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Grazing Intensity and Socioeconomic Activities in Wadi Allaqi Biosphere Reserve, South Egypt

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Research Article

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ABSTRACT

Natural resources, human and socioeconomic activities data were collected directly from human beings at the downstream and upstream parts of Wadi Allaqi. A survey of Bedouin living in this Wadi was undertaken using an open-ended questionnaire to gain information about the best general critical factors that controlling the natural resources of economic activities and their type, only for men Bediouns, furthermore, grazing intensity was estimated. Domestic and wild animals can graze and browse on 58.8% of the total recorded species in Wadi Allaqi. As well as the highly palatable species, some camels can graze over 20 plant species that are usually avoided by other animals. About 38% species in the study area have low palatability, 16.5% species are unpalatable and 13.4% are known to be browsed by camels with some exception (*Crotalaria aegyptiaca* which is poisonous to goats and sheep). Sheep and camel herding, charcoal production, small-scale cultivation, and medicinal plant collections developed a system by Bedouin near Nasser Lake. Out of 93.3% of Bedouin reported that Lake Nasser fluctuation affected their production. Some 13.3% of Ababda and 26.8% Bishari Bedouins agree that the second key which effects their life is the rainfall incidence.

Keywords: Wadi Allaqi; Grazing intensity; Sustainable uses;

Socioeconomic activities; Palatability

INTRODUCTION

There has been much debate on the impact of livestock grazing on plant communities. Some researchers suggest positive impacts due to light grazing intensity with reported increases in plant diversity, while others reported significant negative impacts [1-5]. The properties of these impacts, ranging from simple losses in cover, to variations in general vegetation diversity [1,4-7]. Loss of perennial cover is associated with increased geophyte cover and dominance of less palatable species in response to the selective grazing pressure [8,9]. Now a days considerable attention has been paid in Africa to the inter-relationship between human activity and natural resource use and management [10-13]. Possibly triggered by the Sahel drought of the 1970s, the debate has since broadened to take issues such as population growth and sustainable development [14,15]. Nevertheless, the central principle has remained the human natural environment inter-face; much of the debate has been concerned with resource overuse and abuse, and with the understanding and alleviation of stress conditions. Consequently, the human-natural resource relationship has frequently been portraying in antagonistic terms, dominated by negative and even hostile perceptions, in which the players may be interpreted as passive victims or even worse. Living in extremely arid conditions with very limited resources and completely depending on these resources, local inhabitants (Bedouins) have developed their own means of managing sustainable yields of benefits. In south-east Egypt, the livelihood of the two nomadic tribes in Wadi Allaqi (Ababda and Bishariin) is slightly different from that of the Khushmaan tribe from the Eastern Desert [16-18]. But in general, individual perennial biota, spaces that occupy, and human benefaction of resources are the central components of environmental management for nomadic groups. The main aim of this work is evaluating the grazing potentiality and grazing intensity in Wadi Allaqi Biosphere Reserve (WABR) as a rangeland area for the local inhabitants. In addition, natural resources survey of human and socioeconomic activities was done to assess their sustainable uses and provide basis for their conservation.

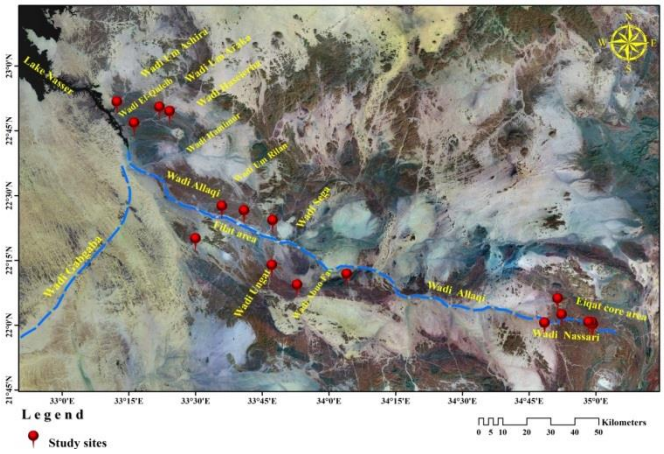
MATERIALS AND METHODS

Study area

Wadi Allaqi Biosphere Reserve is situated in the Egyptian Nubian Desert (*i.e.* Egyptian South-Eastern Desert). It is located south of Aswan for about 180 km, on the eastern bank of Nasser Lake (between latitude 22° and 23°N, and longitude 33°and 35°E), comprises an area of about 22,600 km^2. It creates one of the largest drainage networks in the Egyptian Eastern Desert. Some of the mountains that separate the Nile Valley from the Red Sea coastal plain are drained by its upstream tributaries. This Wadi is around 350 km long and 1 km width; it is narrower upstream and significantly wider downstream as it gets closer to Nasser Lake (Figure 1). Water resources of this area are rare and represented mainly by some important wells that carry good potable water, but in limited quantities. Its lower part is now inundated by water of Nasser Lake [19,20]. The upstream part is elevated; however

the surrounding mountains are high such as Gebel Eiqat that rises up to 1148 m asl [19]. Some of the mountains that serve as a natural barrier between the Eastern Desert and the Red Sea coastal region are drained by the Wadi's upstream tributaries.

Figure 1. General map of south Egypt showing the location of Wadi Allaqi.



Data from Wadi Allaqi Meteorological Station show a mean annual temperature of 25.8°C, minimum of 18.0°C, and maximum 33.6°C. On the other hand, the mean annual relative humidity is 45.9% (Table 1); while the annual rainfall is highly variable in both time and space with trace values. The amount of retained water will depend on thetexture and depth of the surface deposits [21].

