Original Article

Investigating the Environmental Status of *Haloxylon* Plantations in Aran va Bidgol Deserts (Isfahan-Iran)

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Abstract

Aims: A large part of Iran is located in an arid area that is exposed to the influx of quicksand. This research has been done to investigate the environmental situation of *Haloxylon* plantations in Aran and Bidgol deserts. **Materials and Methods:** This research is a descriptive study. First, 31 plots with *Haloxylon* and two plots without *Haloxylon* were selected in Aran and Bidgol deserts, and the parameters of cover density, tree height, wind, humidity, and temperature in those plots were measured. **Results:** The results showed that 80% of the *Haloxylon* in the study area was green and 20% of them were dried. Temperatures and wind speed were lower in plots that had *Haloxylon* and higher humidity than plots without *Haloxylon*. **Conclusion:** The data from this study show that the greenness of the *Haloxylon* was related to the altitude. Moreover, the temperature, humidity, and wind speed had a remarkable relationship with the presence of *Haloxylon* and the greenness and their height.

Keywords: desertification, diseases, environment

Introduction

Iran is one of the countries with less than one-third of the world's average rainfall,[1] which is located on the dry belt of the Northern Hemisphere and contains 60% and 35% of arid and semi-arid climates, respectively.[2] Twelve million hectares of such land are surrounded by quicksand,[3] which is constantly exposed to wind erosion and the influx of quicksand.[4] One of the first steps in stabilizing quicksand and controlling wind erosion is the use of protective mulch on the soil surface. However, today, the oil mulch, due to its problems and limitations, is less used.[5-8] On the other hand, nonoil mulch such as organic matter and animal manure is not used due to their high cost.[8] While the establishment of vegetation cover and ecological barriers with the least damage can have the greatest impact on reducing wind erosion, reducing the movement of quicksand and stabilizing them, and long-term improvement of the ecosystem.[9,10] *Haloxylon* spp. has found a special place in sand stabilization and desertification projects due to having adaptability and coping with the dry and stressful conditions of the desert, salinity, and heat.[11] *Haloxylon* is a genus of spinach belonging to the Chenopodiaceae family, and about 2 million hectares of the country's desert have been afforested by this plant.[12,13] Of the 19 species of *Haloxylon* in the world, three species are known as *Haloxylon persicum*, *Haloxylon aphyllum*, and *Haloxylon ammodendron* in the rangelands of Iran.[14,15] The *Haloxylon* plant uses its root characteristics in drought resistance.[16] The ability to absorb low soil and air moisture, tolerate very high and very low ambient temperatures, tolerate intense sunlight, and natural regeneration are the prominent features of this plant.[17] These resistant species can also be seriously threatened by pests and diseases.[15,18] Furthermore, due to their ability to produce coal, they are misused by humans or used by livestock as fodder.[19,20] Some researchers believe that *Haloxylon* in its shelter creates a

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special environment, in which forage plants can grow better and leads to increasing biodiversity and the floristic composition of the land.[12,21-23] There are also reports of negative effects of *Haloxylon* cultivation on the culture medium. Jafari *et al*. reported an increase in electrical conductivity and soil acidity in areas under *Haloxylon* cultivation in the area.[24] However, today, with the increasing problems caused by desertification, the need to pay more attention to this suitable species has become more apparent. Aran va Bidgol countries have a dry and desert climate and are one of the most endangered areas for wind erosion and sandstorms in the country. In this regard, 120,000 hectares of hand-planted forest in deserts are the result of desertification and transplanting since the 1940s, which is a barrier to quicksand. However, it has been destroyed in the past three decades, which has led to decreasing its beneficial environmental effects. Due to the importance of *Haloxylon* planting, this research has been done to investigate the environmental status of *Haloxylon* planting in Aran and Bidgol deserts.

