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Effect of Wastewater Irrigation on Phytosociological Characteristics of the Vegetation: A Case Study in Sistan Region

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Abstract: The aim of this study is to determine the changes in plant diversity and phytosociological attributes of the vegetation according to the environmental conditions in Sistan Region in the southeast of Iran. For the study of plant communities and quantification of vegetation, quadrate method was used. Quantitative analyses on species diversity in addition to phytosociological attributes analysis were conducted in dry land, agricultural and waste water irrigation area. Data on abundance, density, dominance, frequency, Species Importance Value Indexes, are presented in the study. The plant communities were determined in percentage of frequency, abundance value, relative density and importance value. Based on results of survey that performed in study area, 16 species from 7 botanical families were recorded in all sites. The phytosociological studies reveal in most part of area that the vegetation was characteristically dominated by *Tamarix* species followed by *Aeluropus* sp. and *Alhagi maurorum*, which were the most abundant and frequent species of the study area. The *Tamarix* species has the highest IVI, in all surveyed areas. Species presenting the highest relative density is *Aeluropus littoralis* in the agricultural and wastewater area and *Aeluropus littoralis* in dry land area. It was observed that, wastewater plays an important role in vegetation growth and regeneration. The experiments from wastewater irrigated sites reported maximum number of species, depicting highest diversity among all sites. This clearly indicates that the wastewater can be effectively used in restoration of dry land, since it helps better growth of plants.

Key words: Vegetation · Dry land · Agriculture · Wastewater irrigation · Phytosociology

INTRODUCTION

Arid regions occupy 36% of the earth land surface and water shortage is the main limiting factor in the development of dry lands. Soil degradation, erosion, salinization, sodication are main issues and water and soil management is very important if the dry lands are to be habitable. Vegetation is an essential component in major ecosystems because it displays the effects of various environmental conditions [1-3]. Phytosociological studies reveal the structure and diversity about the vegetation [4-7]. Plant cover protects soil from the erosive action of runoff water by contributing resistance to the movement of water and shielding the soil from its effects. The use of wastewater for irrigation is increasingly being considered as a technical solution to minimize soil degradation and to restore the vegetation in dry lands.

Wastewater irrigation poses several threats to the environment via contamination by nutrients, heavy metals, and salts. Increased loads of nitrates in wastewater may increase the risk of groundwater contamination [8-10]. The risks can be markedly reduced, however, by appropriately matching plant production systems to effluent characteristics [11]. In order to avoid undesirable side effects due to salinity and toxic concentrations of metals from the application of wastewater to soil, it is necessary to determine the effects of wastewater concentration in long-term periods [12-14]. Ecological research on the relationship between biodiversity and environmental conditions has been increasingly emphasized. But, the importance of waste water irrigation has been understood better after severe drought conditions in arid regions.

The Sistan region of southeastern Iran has not only suffered significant destruction of plant life as a result of the droughts of recent years, but erosion caused by wind has also increased. Since natural water sources are limited, efforts are being made to revitalize the vegetation cover using waste water. Helmand River and Hamoon lakes are ecologically very valuable and important wetlands in

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Table 1: Rainfall (mm), temperature (°C) and evapotranspiration (mm) data for 30 years (1973-2003) at Zabol station, Sistan Region

Month Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Y
Rainfall	3.4	1.7	8.7	17.0	8.7	15.1	4.3	0.9	0.5	0.2	0.5	1.2	62.2
Evap	265.0	159.0	101.0	85.0	103.0	163.0	253.0	408.0	496.0	512.0	588.0	429.0	3563.0
Temp	22.0	15.2	10.4	8.3	10.8	16.8	23.8	28.9	32.9	34.6	32.6	28.2	22.0

