



## **EFFECTS OF ENVIRONMENTAL FACTORS ON THE BIODIVERSITY OF WADI EL-ASSIUTI PROTECTED AREA**

**Atef Abou El Wafa Ahmed <sup>1</sup>, Ragab ElSayed Rabeiy <sup>2</sup>,  
 Mohamed Mahmoud Ahmed <sup>3</sup>, and Ali Mohamed Ibrahim Morsi <sup>4</sup>**

<sup>1</sup> *Faculty of Agriculture, Assiut University*

<sup>2</sup> *Faculty of Engineering, Assiut University*

<sup>3</sup> *Environmental Affairs Agency - Upper Egypt Branch of Assiut.*

<sup>4,\*</sup> *Environmental Researcher in Environmental Affairs Agency*

Received 11 June 2017; Accepted 13 July 2017

### **ABSTRACT**

Wadi El-Assiuti Protected Area (WAPA) in Assiut Governorate is considered as the first and foremost zone for wildlife breeding and endangered species. This study investigates the effects of different environmental issues of both anthropogenic and natural factors on the wildlife of WAPA. The examined factors are air quality, water quality, noise levels, local weather, and human activity in WAPA. Additional to environmental agents, biodiversity is monitored by recording the number of each fauna type from 2008 to 2016. The results showed that several kinds of wildlife in WAPA have been endangered while numbers of other increased. The examined air, water, and local weather proved that they have no negative effects on the endangered species. The main reason of the disappeared or increases some species are the human activities especially cultivation and construction of several quarries in the WAPA zone. The quarries are companion with noise, dust, contaminations from their vehicles, and huge movement of human and trucks that have direct impact on the wildlife in WAPA. The main conclusion of this study is that removing the encroachment from the WAPA is the only method to protect its biodiversity.

**Keywords:** Wadi El-Assiuti protected area - environmental pollution – biodiversity- air quality - weather effect.

### **1. Introduction**

Biodiversity is the total variability of life on earth [1, 2]. Biologists are generally defining diversity as the number of species [3, 4]. Protected areas are defined as areas of land and/or sea especially committed to the protection and maintenance of biological diversity, and of natural and associated cultural resources [5]. The creation of Protected Areas (PAs) is a primary strategy to conserve biological diversity in the situ [6]. Protected areas are an effective tool for conserving species and reservation of ecosystems [7].

\* Corresponding author.

E- mail address: amim121981@yahoo.com

In Egypt the number of designated protected areas continued to increase, reaching 27 [8]. The financial and organizational autonomy of Nature Conservation Sector (NCS) was subsumed under the difficult personnel and financial control systems common to Egypt's central ministries. As significantly, the NCS proved less important in coastal land-use decisions, particularly with regard to the current explosion of coastal tourism development along the Red Sea [9].

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment [10, 11]. Air may get polluted by natural causes such as volcanoes, or by human activities. There are five primary pollutants that together contribute about 90 percent of the global air pollution. These are carbon oxides (CO and CO<sub>2</sub>), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter [12].

Water is considered as the most important factor for our life and wildlife. So, it must be offered in a good state and to be sure that it free from any pollutants [13, 14]. In nature, water is not pure as it gets contaminants from its surrounding and those arising from humans and animals as well as other biological activities [15]. Water resources are currently threatened by contamination from municipal, industrial, and agricultural pesticides [16, 17]. The chemical pollutants of drinking water commonly have been cited as an important factor in many diseases [18]. However, heavy metals are the most important chemical pollutants because they are non-biodegradable [19].

Weather can have broad effects on biodiversity [20]. A number of initiatives have highlighted the likely impacts of climate change on biodiversity [21]. Even a relatively modest 2 °C global temperature rise will cause significant modifications to ecosystems and their functions. Climate change is not only a threat in its own right, but many of the response measures being designed for mitigation will also impact adversely on natural habitats and biodiversity. Estimates of future extinction risk vary considerably; one study identified an extinction range from 1% to 29%, depending on the Biome (Biome is a broader term than habitat; any biome can comprise a variety of habitats [5], with an estimated 4% extinction of species in tropical forests [21, 22]. The effect of noise on wildlife has only recently been considered a potential threat to animal health and long-term survival [23]. Ambient Noise Levels by decibel (dB) is Silent Zone (50 dB Day hour and 40 dB Night hour), Residential Zone (55 dB Day hour and 45 dB Night hour), Commercial Zone (65 dB Day hour and 55 dB Night hour), and industrial Zone (70 dB Day hour and 70 dB Night hour) [24, 25].

