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**AN ECOLOGICAL STUDY ON WADI HASANAT, SALAH DISTRICT, TAIZ GOVERNORATE, REPUBLIC OF YEMEN**

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**Abstract**

The Study area in wadi Hasanat, Salah District, Taiz is located between latitude 14° 989' 26" and 14° 994' 18" north and longitude 43° 395' 463" and 43° 395' 702" east. Regular periodic field visits (three visits/month) were carried out during the years 2007-2008 to study and collect plant samples for the different taxa and to collect soil samples from the different habitats of the wadi. All the collected plant samples were correctly identified and classified. This study aimed to enumerate and identify the plants in the study area which reached 165 species belonging to 49 families. Out of them are four species of Pteridophyta distributed in three families. Gymnospermeae are represented by three genera, and 46 families. The Angiospermeae were represented by 128 species for 98 genera within 40 families of the Dicotyledoneae, and 33 species from 25 genera within six families of the Monocotyledoneae.. The study showed that the largest five families in the wadi Hasanat are Poaceae "Gramineae" (26 species), Asteraceae "Compositae" (16 species), Acanthaceae (13 species), Euphorbiaceae (11 species) and Asclepiadaceae (9 species). Out of 165 plant species identified in this study, 29 species disappeared as a result of road paving at the bottom of the wadi the and exposure of the wadi to over grazing and wrongful woodcutting seriously threatened the wadi. The wadi is considered a beautiful green patch, and wonderful view for Taiz City, and an important center for air purification from the pollutants coming out of Taiz city located on its north. Therefore , it is necessary to preserve the wadi disturbance by a planned way especially with the shrinkage of the green areas surrounding Taiz City day after day.

**Introduction**

Republic of Yemen lies in the southwestern corner of Arabian Peninsula between latitude 12° 20' and 19 N and 42° 30' and 53° 05' E. Total area of the Republic of Yemen is about 455,503 km<sup>2</sup>. (The status of Environment Report in Yemen, 2004). The flora of Yemen is very rich and heterogeneous. The species diversity is a result of diverse climate changes, different ecological habitats. Also the location of Yemen makes it a part of the Somalia –Masai region (previously Eritreo-Arabia) which is a part the tropical Asia area (Paleotropic zone). The geographical location is

considered as a meeting area between the Paleotropical kingdom and Heliotropic kingdom (one third of Yemen plants are Heliotropically plants) (Al-Hubaishi and Hohenstein, 1984; White and Leonard, 1991; Al- Khulaidi and Scholte 1991; and Al- Khulaidi 2000). The plants of east Africa (Somalia-Masai region) grow in Yemen especially in the western mountains and high plains where there is plenty of rainfall.

According to the recent administrative division; Yemen has been divided to twenty one Governorates. Taiz is one of the south-western governorates, and contains twenty three Districts; Salah is one of its Districts (the study area). Its inhabitants are about “2.393.425” people covering area 10420 km<sup>2</sup> according to the general enumeration of 2004. (Ministry of International Planning & Cooperation, 2004). Approximately 2810 species of 1006 genera and 173 families are recorded in the flora of Yemen (publications of Environmental Program, 2000). The endemic plants of Yemen are around 415 species, of them 236 species are endemic in Socotra Island (The General Organization for protection of the Environment, 2002).