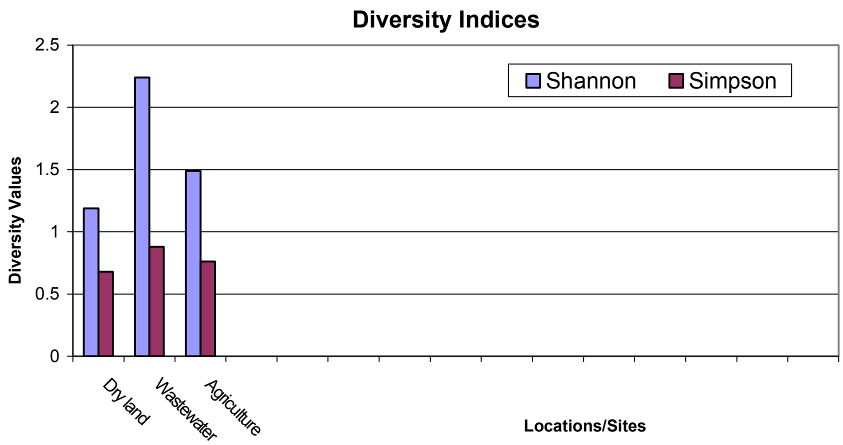

Fig. 1: Graphical representation of diversity indices at selected locations

Sistan region. New irrigation projects have been started after several drought periods in last two decades in the area. On the other hand, due to the recent drought in the eastern parts of Iran and more control of Afghanistan government on Helmand flow, has caused gradually diminished of the lake and with it almost the whole of reed forest and its related economic life with disastrous environmental consequences for the Sistan area. As a result, the recent drought has caused an easily movement of fine-grained sand by a powerful local storm that is called Sistan "the winds of 120 days" and increased significantly airborne dust in the area. This sandy storm has damaged many villages, farmlands, roads, natural vegetation, and such on. In the case of continuing drought and more control of Afghanistan government on the Helmand flow, all the natural vegetation and farmland might become buried under sandy hills. Land use pattern changed after the depletion of Hamoon lakes and wetland system in Sistan region. This study presents the results of a study on comparing phytosociological features of vegetation in the three different sites- dry land, agricultural land, and wastewater area- in Sistan Region on the southeast of Iran.

Study Area: Sistan region covers 8000 km^2 on the southeastern part of Iran. It is located between 30°15'- 31°30' N latitudes and; 60°45'- 61°50'E longitudes along the borders of Afghanistan and Pakistan (Fig. 1). The Sistan basin is an endorheic and it consists of several desert plateaus which are covered by sand dunes. This region forms a part of the Dasht-e-Lut (Desert of Lut) and it is one of the driest regions of the world. It exhibits extreme arid climatic regime, characterized by a dry continental climate, with cold winters and hot summers. The average rainfall is about 62mm in a year. Most of rain occurs in the result of fronts come from the Persian Gulf and Indian Ocean, especially during the period from January to March. The seasonal distribution of rainfall in the Sistan region varies and, 65% and 22 % rainfall receptively occurs during the winter and autumn seasons. The area receives only about 7 mm rain in spring and summer seasons. In the month of January highest rainfall (17.0mm) is recorded at the Zabol meteorological station; while only 0.2mm rainfall occurred during the month of July (Table 1).

The annual average temperature is approximately 22.0°C, but winter temperatures drops minus 12°C, and in summer the temperature may exceed 50°C. The study area also shows a wide variation in its mean monthly temperature.

The summer months show higher evapotranspiration rate. The highest values of evapotranspiration (588mm) have been recorded in August, while January has only 85.0mm of the evapotranspiration. The total annual evapotranspiration is 3563mm, which is far higher than the total amount of annual rainfall received by the Sistan region (Table 1).

Because of extremely high temperatures, the basin is notorious for summer low-pressure systems, tempered by regular north-to-northwest winds, known as "the wind of 120 days". They blow large quantities of very fine sediments (clays and loams) out of the depression, thus contributing to permanent erosion by deflation. The winds, coupled with high temperatures, are the cause of extremely high rate of evaporation.

