

## PROMOTION OF GEOTOURISM AND GEOHERITAGE AT THE OASES OF OUED NOUN

Saïd MIRARI\*

Mohammed V University, Faculty of Science in Rabat, Laboratory of Tourism Engineering, Heritage  
and Sustainable Development of the Territories, P.O. BOX 1014 RP, Rabat, Morocco, e-mail: Mirarisaid@gmail.com

Abdelouahed BENMLIH

Mohammed V University, Faculty of Science in Rabat, Laboratory of Tourism Engineering, Heritage  
and Sustainable Development of the Territories, P.O. BOX 1014 RP, Rabat, Morocco, e-mail: benmlihabdelouahed@yahoo.fr

---

**Citation:** Mirari, S., & Benmlih, A. (2020). PROMOTION OF GEOTOURISM AND GEOHERITAGE AT THE OASES OF OUED NOUN. *GeoJournal of Tourism and Geosites*, 32(4), 1433–1440. <https://doi.org/10.30892/gtg.32435-591>

---

**Abstract:** The objective of this study is to restore the value of Oued Noun Oases that has been less estimated for several centuries, without destroying the collective memory. Our duty is to look through certain models of geotourism and geoheritage practiced elsewhere, which would be the best approach to preserve this natural landscape that has become very fragile. A systematic survey was conducted on several selected geosites, including inventory, characterization, classification, evaluation and appreciation. That is to say, qualitative and quantitative assessments were carried out on the basis of geoheritage values of international significance. This paper is focused on the efforts should be made in all these sites to ameliorate and develop geoheritage and geotourism in Oued Noun Oases. This research is conducted not only for scientific research and indication of sites, but also to developing geological, ecological and cultural infrastructures within the reach of tourists.

**Key words:** Geotourism, Geosite, Geoheritage, Geodiversity, Development and Oued Noun Oases

\* \* \* \* \*

### INTRODUCTION

Sustainability is a principle of action; however, investigating closely this concept, reveals that it does not cover a unified program. A group of factors could be considered as solutions to the current problem only if there is a growing governance in the recognition of the gravity of the issue. According to an advanced regionalization plan, Morocco has adopted a new policy of development that integrates the environmental component, the rationalization of natural resources, measures for poverty reduction and an appropriate social and spatial distribution of wealth (Benkada et al., 2018). Geotourism, which is a new and fundamental concept in the vision of tourism traced by the government for 2020, has currently been demonstrated as a key factor for sustainable development.

The field of tourism responds to a strong demand when it takes into account the programs and the strategic plans implemented by the decision makers and the players of the industrial tourism (Reynard et al., 2017; Pica et al., 2017). Oued Noun Oases faces numerous natural, human-induced, institutional, organizational and legal constraints. Hence, there is a need for a practical tool that would reconcile the imperatives of conservation (Hakim and Soemarno, 2017), the demands of the local population and tourism, and at the same time positively address the constraints that hamper the management of the site. It, therefore, constitutes a sector of undeniable tourist value and an important tourist destination according to its specialization in the territorial offer and thanks to the particularity and specificities of its goods and services related to the geotourism activity that could arise (Nazaruddin, 2019). The identification of geological heritage values (Lazzarini et al., 2014; Brilha, 2016) constitutes the first principle in the elaboration of geotourism circuits and the basis for promoting the revitalisation of rural areas through new tourism opportunities (Ólafsdóttir, 2019; Farsani et al., 2011). This orientation is reflected in the initiation of a broad debate within society on the subject of geotourism, geoheritage and geoconservation (Carcavill et al., 2008, Carcavilla et al., 2009, Poiraud et al., 2017, Duval et al., 2010), in a world of increased industrialization, the environmental issues have been omitted (Henriques et al., 2011). The need to preserve the ecological and geological (El Hadi et al., 2015) space is a major concern in an economic context that promotes the integration of alternative tourism in the new philosophy of the national strategy in the tourism sector (Mirari and Benmlih, 2018).

### STUDY AREA

The Oases of Oued Noun are situated in Guelmim-Oued Noun region, province of Guelmim, on a surface of 2170 ha (Chmourk, 2011). The province establishes a buffer zone between Sahara and Souss on a surface of 10783 Km<sup>2</sup> that is 18.34% of the total surface of the region. It is limited by the province of Sidi-ifni in the north, the province of Tan-Tan in the WS, the province of Assa-Zag in the East, the Atlantic Ocean West and the province of Tata (Souss-Massa region) in the East (HCP, 2015).

The plain of Guelmim is a part of the western anti-atlas. It contains two main morphological units: the trays of limestone of western anti-atlas and Jbel Baní which is considered the source of Feijas (Weisrock et al., 2006), establishing a bridge between the desert zone and the semiarid sub. The city possesses a dry and Saharan climate (MEMWE, 2010) due to the interference of several geologic and geomorphologic aspects: the closeness of the Atlantic Ocean, the influence of the cold currents, and the presence of a mountainous barrier of the anti-atlas (SMDHBA, 2013). All these factors insure a protection against the east and south east sandy winds in addition to the effect of the Saharan continental character, especially in summer. The average annual temperature is 19, 6 °C (SMDHBA, 2013).

The hydrological network of surface is established by three main wadis: Noun, Bouissafe and Aouriouira, on a 9300 Km<sup>2</sup> surface. The aquifer represents the underground water resources: the deep aquifer at oscillating levels of lower limestone of the Georgian then the groundwater and alluvial aquifer between 15 and 45 m (Mahmouhi et al., 2016). The biodiversity of the various ecosystems of the region is based on a sheltered biotope. Thanks to their aridity and the rarity of human activity and especially in a little isolated area, numerous endemic species find an environment which is favorable to them (Cuzin, 2003). The region contains a vegetable belt of forests on 31700 ha,

---

\* Corresponding author

as well as an identified and endemic flora, according to the peculiarities of each life area. The fauna consists of a fair important number of mammalian organisms, avian, amphibians and rare and endangered reptiles (Bergier et al., 2017).