Taiz governorate is around 256 km south of Sana'a south. Taiz is located between latitude 12° .30' and 14° 00' N and longitudes 43° to 45° E. Taiz bordered Lahaj Governorate and parts of, the Al-Dhale Governorate from the east, Ibb Governorate from the north, the Red sea and Al-Hodeidah Governorate from the west (Ministry of Environment and water Taiz branch, 2002), Al-khulaidi, Al-Obaidi, 2000). The different topographic zones of the Taiz governorate are considered good habitats for the flora with 700 species. (Al-khulaidi 2000). This diversity attracted number of the specialists in field of flora to visit the governorate during their trips in the different areas of Yemen. Forsskal (1762) visited Taiz for the first time in March and June (1763), after his death in Yemen on date 11/7/1763 his friend Niebuhr succeeded to return the samples which were collected from Yemen to Copenhagen which reached 1300 samples as he published notices Forsskal in "Flora Aegyptiaco – Arabica" in 1775. Botta (1836) gathered several important samples, most of these samples are present in Paris. Deflers (1885 – 1890, and 1893) gathered several samples from different places including Taiz. His trip was described in his book “Voyage au Yemen”. Scott and Britton (1937 – 1938) gathered a number of the samples, which has been written by Scott. The best Book of Yemen “In the High Yemen”. Chaudhary and Revri 1983 (Weeds of North Yemen, 1983).

This study aims to 1- Enumerate, identify and document the flora existing in Wadi Hasanat. 2- Access the extension of the human impact on the vegetation. 3-The acquaintance on spreading nature of the plants in the wadi and the influential factors. 4-The contribution to build the governorate flora and Yemen flora in general. Wadi Hasanat was selected for the present study because it is subjected to some conflicting environmental conditions such as the free growth of plants in some parts, overgrazing and habitat destruction (through road construction) in other parts.. it therefore seemed worthwhile to record the present status of the vegetation before the impact of these factors can cause disappearance of some species.

### Climate of Wadi Hasanat

The study area in wadi Hasanat Salah Distract directorate of Taiz governorate is located south Taiz city and north of Jabel Sabar in Salah directorate of Taiz. It covers an area of approximately 39945.467m<sup>2</sup>. The elevation of the study area ranged from 1554 to 1605 meter above sea level. The study area is bordered by Salah District from the east, Jabal Saber from south, Thoabat area from the west, and Al-Diam village from the north. The geology of study area showed that wadi Hasanat is volcanic rocks from tertiary, Triassic and quaternary (Al-Anbaawy, 1985).

**Table (1) Mean air temperature(C), relative humidity (R.H), wind speed (km/h) and rainfall (mm/monfh). (obtained from Oseifera Station during (1998-2007)**

	Temperature (C)	Relative humidity %	Wind speed (Km/h)	Rainfall mm / month
January	22.3	49	121	86.9
February	23.5	43	25	72
March	24.1	45	27	88.5
April	25.6	42	147	83
May	25.7	40	39	73.9
June	26.4	42	134	62.8
July	26.4	46	30	70.6
August	24.9	46	30	78.6
September	25.2	40	27	77
October	23.3	35	32	40.9
November	22.7	38	25	49.8
December	19.7	38	123	0.0
Total				753.1

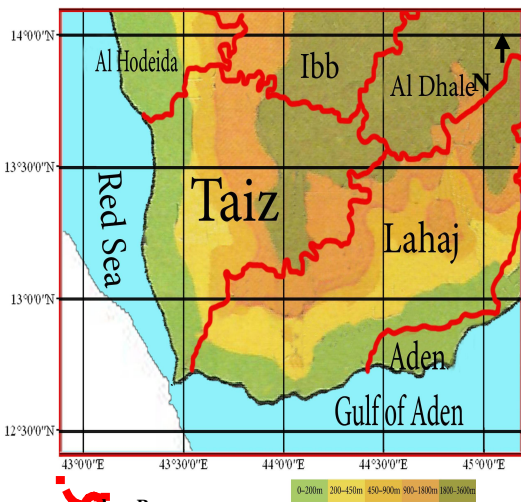
Annual air temperature ranged between 19.7 °C and 26.4° C , the lowest air temperature (19.7 °C) was recorded in June, while the highest air temperature (26.4° C ) was recorded in July. The relative humidity ranged from 38 % to 49%.The

lowest value (38%) was recorded in December , while the highest value (49%) was recorded in January. The wind speed ranged between 2.94 and 4.8 Km/hr. The lowest speed recorded 2.94Km/S. north east in March, while the highest speed was 4.9m/S north east. The total annual rainfall reached 753.1millimeter/year.

