniperus thurifera forest did not exceed 2.50%. However, this factor remains one of the most serious threats the forest may face, as it can lead to the destruction of vast areas in a short period if subjected to fires. Furthermore, Juniperus thurifera trees grow slowly, meaning that any fire will result in permanent losses to the forest, complicating its recovery process and potentially rendering it impossible in some cases.

11.1.5. Theft of Wood and Illegal Tree Cutting for Agricultural Expansion

Forest fires, whether negligent or intentional, are considered factors with minimal impact on the Juniperus thurifera forest in the study area. As shown in the results of the field research questionnaire, the percentage of respondents indicating the impact of fires on the Juniperus thurifera forest did not exceed 2.50%. The forest experiences at least one fire every ten years ; however, this factor is deemed one of the most dangerous threats to the forest, as it can lead to the destruction of vast areas in a short period.

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The wood of Juniperus thurifera is valued for its high quality and rarity, making it highly sought after in traditional industries and as a fuel source. This demand attracts individuals and groups to illegally cut trees for selling wood on the black market or meeting their personal needs. The study area is one of the poorest regions nationally and regionally, prompting residents to rely on tree cutting for income, building their homes, and expanding their agricultural lands at the expense of this forest. Although this factor is considered less impactful according to the respondents' statements at a rate of 3.75%, the continuation of this behavior accelerates the depletion of the forest beyond its natural regeneration capacity.

Illegal and indiscriminate cutting of Juniperus thurifera trees not only disrupts ecological balance but also threatens the habitats of living organisms that depend on the forest, such as birds, insects, and wildlife. Since this type of tree grows slowly, any cutting operation causes damage that takes decades to repair. Furthermore, using Juniperus thurifera wood in traditional industries, such as handicrafts and furniture, leads to the growth of an illegal wood trade, where trees are cut unlawfully for exploitation in these industries. As the demand for luxurious wooden products made from Juniperus thurifera increases, so do cases of theft.

11.1.6. The Role of the Tifirt Naït Hamza Commune in Threatening the Juniperus thurifera Forest and Losing Its Ecological Balance in Collusion with Officials

Field research results (the questionnaire), according to Table N° 6, indicate that 35% of respondents, the highest percentage among the influencing factors on the Juniperus thurifera forest, confirm that the most impactful and painful factor affecting the Juniperus thurifera forest in the Tifirt Naït Hamza commune is the repeated sale of this forest, which is considered a primary source of their financial resources, without allocating a portion of the revenues for its rehabilitation. This situation has a clear and direct negative impact on the forest, leading to the continuous depletion of its resources. It exploits the natural resources it provides without compensation or renewal, contributing to the degradation of its environmental condition in the long term.

The absence of rehabilitation processes leads to a decline in biodiversity, a decrease in the forest's natural regeneration capacity, and an increase in erosion risks and soil degradation. Additionally, the local community may be

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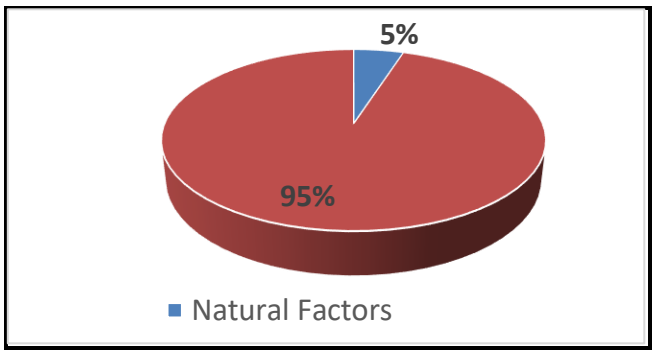
affected, putting its ecological and economic stability at long-term risk due to the loss of sustainable benefits from natural resources.

Moreover, some contractors and forest developers exploit the opportunity to purchase the barren Juniperus thurifera forest to engage in illegal acts in collusion with some collective and forest officials, as they trespass on living trees and steal what is alive and fruitful. This behavior is not limited to financial exploitation but accelerates the destruction of vegetation and leads to significant deterioration in the forest's ecological structure. As a result of this excessive and unlawful exploitation, the forest becomes less capable of natural regeneration, threatening biodiversity and increasing soil vulnerability and erosion.