Materials and Methods

Area of study

Aran va Bidgol countries with an area of 6051 km^2 is located in the north of Isfahan province. This city is limited to Namak Lake and Qom and Semnan provinces from the north, to Kashan city from the west and southwest to Natanz from the south and to Ardestan from the east [Figure 1]. The sand dunes are stretched from the southeast of the city to the northwest, with a length of 120 km and a width of 25 km and a height of between 800 and 1000 m, which covers about 1900 km^2 or 31% of the city's area, and in the local term, it is called Band-e Rig. Of the total area of deserts in Isfahan province (3,200,000 hectares), only about 300,000 hectares have been afforested, and Aran va Bidgol accounts for about 40% of the province's *Haloxylon* sp. habitats [Figure 2]. This region has dry and desert climate. Its summer season is warm and scorching and lasts from mid-June to mid-November, and its winter season, which lasts from December to the end of March, is cold and dry, and spring and autumn seasons are short. According to the statistics of the nearest meteorological station to the study area, i.e., Kashan synoptic station, the average annual rainfall in the region is 120 mm, with the highest percentage of rainfall occurring from winter to early spring. The average monthly temperature is 19.6°C; the maximum average temperature is 41°C in July, and the minimum average is 1.5°C in February. The average annual absolute temperature fluctuations are between −13 and +48°C. The average maximum relative humidity is related to January and is 65%, and the minimum is related to July and is 25%, and the average annual relative humidity is 40%.

Research method

This study is a descriptive study conducted to investigate the environmental status of *Haloxylon* planting development in Aran va Bidgol deserts. At first, the map of the political area

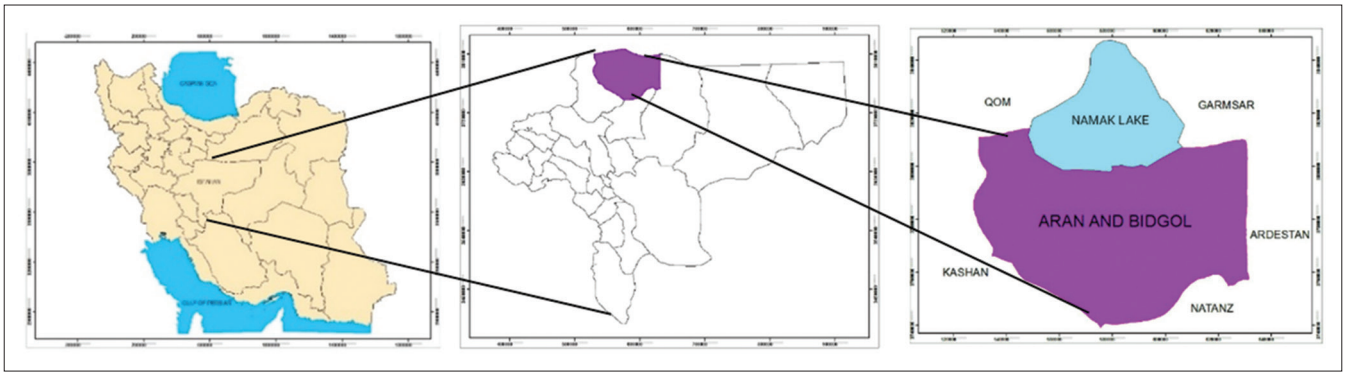

Figure 1: Geographical location of the study area

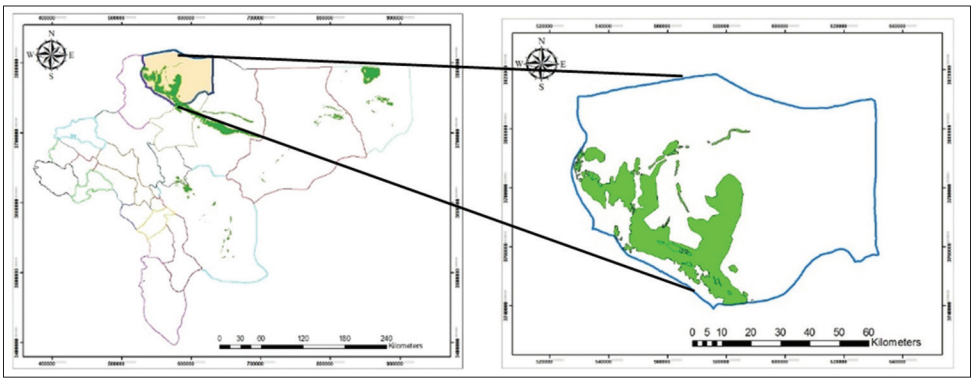

Figure 2: Map of hand-planted forests in Isfahan province and Aran va Bidgol cities