http://www.yemen-explorers.com/yemen/2009/



Map 1 Location

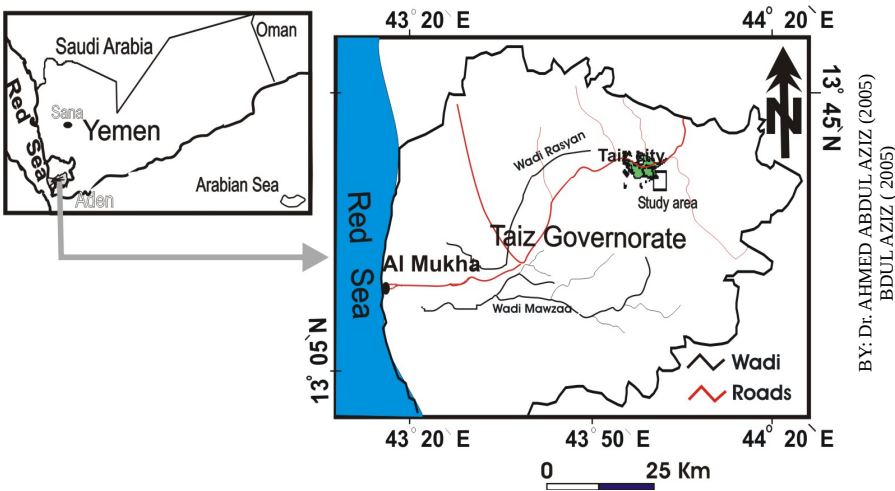


Map. 2

dnA hcræseR larutucirgA  
(AERA) ytirohtuA noisnetxE  
secruoseR larutA elbaweneR  
(CRRNR) retineC hcræseR  
gnisneS etomeR dna SIG

noitceS

setaronrevog



Map 3.

### Materials and Methods

Several periodic field visits were carried out to Wadi Hasanat; three visits per month for the four seasons of the years 2007-2008. At each visit, soil and plant samples were collected from the different sites (habitats) of the wadi. Three replicates were collected from the upper 0-40 cm depth for each assigned soil sample. Soil samples were air dried, ground to pass through a 2 mm sieve, packed in plastic bags ready for soil analysis. Physical and chemical properties were determined according to Piper (1947) and Jackson (1962). Chemical properties of soil samples were analyzed at the General Laboratory of the Agricultural Organization for Studies and Guidance in Taiz branch. Physical properties of soil samples were analyzed at the Laboratory of Faculty of Sciences, Taiz University. Plants were identified according to Migahid (1978); Collenet (1985); Chaudhary and Revri (1983), Wood, (1997), Chaudhary (1999 to 2001) and Bolous (2002).

## Results and Discussion

Table (2) Physical and Chemical properties of soil samples collected from seven localities in wadi Hasanat, Salah District governorate of Taiz. Soil depth at 20-40cm SL = Sandy-Loamy.

Test	Location	1	2	3	4	5	6	7
Physical properties	Coarse Sand %	12.67	24.6	24.67	19.3	33.3	35.33	23.33
	Fine Sand %	58.67	62	62	66	54	49.33	64.67
	Clay %	12.67	13.33	13.33	14.66	12.67	15.33	12
	Soil texture	sandy	sandy	sandy	sandy	sandy	sandy	sandy
	Saturation percentage%	58.17	42.11	52.55	46.34	46.61	46.13	46.13
	Gravitational water %	6.6	1.73	5.42	3.98	2.65	2.83	3.49
	Water holding capacity %	51.57	40.4	47.13	42.36	43.92	43.32	42.64
	Capillary water %	46.63	37.31	41.65	36.51	47.75	38.87	37.92
	Porosity %	48.8	41.61	43.76	40.15	39.38	42.43	39.82
Chemical properties	pH	8.07	8.23	8.3	8.17	8.27	8.4	8.17
	EC ms/cm	0.37	0.31	0.19	0.21	8.46	0.24	0.23
	CaCO <sub>3</sub> %	11.54	12.6	7.56	5.93	20.66	13.51	10.6
	O.M %	2.12	1.03	1.25	0.83	1.57	0.32	0.91