11.1.7. Insufficient Environmental Policies and Law Enforcement

Based on the field research results and the analysis of the questionnaire, it was revealed that 10% of respondents state that insufficient environmental policies and law enforcement represent one of the main issues negatively impacting natural resources and ecosystems in the Juniperus thurifera forest. Due to the absence of integrated environmental strategies and a lack of strict commitment to enforcing environmental laws, the challenges related to environmental sustainability worsen. These gaps allow for the continuation of illegal activities, such as overgrazing and unregulated tree cutting, all of which contribute to the degradation of the natural environment. Developing more comprehensive environmental policies, including rehabilitation plans and tightening oversight on violations, is a necessary step to ensure the protection of biodiversity, the sustainability of natural resources, and the provision of a healthy environment for the communities that depend on them.

Figure N° 8: Illustrating the Most Influential Factor on the Juniperus thurifera Forest in the Lahwant Area of the Tifirt Naït Hamza Commune



Source : Results of the Field Research Questionnaire, June 2025

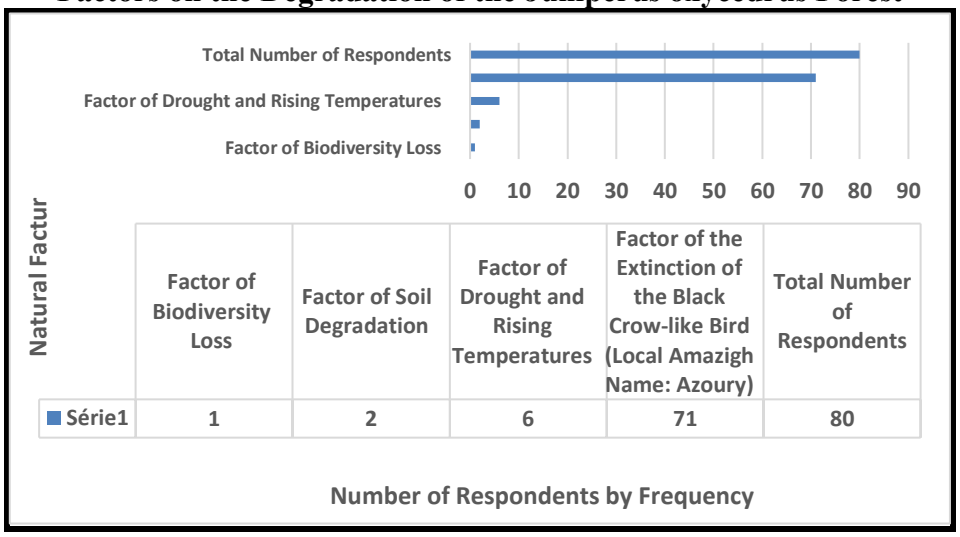
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The results of the field research questionnaire indicate that human factors have a significant impact on the juniper forest in the study area, particularly affecting the overall environment, with a percentage of 95%. In contrast, the influence of natural factors did not exceed 5%. This stark disparity highlights that human activities, such as uncontrolled grazing, illegal logging, and pollution, play a crucial role in the degradation of ecosystems. These figures reflect an urgent need to develop effective environmental management strategies that focus on mitigating the negative impacts of human activities and promoting awareness of the importance of environmental conservation.
There should be an emphasis on enforcing environmental laws and strengthening sustainable policies that protect natural resources. The significant impact of human factors on the environment calls for a collective effort from all sectors, including local authorities and civil society, to ensure a more sustainable future for the coming generations.

11.2. Natural Factors

The *Juniperus thurifera* forests located in the commune of Tifirt Nait Hamza are undergoing notable degradation, primarily as a result of the intensifying impacts of climate change — a phenomenon that ranks among the most critical threats to ecosystems worldwide. This degradation is clearly reflected in the contributing factors illustrated in the chart blow (Figure 9).