### *1.1. Objectives of this Study*

The Aims of the study were;

- a) Explore the biodiversity and the endangered species in WAPA
- b) Assess the various environmental agents that can effect on the biodiversity in WAPA, and
- c) Suggest suitable control methods to maintain the biodiversity on the investigated area.

### *1.2. Research hypothesis*

WAPA area has several species of birds, mammals, and reptiles. Many species of them have been endangered. The protected area is located near an industrial zone and main roads. The main hypothesis of this study is that, the emitted contaminations and noise levels are the main reason of the endangered species. In addition, the violation of protected areas law by the people expressed as building, agriculture and quarrying activities are the

main reasons of the extinction of several species. Global warming in the study area also may have an effect on the life of wildlife in WAPA.

### 1.3. Methodology

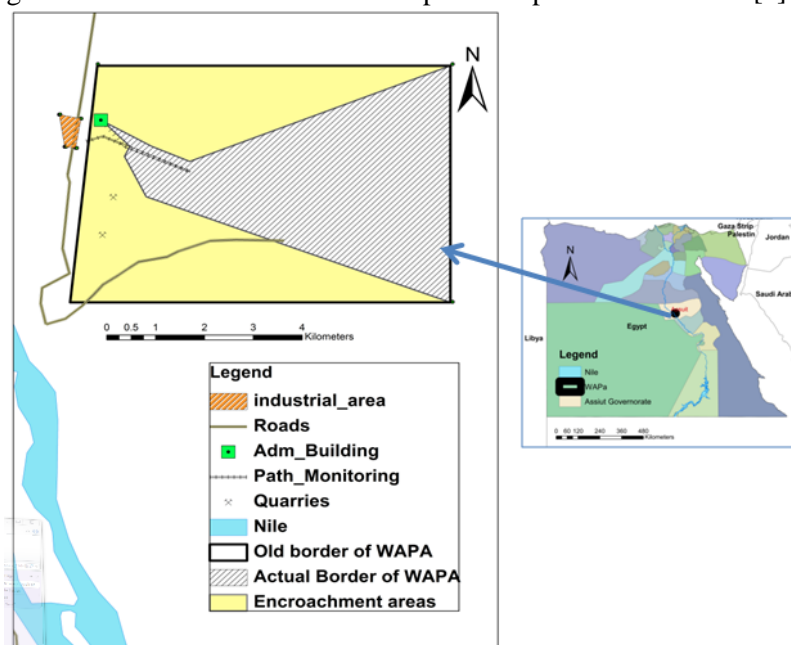
The analysis of the biodiversity in WAPA requires precious data of the various species. Mentoring the number of each type of wildlife in WAPA is implemented from 2008 to 2016. The monitoring is carried out once per week to get the average number for each month of every year. Air quality is assessed by measuring various factors such as gases, dust and noise levels. Drinking water in the WAPA is also sampled to determine the amount of threaten on the wildlife. To examine the effects of global warming, weather data is collected from 2008 to 2016. The data is analyzed and interpreted to get the final conclusion of this study.

## 2. Materials and Methods

In this section we explain the location of the study area, the natural of it and the history if it's assignment. Also a map is created by the authors using GIS to illustrate the different activities within the study area. The data for the map is collected by the authors using GPS and a camera. In addition, we will illustrate the types of devices used in the measurements and the job of each device with the used unit.