Table 1. Annual climatic records of mean, minimum (min) and maximum (max) air temperature (°C), Relative Humidity (RH), Rain-Fall (RF), Solar Radiation (SR), Baro- Pressure (BP), Wind Speed (WS), and Wind Direction (WD) at Wadi Allaqi metrological station (1997).

Year	Temperature (°C)			Relative humidity	Rain fall	Solar radiation	Baro pressure	Wind speed	Wind direction
	Min	Max	Mean	(%)	(mm)	(W m^{-2})	(mm bar)	(km h^{-1})	(Deg)
1996	21.6	35.3	28.4	38.4	traces	254.5	990.7	8.9	247.8
1997	16.8	33.3	25.1	47.6	-	221	992	8.1	242.3
1998	17.2	35.8	26.5	48.9	traces	270.5	990.2	8.9	248.5
2001	18.8	36.8	27.8	40	-	289.3	989.3	10.1	165.1
2002	16.7	35.8	26.2	46.1	-	241.8	991.1	8.6	133.9
2003	18.4	32.7	25.6	47.1	-	235.8	991.5	7.6	140.8
2004	17.5	35.4	26.5	46.6	-	245.1	990.4	8.9	112.7
2005	16.9	24	20.5	52.3	-	216	992	8.1	95.7
Annual	18	33.6	25.8	45.9	0	246.8	990.9	7.9	173.4
SD	1.6	4.1	2.4	4.6	-	24.5	0.9	0.8	63.6

Optional and actual uses of plants

The potential and actual economic uses of plants in the study area were assessed based on three approaches: (1) Literature review (*e.g.* [22-27]); (2) direct observation of the life styles of nomads and their livestock; (3) use of informal interviews and questionnaires with the nomads. The economic uses of the desert vegetation were classified into seven major indigenous uses (*i.e.* goods): Grazing (feed for livestock), medicinal use, human food, timber, fuel, charcoal production and other uses (*e.g.* making mats, baskets, ropes, chairs, extraction of oils, dyes, fibers). An importance value has been attributed for each species for each of the seven categories. The sum of the

values for all uses importance is further expressed as relative percentages of maximum possible score. This Total Importance Value (TIV) can be taken as the measure of the potential importance use for local economy as follows:

$$TIV\% = ((U1 + U2 + U3.....Un)/56) \times 100 \text{ ..... (1)}$$

Where, U= is the importance value for a particular use and n is the total number of uses.

Grazing intensity

For each plant species present within a site, the following data were recorded: The species concerned, percentage cover, and total number of individuals, plant stage, and overall health, level of grazing, and the presence of vehicle tracks. This scale was recorded depended on the subsequent criteria: (1) Amount of reproduction of individuals (flowering and fruiting); (2) Overall vigor and vitality of individuals; (3) Plant height and cover. On the other hand, palatability was recorded based on animal behavior and informal interview with Bedouins over several years of recording notes. Within each site, grazing intensity was evaluated visually and classified into five categories: 1 (no evidence of grazed); 2 (Low Grazed - LG); 3 (Moderate Grazed - MG); 4 (Heavily Grazed - HG) and 5 (Severe Grazed - SG) (Table 2); based on the grazing intensity and amount of dung, grazing-damaged shrubs and extent of livestock footpaths [28-30]. Mammal excrement was visually inspected by counting the number of droppings, the species involved (mostly camel, donkey, rabbit, sheep, ibex, fox, and gazelle), the number of droppings, and the age category of the droppings scaled into five categories: (1) Fresh; (2) Less than one week old; (3) Over one week old; (4) Less than one year old; and (5) Over one year old [30,31]. The dung of ibex and goats are hard to tell apart, and discrimination is likely to be uneasy; others are very characteristic, and easy to identify (Table 2): (1) Number of grazing animals and their types (goats, sheep, donkeys, and camels); (2) Percentage of browsed branches; (3) Number of visits by animals and (4) Rate of cutting and uprooting (number of individual uproots and cut due to human activities [32].

Table 2. Visual measurement of grazing intensity [28-30]; and age categories of the mammal dungs [29,30].

Score	Grazing intensity	Dung age
1	No evidence of grazing	Fresh
2	Low grazing	< one-old week
3	Moderate grazing	> one-old week
4	Heavy grazing	< one-year old
5	Severe grazing	> one-old week

Natural resources, human and socioeconomic activities

Data and information about natural resources, human and socioeconomic activities were collected directly from the Bedouins at the downstream and upstream parts of Wadi Allaqi. A survey of Bedouin living in the study area was undertaken using an open-ended questionnaire to gain information about the best general critical factors that controlling the natural recourses of economic activities and their type, only for men Bedouins (Table 3). It was sufficiently flexible to allow the development of broader debates [33,34]. Thirty interviews were taken place with the heads of households, giving slightly full cover of all households during the time of the survey. Of these, just over 73.3% of them were with Ababda households, and 26.7% with Bishari (the broad of ethnic divisions in Wadi Allaqi). A further method for gaining information involved group discussions, some of which predated the present survey as they formed part of the larger Wadi Allaqi project [35].

Table 3. Open ended questionnaire to gain information about the critical factors that controlling the natural resources in Wadi Allaqi.