The Helmand River comprises the largest watershed in the Sistan basin, but other smaller rivers also feed the Hamoons [15]. Within the Sistan plain are located the Hamoon lakes and wetlands, which occupy an area of about 2000 km^2 of the Sistan region and Afghanistan. These lakes and wetlands support farming, natural vegetation and recently afforested areas in this region. Sistan region, the population depends on agriculture: intensive crop production and horticulture provide the basis of daily existence. Under such conditions, life is only possible if an ‘external’ water source is also available to nourish the region. Waste but shallow water cover in a very dry region where potential evapo-transpiration is more than 3500 milimeters annually makes for a system that is very vulnerable to climatic fluctuations and modifications of water inflow by humans. Severe water shortages have destroyed the ecological system of the wetlands and caused damage to agriculture in the delta, which is primarily based on irrigation from the Helmand River.

With a population around 200,000, the city of Zabol is the only major urban centre of the Sistan region. Moreover, the region is dotted with nearly 800 major villages. The average population of each village is about 300 to 400. The Sistan basin shows the presence of the three distinct land use types, namely, the dry land, agricultural land and irrigated land. The livelihood of the people live in the area depends on animal husbandry and agriculture. Sheep and goat are the common livestock; cattle, buffalo, camel, ass and mule are also kept. All this livestock mostly depend on the natural vegetation.

MATERIALS AND METHODS

During the vegetation period of 2006 and 2007 survey was conducted on three different sites. The dryland, agricultural land and wastewater irrigated land were selected on the 5 km southwest of Zabol city. For the study of plant communities and quantification of vegetation, quadrate method was used. The size of the quadrate was kept large enough to contain trees and significant number of individuals, but small enough that the individuals present can be separated, counted, and measured without confusion leading to duplication or omission of individuals. At each land use type area, 10 quadrates each 10 x 10 m in size were sampled randomly for trees. Within this sub quadrates of 1 x 1m were laid to record the herbs. A total of 30 quadrates in 10 x 10m and 30 quadrates 1 x 1m were sampled for vegetation analysis from the entire study area.

The vegetation or plant communities of the area were analyzed by considering the environmental variables while making the observations. In each quadrate, counted the number of species encountered and was recorded. The density and abundance of each species was recorded within each quadrate. Using the Mueller - Dombois and Ellenberg [16] method, frequency, relative fraquency, relative density, relative dominance, and importance value for each species was calculated. The Shannon-Wiener index was used to calculate species diversity [17-19].

RESULTS AND DISCUSSION

Phytosociological composition of the plant communities in three habitats was determined. The results showed that the abundance of plant species was low in the area and 16 species were scored belonging to 7 families, during the inventories. 8 of these species were Poaceae and the rest 8 species were other families (Table 9). The result shows that the 30 sites have different species richness, evenness, or Shannon-Wiener index values.

Plant communities were determined on the basis of Importance Value Index (IVI). A total of, 6 in dry land, 10 in agricultural and 15 plant species in the wastewater irrigation area were recorded. The species having the highest IVI were considered as the leading dominants of the community. Plant communities recognized were; 1-Tamarix-Aeluropus in agricultural, 2-Tamarix-Alhagi in dry land, 3-Tamarix-Aeluropus in wastewater irrigation area. The plant communities in the study area were dominated by *Tamarix ramosissima, Tamarix aphylla*, *Aeluropus littoralis* and *Alhagi maurorum*. *Tamarix ramosissima* and *Alhagi maurorum* occur on the saline soils but, *A. maurorum* sometimes spreads into cultivated fields. Phytosociological study shows that Tamarix is having the highest IVI in all three habitats (Table 5, 6, 7). None of the species showed regular distribution pattern (Figure 2, 3, 4).

