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in

Acar Z. (ed.), López-Francos A. (ed.), Porqueddu C. (ed.).
New approaches for grassland research in a context of climate and socio-economic changes

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 102

2012

pages 103-106

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=6861>

To cite this article / Pour citer cet article

Qarro M., Ezzahiri M. **The impact of climatic variations on the role and sustainable management of natural ecosystems in the Middle Atlas (Afenourir wetland area case)**. In : Acar Z. (ed.), López-Francos A. (ed.), Porqueddu C. (ed.). *New approaches for grassland research in a context of climate and socio-economic changes*. Zaragoza : CIHEAM, 2012. p. 103-106 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 102)



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The impact of climatic variations on the role and sustainable management of natural ecosystems in the Middle Atlas. (Afenourir wetland area case)

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Abstract. The Afenourir lake (wetland area; 33° 17'N - 5° 16'W) is located in the Central Middle Atlas of Morocco south of Ifrane province about 30km south of Azrou. The lake is part of the perimeter of Ifrane National Park as established in October 2004. It belongs to the Western Palearctic biogeography region. Afenourir area has several land statutes that are subject to rights of land use and various other regulations: (i) the ethnic use tenure, under the authority of the Interior Ministry, (ii) the private domain of the State, this is the forest area which is under the tutelage of forest department, (iii) the swamp area is under the supervision of the watershed hydraulic agency of Sebou. The Afenourir site constitutes important water resources to local people in this area where the physical land characteristics do not allow the storage of rainwater and snowmelt and to develop real rivers. Therefore, the waters of the lake are highly coveted as evidenced by the large number of wells around the lake especially in the eastern part. At present, the area knows the existence of illegal forty wells. The pumping of water from these wells knows great importance. Water withdrawals, either for domestic or for watering the cattle, are valued to 180 m³ per day. This quantity pumped at the wells has a direct effect on the lake since both are fed from shallow aquifer. This situation is more aggravated by climatic conditions which are often dry and which are favorable to the habitat establishments around the lake leading to livestock concentration in the area increasing the needs for water and forage.

Keywords. Grassland – Humid area – Water – Population pressure – Climate variations.

Impact des variations climatiques sur le rôle et la gestion durable des écosystèmes naturels au Moyen Atlas (cas de la zone humide d'Afenourir)

Résumé. Le lac d'Afenourir (33° 17'N - 5° 16'W) se situe dans le Moyen Atlas Central marocain au Sud de la province d'Ifrane à 30km au Sud d'Azrou, dans la commune rurale d'Aïn Leuh. Le lac s'inscrit dans le périmètre du Parc National d'Ifrane créé en octobre 2004. Il appartient à la région biogéographique du Paléarctique occidental. La zone d'Afenourir connaît plusieurs statuts fonciers grevés de droits d'usage et de réglementations variés : (i) Le régime collectif : placé sous l'autorité du Ministère de l'Intérieur, (ii) Le domaine privé de l'Etat, concerne le domaine forestier qui se trouve sous la tutelle du département des eaux et forêts, (iii) Statut domanial qui couvre l'espace du marécage proprement dit et relève de la tutelle de l'agence hydraulique du bassin versant du Sebou. Le site d'Afenourir constitue une ressource en eau d'importance pour les populations locales, dans un secteur où les caractéristiques physiques ne permettent pas le stockage des eaux pluviales et nivales ainsi que le développement de véritables cours d'eau. Par conséquent, les eaux du lac d'Afenourir sont très convoitées comme en témoignent le nombre important de puits creusés autour du lac et notamment dans la partie Est. Actuellement on note l'existence d'une quarantaine de puits illégaux. Le pompage de l'eau au niveau de ces puits connaît une grande importance. Les prélèvements en eau, que se soit pour des usages domestique ou pour l'abreuvement des troupeaux, sont évalués à une quantité journalière de 180 m³. Le pompage au niveau des puits est de plus en plus aggravée par les conditions climatiques souvent sèches du fait de la création des habitats fixes au tour du lac et la concentration des troupeaux dans la zone pour les besoins d'eau et d'herbe.