Figure 1. Oasian area in the Oued Noun Oases

### Geographical and Geological outline of the study area

The chosen study region is located on the southwest of Guelmim city (N28°9, W10° 02, altitude 540 m), in a large synclinorium which forms, on a regional scale, a narrow depressed basin between the Precambrian basement in the South and the Paleozoic cover in the North (Belfoul et al., 2001; Michard et al., 2011).

The lithostratigraphic successions of the region (Table 1) studied are basically formed by Cambrian formations, formed by shales with paradoxids and by sandstones with *conocoryphs* and *lingules* (SMDHBA, 2013). The Ordovician series are represented by green silstones of lower arenig age, the thicknesses is 150 m contain *trilobites*, *Graptoliths* as well as *Echinoderms* (Destombes et al., 1985). On the geological map (Figure 2) of Goulmime and the lower Drâa wadi, these basic terrains pass towards the summit with sandstones and quartzites dating from the middle arenig. Their thickness does not exceed 50 m (Naser, 2006). Caradoc-age quartz deposits and micro-conglomeric sandstones form the last visible bars before the tectonic contact of E-W direction which separates them from detrital carboniferous deposits (Figure 2). These facies are similar to the periglacial Ashgill age (Ettayfi, 2013; Pique et al., 2007). Between the pleated Bani and the Devonian ridges of the Rich, lies the plain of Assa-Aouinat Torkoz, whose quaternary (Pique et al., 2007) cover generally masks the Silurian shales.

Beyond the Western anti-atlas, also pleated, but with more moderate relief than the Bani, spreads out again a broad plain, that of the Drâa wadi with shale (Choubert, 1963) substratum of the Upper Devonian, most often masked by the quaternary alluviums. On another note a geological point of view, the Guelmim area is part of the Anti-Atlantic chain elongated in a WSW-ENE direction, where Precambrian and Sub-Cambrian to Cambrian terrain outcrops (Pique et al., 2007). The southern slope of the Anti-Atlas, to which the region belongs, has a fairly gentle slope with sharp ridges (HCWFFAD, 2008). The terrain is of post-Cambrian Paleozoic age (Pique et al., 2007).

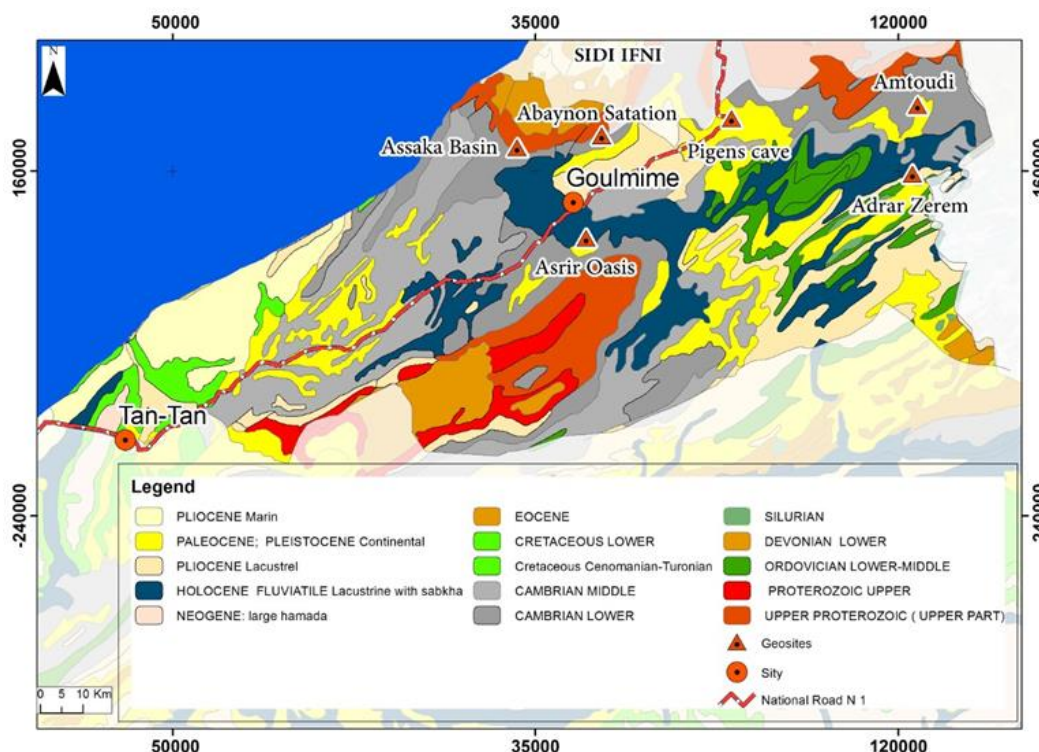


Figure 2. Geological map of the study area

Table 1. Synthetic stratigraphic column of the Plioquaternary of the Guelmim plain SMDHBA, 2011

Plioquaternaire	Unit	Stratigraphic units
	Unit 4	<ul style="list-style-type: none"> <li>▪ Scree regs and cones at the foot of the reliefs</li> <li>▪ Limestone crust, saline crust</li> <li>▪ Alluvium, sand and pebbles around watercourses, silt on the plain.</li> </ul>
	Unit 3	<ul style="list-style-type: none"> <li>▪ Alternation of :               <ul style="list-style-type: none"> <li>- Lake limestones</li> <li>- Sandy marls passing laterally to sandy clays</li> <li>- Marly to marlcalcareous limestone with sand passages</li> </ul> </li> <li>▪ Presence of fossil bed alluvium below these formations</li> </ul>
	Unit 2	<ul style="list-style-type: none"> <li>▪ Conglomerate</li> <li>▪ Clay and Marly Clay</li> </ul>
Acadian	Unit 1	Surface weathered shale with inclusion of sandstone levels

## MATERIAL AND METHODS

This article is based on a set of materials which contain literatures, maps, and photographs related to Oued Noun Oases. The methodology used in this work is the inventory of geosites, its characteristics, classification and evaluation. The inventory was carried out by the identification, classification and distribution of the most important geosites of the Oases through a geological survey. The survey was developed by reading literature reviews, field trips and interviews with specialists in local geological heritage.

