

Environment

DOI: 10.48402/IMIST.PRSM/jasab-v3i1.27391

Biodiversity, an essential component for the M'goun global geopark development (Morocco) - An overview

Abderrazak EL ALAMI^{1*}, Abderrazak FATTAH², Hicham BOUZEKRAOUI³

¹ Khawarezmi High school, Academy of Education and Training of Beni Mellal-Khenifra, Ministry of National Education, Vocational Training, Higher Education and Scientific Research of Morocco

 ² Laboratory of Bio-Geosciences and Materials Engineering, Higher Normal School, Hassan II University, Casablanca, Morocco
³ Research Group of Landscapes Dynamic, Risks and Patrimony, Faculty of Letters and Human Sciences, Sultan Moulay Slimane University, Beni Mellal, Morocco

ARTICLE INFO

Received July 27th, 2021 Received in revised form Spetember 20th, 2021 Accepted Spetember 21st, 2021

Keywords:

M'goun geopark, Geosites, Geotourism, Fauna species, Human-carnivore interaction, Conservation.

ABSTRACT

The M'Goun Geopark (Morocco) has a rich and varied geological and biological diversity. The objective of this paper was to determine the geosites inventory and valorization, fauna diversity and biodiversity conservation, and the humancarnivore conflict and threatened species management in the M'goun global geopark, central High Atlas of Morocco. The geosites of the M'Goun Geopark have a high geological value and are conducive to geotourism and geo-education valorization, mainly: natural bridge of Imi-n-Ifri, sedimentary structure in teepee in Rat Mountain, Tarkeddid syncline, glacial cirques and U-shaped valleys of M'goun. The central High Atlas Mountains are home to a variety of animal species, especially mammals with more than 24 wild mammal species, birth with more than 102 species, reptiles with more than 30 species, amphibians with more than six species, and a large number of invertebrates. Several studies indicated that biodiversity has been declining at an alarming rate in recent years in this area and blamed this decline on habitat destruction, impact of livestock grazing, the habitat and population fragmentation, the illegal capture and the effects of human activities. In this area, the effect of human is among the major problems responsible of the decline of carnivore species and the human-carnivore conflict may act as factors in the decline of carnivore populations. Several measures were recommended to protect biodiversity and geodiversity in the the M'Goun Geopark.

© 2021 EST-Khenifra, University of Sultan Moulay Slimane. All rights reserved.

1. Introduction:

The M'Goun Geopark (31°30'00"N, 06°27'00"W) is the first geopark of Morocco, Africa and the Arab world. It covers an area of 12 791 km² including 5 730 km² labeled "Unesco Global Geopark" by UNESCO in September 2014 [1]. The geological heritage of the Geopark includes outstanding mineralogical and paleontological features, geomorphologic sites and impressive conglomerate cliffs [1]. The following plant species were common in the study area are *Ziziphus lotus*, *Acacia gummifera*, *Ceratonia siliqua*, *Rhus pentaphylla*, *Withania frutescens*, *Euphorbia resinifera*, *Genista sp.*, *Quercus ilex*, *Juniperus phoenicea*, *Juniperus oxycedrus*, *Pistacia lentiscus*, *Phillyrea* sp., *Arbutus unedo*, *Tetraclinis articulata*, *Pinus halepensis*, *Quercus suber*, *Juniperus thurifera*, *Erinacea anthyllis*, *Bupleurum spinosum*, *Alyssum spinosum*, *Cytisus balansae* and *Artemisia* sp. [2-4]. The M'Goun Geopark has a rich and varied geological and biological diversity with existence of many local and artisanal products with a strong territorial link and a real potential for economic development.

^(*) Corresponding author:

Tel.: +212653254363

E-mail address: departement biologiefssm@hotmail.com

The objective of this paper was to determine the geosites inventory and valorization, fauna diversity and biodiversity conservation, and the human-carnivore conflict and threatened species management in the M'goun global geopark, central High Atlas of Morocco.