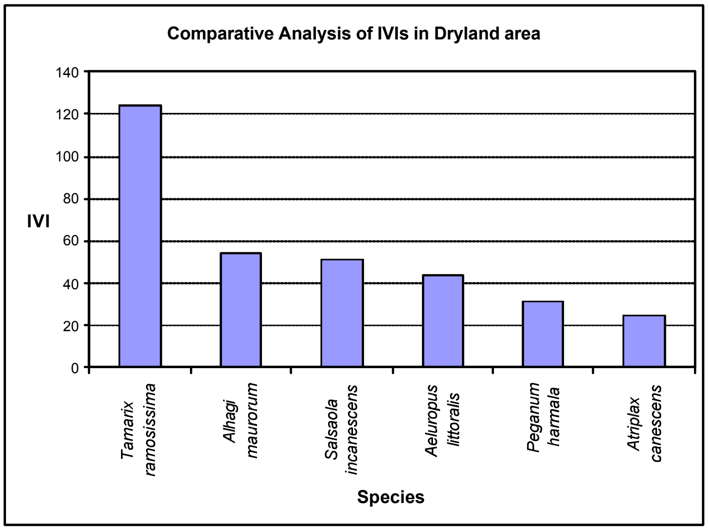

Fig. 2: Comparative vegetation analysis of IVI in Dry Land Area

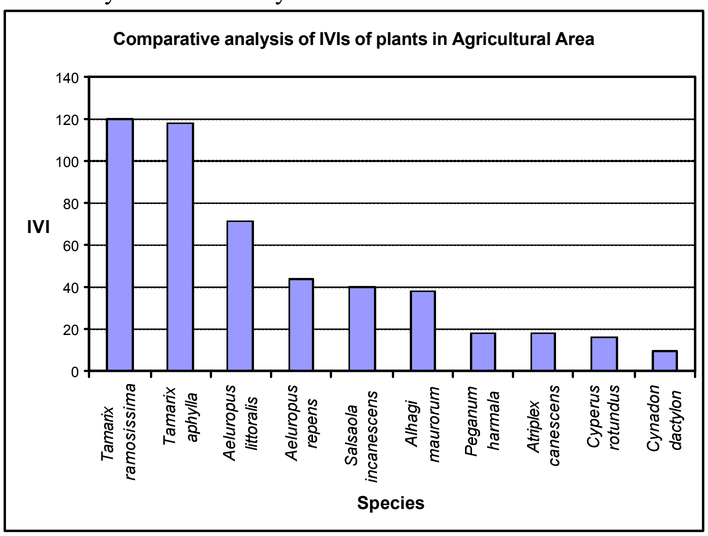

Fig. 3: Comparative vegetation analysis of IVI in Agricultural Area

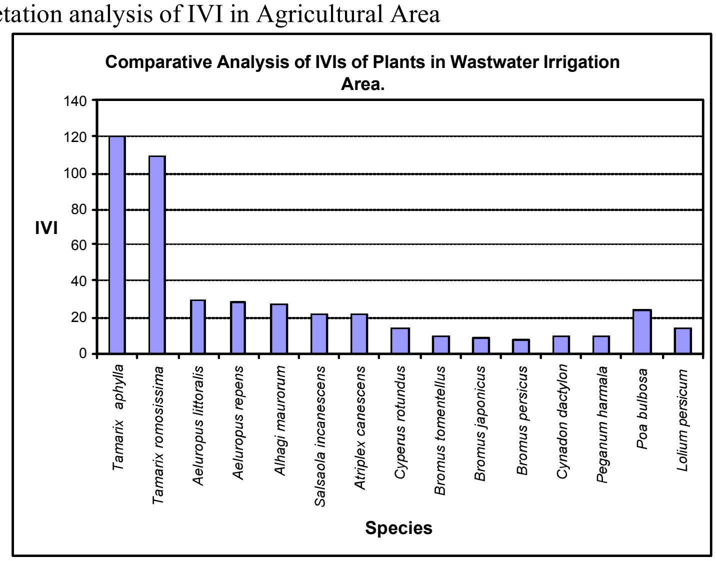

Fig. 4: Comparative vegetation analysis of IVI in Wastewater Irrigation Area

Table 2: Analysis of vegetation in the wastewater irrigation area

Quadrate no Plant species	1	2	3	4	5	6	7	8	9	10	Tot	F %	D
Tamarix aphylla L.	2	2	3	-	2	-	-	-	-	1	10	50	1.0
Tamarix ramosissima Ledeb.	1	-	-	1	-	1	-	-	-	-	3	30	0.3
Alhagi maurorum Medik.	1	2	1	-	2	1	1	-	2	2	12	80	1.2
Salsola incanescens C.A. Mey.	2	1	1	3	-	-	2	1	1	1	12	80	1.2
Cyperus rotundus L.	2	1	2	1	1	2	1	1	-	1	12	90	1.2
Bromus tomentellus Boiss.	1	1	-	1	1	-	-	1	1	-	6	60	0.6
Bromus japonicus Thunb.	-	-	1	1	1	-	-	-	1	-	4	40	0.4
Bromus persicus Boiss. ex Steud	-	-	-	-	-	1	-	-	1	-	2	20	0.2
Aeluropus littoralis (Willd) Parl.	3	2	2	3	3	-	4	5	7	3	32	90	3.2
Aeluropus repens (Desf.) Parl.	4	2	3	1	4	1	1	2	-	-	18	80	1.8
Cynodon dactylon L.	1	1	1	-	1	-	-	-	-	2	6	50	0.6
Peganum harmala L.	1	1	-	-	1	1	-	1	-	-	5	50	0.5
Atriplex canescens L.	2	1	-	-	1	-	-	1	-	1	6	50	0.6
Poa bulbosa L.	1	1	2	2	-	2	1	-	2	-	11	80	1.1
Lolium persicum Boiss. & Hohen. ex Boiss.	1	1	-	1	1	2	1	-	-	1	8	70	0.8
Total	22	16	16	14	18	11	11	12	14	12	147	950	15.2

Abbreviations: F=Frequency, D=Density

Table 3:Analysis of vegetation in agricultural area

Quadrate no Plant species	1	2	3	4	5	6	7	8	9	10	Tot	F %	D
Tamarix aphylla	1	-	-	-	-	1	-	-	-	1	3	30	0.3