The soil physical properties are presented in Table (2). The highest value of sand (66%) was recorded in site 4, while the lowest value (49.33%) was recorded in site 6. Whereas the highest value of silt (35.33%) was in site 6 while the lowest value was 19.33% in site 4. The highest value of clay 15.33% was recorded in site6, while the lowest value of clay (12%) was recorded in site 7, on the other hand , the highest value of saturation (58.17%) was in site 1, while the lowest value of saturation (42.11%) was in site 2. The highest value of gravitational water (6.6%) was recorded in site 1, while the lowest value (1.73%) was recorded in site2. The highest value of water holding capacity( 51.57%) was in site ,, while the lowest value of water holding capacity was 40.4% in site 2.The capillary water was 47.75%

in site 5, while the lowest value was 36.51% in site 4. The highest value of hygroscopic water was 5.82 in site 4, while the lowest value of hygroscopic water was 3.04% in site 2. The highest value of porosity was 48.8% in site 1 while the lowest value of porosity was 39.38% in site 5.

Soil chemical properties are presented in Table (2). The value of pH ranged between 8.08 to 8.27. The highest value (8.27) was in site 5, while the lowest value (8.7) was in site 1. The value of calcium carbonate ranged from 10.6 to 20.66%. The highest value recorded 20.66 % in site 5, while the lowest (10.6 %) was in site 7. The organic matter ranged between 0.32 to 2.12%, the highest value of organic matter (2.12%) was in site 1, the lowest value (0.32%) was in site 6.

Generally, the physical properties indicated that the soil was sandy, while the chemical properties revealed that soil reaction was alkaline. In general, both climatic and edaphic factors controlled the distribution of plants. Moreover, soil condition influences the local pattern of distribution. The indicator value of species varies from area to area and is influenced by competition with other species.

Floristically, Wadi Hasanat represents a rich wadi in the Taiz flora. The number of species recorded in the present study is high compared to Taiz flora in general (Al Khulaidi, 1989 and 1997). The sites in this study represent all the different habitats of the wadi Hasanat. Site 1 is dominated by *Euphorbia inarticulate* and *Cissus rotundifolia* (climbing on *Euphorbia inarticulate*), the associated species in this site are *Capparis Cartilaginea* and *Acaia origena*. This site represents slope and terrace of the wadi. Site 2 is dominated by *Bothriochloa bladhii* and *Euphorbia inarticulate*, this site represents runnel of the wadi and the associated species here are *Barleria trispinosa* and *Capparis Cartilaginea* the soil of this site is recorded the lowest value of gravitational water (1.73). Sites 3, 4 and 5 are dominated by *Acacia etbaica* and *Acaia origena* forming an Acacia forest this because the soil is covered and protected water by large stone. This is because of surface gravel is reduce the moisture loss also it slows down water movement across the surface, allowing more water to penetrate the soil and reducing the amount of soil surface exposed to evaporation (El-Ghareeb & Shabana, 1990). The associated species in these stands are *Barleria trispinosa*, *Conyza pyrrhopappa* and *Euphorbia inarticulate*.

Site 6 is dominated by *Barleria trispinosa*; this is due to the lowest value of organic matter is 0.32 % in the site compared with all sites. The associated species in

this site are *Acacia etbaica* , *Euphorbia inarticulate* and *Aloe vacillans*. Site 7 is dominated by *Aloe vacillans* and *Barleria trispinosa* This site represents a danger slope of the wadi and for this reason *Aloe vacillans* is dominated in the site. (Al Hubaishi and Muller,1984). During the work some species are disappeared due to human impact (road paving work), mostly of these species are growing in the terrace and wadi bed such as *Jatropha cureas*, *Otostegia fruticosa* and *Pergularia daemia*, on the other hand, annual species such as *Flaveria trinerva*, *Solanum villosum* and *Chenopodium ambrosioides* may appear again in growing season. The above results are in agreement with other investigators ( Dubaie and Al- Khulidi,1991 and 1993 Dubaie et al 1991; Al-Khulidi and Dubaie,1993;Al-Kulidi,1989 and 1997; Blatter, 1914-1916 and Al-Kulidi,2006 ) .