Figure N° 9 : Respondents' Perceptions of the Impact of Natural Factors on the Degradation of the Juniperus oxycedrus Forest



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Source : Field Survey Results, June 2025

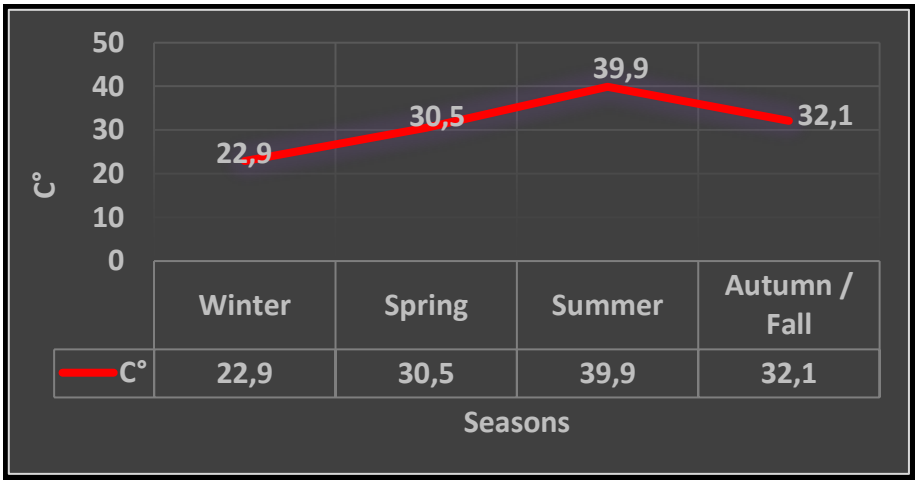
11.2.1. Increase in Temperatures

The rise in average temperatures is a negative factor affecting the juniper forests, leading to changes in the environmental patterns of tree growth. This weakens tree development and adversely impacts forest health. Additionally, higher temperatures contribute to prolonged dry periods, increasing water evaporation and making arid areas drier. This negative impact is reflected in forests that depend on specific amounts of water. The study area has witnessed a noticeable rise in temperatures over the past seven years (2018–2024), resulting from consecutive years of drought, which has significantly affected the forest resources in the region.

Despite these observable climatic shifts, only 6 out of 80 respondents (7.5%) identified the rise in temperatures and atmospheric warming as a key factor contributing to forest degradation. According to this small segment of the population, increasing heat leads to higher evaporation rates, reduces soil moisture, and undermines tree resilience, particularly in species such as Juniperus oxycedrus. They also stressed that higher temperatures significantly raise the risk of wildfires, thereby threatening forest sustainability. While this opinion is held by a minority, it reflects an awareness—among some individuals—of the broader environmental processes shaping the current state of local forest ecosystems.

Figure N° 10 : Seasonal Distribution of Temperature in the Region According to Data from the Tilouguet Station

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The : source The Water Basin Agency of Oum Er-Rbia

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11.2.2. Soil Degradation

Soil is a vital component of the ecosystem, playing a crucial role in supporting plant life and ensuring forest health. With current climate changes, soil faces several problems that negatively affect environmental quality.

Soil Erosion : The increase in temperatures and changes in rainfall patterns lead to increased soil erosion. Heavy rain can wash away the topsoil, resulting in the loss of essential nutrients needed for tree and plant growth. Soil erosion reduces its ability to retain water and affects forest productivity, negatively impacting biodiversity.

According to the survey conducted among local residents, 2 individuals out of 80 respondents (which represents 2.5%) identified soil degradation as a key factor contributing to the deterioration of the Juniperus oxycedrus forest.

In summary, both increased temperatures and soil degradation pose serious threats to the Juniperus oxycedrus forests in the Tifirt Naït Hamza community, undermining their sustainability and overall ecological balance.

11.2.3. Impacts of Climate Change on Biodiversity in the Juniperus Oxycedrus Forest within the Study Area

Climate change has profound effects on biodiversity, with juniper forests being among the most affected environments. These climatic shifts create unfavorable conditions for many species, particularly those that are sensitive, such as those specialized in juniper forests. Changes in temperature or patterns of rainfall can lead to the deterioration of natural habitats, causing declines in species populations or even their extinction. This loss doesn't only affect individual species but also disrupts the broader ecological balance on which local ecosystems rely. In response to climate pressures, some species may move to new areas in search of more suitable conditions, potentially leading to interactions with native species and affecting the ecological balance in their original habitats. This migration may result in shifts in food chains, competition for resources, and the spread of diseases, all of which pose threats to ecosystem stability.