### 2.1. Study area

This investigation concerns with the effects of environmental conditions in the biodiversity of wildlife in Wadi El-Assiuti Protected Area (WAPA). WAPA lies at the south part of the Eastern Desert in Wadi El-Assiuti near Sahel Salim town as illustrated in Fig 1. The date of its announcement was 1989 and this area covers about 8000 acres (or 33.6 km<sup>2</sup>). WAPA was a result of a cooperation project between the University of Arizona in USA and Assiut University in Egypt. The WAPA is a reserve location for raising and breeding of some endangered or on the threat of extinction species of plants and animals [8].



**Fig. 1.** Location of the study area of WAPA in Egypt

In spite of the lack of vegetation in this region of the Eastern Desert, WAPA includes large diversity of animals and plants. It has 44 species of wild plants; mostly with medical importance such as *Zilla Spinosa* and *Acacia Nilotica*. In addition, it includes 65 animal species; 5 mammals such as famous Egyptian endangered deer, 51 species of birds including resident as Crested Lark, visitor as Spanish Sparrow and immigrant as White Stork and 9 species of reptiles such as Horned Viper, and Bosc's Lizard.

## 2.2. Devices used in the measurements

Air quality in the study area was measured using Mobile lab to monitor air pollution as shown in Fig 2. It takes samples of air from the surrounding environment in WAPA to determine dust ( $PM_{10}$ ), oxides of carbon, oxides of nitrogen, and oxides of sulfur. The air sampling was taken twice in winter and twice in summer of year 2016. Also analysis of water samples was carried out for the water wells existing in WAPA (2 wells). Noise levels are measured in WAPA using Sound Level Meter Model 2001 as illustrated in Fig 3. The position of measurements and water samples were determined using GPS GARMIN62s as shown in Fig 4. Also the weather data of Assiut Governorate was collected including temperature, relative humidity, and wind speed for the period from 2008 to 2016. Also Encroachment to the land of WAPA for agriculture, building, and quarries activities was observed and recorded from 2008 to 2016. Biodiversity of birds and mammals is observed daily using Canon Camera and Magnifying Glasses as shown in Figs 5 and 6.



**Fig. 2.** Mobile lab to monitor air pollution in WAPA



**Fig. 3.** Sound Level Meter device



**Fig. 4.** GPS device



**Fig. 5.** Magnifying glasses device



**Fig. 6.** Camera canon device

### 3. Results and discussion

In this section we present and discuss the main results of measurements and the essential interpretations. The biodiversity is estimated and the decreasing or increasing of their number will be explained from 2008 to 2016. Also the results of air quality measurements are presented and compared with the national limits assigned by the Environmental Egyptian Law (EEL) 4/1994 [25]. In addition the local weather along eight years is presented and interpreted to understand its effects on the biodiversity. Other factors are also investigated such as water quality and human activities.

#### 3.1. Investigation of biodiversity

The different types of fauna on the WAPA are monitored one day every week to estimate the average number of each species per month. The average number of birds is registered to show the changes in their count from 2008 to 2016 and the results are presented in Table (1). Several Birds are extinct such as Black Tailed Rock, Goldfinch, Cream-colored Courser, Desert Wheatear, and Isabelline as illustrated in Table (1). Some species are raised and their number is increased such as House Sparrow, Blame Dove, Crested Lark, Little Green Be-eater, and Black eyed Bulbul. Species of Reptiles were also monitored in WAPA from 2008 to 2016 as presented in Table (2). The number of some species is increased after 2016 such as Egyptian Gecko, Fan Footed Gecko and Schokari Sand Snack. While four species are extinct; Eyed Skink, Desert Monitor, Egyptian Dabb Lizard and Horned Viper as given in Table (2). The reasons of the extinction of these species are the violence hunting, and quarries and agriculture activities. Mammals are monitoring in WAPA also from 2008 to 2016. Most mammals are not seen in recent years during the weekly monitoring such as the Egyptian Gazelle and Egyptian Hare, and Greater Gerbil as given in Table (3).