of the study area was prepared using GIS and Google Earth software collaboration with the Natural Resources Organization of Aran va Bidgol County, based on the map of hand-planted *Haloxylon* habitats in Aran va Bidgol desert. Then, a route on the map was randomly chosen from Hoseynabad-e Sheibani, southeast of Aran va Bidgol to Nasrabad, northwest of Aran, and Bidgol so that it was not difficult to access and did not enter agricultural lands and residential areas. After that, 31 plots, each with an area of 1000 m^2 with a length of 50 m and a width of 20 m, covering all areas and lengths of the route and representing the area, with 3 km distances were marked by GIS on the map [Figure 3]. Field studies were carried out in 31 days of spring with the same weather conditions from 10 to 12 in the morning with an expert from Aran and Bidgol natural resources organization and in a continuous and daily, one plot was examined and measured. First, by Global positioning system (GPS), the point of each plot was founded, and the plot area was determined by a string. The length, width, and height of the sea level for each plot were recorded. The dry and green *Haloxylon* was counted and recorded. To measure the height of the trees, the highest, shortest, and most tree height mode were measured in each plot with a tape measure so that the difference in height of the tallest branch to the location of the tree collar became the criterion for action. Wind speed, temperature, and humidity were measured by a digital wind gauge, thermometer, and humidity meter. Moreover, two plots without *Haloxylon* were randomly selected in the vicinity of two plots with *Haloxylon*, and the last three parameters were measured in adjacent plots with *Haloxylon* and without *Haloxylon* at a certain time. Then, the data were extracted and classified and presented by tables and graphs, and the results of the study were interpreted, analyzed, and evaluated.

Results

The results of this study revealed that the study area with an area of 33,000 m^2 includes 33 plots and has located between two longitudes from 529,096 to (UTM) 584,082 and two latitudes from 3,740,657 to (UTM) 3,790,383, and the altitude is 840–985 m. Out of studied plots, two plots were without *Haloxylon*, 27 plots have been planted through seeding, planted seedling, and irregular cutting since 1971, and four plots in the northern region of Nasrabad have been planted in the form of regular and row planting at intervals of 6.5–7.7 m since 2006 during the implementation of seedling projects of Aran va Bidgol Natural Resources Organization.

The number of *Haloxylon* in them is less than the number of plots created through seeding so that in each 1000 m^2 of them, there are 17, 17, 17, and 13 *Haloxylon*, respectively, which only three dry *Haloxylon* trees are present in four plots. The results of the study showed that 3304 *Haloxylon* were identified and counted in the whole study area. The highest number of *Haloxylon* in the landfill plot is 15.57%, and the lowest number of *Haloxylon* 0.77% was in the seedlings planted in the North of Nasrabad [Table 1].

The results of the study showed that, out of a total of 2655 green *Haloxylon* counted, the highest number of green *Haloxylon* was in the landfill plots 12.22%, and the lowest number of green *Haloxylon* was 0.92% in the planted seedlings of North Nasrabad [Table 2].

The results of the study showed that out of a total of 649 dry *Haloxylon* counted, the highest number of dry *Haloxylon* 29.68% was in the landfill plot, and the lowest number of dry *Haloxylon* was 0.18% in the planted seedlings of North Nasrabad [Table 3].

The results of the study showed that the height of trees in the study areas varies from 0.3 to 2.75 m and the highest height belongs to areas of Aliyabad-e Fakhreh with a height mode of 2.35 and Rijen with a height of 2.1 and the lowest height belongs to Hoseynabad-e sheibani, Kaghazi, between the landfill and Majid Abad farm and the bypass road [Figure 4].

The results showed that the average wind speed was 2.17 m/s and the maximum wind speed was 3.2 m/s, and the lowest was 0.9 m/s, and the average relative humidity was 15.88% and the highest humidity was 27% and the lowest was 10%.