The geosites characterization was based on direct observation, relevant selection, detailed description and specialized classification through work on geodiversity (Gray, 2005), vision between the works of Pralong, 2006; Brocx and Semeniuk, 2007; Predrag and Mirela, 2010 and the scale (Brocx and Semeniuk, 2007) (Nazaruddin, 2019).

Two evaluation approaches are adopted for the development of this article: a qualitative approach (Aoulad-Ali et al., 2019; Nazaruddin, 2019), which gives particular attention to the geographic and geological heritage values for classification and description, a quantitative approach which aims to assess the geosites and its geoheritage value and SWOT analysis to establish development strategies.

## RESULTS

### 1. Inventory of geosites

The enhancement and the conservation of the geological heritage (Chakrabarty and Mandal, 2020) have become very important in several countries (Giusti, 2012), especially for sites that have scientific, cultural or economic interest (Ranjbaran et al., 2020). This importance is mainly due to the appearance of a strong tourist demand, who no longer seeks "4S" tourism (Sand, Sea, Sex, Sun) (Cheng, 2016) but "4E" tourism from the beginning of this millennium to improve awareness of responsibility: Educational tourism, Environment and clean nature, culture and history Event, Entertainment and fun.

The Guelmim plain encompasses a vast territory that greatly exceeds the sole area of the Oases; it is to incorporate pre-desert areas of great scenic beauty, but also to house elements that constitute the geological wealth of the plain (Mirari and Benmlih, 2018). To select geosites of geoheritage significance, several criteria must be taken into account: Uniqueness, representativeness and rarity (Predrag and Mirela, 2010; Brocx et al., 2011; Pralong, 2006). In this map (Figure 2), we offer some geosites of geotourism importance with a descriptive table.

Table 2. List of selected geosites as potential geoheritage resources and geotourism attractions in Oued Noun Oases

N°	Geosite	Location	Main geological feature	Other Characterizations
1	Amtoudi	Rural Municipality Amtoudi: N 29 ° 14.930'; W9 ° 11.127 '	Illustration of the Lower Cambrian formations corresponding to the upper limestones, the schisto-limestone series, the schistous series and the terminal sandstones.	the sandstone-quartzitic series of the 1st Bani and the plain corresponding to Feijas which are covered with quaternary deposits
2	Adrar ZerZem	Rural municipality Taghjiit: N 28 ° 926; W 9 ° 042	It is in the form of a rocky ridge oriented E.-O. which overlooks the right bank of the Seyad wadi	The engraving station is located on the rocky outcrops overlooking the plain alluviale surrounding
3	Abaynou station	Rural municipality d'Abaynou N°29°093; W10°019	It is an emergence of this Saudi tablecloth appear at the northern limit of the Guelmim basin	Sandy clay generally less than 7 meters thick
4	Pigeon cave	Rural municipality Ait Boufoulen N 29 ° 300; W9 ° 695	The caves are made up of a set of dark and narrow rocks	Rainwater enters and emerges in a pond called Bizane in Agjal wadi.
5	Assaka Basin	Rural municipality Targa Wassay N 29 ° 07; 'W10 ° 25'	Georgian and Precambrian mass forms an external feija broad of 5Kms on average	It is made up of eruptive rocks dating from the Precambrian II and III (Andesites, Basalts and Granites).
6	Asrir Oasis	Rural municipality of Asrir N 29 ° 074; W 9 ° 432	It is made up of schist, sandstone and Georgian limestones, belonging to the upper part of lower limestone of the Adoudouanian	-

The characterization of the geosites was developed by direct observation and description of the sites during the field trips and supported by data from the literature and interviews with geology scientists and the locals. These geosites have a noticeable geological importance which must enhance its geoheritage, such as geological, archaeological, morphological, hydrogeological and sociocultural values. The following part is a description of the selected geosites at Oued Noun Oases, Guelmim province.

#### Geosite "Amtoudi"

This site is a Berber village in southern Morocco (Figure 3) it has a very rich landscape of the Western Anti-Atlas. It is an oasis of mountainous nature located at the bottom of a canyon where about 325 households live.

With a respectable age of more than 2 billion years, the Stromatoliths of the Anti-Atlas correspond to discoid or nipped constructions produced by mats of bacteria, mainly *cyanobacteria* (blue algae). Islands are formed elongated fossils forming a relief, about 1 to 5 cm high. They can be caused by the agitation of the swell on the beaches, or the action of sea currents on the bottom. They are found on the upper surface of a finely detrital layer and bear witness to a shallow marine environment.

#### Amtoudi travertines

On an altitude of 930 m with geographic coordinates N29°14.361 ' ; W9°10.108 ' (Figure 4), there are travertines which show a particular type of limestone rock which forms at the emergence of certain sources and on the slopes of river beds, as a result of changes in the physico-chemical conditions induced by plants and algae which fix carbon dioxide causing precipitation of travertine.



**Amtoudi waterfall and Bougaa source**

At an altitude of 931 m, with geographic coordinates N29°14.36'; W9 ° 10.108', a log of Oued Amtoudi follows the old faults where water flows all year round (Figure 5); the springs and waterfalls are the result of a resurgence in the gorges cut into the shale-limestone alternation of the lower Cambrian at the bottom of the palm grove of Amtoudi. The First village includes a great part of Agadir (Robles-Marín et al., 2014), spread over the two rivers, but at fairly high level and perched on the cliffs, some were inaccessible. The history of the word Agadir which is the emblem of the region is often explained as collective granaries, and Agadir designates the nose of an eagle.

**Amtoudi's stratigraphy**

Illustration of the Lower Cambrian formations which corresponds to the upper limestones, the schistolimestone series, the schistous series and the terminal sandstones (Figure 6). The "upper limestones" are a transgressive set of dolomites and limestones ranging in thickness from around 400 m in the Western Anti-Atlas to 75 m or even 0 m in the eastern part of the massif.