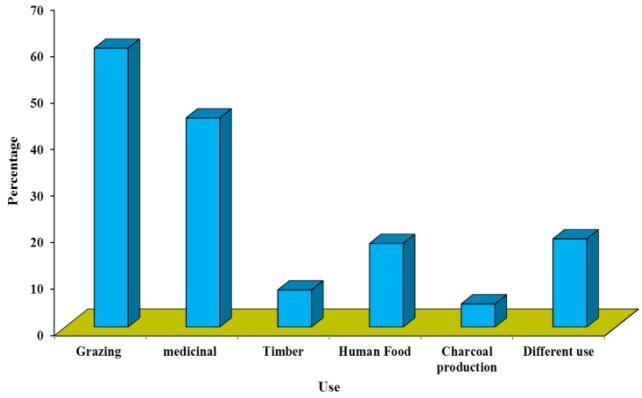
No	Question	Answer
1	What is the critical factors controlling the natural recourses of economic activities?	
2	How the level of Lake Nasser or fluctuations influence the Bedouin production?	
3	Have you developed your livehoods system dependent upon the year, month, or during the year? identify	
4	How much type of your activities within the year?	
5	Have you classified them into primary activities and secondary activities? Based on time interval (e.g. seasons, month) identify?	
6	Which one of your activities classified as winter activities and summer activities?	
7	Which type of your activities considered the key factors of people wealth in the Bedouin tribes?	
8	In your opinion, do you think that medicinal plant collection, greater in the upstream or in the downstream, and which type of species?	
9	Is the medicinal plant collection is an economically important activity for your life?	

RESULTS

Optional and actual uses of plants

Among the 97 species recorded in the current study, 20 species have unknown uses by nomads, while 44 species (45%) have a medicinal value (Table 4). However, only a proportion of this considerable number is currently collected by the nomads. Among the regularly collected are: *Citrullus colocynthis*, *Senna alexandrina*, *Solenostemma arghel*, *Salvadora persica*, *Balanites aegyptiaca*, *Cleome droserifolia* and *Cymbopogon proximus*. There is some evidence that *Hyoscyamus muticus*, which has recently spread along Lake Nasser shores, could be included in the list of important plants for commercial use. The major uses of plant species in this study are grazing (60%) and medicinal use (45%). About 8 % are used for fuel, 25% are edible, and 19% have different uses. Other uses are timber and production of charcoal (Phanerophytes) (Figure 2).

Figure 2. Actual uses of the plants in the present study.



Grazing intensity and palatability pressure

The results indicated that the domestic and wild animals can graze and browse 58 plant species (60.0% of the recorded species). Among the most palatable are the leguminous plants, (expect: *Indigofera argentea* and *Senna*

alexandrina). Selective use of plants by animals provides an example of resource portioning among grazing animals. On the other hand, the field investigation indicated that the camels' diet is of a wider variety than other domestic animals as well as camels can graze over 20 species that are usually avoided by other animals (*e.g. Fagonia* spp., *Leptadenia pyrotechnica*, *Morettia philaeana*, *Zygophyllum simplex* and *Caylusea hexagyna*), while sheep prefer *Cotula cineria* and *Psoralea plicata* (Figure 3 and Table 4). Observation indicated that *Crotalaria aegyptiaca* is grazed by camels and gazelles. *Tamarix nilotica* is apparently good for camels and goats, but not for sheep. *Aerva javanica* and *Salsola imbricata* are the favorable food for gazelles, but not for the domestic animals.

Figure 3. Palatability chart of grazing and browsing species by domestic and wild animals in Wadi Allaqi.

Note: Low to very less palatable; Not palatable; Browsed by camel or browsed by camels and goats; Very good for camels and sheep; Browsed by sheep and goats; Browsed by camels; High palatable and good for all stock; Eaten by all stock particularly good for sheep; Good for all stock; Grazed by all stock animals

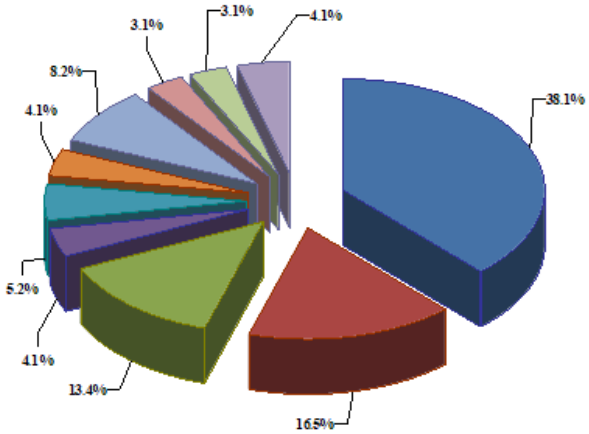


Table 4. Economic importance of the recorded species and their palatability description in Wadi Allaqi.

Species	Palatability	Grazing animal	Grazed part	Economic importance							TIV
				M	T	G	H	F	C	O	
Balanites aegyptiaca (L.) Delile		Camel		8	8	7	8	8	6	8	95
Acacia tortilis subsp. *raddiana* (Savi) Brenan	High			7	8	8	-	8	8	6	80
Acacia tortilis (Forssk.) Hayne subsp. *tortilis*				8	7	8	-	8	8	6	80
Salvadora persica L.				8	6	6	6	6	-	6	68
Acacia nilotica (L.) Delile				6	6	6	-	6	6	6	64
Ziziphus spina-christi (L.) Desf.			Fruit	6	6	6	6	6	-	6	64
Leptadenia pyrotechnica (Forssk.) Decne		Camel		6	-	6	6	7	-	6	55
Tamarix nilotica (Ehrenb.) Bunge		Goat - camel		7	-	7	-	8	-	7	52
Sesbania sesban (L.) Merr.			Leaf - stem - others	6	5	6	-	6	-	5	50