2. Geosites inventory and valorization in the M'goun geopark:

The tourist itinerary of Demnate-Ighil M'goun, the highest mountain peak of the central High-Atlas (4 066 m a.s.l.), is located in the Moroccan central High Atlas in the center of Morocco. In the central High Atlas Chain, the three main families of rocks outcrops are: sedimentary rocks (sandstones, siltstones, and clays from the Triassic, and carbonates of the Jurassic), magmatic (basalts of the Triassic and gabbro of the Jurassic) and metamorphic (flysch, shales, schists, quartzite and pelites of the Paleozoic era) [5]. The geomorphology of the central High Atlas consists of folded sedimentary rocks layers, generating large synclines and anticlines. The anticline hinges have been eroded, which led to reverse relief; perched synclines in the limestone of the lower Jurassic and deep valleys, which have been cut until the Triassic and Paleozoic basement [6]. Based on several geological and geomorphological criteria, a high number of geosites in the central High Atlas were identified [7-9]. The inventory of geosites is an important tool to protect geo-heritage from natural and antropic risk of degradation and is the basis of geotourist itineraries [9,10]. These geosites have a high geological value and are conducive to geotourism and geo-education valorization, mainly: natural bridge of Imi-n-Ifri, sedimentary structure in teepee in Rat Mountain, Tarkeddid syncline, glacial cirgues and U-shaped valleys of M'goun. Furthermore, this area contains footprints of herbivorous and moving tracks of carnivorous dinosaurs of Iouariden in Sidi Boulkhalf, they are printed on tilted layers of siltstones of the Iouaridene formation (165 Ma). Moreover, footprints tracks of small carnivorous 'Coelulosaurian', small dinosaurs from the lower Jurassic, are clearly visible on the right side in the road located at few km from Ait Blal. The proposed geotourist itinerary can be completed in four days and can be reached out by car, bike, or geohiking. This route has been conceived in such a way as to illustrate the geological and geomorphological evolution of this mountain from the Paleozoic to the present [9]. Furthermore, it offers the opportunity to visit some of the most interesting and best exposed geosites of the Moroccan central High Atlas.

3. Fauna diversity and biodiversity conservation in the central High Atlas:

The central High Atlas Mountains are home to a variety of animal species, especially mammals with more than 24 wild mammal species, birth with more than 102 species, reptiles with more than 30 species, amphibians with more than six species, and a large number of invertebrates [2,11-15]. This area has a rich fish species living in lakes, rivers and dams. The main threatened mammals in this area are: *Canis sp., Lutra lutra, Genetta genetta, Ammotragus lervia, Gazella cuvieri, Macaca sylvanus, Gerbillus campestris* [11,13]. Several birth species are threatened in this area, such as *Aquila chrysaetos, Gyps fulvus, Gypaetus barbatus, Corvus Corax, Troglodytes troglodytes, Oenanthe leucura, Athene noctua,* and *Aquila pennata* [14]. Several studies indicated that biodiversity has been declining at an alarming rate in recent years in this area and blamed this decline on habitat destruction, impact of livestock grazing, the habitat and population fragmentation, the illegal capture and the effects of human activities [2-4,11]. Several measures were recommended to protect biodiversity: 1. increase habitat and species protection; 2. raise the awareness of local people about the biodiversity conservation; 3. encourage research and development projects involving local communities, local authorities and associations in the protection of the wild species; 4. find solutions to reduce the conflict between local people and wild fauna; 5. initiate development projects in order to encourage the local economy; and initiate wildlife volunteering programs in the central High Atlas.

4. Human–carnivore conflict and threatened species management and conservation in the central High Atlas Mountains:

The central High Atlas Mountains have a great diversity of habitats and of plant and animal species. This area is home to a variety of animal species, especially mammals. In this area, there were the last observations of several carnivore species in Morocco as the case of the serval [16], the panther [11] and the Barbary lion [17]. The available data showed that seven carnivore species occur actually in the central High Atlas: the golden jackal *Canis aureus*, the red fox *Vulpes vulpes*, the African wolf *Canis lupus lupaster*, the wild cat *Felis silvestris*, the common genet *Genetta genetta*, the Eurasian otter *Lutra lutra*, and the least weasel *Mustela nivalis* [18]. During the XXth century, Lion (*Panthera leo*) were extirpated from the central High Atlas. Several carnivore species become extinct or very rare as the panther *Panthera pardus*, the serval *Leptailurus serval*, the striped hyena *Hyaena hyaena*, and the Egyptian mongoose *Herpestes ichneumon* [18]. In central High Atlas, the carnivore species are threatened by overhunting, habitat destruction, a highly fragmented population and the risk of local extinction [11]. In this area, the effect of human is among the major problems responsible of the decline of carnivore species and the human-carnivore conflict may act as factors in the decline of carnivore populations. Several studies reported that there is an increasing in the local people-carnivore conflict. The predation of livestock is the main cause of the local people-carnivore conflict. In this area, local people continue to use illegal techniques such as poisoning

Journal of Analytical Sciences and Applied Biotechnology

against these carnivores **[13]**. The removal of carnivores can have major cascading impacts on ecological communities, destabilizing ecosystems and their food webs **[19-21]**. For example, the numbers of wild boars increased significantly during the two last decades in the central High Atlas **[3]**. This study showed that the wild boar has negative impacts on natural ecosystems and cultivated flora and that the increase in wild boar populations is due mainly to the regression of its natural predators. Several measures were recommended to reduce the likelihood of the carnivore species becoming extinct in the central High Atlas: development projects, surveillance of wild habitats, education to raise the awareness of the local people, scientific research, and the use of non lethal methods to prevent conflicts between predators and livestock. Since 2019, the two first authors started a project about the carnivores in the central High Atlas. This project is funded by the Rufford Small Grant Foundation and aims to determine the current distribution and the status of the carnivore species, to assess the human-carnivores interactions, and to develop effective carnivore species conservation strategies.