**Archaeological Geosite "Adrar Zerzem"**

The Adrar ZerZem Site is located in the rural commune of Taghjijt, 80km towards Tata (Figure 7). This site dates back to almost 2,500 years before our era (Louart et al., 2013). A quality of about 37 mortuary monuments of former Amazigh inhabitants and other monuments confirm human settlement in the region (BOKBOT et al., 2005). This area shelters a very important archaeological complex which includes several types of vestiges: rock engravings showing a great thematic variety, burial mounds connected to other dry stone structures with circular plan, and finally, an outdoor habitat with abundant archaeological material surface.

These discoveries will contribute to the enrichment of historical research concerning this important period in the history of Morocco which preceded the discovery of the Moroccan coasts by Phoenician sailors (Figure 8).



Figure 3. Panoramic view of the Amtoudi basin

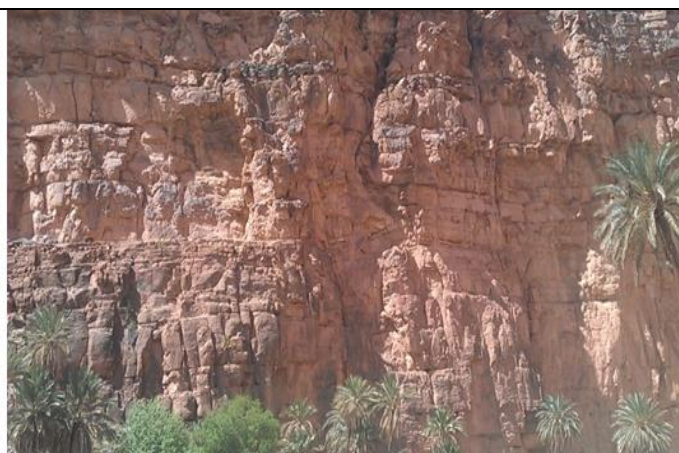


Figure 4. The Amtoudi lineaments



Figure 5. Bougaa source



Figure 6. Tumulus in "Adrar Zerzem" ((Bokbot et al., 2005)



Figure 7. Rock carvings

**Geomorphological geosite "Cave of pigeons"**

Located at Ait Boufoulen 50 km towards Agadir (Figure 9), the caves are made up of a set of dark and narrow rocks. Access to these caves is difficult. A set of palm groves is spread across the geographic space of this site, among others, such as those of Bouzakarn and Ait Boufoulen.

**Thermal Geosite "Abaynou"**

The Abaynou source, located at the rural commune of Abaynou 10 km to the north, is an outlet of this Adoudounian water table appearing at the northern limit of the Guelmim basin (Figure 10). Water of this spring comes out with a temperature of 45°C and a sulphate-calcium facies. Its origin is deep and probably appears at a fault affecting the Georgian limestones of the West of Ouggoug Oases



(SMDHBA, 2013). In the upper part, at the entrance to the gorge taken by the Guelmim-Ifni road, there are thick banks of black limestone. The series are said to be 400 to 500 m thick south of Abaynou. This unit is distinguished by more accentuated reliefs, with a characteristic light color on satellite images. The water from this spring has healing properties, particularly with regard to dermal and rheumatic diseases.



Figure 8. The waterfalls of the wadi Amtoudi



Figure 9. Travertine in the vicinity of the cave

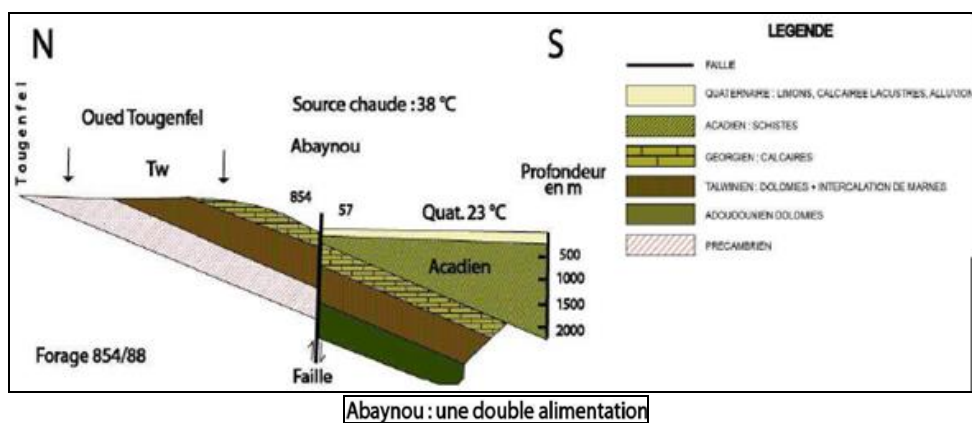


Figure 10. Chematic section illustrating the deep origin of the source of Abayno, SMDHBA.2013



Figure 11. A panoramic view of the Assaka bassin



Figure 12. A panoramic view of the Asrir oases

**Hydrogeological geosite "Assaka Basin"**

A beautiful outcrop of sandstone and greenish subhorizontal shales on the Seyad wadi (dip of 5-10° to the SE). We are at the top of the "terminal sandstones", in the zone of passage to the schists at paradoxides (Figure 11). The terminal sandstones were formerly stored in the lower Cambrian, but are now dated to the beginning of the middle Cambrian. The top of several benches shows bioturbations and asymmetrical ripple marks in the N-S direction. The Wadi bed is guided by these deaclases (Weisrock et al., 2006).

**Sociocultural geosite "Asrir Oases"**

The Asrir Oases, formerly known as "Noul-Lamta" (Joumani, 2008), has played a very significant role in the history of the southern provinces (Figure 12) thanks to its strategic position between the Atlas Mountains and the Atlantic plains. Asrir represented a place of ancient settlement of human groups and a point of convergence and crossing point for many transhumant tribes. Furthermore, this site shows particular, cultural, archaeological and geotourist features which are represented by rock shelters, Kasbahs, granaries and others.