Ricinus communis L.				7	-	-	5	7	-	7	46
Alhagi graecorum Boiss.	Palatable	All stock	Leaf - stem - others	6	-	7	6	6	-	-	45
Phragmites australis (Cav.) Trin. ex Steud.				6	-	6	6	-	-	6	43
Maerua crassifolia Forssk.				5	6	5	-	6	-	-	39
Calotropis procera (Aiton) W.T. Aiton			-	7	-	-	-	7	-	7	38
Panicum turgidum Forssk.		All stock		6	-	8	7	-	-	-	38
Acacia ehrenbergiana Hayne		Camel - goat	Seedling , -Veg. parts	-	-	8	-	6	6	-	36
Cymbopogon schoenanthus subsp. *proximus* (A. Rich.) Maire & Weiller				7	-	6	7	-	-	-	36
Capparis decidua (Forssk.) Edgew.				7	-	-	5	6	-	-	32
Faidherbia albida (Delile) A. Chev.			Seedling	6	5	6	-	6	-	-	32
Medemia argun (Mart.) Württemb. ex H. Wendl.			-	6	-	-	-	6	-	6	32
Pulicaria crispa (Forssk.) Oliv.				6	-	6	-	6	-	-	32
Imperata cylindrica (L.) Raeusch.				6	-	4	-	-	-	6	29
Lupinus digitatus Forssk.				-	-	5	6	-	-	6	29
Zilla spinosa (L.) Prantl		Camel - goat		5	-	6	-	5	-	-	29
Cocculus pendulus (J.R. & G. Forst.) Diels				5	-	-	5	5	-	-	27
Cotula cinerea Delile				5	-	6	-	-	-	5	27
Senna alexandrina Mill.				6	-	-	-	5	-	4	27
Senna italica Mill.				6	-	-	-	5	-	4	25
Pulicaria incisa (Lam.) DC.				7	-	5	7	-	-	-	23
Cynodon dactylon (L.) Pers.				6	-	6	-	-	-	-	21
Pergularia tomentosa L.	Unpalatable - low	All stock	Leaf - stem - others	6	-	-	6	-	-	-	21
Cullen plicatum (Delile) C.H. Stirt.		Sheep - Goat		5	-	8	-	-	-	-	21
Arnebia hispidissima (Lehm.) DC.				4	-	7	-	-	-	-	20
Aerva javanica (Burm.f.) Juss. ex Schult.	Low	Camel - goat	Leaf - stem - others	5	-	5	-	-	-	-	18
Asphodelus tenuifolius Cav.			-	5	-	-	5	-	-	-	18
Polycarpaea repens (Forssk.) Asch. & Schweinf.				5	-	6	-	-	-	-	18
Zea mays L.		All stock		-	-	5	-	5	-	-	18

Crotalaria aegyptiaca Benth.		Camel		5	-	5	-	-	-	-	16
Citrullus colocynthis (L.) Schard.	Low			8	-	-	-	-	-	-	14
Glinus lotoides L.			Seedling - dried plant	5	-	4	-	-	-	-	14
Hyoscyamus muticus L.			Seedling	8	-	6	-	-	-	-	14
Solenostemma argel (Delile) Hayne			-	8	-	-	-	-	-	-	14
Lotononis platycarpa (Viv.) Pic. Serm.		Camel		-	-	7	-	-	-	-	13
Aristida adscensionis L.				-	-	6	-	-	-	-	11
Aristida mutabilis Trin. & Rupr.				-	-	6	-	-	-	-	11
Astragalus eremophilus Boiss.		Camel–sheep		-	-	6	-	-	-	-	11
Astragalus vogelii (Webb) Bornm.	High		Leaf - stem - others	-	-	6	-	-	-	-	11
Caylusea hexagyna (Forssk.) M.L. Green				-	-	6	-	-	-	-	11
Cleome droserifolia (Forssk.) Delile	Unpalatable	All stock	-	-	-	6	-	-	-	-	11
Crypsis schoenoides (L.) Lam.				-	-	6	-	-	-	-	11
Eragrostis aegyptiaca.(Willd.) Delile	Palatable	All stock		-	-	6	-	-	-	-	11
Fagonia indica Burm.				-	-	6	-	-	-	-	11
Indigofera argentea Burm.				-	-	6	-	-	-	-	11
Morettia philaeana (Delile) DC.				-	-	6	-	-	-	-	11
Salsola imbricata Forssk.				-	-	6	-	6	-	-	11
Stipagrostis plumosa (L.) Munro ex T. Anderson				-	-	6	-	-	-	-	11
Trianthema triquetra Willd.				-	-	6	-	-	-	-	11
Crotalaria microphylla Vahl.				-	-	6	-	-	-	-	9
Dichanthium foevulatum (Delile) Roberty			Leaf - stem - others	-	-	5	-	-	-	-	9
Dipterygium glaucum Decne				-	-	-	-	5	-	-	9
Farsetia aegyptiaca Turra		Camel		-	-	5	-	-	-	-	9
Fimbristylis bisumbellata (Forssk.) Bubani				-	-	5	-	-	-	-	9
Lotus deserti Täck. & Boulos				-	-	6	-	-	-	-	9
Lotus sp	High			-	-	6	-	-	-	-	9
Aizoon canariense L.		All stock	Leaf - stem - others	-	-	-	4	-	-	-	7
Chenopodium murale L.				-	-	4	-	-	-	-	7