Tamarix ramosissima	1	2	1	-	-	-	1	2	-	-	7	50	0.7
Alhagi maurorum	3	-	1	2	1	-	2	1	3	3	16	80	1.6
Salsola incanescens	2	-	1	3	1	2	1	1	-	1	12	80	1.2
Cyperus rotundus	2	2	-	-	-	-	-	4	-	-	8	30	0.8
Aeluropus littoralis	1	2	2	-	3	1	1	3	-	2	15	80	1.5
Aeluropus repens	3	1	-	1	-	2	2	2	2	1	14	80	1.4
Cynodon dactylon	2	-	1	-	-	-	-	-	-	-	3	30	0.3
Peganum harmala	1	-	1	-	1	-	1	-	-	-	4	40	0.4
Atriplex canescens	1	-	-	-	-	-	1	-	1	1	4	40	0.4
Total	17	7	7	6	6	6	9	13	6	9	86	530	8.6

Abbreviations: F =Frequency, D=Density

There were 16 species and 296 individuals in all quadrates. The numbers of species in the quadrates are 147, 86, 63 in the wastewater irrigation, agricultural, dryland area respectively. Wastewater irrigation area has the highest number of individual and species diversity with 15 plants. Poaceae had 8, Tamaricaceae 2, Chenopodiaceae 2 species and the remaining families were represented by only single species (Table 9). The species in Poaceae might have higher dispersal capacity and adaptability to the present habitat conditions especially in the wastewater irrigation area. The species in Fabaceae, Cyperaceae, Zygophyllaceae and Chenopodiaceae have higher growth ability in dry conditions and they are resistant to water shortage.

Tamarix sp has the highest IVI value in all habitats. It is followed by *Aeluropus littoralis*, *Alhagi maurorum, Salsola incanescens* with 71.48, 54.41, 50.96 IVI values respectively. The species have higher IVI are best adapted to the environmental conditions in the habitats.