## 2. Classification of geosites

Table 3. The classification of selected geosites

N°	Geosites	Geodiversity	Scope	Scale
1	Amtoudi	Relief / Landscape / Rock	Geomorphological	Big ladder
2	Adrar ZerZem	Relief / Landscape /	Archaeological	Medium scale
3	Abaynou station	Relief / Rock and Hydrological Process	Geomorphological / hydrogeological	Medium scale
4	Pigeon cave	Relief / Landscape / Rock	Geomorphological	Medium scale
5	Assaka Basin	Hydrological process	Hydrogeological	Bigscale
6	Asrir Oases	Relief / Landscape / Oasis	Geomorphological	Big ladder

Table 4. Qualitative assessment of selected geosites for potential geoheritage resources and geotourism attractions in Oued Noun Oasis, Morocco

N°	1	2	3	4	5	6
geosites	Amtoudi	Adrar Zerzem	Abaynou station	Pigeon cave	Assaka Basin	Oasis Asrir
<b>Scientific (and educational) value</b>	Formation of the cascade and diacalse scade and diacalse lithology	Formation of the rock engraving process, Tumulus	Hot spring process training / Geothermal system	Cave / sinkhole formation	Formation processes of waterfall; the lithology of the waterfall	Formation of the Oasis / Fieja process
<b>Aesthetic value</b>	Relief and Landscape and panoramic view of the Anti-Atlas	Relief and Landscape of Monuments	Relief and Landscape / Biodiversity	Relief and Landscape of Discovery	Vegetable landscape of middle mountains	Pre-Saharan landscape
<b>Recreational value</b>	Leisure activities and hiking on site	Discovery activities and scientific research	Leisure activities, hiking and swimming	Exploration activities	Leisure activities, hiking	Leisure activities, hiking
<b>Cultural (and historical) value</b>	An Amazigh village in southern Morocco / heritage of the collective granary	the history of Morocco which preceded the discovery of the Moroccan coasts by Phoenician sailors.	-	-	-	Dating of the site exists during the Almoravids period (Noul-Lamta)
<b>Aesthetic value</b>	Relief and Landscape and panoramic view of the Anti-Atlas	Relief and Landscape of Monuments	Relief and Landscape / biodiversity	Relief and Landscape of Discovery	Vegetable landscape of middle mountains	Pre-Saharan landscape
<b>Functional value</b>	-	-	Curative virtues in particular with regard to dermal and rheumatic diseases	-	-	-
<b>Religious value</b>	National	International	Regional	State	State	National
<b>Contents</b>	documentary	Iconographic	Symbolic	Indicial	Indicial	Indicial

Table 5. Numerical assessment of selected geosites for potential geoheritage resources and geotourism attractions in Guelmim Oasis

N°	Geological site	Scientific (and educational) value	Aesthetic value	Recreational value	Cultural (and historical) value	Economic value	functional value	Significance level	Total
1	Amtoudi	5	5	5	5	5	0	4	29
2	Adrar ZerZem	5	5	2	5	0	0	5	22
3	Abaynou station	5	5	5	0	5	5	3	28
4	Pigeon cave	5	5	0	0	0	0	2	28
5	Assaka Basin	5	5	3	0	2	0	3	18
6	Asrir Oases	5	5	5	5	5	0	4	29

## DISCUSSION

The degradation processes with the action of mass tourism presents a strong threat to the oases of Oued Noun. However, care must be taken to avoid any disturbance that could, in the long term, affect its biological and heritage quality through geotourism. The Amtoudi site and Asrir oasis represent the main heritage of Oued Noun Oases and they must be maintained in an optimal ecological state as much as possible.

This synthesis values the quality of the Oases's geosite and geodiversity, the sharing of geoconservation standards, best practices in geotourism development, the exchange of expertise and support for geoheritage preservation (Henriques et al., 2011; Reynard and Brilha 2018; Gordon et al., 2018). On the other hand, this synthesis makes it possible to present the geosites with a notion of responsibility and at the same time to valorize the quality of the geodiversity of the selected ones. The selected geosites of the Guelmim Province have been classified according to the following classification: geodiversity, scope and scale. According to Gray (2005), geodiversity is divided into eight components: rock, mineral, fossil, relief, landscape, processes, soil and other georesources. Predrag and Mirela (2010) and Brocx and Semeniuk (2007) have classified geosites as petrological, stratigraphic, mineralogical, (palentological), geomorphological, speleological, hydrological/hydrogeological, structural, etc., sites. Brocx and Semeniuk (2007) classified geosites into six categories based on scale: regional/megascale (coverage of 100 × 100 km or more), large/macro-scale (coverage of 10 × 10 km or more), medium/mesoscale (coverage of 1 × 1 km or more), small-/microscale (coverage of 10-100 m × 10-100 m or more), fine/leptoscale (coverage of 1 × 1 m or more), and very fine-scale (coverage of 1 × 1 mm or more).

Two approaches have been carried out to scientifically evaluate the geosites of the Guelmim Province, qualitative and quantitative:

The qualitative approach is based on the values of geological heritage (Gray, 2004, 2005). Especially scientific values (related to geological meanings and interests); educational values (related to earth sciences and environmental education); aesthetic values (related to landscape beauty features); recreational values (related to recreational and tourist activities); cultural values (related to cultural and historical values); economic values (related to financial characteristics); functional values (related to use characteristics), etc

On the other hand, the quantitative approach was developed to evaluate sites in a numerical way or to rank them according to their geopatrimonial values. For natural heritage values, six values were established for this study: 0 = none, 1 = very poor, 2 = poor, 3 = fair, 4 = good and 5 = very good. In contrast, for levels of significance, there are five categories of values: 1 = local, 2 = regional, 3 = national, 4 = international and 5 = international. In effect, Brocx and Semeniuk (2007) presented the levels of significance (ranking) according to the level of importance of these sites, which must also be determined, including international, national, state, regional and local levels.