**Table (3) List of plant species in seven sites collected from the study area in wadi Hasanat Salah District, Governorate of Taiz, Yemen durig years 2007 - 2008. (C) = Catchment area, (+)= Present and (#)= Disappeared.**

Species	1	2	3	4	5	6	7	.C
<i>Abutilon figarianum</i> Webb.							#	
<i>Acacia etbaica</i> Schweinfl			+	+	+	+	+	
<i>Acacia origena</i> Asfaw			+	+	+	+	+	
<i>Acacia yemenensis</i> Boulos					+			+
<i>Acalypha fruticosa</i> Forssk.							#	
<i>Acalypha indica</i> L.				+				
<i>Acanthus arboreus</i> Forssk							#	
<i>Actiniopteris semiflabellat</i> Pichi-Semlli								+
<i>Adenium obesum</i> Forssk.	+	+			+			
<i>Adiantum capillus-veneris</i> L.								+
<i>Adiantum incisum</i> Forssk						+		+
<i>Aerva javanica</i> Burm.f.							#	
<i>Aloe vacillans</i> L.				+	+	+	+	+
<i>Alternanthera pungens</i> L.				+			+	
<i>Amaranthus lividus</i> L.							#	
<i>Amaranthus spinosus</i> L.							#	

**Table (3): Cont.**

Species	1	2	3	4	5	6	7	.C
<i>Argemone mexicana</i> L.			+	+		+	+	



<i>Argemone ochroleuca</i> Sweet				+				
<i>Aristida adscensionis</i> sL.			+	+				
<i>Asystasia guttata</i> Forssk.			+			+		+
<i>Barleria bispinosa</i> Forssk.			+					
<i>Barleria pvuiflora</i> R.poox					+		+	+
<i>Barleria trispinosa</i> Forssk.	+	+	+	+	+	+	+	+
<i>Bidens biternata</i> Lour						+	+	+
<i>Blepharis ciliaris</i> L.			+	+		+	+	
<i>Boerhavia diffusa</i> L.			+	+	+	+	+	
<i>Bothriochloa bladhii</i> Retz.	+	+	+	+	+			
<i>Bothriochloa insculpta</i> Hochst. ex A.Rich.	+	+		+	+			
<i>Brachiaria leersioides</i> Hochst.			+	+		+	+	
<i>Cadia purpurea</i> Picc.					+	+	+	+
<i>Calotropis procera</i> Aiton.			+			+	+	
<i>Capparis cartilaginea</i> Decne	+	+	+	+	+	+	+	
<i>Caralluma cicatricose</i> Defl.			+					
<i>Cardiospermum halicacabum</i> L.								#
<i>Catharanthus roseus</i> L.							+	+
<i>Celosia argentea</i> L.								#
<i>Ceropegia rupicola</i> Defl.			+					+
<i>Chenopodium ambrosioides</i> L.								#
<i>Chenopodium murale</i> L.							+	
<i>Chloris barbata</i> sw.			+	+	+		+	
<i>Chloris quinquesetica</i> Bhde			+	+	+		+	
<i>Cissus quadrangularis</i> L.		+	+			+		
<i>Cissus rotundifolia</i> Forssk.	+	+	+	+	+	+	+	
<i>Citrullus lanatus</i> Thunb.				#				
<i>Clutia lanceolata</i> Forssk.	+	+			+			+
<i>Commelina boissierana</i> C.B.Clarke								#
<i>Commicarpus grandiflorus</i> A. Rich.			+	+			+	
<i>Commicarpus plumbagineus</i> Cav	+	+					+	
<i>Conyza pyrrhopappa</i> Sch.B.P.B.Dex			+	+	+	+	+	+

Table (3): Cont.