These impacts highlight the interconnectedness of climate change and biodiversity, as species loss and extinction contribute to the degradation of ecosystems that sustain various forms of life.

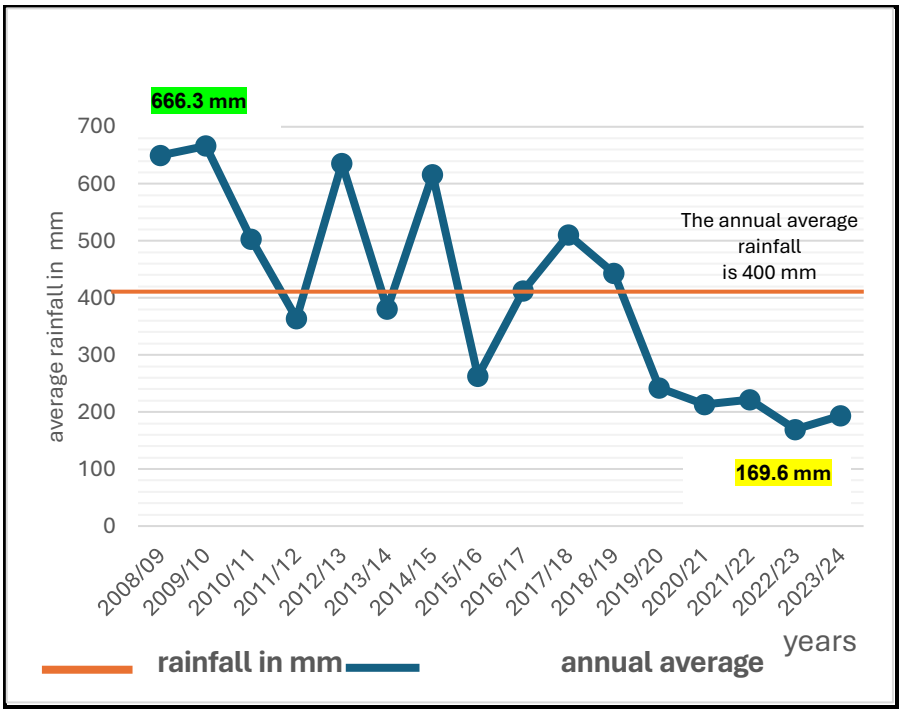
Figure No 11 illustrates a noticeable fluctuation in rainfall amounts in the study area during the period from 2008 to 2024. The highest recorded precipitation occurred during the 2009/2010 season, reaching 666.3 mm. This reflects favorable climatic conditions that contributed to increased soil

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moisture levels, which in turn had a positive impact on agricultural activity, water resources, and vegetation cover.

In contrast, the lowest rainfall was recorded during the 2022/2023 season, with only 169.6 mm. This sharp decline is indicative of the persistent effects of climate change and highlights the drought conditions that have prevailed over the past seven years (2018–2024). As a result, both surface and groundwater resources have diminished, leading to a slowdown in vegetation regeneration, particularly affecting the natural succession of *Juniperus oxycedrus* shrubs, thus threatening the ecological balance of the study area.

Figure N° 11: Shows rainfall levels in the study area from 2008 to 2024.



Source: Data from the Oum Er-Rbia Basin Water Agency, Beni Mellal.

11.2.4. The Extinction of the "Azuri" Bird and Its Impact on Juniperus oxycedrus Regeneration: A Perspective Based on Local Know-How

The crow sparrow, locally called **"Azuri"**, is a bird species that typically inhabits mountainous regions and forests, such as juniper forests. This bird

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plays a crucial role in maintaining biodiversity and supporting the germination process of juniper trees (*Juniperus oxycedrus*). According to an old legend among the inhabitants of the Tifirt Naït Hamza community, the juniper seed is not ready for germination until it has passed through the digestive system of the pink-winged crow sparrow seven times. It is said that any seed not undergoing this process loses its ability to grow into a tree.

This legend reflects a deeply rooted belief among local farmers, who attribute the limited spread of juniper trees to the scarcity—and now near extinction—of this bird. These few remaining birds uniquely contribute to forest regeneration by dispersing juniper seeds to new areas. The decline in the *Azuri* population is attributed to habitat loss caused by human activities and to changes in climate, both of which threaten the survival and reproductive success of these birds.