Analysis of Vegetation in Experimental Sites: The vegetation in each of the three areas of this study shows differences in their characteristics. It has been confirmed that the area irrigated by wastewater has the highest number species, and the least dryland area. 16 species and a total of 296 individual plants belonging to 7 families were identified in the study area. Large differences were observed in population distribution. In the area irrigated by waste water a total of 147 plants were found and 86 on agricultural land and 63 on dry land. In each of the three areas, the dominant plants species showed differences in their (IVI) Importance Value Index.

Table 4: Analysis of vegetation in dry land area

Quadrate no Plant species	1	2	3	4	5	6	7	8	9	10	Tot	F %	D
Tamarix ramosissima	2	1	-	-	1	-	1	-	-	1	6	50	0.6
Alhagi maurorum	2	2	1	2	-	1	1	3	1	2	15	90	1.5
Salsola incanescens	2	3	1	1	1	-	1	1	2	1	13	90	1.3
Aeluropus littoralis	2	2	-	-	1	-	4	2	-	3	14	60	1.5
Peganum harmala	1	3	-	2	-	2	-	-	1	-	9	50	0.9
Atriplex canescens	1	-	1	-	1	-	1	-	1	-	5	50	0.5
Total	10	11	3	5	4	3	8	6	5	7	63	390	6.3

Abbreviations: F=Frequency, D=Density

Table 5: Phytosociological attributes of vegetation occurring in the Dry Land area

Species	N	% F	FC	RF	A	D	RD	RDo	IVI
Tamarix ramosissima	6	50	C	16.66	1.20	6.60	9.67	100.00	124.47
Alhagi maurorum	15	90	E	30.00	1.36	1.50	24.41	0.00	54.41
Salsola incanescens	13	90	E	30.00	1.44	1.30	20.96	0.00	50.96
Aeluropus littoralis	14	60	C	20.00	3.75	1.50	24.19	0.00	44.19
Peganum harmala	9	50	C	16.66	1.80	0.80	14.51	0.00	31.16
Atriplex canescens	5	50	C	16.66	1.00	0.50	8.00	0.00	24.66

Abbreviations: N=Number of individuals, F=Frequency, FC= Frequency Class, RF= Relative frequency, A= Abundance, D=Density, IVI= Importance Value Index, RD= Relative Density, RDo=Relative Dominance

Table 6: Phytosociological attributes of vegetation occurring in the Agriculture area

Species	N	% F	FC	RF	A	D	RD	RDo	IVI
Tamarix ramosissima	7	50	C	16.66	1.00	0.30	3.48	100.00	120.14
Tamarix aphylla	3	30	B	6.66	1.42	1.00	11.49	100.00	118.15
Aeluropus littoralis	15	80	D	26.66	1.87	1.50	44.82	0.00	71.48
Aeluropus repens	14	80	D	26.66	1.87	1.50	17.44	0.00	44.10
Salsola incanescens	12	80	D	26.66	1.50	1.20	13.79	0.00	40.45
Alhagi maurorum	16	80	D	26.66	2.00	1.60	13.79	0.00	38.05
Peganum harmala	4	40	B	13.30	1.00	0.40	4.59	0.00	17.92
Atriplex canescens	4	40	B	13.30	1.00	0.40	4.59	0.00	17.92
Cyperus rotundus	8	30	B	6.66	4.00	0.80	9.19	0.00	15.82
Cynodon dactylon	3	30	B	6.66	1.50	0.30	3.44	0.00	10.00

Abbreviations: N=Number of individuals, F=Frequency, FC= Frequency Class, RF= Relative frequency, A= Abundance, D=Density, IVI= Importance Value Index, RD= Relative Density, RDo=Relative Dominance

Table 7: Phytosociological parameters (attributes) of vegetation occurring in the Wastewater irrigation area