Species	1	2	3	4	5	6	7	.C
<i>Crepis ruepellii</i> L			+				+	
<i>Crinum album</i> Forssk.				+				+
<i>Cucumis prophetarum</i> L.				#				







<i>Senna occidentalis</i> L.			+	+		+	+	
<i>Setaria pumila</i> Poir.				+		+		
<i>Sisymbrium erysimoides</i> Desf.						+		
<i>Solanum incanum</i> L.	+	+	+			+	+	
<i>Solanum villosum</i> Miller				#				
<i>Sorghum bicolor</i> Forssk.						+		
<i>Striga asiatica</i> L.	+					+		
<i>Striga gesnerioides</i> Latke			+				+	
<i>Tagetes minuta</i> L.							+	
<i>Tecoma stans</i> L.							#	
<i>Tetrapogon tenellus</i> L.				+				
<i>Tragia pungens</i> Forssk.							#	
<i>Tribulus terrestris</i> L.							+	
<i>Tridax procumbens</i> L.			+	+	+	+	+	
<i>Verbascum bottae</i> Defl.							#	
<i>Vigna unguiculata</i> L.						+		
<i>Withania somnifera</i> L.	+	+	+	+	+	+	+	
<i>Xanthium spinosum</i> L.							#	
<i>Zingiber trichopoda</i> L.				+		+		
<i>Ziziphus spina-christi</i> L.	+	+	+	+	+	+	+	

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## دراسة بيئية على وادي حسنات , مديرية صالة, تعز, الجمهورية اليمنية

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### الملخص

تمت دراسة فلورة وادي حسنات مديرية صالة محافظة تعز المحصور بين خطي عرض 14 989 26 و 14 994 702 شمالاً وخطي طول 395 46 و 43 702 43 شرقاً) حيث تمت عدة زيارات ميدانية على فترات متتالية (ثلاث رحلات شهرياً خلال عامي 2007-2008) لدراسة وجمع العينات النباتية وعينات التربة المصاحبة لها بالمواقع المختلفة. تم تعريف وتصنيف وترتيب المعلومات المستقاة والواردة من الحقل الميداني بالإضافة إلى جمع المعلومات ذات العلاقة من المراجع والدراسات المشابهة الأخرى. والتي تهدف إلى حصر وتعريف النباتات في المنطقة والتي بلغ عددها 165 نوع و جنس نباتي يتبع 49 عائلة. منها أربعة أنواع من السرخسيات موزعة على ثلاث عائلات تضم ثلاثة أجناس، و 46 عائلة من النباتات مغطاة البذور موزعة إلى 128 نوع يتبع 98 جنس ضمن 40 عائلة من النباتات ذوات الفلقتين و 33 نوع يتبع 25 جنس ضمن 6 عائلات من النباتات ذوات الفلقة الواحدة. وأظهرت الدراسة أن أكبر خمس عائلات في الوادي هي العائلة النجيلية ( 26 نوع)، العائلة المركبة (16 نوع)، العائلة الأكاثية (13 نوع)، العائلة اللببية ( 11 نوع)، العائلة العشارية (9 أنواع). أختفى من الوادي 29 نوع نباتي نتيجة شق الطريق أسفل الوادي.

كما أظهرت الدراسة تعرض الوادي إلى الرعي و التحطيب الجائر مما يهدد الوادي وبشدة. ويعتبر الوادي رقعة خضراء جميلة، ومنتفس رائع لمدينة تعز، ومركز مهم لتنقية الهواء من الملوثات المندفعة من مدينة تعز الواقعة في الشمال منه وعليه يجب الحفاظ على الوادي واستغلاله بصورة مدروسة وجيدة خصوصاً مع تقلص المسطحات الخضراء المحيطة بمدينة تعز يوماً بعد يوم.

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