Chrozophora obongifolia (Delile) Spreng.				-	-	-	-	-	-	4	7
Cistanche phelypaea (L.) Cout.				4	-	-	-	-	-	-	7
Euphorbia granulata Forssk.				4	-	-	-	-	-	-	7
Haplophyllum tuberculatum (Forssk.) Juss.			-	5	-	-	-	-	-	-	7
Heliotropium supinum L.				4	-	-	-	-	-	-	7
Senecio flavus (Decne) Sch.Bip.		Camel - gazelle		-	-	5	-	-	-	-	7
Sonchus oleraceus L.			-	-	-	5	-	-	-	-	7
Tephrosia purpura (L.) Pers.				-	-	5	-	-	-	-	7
Tribulus ochroleucus (Maire) Ozenda & Quézel				-	-	5	-	-	-	-	7
Tribulus pentandrus Forssk.				-	-	4	-	-	-	-	7
Zygophyllum simplex L.				-	-	4	-	-	-	-	7
Total				44	8	58	17	25	5	18	
Percentage				45	8	60	18	26	5	19	

Note: (M) Medicinal plant; (T) Timber; (G) Grazing; (H) Human food; (F) Fuel use; (C) Charcoal; (O) Other use; (TIV) Total Economic Importance Value; 4=Minimum use, 8=Maximum use. The species are arranged according to their TIV values.

Thirteen species are known to be browsed by camels and goats (*e.g. Farsetia aegyptiaca*, *Leptadenia pyrotechnica*, *Lotononis platycarpa*, *Aerva javanica*, *Balanites aegyptiaca*, *Tamarix nilotica*, *Acacia ehrenbergiana* and *Senecio flavus*). Nine species are known to be very good for camels and sheep and sometime goats (*Astragalus eremophilus*, *Astragalus vogelii* and *Phragmites australis*, *Psoralea plicata*, *Cynodon dactylon*, *Cyperus laevigatus*, *Heliotropium arbainense*, *Heliotropium pterocarpum* and *Heliotropium supinum*). Four Legume trees are browsed by camels, and their seedlings are eaten by all animals (*Faidherbia albida*, *Acacia nilotica*, *Acacia tortilis* subsp. *tortilis* and *Acacia tortilis* subsp. *raddiana*). Eight species (*Dichanthium foevulatum*, *Dipterygium glaucum*, *Eragrostis aegyptiaca*, *Euphorbia forsskalii*, *Euphorbia granulate*, *Fimbristylis bis-umbellata*, *Lotus* sp and *Lotus deserti*) are known as palatable herbs for all stocks. Three species are eaten by all animal species, but are particularly good for sheep (*Aristida adscensionis*, *Aristida mutabilis* and *Arnebia hispidissima*). Finally seven species are good for all stock animals *(Zea mays, Alhagi graecorum, Panicum turgidum, Caylusea hexagyna, Crypsis schoenoides*, *Stipagrostis plumosa* and *Sesbania sesban*).

Plant health and grazing pressure

Grazing intensity is used as an indicator upon the grazing pressure. The most affected part by grazing animals, is the lower part of tree canopy, this part sometimes reach 3-4 m height depending upon animals tall, and in some cases considered the damaged part of tree. This can be clear to recognize in *Acacia tortilis* subsp. *raddiana*, *Tamarix nilotica*, *Balanites aegyptiaca*, *Faidherbia albida*, *Acacia nilotica* and *Acacia tortilis* subsp. *tortilis* (Figures 4 and 5).

Figure 4. Prominent browse-line on moderate-high preferred browse species (*e.g. Acacia tortilis* subsp. *raddiana*). (A) Indication of the past; (B) Continuous overuses.

Figure 5. Prominent browse-line on a low-preferred plant (*e.g. Tamarix nilotica*). It is an indication of severe overuse of the browse resource

Range to be overused

In the upstream part, the grazing intensity varied from moderate to high. The results suggest that if the grazing intensity is high to severe, the resulting disturbance pressure on the vegetation may be an important factor contributing to the observed plant diversity. In midstream part, the vegetation cover steadily decreases with moisture decrease. Absence of drinking water sources is probably the reason why the vegetation here is slightly utilized for grazing. Based on felid work, low to moderate grazing intensity; was observed close to area of wells. In the downstream part, the vegetation cover steadily increases with moisture increase, vegetation is slightly sparse to high dense toward Lake Nasser shoreline. The grazing intensity varied from low to high of most the downstream sites (Figures 6 and 7).

Figure 6. Grazing intensity index in Wadi Allaqi biosphere reserve. This index is classified into five categories: No evidence of grazing; Downstream part; Midstream part; Upstream part; Severe grazing.

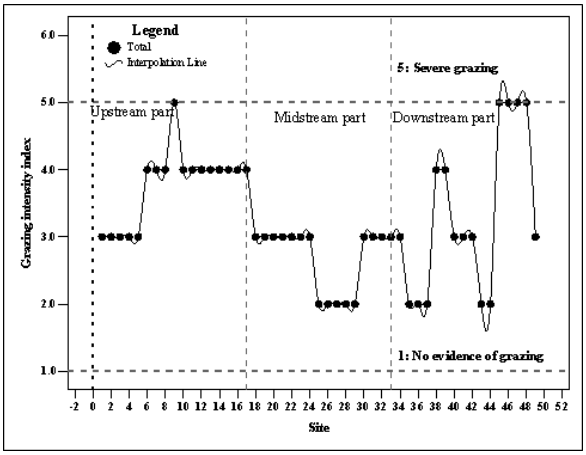
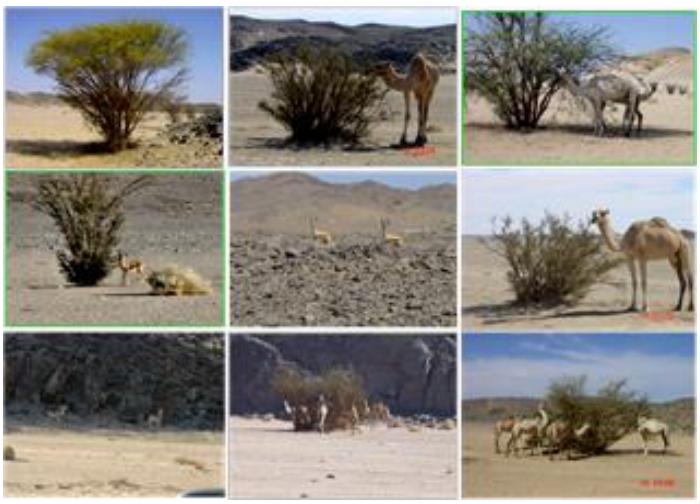