In addition, Pena dos Reis and Henriques (2009) presented the contents displayed by geological objects are designated as indexical (a clear relationship between geological processes and their products), iconographic (a particular geological phenomenon), symbolic (an image with

geological characteristics used by the public) at the local scale. For documentary (a phenomenon understanding geological changes), scenic (a phenomenon with a great recreational function) at the regional scale. Finally, the conceptual (a reference to singular geological occurrences) on a global scale. The geosites of the province of Guelmim are composed by reliefs, landscapes, rocks, waters and oases. Besides, these geosites are possessed by relief features (geomorphological sites), such as oasis, waterfall, mountain and cave. A hot spring phenomenon that is classified as a hydrogeological site is also a valuable resource of the province. An archaeological area contains a very important landscape that includes several types of remains. A hydrological area has a very rich biodiversity (Table 1). These sites range from small to large scale (Table 2). These qualitative and quantitative assessments can speak directly to the priority that should be given to geosites for geoconservation and development efforts. On the other hand, three geosites are designated for the geological objective Indicinal and the three other geological objectives are developed: documentary, symbolic and iconographic (Table 3). Geosites with higher scores or values should receive greater attention and priority. Table 4 presents the scores obtained for each site with regard to geoheritage values and levels of significance. The SWOT analysis was used to assess the strengths, weaknesses, opportunities and threats of geosites in the province of Guelmim and to help decide on geoconservation and geotourism development efforts (Mirari et al., 2020) The SWOT analysis of all these sites can be found in Table 5.

Table 6. SWOT presents a diagnostic analysis of the selected geosites

N°	Geosites	Strength	Weakness	Opportunity	Threat
1	<b>Amtoudi</b>	Quality environment: a landscape heritage, an archaeological heritage and a cultural and historical heritage	The Establishment of reception facilities on the ground such as rest areas	Fragility of the most precious and most visited ecosystems; Low environmental awareness and education	Failure to comply with environmental management principles Growing tourist pressure
2	<b>Adrar ZerZem</b>	Quality environment: a landscape heritage, an archaeological heritage and a cultural and historical heritage	Establishment of reception facilities on the ground such as rest areas; The layout of the tracks	Inaccessibility Lack of signage	Destruction of environments Possibility of losing cultural identity
3	<b>Abaynou station</b>	Typical surrounding villages	The development of the slopes	Low Environmental awareness and education	Growing tourist pressure
4	<b>Pigeon cave</b>	Typical surrounding villages	Environmental education	Inaccessibility Lack of signage	Destruction of environments Possibility of losing cultural identity
5	<b>Assaka Basin</b>	The Destination with high biodiversity: magnificent landscapes – fauna and flora diversity – preserved and diversified ecosystem	Environmental education	Fragility of the most precious and most visited ecosystems	Failure to comply with Environmental management principal
6	<b>Asrir Oases</b>	Quality environment: a landscape heritage, an archaeological heritage and a cultural and historical heritage	The establishment of reception facilities on the ground such as rest areas; The development of tracks	Fragility of the most precious and most visited ecosystems; Risk of silting up and desertification	Failure to comply with environmental management Principles Growing tourist pressure

The promotion of geosites in the region understudy and its networking to constitute geotourism routes like certain themed circuits can constitute a factor of development and enhancement of this region of southern Morocco. These circuits have been designed to discover the geological and archaeological history of the region through all of the geosites, where it is possible to find information and infrastructures intended to the public. This policy may represent a new offer for encouraging the promotion of cultural tourism.

Geosites provide essential scientific information. They represent the beauty of the landscape, and allow reconstructing the history and the geological processes of the region. These archives of nature, very numerous and diverse in southern Morocco, will undoubtedly generate significant tourist flows if they are well valued.

## CONCLUSION

The geographical location of the Oued Noun Oases gives this territory a great potential for sustainable development with an interesting geological experience that has not yet been exploited. Certain rules and tools are required systemically and responsibly to a development policy within the framework of an Oued Noun Oases development project and the creation of a geoterritorial image.

The observation scale begins at the local platform to take into account the problems, the different issues and the impacts on geosites. Development must, however, integrate a reflection on a global scale to consider external elements such as climatic factors, the structure of geosites and the policy adopted at the regional level. In this respect, the oases's diversity of exceptional landscapes predisposes it to play an important role in geotourism, which must respect the environments and the biodiversity. In this sense, care must be taken to promote respectful geotourism and geoheritage in the Oued Noun Oases in general and in the Amtoudi geosite and Asrir Oases in particular.

The target is to protect and preserve the local, cultural and natural geoheritage. It will be the same for the rationalization of socioeconomic activities and the involvement of all in a responsible and sustainable spirit.

## Acknowledgement

This strategy will constitute a real initiative for sustainable development and according to the charter that will be established, it will become possible to observe rules of respect for the environment, the geological and cultural heritage of the region.

## REFERENCES

- Aoulad-Sidi-Mhend, A., Maaté, A., Amri, I., Hlila, R., Chakiri, S., Maaté, S., & Martín, M.M. (2019). The Geological Heritage of the Talassemiane National Park and the Ghomara coast Natural Area (NW of Morocco). *Geoheritage*, 11, 1005–1025. <https://doi.org/10.1007/s12371-019-00347-4>
- Beggier, P., Thevenot, M., Quinba, A., & Houllie, J.R. (2017). Evolution of the avifauna of a contact zone between Saharan and non-Saharan Morocco in 60 years. *Go-South Bull*, 14, 142-161.
- Belkoul, M.A., Faik, F., & Hassenforder, A.B. (2001). Evidence of a tangential tectonic event prior to the major folding in the Variscan belt of western anti-Atlas. *Journal of African Earth Sciences*, 32 [https://doi.org/10.1016/S0899-5362\(02\)00051-9](https://doi.org/10.1016/S0899-5362(02)00051-9)
- Benkada, A., Belouçgi, M., Lallouchen, A., & Essarsar, M. (2018). Regional financial governance: a lever for change for advanced regionalization in Morocco. *International Journal of Scientific and Engineering Research*, 9, 8.
- Bokbot, Y., Rodriguez A., Onrrubi-Pintado, J., Rodriguez-Santana, G., Velasco-Vazquez, J., & Amarira, A. (2005). The funeral and cult complex of Adrar Zerzem (Anti-Atlas, Morocco), Preliminary results. *African Iniquities Studies*, 21-29.
- Brilha, J. (2016). Inventory and Quantitative Assessment of Geosites and Geodiversity Sites: a review. *Geoheritage*, 8, 119–134. <http://dx.doi.org/10.1007/s12371-014-0139-3>
- Brocx, M., & Semeniuk, V. (2007). Geoheritage and Geoconservation – History, Definition, Scope, and Scale. *Journal of the Royal Society of Western Australia*, 90, 53–80.
- Carcavilla, L., Durán, J.J., García-Cortés, A. & López, M.J. (2009). Geological heritage and geoconservation in Spain: Past, present and future. *Geoheritage*, 1, 75–91. <http://dx.doi.org/10.1007/s12371-009-0006-9>