**Table 1.**

Average recorded numbers per month of some birds in WAPA in years 2008, 2012 and 2016

Species \ Year	2008	2012	2016
Rock Dove	450	1200	2700
House Sparrow	900	1200	1500
Crested Lark	150	210	270
Little Green Bea-eater	150	220	360
Kestrel	30	60	120
Desert Raven	210	120	30
Trumpeter Finch	900	330	0
Rufous Scrub Robin	90	60	0
Collard Turtle Dove	120	60	0
Blue throat	150	60	0
Osprey	90	60	0
Peregrine Falcon	30	60	0
Tawny pipit	60	30	0
Desert Wheatear	90	30	0
Wood Chat	60	0	0
Yellow Wagtail	60	0	0
Black Tailed Rock	90	0	0
Goldfinch	120	0	0
Cream-colored Courser	90	0	0

**Table 2.**

Average recorded numbers per month of some Reptiles in WAPA in years 2008, 2012 and 2016

Species	Year		
	2008	2012	2016
Bosc's Lizard	210	120	90
Bean Skink lizard	30	120	150
Egyptian Gecko lizard	30	90	150
Schokari Sand Snack	120	60	0
Desert Monitor lizard	0	30	0
Egyptian Dabb Lizard	90	0	0
Horned Viper snack	60	30	0

**Table 3.**

Average recorded numbers per month of some mammals in WAPA in years 2008, 2012 and 2016

Species	Year		
	2008	2012	2016
Red fox	30	90	30
Egyptian Gazelle	60	120	0
Egyptian Hare	60	90	0
Greater Gerbil	150	90	0

### 3.2. Assessment of air quality in WAPA

The mobile laboratory of the Environmental Affairs Agency- Assiut Branch, measured air quality in WAPA in summer and winter of year 2016 and the results of measurements are presented in Tables 4 & 5 respectively. The measured factors inside WAPA are carbon monoxide, nitrogen monoxide, nitrogen dioxides (NOX), sulfur dioxide and dust.

**Table 4.**

Air sampling in WAPA during summer and the permissible limit assigned by Law No. 4 of 1994

Date time	Parameter	NOX	NO <sub>2</sub>	NO	SO <sub>2</sub>	CO	PM <sub>10</sub>
		Limit(150) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>	Limit(10) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>
20/7/2016	18:00	12.05	11.90	0.09	13.64	0	60
20/7/2016	21:00	33.18	33.12	0.05	8.58	0	200
20/7/2016	24:00:	15.32	15.19	0.10	8.58	0	150
21/7/2016	3:00	10.44	10.36	0.05	8.58	0	30
21/7/2016	6:00	14.23	13.76	0.31	8.58	0	60
21/7/2016	9:00	29.60	23.93	3.81	8.58	0	140
21/7/2016	12:00	16.14	15.54	0.39	8.58	0	140
	Min	10.44	10.36	0.5	8.58	0	30
	Average	21.18	21.74	1.84	11.11	0	120
	Max	33.18	33.12	3.18	13.64	0	200

**Table 5.**

Air sampling in WAPA during winter and the permissible limits assigned by EEL 4/1994 [25]

Parameter		NOX	NO <sub>2</sub>	NO	SO <sub>2</sub>	CO	PM <sub>10</sub>
Date time		Limit(150) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>	Limit(10) µg/m <sup>3</sup>	Limit(150) µg/m <sup>3</sup>
19/11/2016	24:00 AM	37.77	37.21	0.36	12.18	0.08	164
20/11/2016	8:00 AM	45.75	41.86	2.53	13.16	0	199
20/11/2016	16:00 PM	26.83	25.19	1.09	44.16	0.76	216
20/11/2016	24:00 AM	37.563	37.30	0.16	55.66	0.28	164
21/11/2016	8:00 AM	42.77	40.13	1.72	43.16	0.13	143
21/11/2016	24:00 AM	41.51	41.08	0.28	48.53	0.98	278
22/11/2016	8:00 AM	30.35	29.67	0.44	44.07	0.68	193
22/11/2016	16:00 PM	38.65	33.92	3.10	34.81	0.5	190
22/11/2016	24:00 AM	40.19	39.93	0.17	15.13	0.55	253
23/11/2016	8:00 AM	52.80	47.64	3.36	10.15	0.45	215
Min		26.83	25.19	0.16	10.15	0	143
Average		39.82	36.42	1.76	32.91	0.34	210.5
Max		52.80	47.64	3.36	55.66	0.98	278