5. The Barbary macaque Macaca sylvanus in the tourist valley of Ouzoud, central High Atlas:

Since 2008, the Barbary macaque *Macaca sylvanus* has been classified as an endangered species (Endangered A2bcd) on the IUCN's Red List **[22]** and this species is listed in CITES Appendix I **[23]**. Several studies indicated a dramatic decline of the Barbary macaque populations in the central High Atlas and blamed this decline on habitat destruction, impact of livestock grazing, the population fragmentation, the illegal capture of macaques and the effects of human activities on Barbary macaques' behaviour **[2]**. In the tourist site of Ouzoud, Barbary macaques are affected by the presence of visitors providing food to them. Barbary macaques living in the tourist site of Ouzoud showed more aggressive behavior, which were likely related to higher levels of competition for the clumped human foods it consumed and that Barbary macaques exploit additional food resources to become more omnivorous **[24]**. The Barbary macaques can facilitate ecotourism, but the inclusion of human food and human disturbance often results in the modification of macaques' behavior **[25]**. Barbary macaques in the tourist site of Ouzoud used large parts of their home range very infrequently, concentrating their activities in the tourist site **[2]**. We recommend placing clear information panels for tourists and sufficient training of the local tourist guides to reduce human provisioning in tourist sites.

6. Conclusion:

The M'Goun Geopark has a rich and varied biological and geological diversity. It includes famous and spectacular footprints of sauropod and theropod dinosaurs and many deposits of bones and has a very geological interest. It also has a great diversity of habitats and of plant and animal species with existence of many local products with a strong territorial link and a real potential for economic development. It is important to initiate development projects, especially ecotourism, geotourism, ssustainable mountain tourism, speleology, etc. We also note that more than 80 medicinal plants, used for medicinal purposes in Morocco and worldwide, grow spontaneously in this area. To conserve medicinal plants in their native ecosystems, it is important to encourage the cultivation of these plants in the M'Goun Geopark territory. This can serve as a tool for combined biodiversity conservation and poverty alleviation. Education to raise the awareness of the local people about the ecological and economical roles of biodiversity can involve inhabitants, local authorities and associations in the surveillance of native species and of ecosystems and local habitats.

Acknowledgements

We would like to acknowledge Mr Achbal Driss, president of the M'goun geopark association, Mr Abdelwahab Semlali, president of the AESVT -Beni Mellal section- and vice president of the M'goun geopark association, Mrs Fatima Amkar, director of M'goun geopark museum who organized the event of the celebration of the World Environment Day in May 5, 2121 at the Azilal province. El Alami A. and Fattah A. are highly indebted to Rufford Small Grant Foundation, UK for providing funding for their Project "Human–Carnivore Conflict and Threatened Species Management and Conservation in the Central High Atlas Mountains, Morocco" (https://www.rufford.org/search/?q=el+alami+abderrazak). Finally, we acknowledge El Mustapha Bouzid for its great effort in the documentation of the scientific and educational activities of the AESVT.

References:

- 1. UNESCO Global Geopark (2017). M'Goun UNESCO Global Geopark (Morocco): Valleys, natural curiosities, fossilised footprints, engravings and authentic Berber villages. UESCO Report, <<u>http://www.unesco.org</u>>.
- 2. El Alami, A., Van Lavieren, E., Aboufatima, R., Chait, A (2013). A Survey of the Endangered Barbary Macaque *Macaca sylvanus* in the Central High Atlas Mountains, Morocco. *Oryx The International Journal of Conservation*, 47(03), 451-456.
- 3. El Alami, A. (2019a). Étude écologique du sanglier *Sus scrofa barbarus* et de son impact sur la biodiversité dans les montagnes du haut atlas central d'azilal, Maroc. American Journal of Innovative Research and Applied Sciences, 8(1), 24-33.
- 4. El Alami, A. (2019b). A survey of the Vulnerable Cuvier's gazelle in the Mountains of Ait Tamlil and Anghomar, Central High Atlas of Morocco. *Mammalia*, 83(1), 74-77.
- 5. Pique A. (1994). Géologie du Maroc : les domaines régionaux et leur évolution structurale. PUMAG, FSSM Marrakech, Maroc.