Figure 7. Grazing and browsing by domestic and wild animal at Wadi Allaqi.



Natural resources availability

Thirty interviews were done using an open-ended questionnaire to represent the heads of households, in Wadi Allaqi at the time of survey. Twenty-two of them were Ababda tribe (73.3%) and 8 were Bishari tribe (26.8%). Twenty eight of the total samples (93.3%) agreed that Lake Nasser fluctuation affected their production (Table 5).

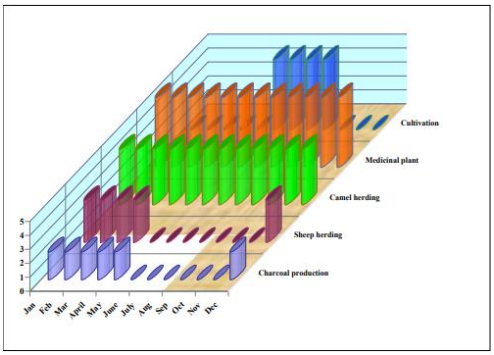
Table 5. Livehood system and their activities in Wadi Allaqi.

Character	No. of interviews	%
Ababda	22	73.3
Bishari	8	26.8
Activity		
Charcoal production	23	76.7
Cultivation	21	70
Camel-herding	19	63.3
Sheep-herding	17	56.7
Medicinal plant collection	7	23.3
Critical factors controlling the natural resources		
Water	30	100
Lake Nasser fluctuation	28	93.3
Rainfall incidence	12	40

Furthermore, the whole samples agreed that the water is the critical factor of natural resource of economic activity. Its availability varies all over the year which in turn controls the Bedouin production. Twelve interviews (4 of Ababda and 8 of Bishari) agreed that the second key is the rainfall incidence. Those who dependent upon collection of medicinal plant are mostly Bishari, while the main activities of Ababda are camel and sheep herding. Although rainfall is negligible around Wadi Allaqi, and southern Nile Valley, there is slightly regular rainfall during the winter period (December-February) in the hill areas to the east, and especially towards the Red Sea coast. Although only low rainfall totals are experienced (around 50 mm), it is sufficient to stimulate the growth of potential grazing resources. The area in almost months of the year is practically rainless and consequently offers a difficult environment, apart from one or two basin areas. Seventeen of the total interviews (56.7%) agreed that sheep-herding and small-scale cultivation are important for them, while 19 interviews (63.3%) expressed that camel-

herding is the main activities. Livestock transhumance, particularly sheep herding and charcoal making are considered as primary winter activities (Figure 8).

Figure 8. Calendar of socio-economic activities throughout Wadi Allaqi. **Note:** ■ Charcoal production; ■ Sheep herding; ■Camel herding; ■ Medicinal plant; ■ Cultivation.



This is associated with the availability of ephemeral grazing in the hills of south and east. In these areas there are also relatively abundant resources of acacia trees, which are the preferred species for charcoal production. While Bedouin are away with the sheep in the hills, they take the opportunity to make charcoal at the same time. The two economic activities are, therefore, very closely related to each other as far as Wadi Allaqi Bedouin are concerned. But in fact, charcoal production as economic activities disappeared by time especially in the down and the midstream parts, and restricted nowadays at the upstream part that was resulted by 23 of total interviews and free debates (76.7%). Seventy percent of the Bedouin interviews and debates pointed out that cultivation is mainly a summer activity, although since the late 1990s it has extended throughout the year among some households. This reflects the fact that during the summer, most Allaqi Bedouins are back living in the Wadi itself, because the desert beyond is too hot and uncomfortable for long periods in comparison. The timing of planting is crucial because Bedouin have to make prediction about lake water retreats and advances. Otherwise, 23 of the total sample (76.7%) expressed that the collection of medicinal plant becomes not important for them, while 7 Bedouins still work with this activity (21%).

DISCUSSION

The present results suggested that if the grazing intensity is high to severe, the resulting disturbance pressure on the vegetation may be an important factor contributing to the observed plant diversity close to nomadic settlements and their animals. A special note should be taken into account that the moderate grazing intensity was close to area famous with wells (such as W. Murra and Wadi Ungat); where grazing intensity was high, close to Lake Nasser in the downstream part of Wadi Allaqi resulting in disturbance pressure on the vegetation may be an important factor contributing to the observed low to moderate plant diversity. The salinization and dominance of *Tamarix nilotica* may also be significant in downstream locations. Grazing had negative significant effects on reproductive structures. Flower and seed production were significantly lower under grazing, and their reduction correlated with grazing intensity where animals feed on inflorescences and seeds [36]. The present results show that the increasing grazing intensity and the history of previous grazing affected the performance of plants. Plant biomass, height, as well as flower and seed production were reduced when the plant was exposed to animal grazing. Moreover, the plant cover remained largely steady at moderate grazing intensities, indicating that it is potentially tolerant of grazing under these stocking rates [37-39].