Figure 3: Map of the study route

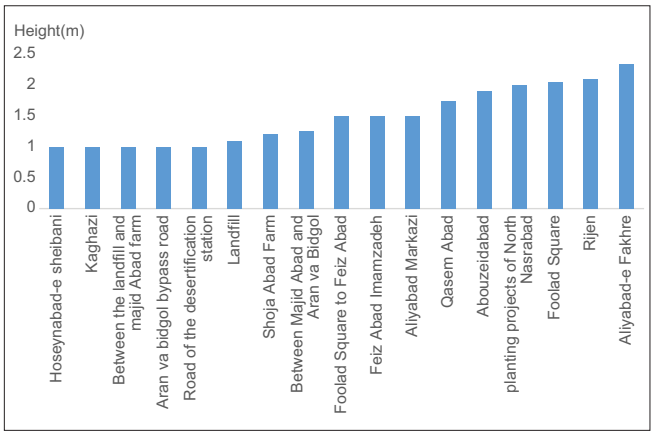

Figure 4: The height of the trees in the study areas according to the height mode

Table 1: The average frequency of the number of *Haloxylon* per region

Areas	Plot number	Total number of *Haloxylon* per region	Average per plot	Percentage of each region
Planting projects of North Nasrabad	4	64	16	0.77
Foolad Square to Feiz Abad	1	21	21	1.02
Aran va Bidgol bypass road	3	104	34	1.65
Foolad Square	2	138	69	3.35
Rijen	2	176	88	4.28
Between the landfill and majid Abad farm	1	100	100	4.86
Kaghazi	1	100	100	4.86
Qasem Abad and Yazdelan	2	202	101	5.01
Shoja Abad Farm	1	110	110	5.35
Hoseynabad-e sheibani	3	339	113	5.5
Aliyabad and Mohamad Abad-e Markazi	1	142	142	6.91
Road of the desertification station	2	290	145	7.05
Abouzeidabad	2	310	155	7.54
Between Majid Abad and Aran and Bidgol	2	320	160	7.78
Feiz Abad Imamzadeh	1	190	190	9.25
Aliyabad-e Fakhreh	2	380	190	9.25
Landfill	1	320	320	15.57
Total	31	3306	2054	100

Table 2: The average frequency of the number of green *Haloxylon* per region

Areas	Plot number	Total number of green *Haloxylon* per region	Average per plot	Percentage of each region
Planting projects of North Nasrabad	4	61	15.25	0.92
Aran va Bidgol bypass road	3	54	18	1.05
Foolad Square to Feiz Abad	1	20	20	1.21
Foolad Square	2	125	62.5	3.78
Road of the desertification station	2	148	74	4.48
Rijen	2	156	78	4.72
Between the landfill and majid Abad farm	1	80	80	4.84
Qasem Abad and Yazdelan	2	162	81	4.89
Kaghazi	1	84	84	5.09
Shoja Abad Farm	1	90	90	5.45
Hoseynabad-e sheibani	3	308	102	6.22
Between Majid Abad and Aran and Bidgol	2	250	125	7.57
Abouzeidabad	2	260	130	7.87
Aliyabad and Mohamad Abad-e Markazi	1	133	133	8.06
Aliyabad-e Fakhreh	2	338	169	10.24
Feiz Abad Imamzadeh	1	188	188	11.39
Landfill	1	200	200	12.22
Total	31	2657	1649.08	100

The average temperature is 37.34°C, the highest temperature is 45°C, and the lowest is 30.16°C.

The results of the study showed that the average wind speed in the two plots without *Haloxylon* is 4.9 m/s; in the first plot, it is 3.8 m/s, and in the second plot, it is 6 m/s. The wind speed in the adjacent plots with *Haloxylon* is 1.4 and 3.5 m/s, respectively, and their average is 2.45 m/s. The wind speed is higher in plots without *Haloxylon*. The average humidity in the two plots without the *Haloxylon* is 10.5%; in the first plot, it is 11%, and in the second plot, it is 10%. Humidity in adjacent plots with *Haloxylon* is 14% and 13%, respectively, and their average is 13.5%. Humidity is lower in plots without *Haloxylon*.