The maximum measured level of sulfur dioxide (SO<sub>2</sub>) in WAPA was 13.6 µg/m<sup>3</sup> and 55.66 µg/m<sup>3</sup> in summer and winter respectively. These values are much less than the permissible limits assigned by Environment Law No 4/94 (150 µg/m<sup>3</sup>). The maximum measured value of total nitrogen oxides (NOX) in WAPA was 33.18 µg/m<sup>3</sup> and 52.80 µg/m<sup>3</sup> in summer and winter respectively, which is also less than the guideline value assigned by EEL 4/94 (150 µg/m<sup>3</sup>) [25]. The Maximum recorded level of carbon monoxide was zero mg/m<sup>3</sup> and 0.98 µg/m<sup>3</sup> in summer and winter respectively, which is very low level. All the measured chemical agents are less than the permissible levels and their effects on the health of WAPA wildlife can be neglected. The maximum measured concentrations of PM<sub>10</sub> in WAPA was 200 µg/m<sup>3</sup> in summer and 278 µg/m<sup>3</sup> in winter, which is higher than the permissible limit according to EEL 4/94 (150 µg/m<sup>3</sup>). The source of high levels of PM<sub>10</sub> is the quarries activities at the border of the WAPA. In spite of PM<sub>10</sub> concentration is higher than the guideline value, its effect on the wildlife can't be causes their endangered.

### 3.3. Investigation of water pollution in WAPA.

Table (6) indicates chemical and physical analysis of water wells located within WAPA (2 wells) in summer and winter. The results show that water samples of the well 2 are agreed with the permissible limits according to Egyptian Standard Specifications For Potable Drinking Water according to decision of population and health minister No.

458/2007 (Egyptian Standard Specifications For Potable Drinking Water 2007). The turbidity in well 2 is higher than permissible level, where in winter it recorded 10 Formazin Turbidity Unit (FTU) while in summer it has 7 FTU. The heavy metals in both wells are less than the guideline values. Water samples from the well 1 contain a high percentage of Total Dissolved Solids (TDS). Certain components of TDS such as chlorides, sulfates, magnesium, calcium, and carbonates, affect corrosion or encrustation in water-distribution systems but their effects on the wildlife are not verified. Nitrate almost coincides with the permissible limits [26]. Values of ammonia, calcium, magnesium, zinc, manganese, iron, and copper are less than the permissible limits. Although, Well 2 has more quality than well 1, both of them have no dangerous effects on the health of wildlife. So water in WAPA does not have negative effects on biodiversity especially well 2.

**Table 6.**

Results of water samples from the two wells in WAPA in summer and winter of 2016

Parameter	Unit	Summer		Winter		Limit*
		well 1	well 2	well 1	well 2	
temperature	C°	23.9	27.2	17	18	
conductivity	ms/cm	5.61	0.842	5.114	0.806	
PH	Unit	7.95	8.51	7.05	7.61	6.5-8.5
Turbidity	NTU	0.37	6.8	10	12.5	1
total dissolved solid	ppm	3700	585	4039	550	1000
Nitrate	ppm	53.7	6	13.6	1.49	45
ammonia	ppm	0.078	0.248	0.1	0.3	0.5
Chloride	ppm	949	249.9	880	60	250
Sulfate	ppm	1520	112	1410	124	250
hardness	ppm	1600	180	1600	144	500
Calcium	ppm	400.8	40.8	360	25.6	350
magnesium	ppm	144	19.2	168	19.2	150
Zinc	ppm	0.0644	0.0718	0.0882	0.1	3
manganese	ppm	0.1034	0.115	0.1533	0.1932	0.4
Iron	ppm	0.2927	0.2363	0.321	0.2872	0.3
Copper	ppm	0.136	0.134	0.1234	0.1446	2
carbonates	ppm	544.8	60	548	44.8	500

\*The limit allowed according to decision of population and health minister No. 458/2007.