According to survey data, **71 out of 80 respondents (88.75%)**, most of whom are over the age of 60, affirmed that the extinction of *Azuri* is the **main reason** behind the decline of Juniperus oxycedrus regeneration. Their claims are based on traditional ecological knowledge passed down over generations. These elders emphasized that this species of juniper is native and has long existed naturally in the region under the same climatic conditions and in the same soil that still exists today. They argued that since the area has not undergone any drastic climatic or edaphic (soil-related) changes, the disappearance of *Azuri*—rather than environmental factors—is the most probable explanation for the current failure of natural regeneration.

The implications of this bird's extinction are significant, as its absence drastically limits the ability of juniper seeds to spread and germinate naturally. This hinders the forest's natural recovery processes and negatively affects the broader ecosystem, further threatening biodiversity and forest sustainability.

12- Intervention of Relevant Authorities: Local Commune and Forest Authority in Forest Management

Field research results regarding the question : Do the relevant authorities, namely the local commune and forest authority, intervene in preparing, rehabilitating, and preserving the forest area ? And do these authorities respect the laws and customs governing forest exploitation ? indicate the following :

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Table N° 7 : Shows the extent of authority intervention in forest management and enforcement

Categories	Frequency		Declared Percentage Yes
	No	Yes	
Yes, Juniper Forest	72	8	10%
Yes, Other Formations	8	72	90%
Total	80		100%

Source : Field Survey Questionnaire Analysis, June 2025

The table shows that only 10% of respondents believe the juniper forest is positively impacted by the intervention, while 90% consider other environmental formations to be more significantly influenced. These findings indicate a lack of adequate attention from relevant authorities, including the local commune and forest services, toward the juniper forest in comparison to other formations.

This discrepancy suggests that the juniper forest may be subjected to depletion and degradation due to the insufficient measures and policies currently in place for its protection. This could exacerbate existing environmental issues. The limited attention from responsible entities reflects an oversight of the importance of this forest and its essential role in maintaining biodiversity.

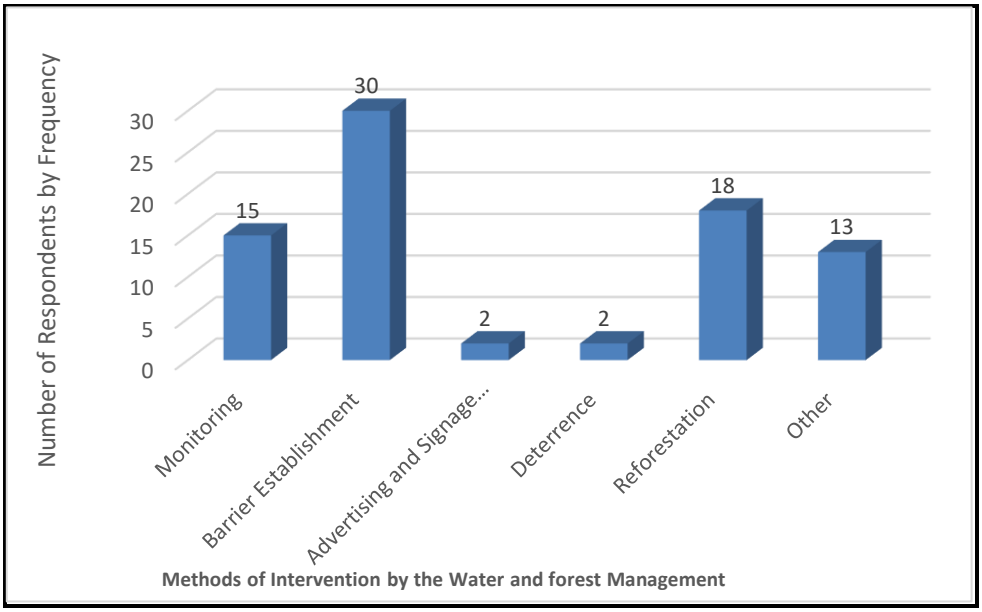
Therefore, it is essential for the relevant authorities to reassess their strategies and allocate resources more effectively to enhance the protection and rehabilitation of the juniper forest, aligning their efforts with those dedicated to other formations. There must be an increased awareness of the need to protect the juniper forest to ensure its sustainability and to achieve an ecological balance that will improve environmental conditions in the region.