- Carcavilla, L., Durán, J.J., & López M.J. (2008). Geodiversity: concept and relationship with geological heritage. *Geo-Temas*, VII Geological Congress of Spain. Las Palmas de Gran Canaria, 10, 1299–1303
- Chakrabarty, P., & Mandal, R. (2019). Geotourism Development for Fossil Conservation: A Study in Amkhoi Fossil Park of West Bengal in India. *Chakrabarty, P., & Mandal, R. (2019). Geotourism Development for Fossil Conservation: A Study in Amkhoi Fossil Park of West Bengal in India. GeoJournal of Tourism and Geosites*, 27(4), 1418–1428. <https://doi.org/10.30892/gtg.27425-444>
- Cheng, F.L. (2016). An investigation of factors determining industrial tourism attractiveness. *Tourism and Hospitality Research*, 16(2), 184-197. <http://dx.doi.org/10.2307/26366483>
- Chmourk, E. (2011). The Oued Noun Oases: degradation of the natural environment and prospects for development. *Journal Cinq Continents*, 1(2), 105-117.
- Choubert, G. (1963). Geological history of the Precambrian Anti-Atlas. *Notes and Memoirs of the Geological Service of Morocco*. 1, 85-123
- Cuzin, F. (2003). *Large mammals of southern Morocco (High Atlas, Anti-Atlas and Sahara), Distribution, ecology and conservation*. Doctoral thesis in science. University of Montpellier II. France.
- Destombes, J., Hollard, H., & Willefert, S. (1985). *Lower Paleozoic rocks of Morocco*. in Lower Palaeozoic of North-Western and West-Central Africa, edited by C.H. Holland, Trinity Coll., Dep. of Geol., Dublin, Ireland, 4, 91 – 336.
- Duval, M., & Gauchon, C. (2010). Tourism, geosciences and territorial issues: news on geotourism. *Téoros*, 29 (2), 3–14. <https://doi.org/10.7202/1024865ar>
- El Hadi, H., Tahiri, A., Brilha, J., El Maidani, A., Baghdad, B., & Zaidi, A. (2015). Geodiversity Examples of Morocco: From Inventory to Regional Geotourism Development. *Open Journal of Ecology*, 5, 409-419. <http://dx.doi.org/10.4236/oje.2015.59034>
- Ettayfi, N. (2013). *Chemical and isotopic characterization of groundwater in the Western Anti-Atlas (Lakhssas-Taфраout) to assess recharge, water-rock interaction, salinity and residence time*. Ph.D. thesis in science, University of Ibn Zohr Agadir.Morocco.
- Farsani, N.T., Coelho, C., & Costa, C. (2011). Geotourism and geoparks as novel strategies for socio-economic development in rural areas. *International Journal of Tourism Research*, 13(1), 68–81. <https://doi.org/10.1002/jtr.800>
- Giusti, C. (2012). with a geomorphological interest – an invisible heritage? *Géocarrefour*, 87/3-4. <https://doi.org/10.4000/geocarrefour.8834>
- Gordon, J.E., Roger, C., & Enrique, D.M. (2018). Geoheritage Conservation and Environmental Policies. Chapter in *Geoheritage*, 213-236. <http://dx.doi.org/10.1016/B978-0-12-809531-7.00012-5>
- Gray M. (2004). Geodiversity: Valuing and Conserving Abiotic Nature. John Wiley, Chichester, 434. <https://doi.org/10.4000/geomorphologie.416>
- Gray M. (2005). Geodiversity and Geoconservation: What, Why, and How? *The George Wright Parks Stewardship Forum*, 22(3), 4–12.
- Hakim, L & Soemarno, M. (2017). Biodiversity Conservation, Community Development and Geotourism Development in Bromo-Tengger-Semeru-Arjuno Biosphere Reserve, East Java. *GeoJournal of Tourism and Geosites*, 20(2), 220-230.
- Henriques, M.H., Pena dos Reis, R., Brilha, J., & Mota, T.S. (2011). Geoconservation as an emerging geoscience. *Geoheritage*, 3, 117–128. <http://dx.doi.org/10.1007/s12371-011-0039-8>
- Joumani, A. (2008). The Asrir oasis: elements of the social history of Oued Noun. *Collection History and societies of southern Morocco*. P.40
- Lazzarini, M., & Aloia, A. (2014). Geoparks, Geoheritage and Geotourism: Opportunities and Tools in Sustainable Development of the Territory. *GeoJournal of Tourism and Geosites*. 13, 8–9.
- Louart, A. Alaoui, A., Bokbot, Y., Onrubia, J.P., Sanchez, C.A., & Fleitas, A.R. (2013). Rock art landscapes and settlements in the Noun wadi basin (Pre-Saharan Morocco). The upper valley of the Seyyad wadi. *Actes la septième rencontre Quaternaristes Marocains RQM7*, Agadir, 66-78.
- Mahmouhi, N., El Wartiti, M., Astite, W.S., Kemmu, S., & El Bahi, S. (2016). The use of geographic information system for the extraction of physical characteristics of assaka watershed: sub-basins of sayed and oum laachar wadis (southern Morocco) *International Journal of Innovation and Applied Studies*, 16(2), 370-377
- Michard, A., Rjimati, E., & Saddiqi, O. (2011). Western Anti-Atlas and Saharan Provinces, *Notes and Memoir*, 561(6), edition of the Geological Survey of Morocco, Rabat.