### 3.4. Investigation of local weather in WAPA

To study the effect of local weather on the biodiversity, weather factors were analyzed from 2008 to 2016 and given in Table (7). The maximum temperature during the previous period was recorded in July 2016 and May 2010 (42 °C). While the minimum measured temperature was recorded January 2008 (0.2 °C). Moisture content ranges from 86% to 98% during winter seasons, while its range is from 10 to 22% in summer seasons as illustrated in Table (7). Wind speed is variable with time, where the maximum wind speed was recorded in different months. The maximum wind speed recorded (12 km/h) in May 2008 as presented in Table (7). There are no changes in the weather conditions from 2008 to 2016 in the investigated area as shown in Table (7), therefore negative effects of global warming or harsh weather on biodiversity is excluded.



**Table 7.**

Weather factors in Assiut governorate from 2008 to 2016 measured the meteorological station in Assiut University

year	Temp Max		Temp Min		Moisture Max		Moisture Min		Wind speed	
	month	Value °C.	month	Value °C..	month	%	month	%	month	Speed km/hr
2008	6	40.8	1	0.2	12	88	5	14	5	12
2009	9	41.4	12	6.4	1	80	4	10.4	6	10
2010	5	42	12	6.6	1	92	5	11	3-6-9	7
2011	7	40.8	1	7	12	98	4	12	2	4
2012	7	41.8	1	2.2	12	93	6	22	8	4
2013	9	38.6	1	4.8	1	94	3	16	2-3-4-9	3
2014	7	41	1	6.1	2	95	6	20	2	4
2015	8	41.6	1	5.4	4	86	6	21	2-3-4-5-6	2
2016	7	41.9	12	6	ND*	ND	ND	ND	ND	ND

ND: Not detected

### 3.5. Noise levels inside WAPA

The process for measured Noise levels was carried out in months January, April, August and December during the year 2016. Noise levels were measured (day and night) at different sites in WAPA, and the border of the industrial zone as illustrated in Fig 7. It is found that the average noise levels inside WAPA in Wadi Imo was 42.5 dB at day hours and 36 dB at night hours. The average noise levels measured in the zone near the quarries was 45.05 dB at day hours and 39 dB at night hours. Average measured noise levels beside the road and Industrial Zone were 60 dB in day hours and 54.5 dB in night hours. While, average noise levels measured at the borders of the quarries area were 58.1 dB at day hours and 51.5 dB at night hours. All the measured noise levels are less than the permissible limits (65 dB) according to the EEL 4/94 hence we can say that noise level is unsent from the negative effects of the wildlife in WAPA.

### 3.6. Human activities on WAPA

The effect of Human activity within WAPA is the encroachment on the land of the protected area. The invasion of people to WAPA is one of the serious problems facing the protected area. People invasion the lands of protected for several proposes such as agriculture, building and quarries as illustrated in Fig 8 and 9. The human activities within WAPA has led to the increase of number of vehicles in the protected are (500 vehicles per day) as presented in Fig 10. As a result of this encroachment almost 50 % of the investigated area is taken by the people for the mentioned activities as illustrated in Fig 7. These activities also have led to the destruction of the habitats of many organisms in the protected area, increase the rate of emitted dust and sometimes increase noise levels especially around the quarries. In addition to hunting of some species such as the deer and falcon in the protected is the main reason of the extinction of several species. While, the agricultural activates have increases some species such as Red Fox among other.