13- Local Perception of the Interventions by the Water and Forest Authority

According to field survey data on the local perception regarding the interventions by the Water and Forest Authority to secure and preserve the forests in the Tifirt N'ait hamza commune, the findings are as follows :

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Figure N° 12: Frequency of Local Perceptions on the Authority's Interventions



Source : Field Survey Questionnaire Analysis, June 2025

Based on Figure N° 12, which displays the number of responses regarding local residents' perceptions of the interventions by relevant authorities in forest protection, the results indicate various types of interventions with differing levels of support. "Monitoring" received the highest number of endorsements, with 30 respondents considering it the most effective or important intervention, reflecting the local community's awareness of the importance of continuous oversight to maintain environmental integrity.

In second place, "deterrence" was chosen by 18 respondents, indicating a perceived need for preventive measures to protect the forest. This response highlights a local understanding that deterrence can positively reduce harmful activities.

"Reforestation" followed with 13 respondents, reflecting an interest in enhancing the natural environment and increasing vegetation cover as a method of forest conservation.

Conversely, interventions such as "installing barriers" and "awareness campaigns" received the lowest support, with only 2 respondents each, suggesting that the community views these approaches as less effective or

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less significant. This may call for a reassessment of these strategies and an understanding of the factors behind lower acceptance.

Additionally, there were 15 responses under "None of the above," indicating that some residents feel the current interventions do not meet their needs or align with their expectations.

Based on this analysis, it can be concluded that strengthening monitoring programs and increasing deterrent efforts may contribute to improving the environmental situation. Moreover, there is a need to reassess the less effective interventions, such as installing barriers and awareness campaigns, and engage in ongoing communication with the local community to better understand their opinions and aspirations.

14- Local Residents' Perspectives on the Future of the Juniperus oxycedrus forests Amid Growing Environmental Challenges

The Juniperus oxycedrus forests are a vital component of the local ecosystem, playing a crucial role in preserving biodiversity and providing essential natural resources for the community. Considering the increasing environmental challenges, the opinions and perceptions of residents regarding the future of this forest are important. As part of our field research, we sought to gather the views of the local community concerning the Arar Fawah Forest, and the results obtained from the survey are as follows:

Table N° 8: Future of the Juniperus oxycedrus forests According to Local Residents' Perspectives

Condition	Frequency	%
Deterioration	73	91.25%
Development	2	2.5%
Stability	5	6.25%
Total	80	100%

Source : Field Survey Questionnaire Analysis, June 2025

The data collected indicate a profound concern among residents regarding the condition of the Arar Fawah Forest. The analysis reveals that 91.25% of participants, equating to 73 individuals, perceive that the forest is suffering from deterioration. This high figure reflects a deep awareness within the

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community of the forest's problems and the environmental degradation affecting their surroundings.

Conversely, the "development" condition received only 2 responses, representing 2.5% of participants, indicating that most residents do not see any progress or improvement in the state of the forest, which reflects their frustration with the efforts made to preserve it. Additionally, the number of responses indicating "stability" did not exceed 5, meaning that only 6.25% of residents believe that the forest's condition is stable. This low number reinforces the lack of confidence in current efforts to protect the forest.

Based on the above, we can conclude that most residents feel a significant concern regarding the future of the Arar Fawah Forest, necessitating urgent intervention from relevant authorities. There is a need to enhance efforts to protect the forest and restore its ecological balance. Concrete strategies should be implemented to address the issues of deterioration and improve communication with the local community to ensure their active participation in conservation and development efforts.

These negative perceptions highlight the urgent need for effective interventions to ensure the sustainability of this vital natural resource, which is fundamental to the well-being and stability of the local community.

15- Outdated Legislative Framework :

The results of the questionnaire administered to a sample of 80 residents from the study area revealed a unanimous consensus (100%) that Moroccan forests, including the one under investigation, remain governed by a legal framework dating back to the colonial era, specifically the Dahir of October 10, 1917. This outdated legislation is no longer adequate to keep pace with current environmental and socio-economic changes, which further exacerbates the fragility of the forest ecosystem and makes it increasingly vulnerable to various forms of unregulated exploitation—contributing significantly to its degradation and potential disappearance.