Journal of Analytical Sciences and Applied Biotechnology

- 6. Couvreur, G. (1988). Essai sur l'évolution morphologique du Haut-Atlas central calcaire (Maroc). Notes et mémoires du Service géologique du Maroc, pp.318
- 7. Bouzekraoui, H., Barakat, A., Touhami, F., Mouaddine, A. El Youssi, M. (2017). Inventory and assessment of geomorphosites for geotourism development: a case study of Att Bou Oulli valley (central High-Atlas, Morocco). *Area*, 50, 331-343.
- 8. Bouzekraoui, H., Barakat, A., El Youssi, M., Touhami, F., Mouaddine, A., Hafid, A., Zwoliński, Z. (2018a). Mapping geosites as gateways to the geotourism management in Central High-Atlas (Morocco). *Quaestiones geographicae*, 37(1), 87-102.
- Bouzekraoui, H., Barakat, A., Mouaddine, A. El Youssi, M., Touhami, F., Hafid, A. (2018b). Mapping geoheritage for geotourism management, a case study of Aït Bou Oulli Valley in Central High-Atlas (Morocco). *Environ. Earth. Sci.*, 77, 413-413.
- 10 Bouzekraoui, H., Barakat, A., El Youssi, M., El Khalki, Y., Hafid, H., Mouaddine, A. (2016). Mapping geodiversity and cultural heritage; a case study: Aït Bou Oulli valley in central High-Atlas, Morocco. *Geophysical Research Abstracts*, Vol. 18, EGU2016-17926.
- 11 Cuzin, F (2003). Les grands mammifères du Maroc méridional (Haut Atlas, Anti Atlas et Sahara): Distribution, écologie et conservation. Thèse de doctorat, Université de Montpellier II, Montpellier, France.
- 12 Fattah, A (2008). Contribution à la connaissance de l'Ecologie de *Bufo brongersmai* (Amphibia, Anura, Bufonidae) dans les Jbilets Centrales (Maroc occidental). Implication en termes de conservation. Mémoire Master II recherche. Fac. Sc. Semlalia, Marrakech. 38 p.
- 13 El Alami, A (2016). Les mammifères sauvages actuels et disparus de l'Atlas d'Azilal, Maroc: Distribution géographique, statut et menaces. Éditions universitaires européennes, ISBN: 978-3-8416-1141-3
- 14 El Alami, A., El Alami, I. (2018). Les oiseaux du Haut Atlas central marocain- Découverte et inventaire de l'avifaune des montagnes d'Azilal. Les Éditions du Net; ISBN: 978-2-312-06232-7.
- 15 Dakki, M., El Ayachi S. (2004). Diagnostic pour la gestion durable des Zones humides du Mgoun-Dades. CBTHA Project Report, Ouarzazate, Morocco.
- 16 Lambert, MRK (1967). A report on the Trinity College, Dublin, High Atlas and Sahara Expedition 1966. Trinity College, Dublin. Pp. 65.
- 17 Black, S.A., Fellous, A., Yamaguchi, N., Roberts, DL (2013). Examining the Extinction of the Barbary Lion and Its Implications for Felid Conservation. *PLOS ONE*, 8(4), 1-12.
- 18 Cuzin, F., (1996). Répartition actuelle et statut des grands Mammifères sauvages du Maroc (Primates, Carnivores, Artiodactyles), *Mammalia*, 60, 101–124.
- 19 Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M.P., Schmitz, O.J., Smith, D.W., Wallach, A.D. and Wirsing, A.J. (2014). Status and ecological effects of the world's largest carnivores. *Science*, 343, 1241484.
- 20 Newsome, T.M., Greenville, A.C., Cirovi C.D., Dickman, C.R., Johnson, C.N., Krofel, M., Letnic, M., Ripple, W.J., Ritchie, E.G., Stoyanov, S. and Wirsing, A.J. (2017). Top predators constrain mesopredator distributions. *Nat. Commun.*, 8, 15469.
- 21 LeFlore, E.G., Fuller, T.K., Tomeletso, M. and Stein, A.B. (2019). Livestock depredation by large carnivores in northern Botswana. *Global Ecology and Conservation*, 18, 1-12.
- 22 IUCN (2020). Red list of Threatened Species. The International Union for the Conservation of Nature, Gland, Switzerland, et Cambridge, UK.
- 23 CITES (2017). Convention on international trade in endangered species of wild fauna and flora: Appendices I, II and III (valid from 4 October 2017).
- 24 El Alami, A., E. Van Lavieren, R. Aboufatima and A. Chait. (2012). Differences in Activity Budgets and Diet Between Semiprovisioned and Wild-Feeding Groups of the Endangered Barbary Macaque (*Macaca sylvanus*) in the Central High Atlas Mountains, Morocco. *American Journal of Primatology*, 74, 210-216.
- 25 El Alami, A., A.Chait. (2015). Roles of tourism in the local people opinion regarding human macaque conflict in the central High Atlas, Morocco. *Revue de primatologie*, 6, 1-7.

© JASAB 2021