In the present study, 37 species were less palatable (*e.g. Aizoon canariense*, *Capparis decidua*, *Senna italica*, *Senna alexandrina Chenopodium* album and *Chenopodium murale*). *Chrozophora obongifolia* is potentially toxic to

all grazing animals. Furthermore, 16 species were unpalatable, although their seedlings are eaten by goats and sheep (*e.g. Forsskalea tenacissima*, *Hyoscyamus muticus*, *Ziziphus spina-christi* and *Glinus lotoides*). In addition, *Ziziphus spina-christi* is unpalatable, but its fruits are eaten by all stock. Palatability refers to the plant attributes which determines its acceptability by grazing animals. Characteristics of plant species such as chemical composition, growth stage, external plant form and kinds of plant affect the acceptability, and may stimulate selective responses by animals [40]. Otherwise, palatability of plants depends upon dietary need and energy of animals [41]. The favorites for grazing species were grasses by sheep and woody plants by goat and camel. These results are in accordance with the study of Angassa and Baars in Borana and Ethiopia and Hussain and Durrani in Harboi arid rangeland [40,42,43]. In the current study, domestic and wild animals, can graze and browse on 57 of the recently recorded species in Wadi Allaqi (58.8%). Among the most palatable of these are some Legumes (*e.g. Acacia tortilis* subsp*. raddiana*, *Acacia nilotica*, *Lotus deserti* and *Acacia tortilis* subsp. *Tortilis*) as well as the camels can graze over 20 species that are usually avoided by other animals (*e.g. Fagonia* spp., *Leptadenia pyrotechnica*, *Morettia philaeana*, *Zygophyllum simplex* and *Caylusea hexagyna*). Selective use of plants by animals is described by several workers and provides an example of resource portioning among grazing animals. The camels' diet is of a wider variety than other domestic animals. The green *Crotalaria aegyptiaca* is grazed by camels and gazelles, but is poisonous to sheep and goats, thus its use by grazing animals should be avoided, due to its toxicity and carcinogenicity [44]. *Tamarix nilotica* is apparently good for camels and goats, but not for sheep; while *Aerva javanica* and *Salsola imbricata* are the main food for gazelles, but not for the domestic animals [45].

Some morphological attributes of the plants act as physical defenses (such as spines, hairs, stickiness, severity, coarse texture, unfavorable odor or chemical natures and toxicity) to reduce their palatability. These results are in accordance with the study of Hussain and Durrani, who stated that intensive browsing often lead the plants to produce long thorn against browsing [24]. Palatability is a relative factor and depends upon the availability and nature of forage and kinds of animals. The chemical nature such as nutritive value and mineral contents cause variation in selection of the parts of the same plant by the grazing animals. The plant parts with low nutrition or containing harmful or toxic chemicals is generally avoided by most animals. The choice of dried plant material declines due to taste, odor and feel [40]. Moreover, Shaltout et al. indicated that the protection process led to an improvement in the vegetation and its individual populations, in relation to the plant cover, diversity indices, and bio volume. Many of the plant populations are either endemic or threatened species of high conservational value [46,47].

It might be possible that poor health and bad performance of livestock in the study area are partially due to toxic, salty and carcinogenic species such as *Tamarix nilotica* and *Crotalaria aegyptiaca*. Since there is always shortage of the livestock feed, therefore the less to non-palatable species are grazed under pressure, as no other choice is available. Towhidi et al. in Iran reported that due to lack of fodder, non-palatable plants like Salsola, Alhagi and Tamarix species are grazed under pressure; the same is true in our study area [48]. *Calotropis procera*, *Tamarix aphylla* and *Tamarix nilotica* are non-palatable in other parts of the world, but they grazed under compulsions in the study area. Although, 3 species (*Aristida adscensionis*, *Aristida mutabilis* and *Arnebia hispidissima*) are eaten by all animals, but are particularly good for sheep. In addition, 4 species (*Caylusea hexagyna*, *Crypsis schoenoides*, *Stipagrostis plumosa* and *Sesbania sesban*) are grazed by all stock animals. These findings are in agreement with the study of White, Hirata et al. evaluated that the amount of forage available at the end of the growing season was reduced due to higher grazing impacts on herbaceous vegetation with a higher cover [49,50]. On contrary, light grazing impact would occur with a higher cover of shrub vegetation types. The plant cover over the rangeland is maintained by simulated grazing. The ratio of most palatable species decreased in response to overgrazing, while

that of unpalatable species increased *(e.g. Calotropis procera*) in the upstream part. Camels and wild animals (such as *Gazelle dorcas*) are of a wider variety than other domestic animals.