16- Discussion of Results

The Juniperus oxycedrus forest located within the territorial jurisdiction of the Tifirt N'Ait Hamza commune, in the Azilal Province of the Central High Atlas, is facing a complex array of environmental challenges that are threatening its ecological balance and pushing it toward potential extinction. The main factors contributing to this degradation can be grouped into four categories :

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1. **Human Pressure:**

Human activities play a significant role in the deterioration of this forest ecosystem. The local population heavily depends on the forest for economic and social subsistence, leading to the expansion of cereal cultivation and grazing areas at the expense of forest land. The forest is often perceived as a reserve land asset, which encourages its clearing, weeding, and even burning, selectively and opportunistically, based on local needs.

2. **Institutional Deficiencies in Protection:**

Despite the high ecological value of the Juniperus forest, institutional efforts—particularly from the Water and Forests Administration—have proven insufficient in the face of mounting threats. There is a notable lack of effective field monitoring and follow-up. Reforestation programs, especially those aiming to restore native species like Juniperus oxycedrus, remain limited and often encounter resistance from nearby communities, which significantly undermines their impact.

3. **Outdated Legal Framework:**

The governance of Moroccan forest areas, including the one under study, is still based on a legislative framework dating back to the French protectorate era, specifically the Dahir of October 10, 1917. This outdated system is no longer adequate to respond to current environmental and socio-economic dynamics, thereby exacerbating the vulnerability of forest ecosystems to various forms of unsustainable exploitation.

4. **Climate Change:**

The region suffers from increasingly erratic climatic patterns, including heightened evaporation rates and prolonged periods of drought. These stressors weaken the vegetative cover and reduce its natural capacity for regeneration and succession, particularly in the absence of effective adaptive strategies.

Given these compounded pressures, there is an urgent need for a comprehensive and integrated strategy that mobilizes all stakeholders, governmental agencies, local authorities, civil society organizations, and the resident population. The preservation of this rare forest heritage requires a participatory approach based on principles of environmental governance, balancing the imperatives of local development with long-term ecological sustainability.

These results confirm the previous study by (Ouhammou et al. 1996), which indicated that anthropogenic pressure on *Juniperus thurifera* in Morocco is

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particularly strong at lower altitudes, where population centers are concentrated and access is relatively easy. In contrast, human impact is relatively weak in higher altitude areas. It is worth noting that these findings are consistent with those of other studies conducted in Morocco, Algeria, and Europe, which concluded that *J. thurifera* formations have long suffered—and continue to suffer—from harsh and fluctuating natural and anthropogenic conditions (Benabid, 1982 ; P. Boudy, 1958).

5. Loss of biodiversity

The loss of biodiversity is considered one of the contributing factors to the degradation of forest ecosystems. Conversely, the decline in forested areas further exacerbates biodiversity loss, reflecting a reciprocal relationship between the two phenomena. The extent to which forests are affected by the disappearance of certain animal and bird species is evident, as confirmed by the field study, which relied on local knowledge. It was concluded that the extinction of the black raven, locally known as "Azuri," may be one of the underlying causes of the degradation of the Fragrant Juniper Forest, according to the statements of the majority of respondents.

17- Possible Solutions and Recommendations :

To address the degradation of the fragrant juniper forest within the study area and to protect it from the threat of extinction, I propose a set of recommendations directed to the relevant authorities. These may serve as a basis for formulating effective and sustainable interventions, as follows :

a. Enhancing local community awareness and engagement :

☞ There should be stricter monitoring of human activities threatening the Juniperus oxycedrus forests in this region, such as illegal logging and unregulated grazing. Environmental laws can be enforced to prevent the unsustainable exploitation of natural resources.

☞ The Juniperus oxycedrus Forest, along with other areas in Morocco, should be designated as nature reserves or officially protected areas, providing a higher level of safeguarding.

☞ Establish field monitoring patrols in coordination with residents to protect the forests from theft and illegal activities.

☞ Implement a participatory approach with the local community, as their involvement will play a crucial role in forest conservation.