Species	N	% F	FC	RF	A	D	RD	RDo	IVI
Tamarix aphylla	10	50	C	11.43	1.000	0.50	8.77	100.00	120.20
Tamarix ramosissima	3	30	B	6.660	1.000	0.30	2.40	10000.00	109.06
Aeluropus littoralis	32	90	D	11.43	2.170	3.20	17.54	0.00	28.97
Aeluropus repens	18	80	D	11.43	12.24	1.80	16.80	0.00	28.23
Alhagi maurorum	12	80	D	11.43	2.250	1.80	15.79	0.00	27.22
Salsola incanescens	12	80	D	11.43	1.500	1.20	10.53	0.00	21.95
Atriplex canescens	6	80	D	11.43	1.500	1.20	10.53	0.00	21.95
Cyperus rotundus	12	60	C	8.570	1.000	0.60	5.26	0.00	13.83
Bromus tomentellus	6	60	C	5.710	1.000	0.60	4.08	0.00	9.22
Bromus japonicus	4	40	B	5.710	1.000	0.40	2.72	0.00	8.83
Bromus persicus	2	20	B	5.710	1.000	0.20	1.36	0.00	7.27
Cynodon dactylon	6	40	B	5.710	1.000	0.40	3.51	0.00	9.22
Peganum harmala	5	40	B	5.710	1.000	0.40	3.51	0.00	9.22
Poa bulbosa	11	60	C	8.570	3.000	1.80	15.79	0.00	24.36
Lolium persicum Boiss. & Hohen. ex Boiss.	8	60.00	C	8.57	1.00	0.60	5.26	0.00	13.83

Abbreviations: N=Number of individuals, F=Frequency, FC= Frequency Class, RF.= Relative frequency,
A= Abundance, D=Density, IVI= Importance Value Index, RD= Relative Density, RDo=Relative Dominance

Table 8: Shannon and Simpson Diversity Indices

	Diversity Index	
	Shannon	Simpson
Wastewater area	2.24	0.88
Agriculture area	1.56	0.78
Dry land area	0.97	0.59

Table 9: Analysis of vegetation in the study area

Plant species	WWI	AGR	DRY	T	Family	Q
Tamarix aphylla L. (Karst.)	10	3		13	Tamaricaceae	2
Tamarix ramosissima Ledeb.	3	7	6	16	Tamaricaceae	
Alhagi maurorum Medik.	12	16	15	43	Fabaceae	1
Salsola longifolia Forssk.	7	-	-	7	Chenopodiaceae	2
Salsola incanescens C.A. Mey.	5	12	13	30	Chenopodiaceae	
Cyperus rotundus L.	12	8	-	20	Cyperaceae	1
Bromus tomentellus Boiss.	6	-	-	6	Poaceae	8
Bromus japonicus Thunb. ex Murr.	4	-	-	4	Poaceae	
Bromus persicus Boiss. ex Steud	2	-	-	2	Poaceae	
Aeluropus littoralis (Gouan) Parl.	32	15	15	62	Poaceae	
Aeluropus repens (Desf.) Parl.	18	14	-	32	Poaceae	
Cynodon dactylon (L.) Pers.	6	3	-	9	Poaceae	
Poa bulbosa L.	11	-	-	11	Poaceae	
Lolium persicum Boiss. & Hohen. ex Boiss.	8	-	-	8	Poaceae	
Peganum harmala L.	5	4	9	18	Zygophyllaceae	1
Atriplex canescens (Pursh) Nutt.	6	4	5	15	Chenopodiaceae	1
Total	147	86	63	296		16

Abbreviations: WWI= Waste Water Irrigation Area, AGR = Agricultural area, DRY=Dry land area,
T=Total number of individuals, Q= Number of species in families

The number of species in the wastewater irrigated area was greater than that of the agricultural and dryland area. Higher density of individuals of *Aeluropus* sp was registered in the wastewater irrigation area. Results confirm that the use irrigation water, sewages are a potential source of plant nutrients. *Aeluropus* spp, occupied more than a third of recorded species in all habitats.