Mots-clés. Zone humide – Parcours – Eau – Pression anthropique – Variations climatiques.

I – Introduction

Forest ecosystems of the Middle Atlas, especially cedar forest, are undoubtedly a natural heritage of exceptional richness: Biological, economic and also cultural richness. The cedar tree is a symbol with excellence of the “Mediterranean region”, and also a historical symbol of North African art whose powerful roots still feed a strong traditional current. The cedar forests of the Middle Atlas are still an exemplary in Morocco and occupy a vast region in Morocco where “the forest environment” prevails over a wide range. The Atlas cedar is a species listed in the global agenda of biodiversity. A development plan of management of the Natural Park of Ifrane was established by forest services in 1995 as part of the conceptual design of a network of protected sites and areas and management plans of National Parks in Morocco (BCEOM-SECA/ISR/IBM - AEFCS-BAD). This document was the basis of the decree creating the National Park of Ifrane, promulgated in October 2004, over an area of 51,800 ha.

This study has as main objectives: (i) to implement a participatory management to make a local community as responsible of natural resources management, (ii) to alleviate the dryness of the Lake Afenourir during dry conditions, (iii) to reduce the grazing pressure of pastoral ecosystems around the wetland site.

II – Materials and methods

The national Park zone of Ifrane makes about 50,000 ha and incorporates human activities and use rights of resources and space for local communities. One of the most important wetlands of the Middle Atlas is Afenourir Lake which is located in the south of Ifrane province, 30 kms south from Azrou (Ain Leuh rural community). The Afenourir Lake is a wetland of high altitude surrounded by cedar forest. It contains ecological, landscape, socio-economic and cultural values of great interest that let it be a part of Ramsar list since 1980. Indeed, the uniqueness of its landscape character in the North African region, and its avifaunal interest, allowed it to satisfy criteria of the Ramsar Convention (signed in Iran, 1971) which requires the taking of measures to preserve values of the site.

However, no appropriate management action has yet been taken despite the diversity of threats from many anthropogenic factors (overgrazing, settlement, poaching) and natural factors (less rainfall and snowfall) that endanger the functionality of the site and its sustainability. These constraints are increasingly exacerbated by climate variations in the latest decades and agri-silvopastoral imbalance existing in the Middle Atlas region.

III – Results and discussions

1. Land tenure and use

Land tenure issues, and uses of Afenourir area has several statutes that are subject to various rights and regulations of land use:

- (i) The ethnic statute: It corresponds to grazing areas in the non forest land. This land status has some problems in terms of access to resources among the beneficiaries (Ait Mouli) and non-rights holders (Oulad Khawa) and is currently at present some illegal overtaking, particularly in terms of settling permanently on this area.
- (ii) The private domain of the State: It corresponds to forest area which is under the tutelage of forest department. However, people keep their rights of land use (harvesting deadwood and grazing) on this space.

- (iii) The domain status: It corresponds to land covered by water (wetland) and it's under the authority of the watershed hydraulic agency of Sebou.

2. Climatic variation effects on water resources of Afenourir Lake

A. Climatic variations and drought

The climate in the Afennourir region, and more generally in this part of the Central Middle Atlas, is defined as a Mediterranean mountain climate. The altitude influences the quantity and type of precipitation that takes in the form of snow during the winter period (November-February). The Ain Leuh station, located at about 4 km north-west of Afennourir Lake has an average annual rainfall of 567.6 mm and Azrou station has 827 mm.

The quantities of rainfall for the years 2007 and 2008 have not, particularly, exceeded 300 mm while the average rainfall in normal years exceeds 800 mm / year (Ain Kahla station). The water covered area of the lake in June 2008 (dry conditions) is 11.5 ha. This shows, by comparison with the maximum water level of Lake that the lake is dried to 95%. This finding was also verified by the participatory card established with the shepherds and users. Indeed, to appreciate the drying importance of the lake by the population we used the approach by asking the population users to realize the current limits of the lake, the maximum of filling level of the lake and the level reached by water during the last two dry years.