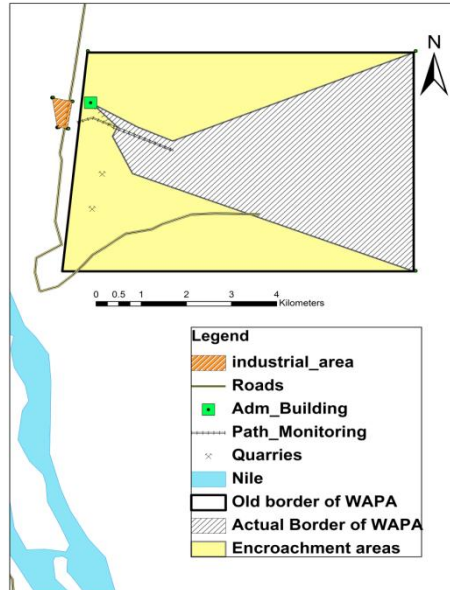


Fig. 7. Old and new borders of the WAPA



Fig. 8. Agriculture and building activities in WAPA



Fig. 9. Drilling of wells in WAPA



Fig. 10. Quarries with large number of vehicles in WAPA

#### 4. Conclusion

Examining air quality in WAPA proves that all the measured concentrations are less than the permissible limit of assigned by EEL 4/94. In addition, Water quality is compatible with the permissible limits according to Egyptian Standard Specifications for Potable Drinking Water No. 458/2007 especially in well 2. The average measured noise levels in WAPA are less than permissible limits for noise pollution. There is no detected change in the ambient temperature during the study period; from 2008 to 2016. The

previous environmental agents have little or no effects on the endangered species in WAPA. The effect of Human activity within WAPA is the main factor that influences the extinctions of several species of wildlife. The invasion of people to WAPA for agriculture, building and quarries has most negative impacts on biodiversity. These activities has led to the destruction of the habitats of many organisms in the protected area, killing some living species such as Snakes and Lizards, hunting others such as Deer and Falcon, and increase the rate of emitted dust and noise levels, especially in the quarries areas. Factors; Air quality, water quality, Local weather, and noise are less than or consistent with the permitted limits, so they are has not a negative impact on biodiversity in WAPA.

## 5. Recommendations

According to the investigations of the causes of endangered some species in WAPA, some recommendation are suggested. More care is required for the wildlife in WAPA such as increasing the feeding sources, increasing water resources, and medical treatments. Specialist scientists have to be invited to do more research and find new methods to safe and increase the biodiversity in the investigated area. Propose new boundaries for WAPA to be far away from the human activity and industrial areas. The new boundary includes the deep Imo valley in the south-east and or the rest of the Wadi El-Assiuti in the Northeast. The encroachment on the land of the WAPA should be finished and removed especially the quarrying activities. Digging more wells within the protected area such as in Imo valley and Wadi El-Assiuti is required to increase water sources.

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## تأثير العوامل البيئية على التنوع البيولوجي في محمية الوادي الأسيوطي بمصر

### الملخص العربي:

تعتبر محمية الوادي الأسيوطي في محافظة أسيوط هي المنطقة الأولى والرئيسية لتربية الحيوانات البرية والأنواع المهددة بالانقراض. في هذه الدراسة نفحص تأثير القضايا البيئية المختلفة لكل من العوامل البشرية والطبيعية على الحياة البرية في المحمية. العوامل التي تم فحصها هي جودة الهواء، وجودة المياه، ومستويات الضوضاء، والطقس المحلي، والنشاط البشري في المحمية. إضافة إلى هذه العوامل تم رصد التنوع البيولوجي عن طريق تسجيل عدد كل نوع من أنواع الحيوانات من عام 2008 إلى عام 2016. وأظهرت النتائج أن العديد من أنواع الحياة البرية في المحمية قد انقرضت بالفعل ومنها ما هو مهدد بينما زادت أنواع أخرى. كما أثبتت دراسة جودة الهواء والماء والطقس المحلي انها ليس لها آثار سلبية على الأنواع المهددة بالانقراض والسبب الرئيسي لاختفاء أو زيادة بعض الأنواع هو الأنشطة البشرية خاصة الزراعة وزيادة عدد المحاجر في منطقة المحمية. ويرافق عمل المحاجر ضوضاء وغبار ومولوثات والحركة الكبيرة للبشر والشاحنات وهي المؤثر المباشر و الرئيس على الحياة البرية في المحمية. والاستنتاج الرئيسي لهذه الدراسة هو أن إزالة التعدي من المحمية هي الطريقة الوحيدة لحماية التنوع البيولوجي.

*الكلمات الدالة:* محمية الوادي الأسيوطي - التلوث البيئي - التنوع البيولوجي - نوعية الهواء - تأثير الطقس.