- Mirari, S., & Benmlih, A. (2018). The Sustainable Development of Oued Noun Oases through the Integration in the Biosphere Reserve Oasis of Southern Morocco. *International Journal of Science and Research (IJSR)*, 7(11), 1211-1218. <http://dx.doi.org/10.21275/ART20192816>
- Mirari, S., Aoulad-Sidi-Mhend, A., & Benmlih, A. (2020). Geosites for Geotourism, Geoheritage, and Geoconservation of the Khnefiss National Park, Southern Morocco. *Sustainability*, 12, 7109. <https://doi.org/10.3390/su12177109>
- Naser, N. (2006). *Use of geographic information systems in hydrology for the development of a water resources management tool for the Guelmim basin*. Thesis of State Engineer in Rural Engineering, Institute of Agronomy and Veterinary Medicine Hassan II, Rabat. p 24.
- Nazaruddin, D.A. (2019). Selected geosites for geoheritage, geotourism, and geoconservation in Songkhla Province, South-ern Thailand. *Quaestiones Geographicae*, Bogucki Wydawnictwo Naukowe, Poznań, 38(1), 161–177. <http://dx.doi.org/10.2478/quageo-2019-0011>
- Ólafsdóttir, R. (2019). Geotourism. *Geosciences*, MDPI, 9, 48. <http://dx.doi.org/10.3390/geosciences9010048>
- Pena dos Reis, R., & Henriques, M.H. (2009). Approaching an Integrated Qualification and Evaluation System for Geological Heritage. *Geoheritage*, 1(1), 1–10. <http://dx.doi.org/10.1007/s12371-009-0002-0>
- Pica, A., Luberti, G.M., Vergari, F., Fredi, P., & Del Monte, M. (2017). Contribution for an urban geomorphoheritage assessment method: proposal from three geomorphosites in Rome (Italy). *Quaestiones Geographicae*, Bogucki Wydawnictwo Naukowe, Poznań, 36(3), 21–36. <http://dx.doi.org/10.1515/quageo-2017-0030>
- Pique, A., Soulaïmani, A., Amhrhar, M., La Ville, E., Bouabdelli, M., Hoepffner, C., & Chalouan, A. (2007). *Geology of Morocco*. Editions GEODE, Marrakech, 9-19.
- Poiraud, P., & Dandurand, G. (2017). From geoconservation to geotourism: a paradigm shift. *Annales de Géographie*, 717, 625-653.
- Pralong, J.P. (2006). Geotourism and the use of natural sites of interest to the earth sciences: The regions of Crans-Montana-Sierre (Valais, Swiss Alps) and Chamonix-Mont-Blanc (Haute-Savoie, French Alps). *Doctorat thesis presented at the Faculty of Geosciences and Environment of the University of Lausanne*. <https://dx.doi.org/10.1108/eb058476>
- Predrag, D., & Mirela, D. (2010). Inventory of Geoheritage Sites – the Base of Geotourism Development in Montenegro. *Geographica Pannonica*, 14(4). 126–132. <https://doi.org/10.5937/GeoPan1004126D>
- Ranjbaran, M., Zamanzadeh, S.M., & Sotohan, F. (2020). Geotourism Attractions of Hormuz Island, Iran. *GeoJournal of Tourism and Geosites*, 28(1), 232–245. <https://doi.org/10.30892/gtg.28118-465>
- Reynard, E., Pica, A., & Coratza P. (2017). Urban geomorphological heritage. An overview. *Quaestiones Geographicae*, Bogucki Wydawnictwo Naukowe, Poznań, 36(3), 7–20. <https://doi.org/10.1515/quageo-2017-0022>
- Reynard, E., & Brilha, J. (2018). Geoheritage: assessment, protection and management. *Elsevier*, Amsterdam, 1–450.
- Robles, M.P., Guerrero, F., Martín, M.M.G., Raffaelli, F.J., Alcalá, J., Tejera de León, T.E., Cherkaoui, L., Asebriy, I.E., El Amraniand, S., & Moliner, A. (2015). Geological risk assessment of Amtoudi Agadir in southern Morocco: a key case for sustainable cultural heritage. *Nat Hazards*, 75, 415–440. <https://doi.org/10.1007/s11069-014-1329-7>
- Weisrock, A., Wengler, L., Mathieu, J., Ouammou, A., Fontugne, M., Mercier, N., Reyss, J.L., Valladas, H., & Guery, P. (2006). Upper Pleistocene comparative OSL, U/Th and 14C datings of sedimentary sequences and correlative morphodynamical implications in the South-Western Anti-Atlas (Oued Noun, 29° N, Morocco). *Quaternaire*, 17/1. <https://doi.org/10.4000/quaternaire.645>
- \*\*\* High Commission for Planning (HCP) (2015). General population and housing census 2015. Available via the following link: [http://www.hcp.ma/Recensementgeneral-de-la-population-et-de-l-habitat-2015\\_a633.html](http://www.hcp.ma/Recensementgeneral-de-la-population-et-de-l-habitat-2015_a633.html)
- \*\*\* High Commissioner for Water and Forests and the Fight against Desertification (HCWFFAD) (2008). Monographic Overview of the Forestry Sector in the Province of Guelmim.
- \*\*\* Minister Of Energy, Mines, Water and the Environment (MEMWE). (2010). Second National Communication to the United Nations Framework Convention on Climate Change.
- \*\*\* Souss Massa and Draa Hydraulic Basin Agency (SMDHBA). (2013). Water resources monograph in the province of Guelmim.
- \*\*\* Souss Massa and Draa Hydraulic Basin Agency (SMDHBA). (2011). Study for the release of water resources and implementation of water catchments for the AEP of the centre of Guelmim.