B. Uses and water withdrawals estimation

Waters collected from the site are exhausted either directly from the lake or from wells opened in the nearby grazing (non-forested) area.

The livestock watering on site. To satisfy the water needs of livestock on the site, we estimated the daily taking at 125 m³ per day by multiplying 25 thousand grazing by the daily need of each individual sheep estimated to 5 liter/day.

The off-site livestock watering. Two means of taking off are practiced: (i) Tanks towed by animals: we identified 60 users who make three to four hours drive to seek for water, and they make two round-trip travel. The size of the tank is 350 liters. So that for this category the quantity of water taken off is about 42 m³ per day, (ii) Tractor tanks: With a size of 2000 liters, the number of users is six. For this category the quantity of water taken off is about 12m³ per day.

Domestic purpose Uses. For this category we have estimated the taking of water to 1.6 m³ per day (20 settling users consuming about 80 liters per day).

C. The settlement of transhumant breeders

This phenomenon is qualified as a major constraint, because it is considered as a generator of other constraints such as overgrazing, delimiting, etc. The settlement near the Afenourir area is encouraged by the water potential existing at the wetland. At the time of the study (2008), 41 habitats have been identified and are located within or adjacent to the wetland.

These houses are ephemeral; they are built of dry stone with wood frames covered with plastic material.

D. Impact on forest ecosystem

The nearby forest of Afennourir site is characterized by cedar species (*Cedrus atlantica*), *Craetagus laciniata*, *Quercus rotundifolia* (green oak) and *Fraxinus angustifolia*. The forest ecosystems around the Afenourir site are characterized by a high pressure and degradation effects.

Moreover, the local populations began to practice livestock association with non legal users, with as consequence an increase in livestock number. This led to overgrazing of silvopastoral ecosystems of Central Middle Atlas. In addition, the cedar trees at forest edges are consistently subjected to pruning and topping by shepherds settled or grazing near the lake. Afennourir site situation is extremely serious because, if some broad-leaved species (*Quercus rotundifolia*) seem to be more resistant to such practices, cedrus tree can be easily negatively impacted. In fact, the physiological imbalance that occurs due to the decrease in aerial biomass, comparatively to the root system, let to reduce photosynthetic functions witch causes the dead of trees.

3. Recommendations for sustainable management of resources

For each of the above problems, we proposed a number of concrete actions that will subsequently be a possible planning action.

The main objective is to alleviate the dryness of the lake. To attend this objective we propose to do the following actions: (i) deviation of water stream to control frequencies in order to achieve an optimal level of the lake about 300 ha. This action allows to maintain the lake not dried during the summer, (ii) drilling a well to the level of the deep aquifer. By a simple calculation we can deduce that a single well of a flow rate of 5 l / sec per day ($5 * 12 * 3600 = 216\ 000$ l) can satisfy all the needs of the population with water during the summer period. The quantity needed in this period was estimated at, approximately, 180 000 l / day.

The second objective concerns the reduction of grazing pressure. To achieve this objective it is suggested the following interventions: (i) resting implementation of degraded grasslands, (ii) possibility to regulate association herds (limitation or prohibition).

IV – Conclusion

The Afenourir Lake is subject to various pressures induced by over-pumping of water resources and overgrazing of nearby rangelands. In addition the sedentarization of herders which exacerbate the imbalance between ecosystem supply and permanent demand of settled populations in water and fodder.

However, no appropriate management action has yet been established despite the diversity of threats from many anthropogenic (overgrazing, settlement, poaching, etc) and natural factors (less winter snowfall) that endanger the functionality of the site and its sustainability. The need for an appropriate management plan is essential. The analysis in this study comprises both the inventory and synthesis of knowledge (ecological, institutional and socio-economic diagnosis) in Afennourir site ecosystems. So, some proposals are made aiming sustainable management including rehabilitation and habitat restoration.

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