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b. Raising Awareness among Local Communities :

- ☞ Organize awareness campaigns targeting local communities about the importance of preserving the Juniperus oxycedrus forests and their environmental and economic benefits. Residents should be engaged in environmental education programs.
- ☞ Provide training for residents on sustainable resource use methods, such as agriculture and grazing practices, to ensure ecological balance is maintained.
- ☞ Emphasize the necessity of awareness regarding the dangers of biodiversity loss, stressing that its threat is fundamentally a threat to our lives.

c. Investing in Sustainable Forest Management :

- ☞ Implement reforestation programs for degraded areas using seedlings of Arar trees or other native species that are resilient to climate change to rehabilitate the forest.
- ☞ Improve forest management practices by activating monitoring and remote sensing systems to periodically assess the forest's condition and adopt modern techniques for water and soil management.
- ☞ The use of native species after fires or other environmental events for the re-naturalization of habitats containing juniper species, which also contributes to the preservation of local genetic resources and the prevention of genetic pollution. Additionally, Phyto toponym analysis is employed to gain a better understanding of the potential areas for their growth, (Ana Cano Ortiz & Giovanni Spampinato, 2021).

d. Limiting Overgrazing :

- ☞ Regulate grazing by establishing laws that define permitted grazing times and areas, thereby reducing the damage caused by overgrazing plants and vegetation.
- ☞ Provide technological alternatives for herders, such as improved fodder and more sustainable animal resource management practices.

e. Addressing Climate Change :

- ☞ Adopt strategies that help the forest ecosystem adapt to the impacts of climate change, such as protecting water sources and developing strategies to manage potential wildfires.

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☞ Encourage environmental studies and scientific research on the Juniperus oxycedrus forests to develop evidence-based solutions that contribute to its conservation.

f. Promoting Eco-Tourism :

☞ Encourage eco-tourism projects that contribute to the local economy by attracting nature enthusiasts while preserving the forest.

☞ Develop simple and sustainable infrastructure that supports eco-tourism without harming the ecosystem.

Conclusion :

The Juniperus oxycedrus forests in the Lahwant area (Tifirt N'ait Hamza, Azilal Province) represent a natural and ecological heritage of great importance, due to their rich biodiversity and the vital environmental functions they perform—such as soil stabilization, local climate regulation, and carbon sequestration. Based on field observations and photographic documentation, this study has revealed alarming signs of accelerating ecological degradation, characterized by a decline in vegetation cover, intensified soil erosion, and fragmentation of forested patches.

The findings indicate that the immediate causes of this deterioration are linked to unsustainable human activities, including overgrazing, indiscriminate logging, and agricultural encroachment. These pressures are further exacerbated by the inefficiency of existing environmental policies and the effects of ongoing climate change, especially recurrent droughts. Field data—particularly insights drawn from local ecological knowledge—have also pointed to a crucial environmental factor that has received little attention in previous studies : the disappearance of the black raven, locally known as Azoury. This bird was identified by 71 out of 80 respondents as a key factor in the decline of the Fragrant Juniper Forest.

According to local testimonies, Azoury played a highly specific ecological role. It fed on the fruits of the juniper tree and dispersed its seeds through its droppings after digestion. This natural process protected the seeds from insects and pests, and helped prepare them for germination once favorable moisture conditions—such as early rainfall—were met. In this way, the bird significantly contributed to the natural regeneration of Juniperus oxycedrus. Its disappearance therefore represents the loss of an essential biological mechanism critical to the sustainability of this plant species.

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These accounts also suggest that the bird's role extended to stirring and burying seeds in the soil, further facilitating regeneration. Thus, its absence poses a severe ecological threat to the future of this forest system. Building on this valuable local ecological knowledge, the study recommends that advanced laboratory research be undertaken to better understand the bird's ecological function and to explore biological alternatives or ecological solutions to support natural regeneration processes.

Despite the strength of these findings, the study remains limited in scope, focusing on a single commune and lacking long-term data needed to track ecological changes over time. This highlights the need for broader and more temporally extensive research, with a greater integration of local ecological knowledge into scientific frameworks, recognizing it as a rich and valid source of environmental understanding.

Ultimately, the study advocates for a holistic approach to forest conservation—one that includes updated legal frameworks, the valorization of local knowledge systems, participatory governance, and enhanced community awareness regarding their central role in ensuring environmental sustainability and resilience to climate change.

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