Dry Land Area: The phytosociological studies reveal that the *Tamarix ramosissima* was the dominant and showed the highest Importance Value Index in dryland area (Table 5, Figure 2). This site showed mixed vegetation of species like, *Alhagi maurorum*, *Salsola incanescens, Aeluropus littoralis, Peganum harmala* and *Atriplex canescens*, which were the species occur in this site (Figure 4). The plant community was represented by *Tamarix-Aeluropus-Alhagi-Salsola. Alhagi* and *Salsola* have the highest frequency and IVI in dryland area compared to the other two sites. *Tamarix* has the highest IVI and it is followed by *Alhagi maurorum, Salsola incanescens, Aeluropus littoralis, Peganum harmala* and *Atriplex canescens*.

Agricultural Area: The study suggests that the vegetation was characteristically dominated by *Tamarix* species in agricultural area. The other abundant and most frequent species of this area were *Alhagi maurorum, Salsola incanescens, Aeluropus littoralis, Aeluropus repens*. *Tamarix ramosissima*, *Tamarix aphylla* have highest IVI followed by *Aeluropus repens* and *Salsola incanescens* (Table 3, 6; Figure 3). The frequency shows the homogeneity of vegetation. However, based on the results, the community, ecosystem structure is disturbed by human activities and showed integrity.

Wastewater Irrigation Area: The wastewater of the Zabol city is collected, treated and used for the afforestational, horticultural and agricultural purposes in some parts of the study area. The studies in this area suggest that *Tamarix* species was the dominant and showed the highest IVI. Other species were equally frequent in distribution and rather showed more abundance and density values. This site has higher number of species and individuals. *Aeluropus littoralis, A. repens, Alhagi maurorum*, *Salsola incanescens* and *Atriplex canescens*, were the most abundant and frequent species of this site. The plant community was represented by *Tamarix-Aeluropus-Alhagi-Salsola* in wastewater irrigation area (Table 2).

The highest IVI was of *Tamarix* species followed by *Aeluropus littoralis, A. repens* and *Alhagi maurorum*. The *Bromus persicus, B. japonicus B. tomentellus, Cynodon dactylon* and *Peganum harmala* species were represented by least IVI values (Table 7, Figure 4). However, based on the results, the community and ecosystem structure is disturbed and the vegetation shows heterogeneity [20].

Diversity Indices: Diversity is often represented in the form of statistical indices. These are referred to as heterogeneity indices. The Shannon ($H = -\sum P_i(\ln P_i)$) and Simpson's ($D = -\sum P_i^2$) diversity indices for this study indicate that the area is represented by few species [21]. The highest diversity (Shannon 2.24 and Simpson 0.88) was recorded from wastewater area where as dry land showed lowest diversity (Table 8, Figure 1). These results were clearly supported by the IVI values of the species. It depicts the impact of factors like livestock grazing and other human intervention on the regeneration of different species.

CONCLUSIONS

This study shows that the use of waste water for irrigation has a positive effect on the development of natural vegetation. Moreover, it emerged that of the 3 different types of land use in Sisan, the areas irrigated with waste water were richest in terms of number of species and population. The irrigation with waste water from inhabited areas is of great significance for dry and semi-dry regions. The amount of waste water has increased with the growth of cities and the burgeoning population. In contrast to the environmental risks posed by developing and low-income countries, the use of waste water contributes to development of vegetation in dry lands. The increased use of treated waste water will in fact reduce environmental risks. The agricultural and afforestation areas of the Sistan region which were previously irrigated by rivers flowing from Afghanistan are now without water. Consequently, natural vegetation has been adversely affected and agricultural production has greatly decreased. The use of waste water is therefore seen as a solution. In the result of these, the wastewater in the Sisan region favors the development of vegetation. The other studies suggest that the use of treated waste water to irrigate vegetation had positive effects on growing of the plants [22-24]. The studies from wastewater irrigated sites reported maximum number of species, depicting highest diversity among all sites. This clearly indicates that the wastewater, particularly city sewage after purified can be effectively used in restoration of dry land in Sistan Region.

In this respect, urban wastewater is a rich source of nutrients, but there are many aspects of using wastewater based on chemical, biological and physical properties of soils which need to be investigated in more details.

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