Grazing intensity in this study depends upon morphometric characteristics as well as nature and animal type (whether domestic or wild). For instance, sheep, goats and gazelles are not tall enough to reach the higher trees; therefore, their effects seem to be slightly moderate on most of Allaqi trees and shrubs [39]. On the other hand, Camels can feed upon higher trees and shrubs that resemble camel's height (*e.g.* 3-4 m height), therefore the most lower parts of some plant canopies are more affected by camel grazing (*e.g. Balanites aegyptiaca* and *Acacia tortilis* subsp. *raddiana)*. Grazing intensity can provide a rapid indication of the biodiversity support capacity of desert plants. As grazing intensity increased, vegetation structural values decreased. Thus, overgrazing by stock, especially camels, is a likely cause of this severe degradation. In addition, the second core area in the upstream part (Wadi Eiqat) had high plant diversity [51]. Grazing pressure varied from moderate to high at Eiqat core area. On the other hand, some sites (*e.g.* west Wadi Eigayib and south Halafway) suffer from severe grazing intensity. These sites were close to nomadic settlements and their animals. The results suggest that if the grazing intensity is high to severe, the disturbance pressure on the vegetation may be an important factor contributing to the observed plant diversity. The data from the open ended questionnaire indicated that Ababda and Bishari societies still remain highly sex isolated, concerning the nature resources and socioeconomic activities. This can explain why the questionnaire carried out on a sample of men rather than women or the two together. During the years of this study, a recognizable comfortable or said observed a relaxing of gender relations during the worked years in the desert. This may reflect the fact that women are now comfortable with the team of Allaqi protectorate, or male in some restricted condition [52,53]. Although, the entire studied interviewers were out of educational level, but the data collected explain that most of them have a great knowledge of life and issues of their life, such as water level of Nasser Lake and inundation effect. There is a vertical difference of 6-8 m between minimum and maximum water levels in any year. This can result in around 10 to 12 km of Wadi floor being seasonally exposed, this was agreed by 86.7% of the Bedouins especially those by/around the lake. Significantly, the soils in the exposed area are resulted and well flooded annually, contributing to their continued relative fertility. Furthermore, even after the surface water has retreated, associated groundwater can still be found, ensuring the regeneration and maintenance of vegetation such as *Tamarix nilotica*, Acacias and some grasses, as well as being available for small-scale irrigation from the hand-dug wells of depths of 4-6 m. Although it was the former long-term changes which were responsible for generating the new resource opportunity for attracting Bedouin to Wadi Allaqi in the first place, it is the latter short term changes which form the underlying basis of the present Bedouin livelihood systems.

The 30 interviews were compatible that Bedouin in Wadi Allaqi have developed a livelihood system; each of its elements makes use of the available resource opportunities, but does so in a managed and sustainable manner. The water availability and economic activity are closely related. This relationship is strongest regarding the sheep-herding, charcoal production and small-scale cultivation. Camel-herding and medicinal plant collections are less constrained by seasonal water availability. Generally, sheep-camel herding and small-scale cultivation characterized the Bedouins in downstream part. On contrast, medicinal plant collections, charcoal production, sheep-camel herding characterized the Bedouins in upstream part. It is useful to reiterate some of the significant long and short-term changes in livelihood strategies that have occurred in the study area. Camels, once prominent in the local economic system, have declined in importance in the past two decades as new and faster forms of transport emerged. A similar and more extreme pattern has been observed in other Arab countries, where camels have been neglected, and in some instances, have returned to a feral state [53]. Small stocks, both for subsistence and

commercial exchange are now increasingly important, where they require different fodder and husbanding-labour arrangements than camels. Nineteen of Bedouins (63.3%) expressed that camel herding constitutes an important activity. For those households with significant numbers of camels, they represent a stock of savings that can be drawn upon as capital when needed. Within Wadi Allaqi community, the numbers of camels owned by households varies between 2-1000 camels for one household, while the classic household had 10-15 camels at the most. Camels not only make up an economic investment in their own right, but also provide the means for further economic activity. The key mode of transport that allows households to participate in grazing in winter grazing and charcoal production, as well as transport for selling products in Aswan and elsewhere beyond Wadi Allaqi. Households with fewer than seven camels cannot afford to commit such scarce resources to these types of activities, because of the other economic demands exerted on the household.

CONCLUSION

The Wadi Allaqi Biosphere Reserve, situated in the Egyptian Nubian Desert, is a unique and diverse ecosystem that plays a crucial role in supporting the livelihoods of the local Bedouin communities characterized by its unique geographical and climatic features. The economic uses of desert vegetation in this region are diverse, including grazing for livestock, medicinal purposes, human food, timber, fuel, charcoal production, and various other uses such as crafting and extraction of oils and fibers. Grazing, in particular, is a dominant economic activity, with approximately 60% of plant species in the area serving as valuable fodder for livestock. Domestic and wild animals can graze and browse on 60% of the recorded plant species. Water availability, primarily from Lake Nasser, plays a central role in shaping the livelihood strategies of the Bedouin communities in Wadi Allaqi. The Total Importance Value (TIV) was used to measure the potential economic importance of these uses for the local economy. Grazing intensity was evaluated based on various criteria, including plant reproduction, overall health, height, cover, palatability, and the presence of livestock and vehicle tracks. The Wadi Allaqi provides valuable insights into the diverse uses of plants by nomads, the grazing and browsing habits of domestic and wild animals, and the impact of grazing pressure on plant health.

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DATA AVAILABILITY STATEMENT

Please contact the authors for data requests.

CONFLICT OF INTEREST

All of the authors confirm that there are no conflicts of interest.

AUTHORS CONTRIBUTIONS

Kamal H. Shaltout: involved in conception and design, acquisition, analysis, statistical analysis and interpretation of results, revising the article and approved the final version to be submitted for publication. Ashraf H. Salem: involved in conception and design, acquisition, analysis, statistics analysis and interpretation of results and drafting the article. Yassin M. Al-Sodany: involved in statistical analysis and interpretation of results, drafting the article and revising it, and approved the final version to be submitted for publication. Mohamed G. Shedded: involved in conception and design, acquisition and interpretation of results.

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