In the study area, several subsidence sections were observed in the plot of Aliyabad-e Fakhreh with lengths of 2.5 and 1.5 m, width of 50 and 30 cm, and unlimited depth [Figure 5].

Discussion

According to the results of the study, out of 3304 counted *Haloxylon*, there should be an average of 106 *Haloxylon* in

Table 3: The average frequency of the number of dry *Haloxylon* per region

Areas	Plot number	Total number of dry *Haloxylon* per region	Average per plot	Percentage of each region
Planting projects of North Nasrabad	4	3	0.75	0.18
Foolad Square to Feiz Abad	1	1	1	0.24
Feiz Abad Imamzadeh	1	2	2	0.49
Foolad Square	2	13	6.5	1.6
Aliyabad and Mohamad Abad-e Markazi	1	9	9	2.22
Rijan	2	20	10	2.47
Hoseynabad-e sheibani	3	31	10.33	2.55
Kaghazi	1	16	16	3.95
Aran va Bidgol bypass road	3	50	16.66	4.12
Shoja Abad Farm	1	20	20	4.94
Between the landfill and majid Abad farm	1	20	20	4.94
Qhasem Abad and Yazdelan	2	40	20	5.04
Aliyabad-e Fakhreh	2	42	21	5.19
Abouzeidabad	2	50	25	6.18
Between Majid Abad and Aran and Bidgol	2	70	35	8.65
Road of the desertification station	2	142	71	17.56
Landfill	1	120	120	29.68
Total	31	649	404.24	100

Figure 5: View of two subsidence in the study area

each plot, which in some plots, the number of *Haloxylon* was lower than average, and in some other plots, it was higher than average. Moreover, in some areas, the number of dry *Haloxylon* was more than green, which is likely due to proximity to roads, rural and residential areas, people's entertainment and the use of *Haloxylon* wood for the fire or wood smuggling by profiteers, *Haloxylon* diseases, overgrazing, and the destruction by local livestock, which is consistent with the research of some researchers.[25-28]. *Haloxylon* in the lowlands was more vibrant and lush than the trees in the higher lands due to their high gravity and proximity to groundwater, which is consistent with the research of some researchers.[18] One of the reasons for the decrease in plant height in different areas of stress is due to factors such as drought and sandstorms and the quality of the soil, in which the plant is grown. According to the results of the study in plots where the height of the trees is higher, the wind speed is lower than in other plots. Furthermore, in the plots with *Haloxylon*, the wind speed is lower than the adjacent plots without *Haloxylon*; it means that the vegetation is largely effective in declining the in wind speed, which is due to the fact that trees can be considered to act as windbreaks. These results are consistent with the research of some researchers.[29-31] Our findings suggest that the temperature is lower in plots with *Haloxylon* compared to plots without *Haloxylon,* but the humidity is higher than adjacent without *Haloxylon* plots; this is due to the presence of vegetation, which is led to balancing the temperature and humidity, which is consistent with the research of some researchers.[32-36] Based on the results, a number of land subsidence was observed in the study area, which can be attributed to the outflow of water from the soil particles due to groundwater abstraction and the vacuum between the aggregates, which has caused this subsidence; probably the overharvesting of water and excessive pumping of water for agricultural use is the main reason for this. This is consistent with the research of some researchers.[37-39] Our study showed that the current environmental situation of *Haloxylon* planting in Aran va Bidgol deserts has made it a sustainable ecosystem. This ecosystem is self-sufficient, and if not tampered with and destroyed, it can play a valuable role in balancing the climate of the region. Biorichness in this area includes animals such as birds, rodents, insects, and other hunter and vegetarian arthropods, each of which has its own special effects on the nature of the region.[24]

Conclusion

The data from this study show that the greenness of the *Haloxylon* was related to the altitude so that the *Haloxylon* that were in lower altitude was greener than the trees in the higher altitude due to the force of gravity and moisture. Moreover, the temperature, humidity, and wind speed had a remarkable relationship with the presence of *Haloxylon* and the greenness and their height. Humidity was higher in green

areas; temperature and wind speed are lower. it is suggested that the number of custodians is considered in accordance with the global standard for natural areas and that legal protection is provided to them.

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Conflicts of interest

There are no conflicts of interest.

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