The Impact of Climate Changes on Medicinal Plants in the Western Plateau / Al-Anbar Governorate

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Abstract:
This paper looked at the impact of climate changes represented by humidity, temperature and other related phenomena, on the growth of desert plants in the western plateau of Anbar Governorate. Desert plants covers 70% of Iraq area, consist of short herbs and thorny plants that resists drought. The number of desert plants is around 450 species of which 99% of medicinal use. Climate data analysing of the region under study, has been conducted for both annual and monthly temperature and humidity rates from 2010-2019. In addition, the effect of humidity and temperature on desert plants were reviewed, due to the importance of the temperature and its close relationship with humidity which is essential for plants growth. The article found that the changing of climate phenomena is one of the main factors that determine the quality and nature of the presence of different plant species in the study area.

Introduction

The atmosphere on earth contains a ratio of water content called, water vapor. If this amount of water is low, then the atmosphere called dray at this region. Or hummed if the water ratio is high (Joda & Abuayana, 1986). To refer to this ratio, the term relative humidity is used. Relative humidity defined as the percentage of water vapor that exist at a certain temperature in the air to the amount of water vapor that could be carried by that air (Joda & Abuayana, 1986).

Atmospheric humidity refers to the air content of water vapor, whose percentage in the atmosphere varies from one place to another and varies with time. This difference has clear implications on weather and climate phenomena (Musa, 2017). Plant growth wise, it is considered one of the most important factors due to its role on decreing the transpiration rate thus the decrease in the ability of the plant to adsorb water and nutrients from the soil. Low humidity and dryness of the air coupled with the high temperature, raises the rate of transpiration and may reach the point where roots became unable to supply the plant with sufficient moisture to compensate what has been lost by transpiration, which may cause plant wilting and then death. Therefore, studying humidity and its effects on plant growth is very important, especially in arid and semi-arid regions, which includes the study area (Musa, 2017). The research aim is to know humidity impact on the growth of desert medicinal plant by analysing temperature, and relative humidity data for the study area. Also, knowing the direct and indirect effects on the morphology of the plant in the western region of Iraq.

1. General characteristics of the study zone

1.1. The zone borders

The study area located west of Iraq in the western plateau within Alanbar governorate, and it is sometimes called the Northern Badia. Wadi al-Khar forms the border that separating it from the southern desert, as the boundaries of the administrative governorate coincide with this valley,
separating it from the borders of Najaf governorate. While the Euphrates River forms the eastern border of the study area. From the west and southwest, its bordered by Syrian Arab Republic, the Hashemite Kingdom of Jordan, and the Kingdom of Saudi Arabia. The study area is located between two latitude (21′35′30″ to 48°31′34″) north and between longitudes (46°47′38″ to 02°08′44″) east as shown in the map (1). The total area is (116,000) km² (Alfaḥdawī, 2012). It is equal to (84.2%) of Alanbār Governorate area, amounting to (137723) km², while it forms (26.5%) of the total area of Iraq (438317) km² (Alfaḥdawī, 2012). Because of the large study area and the difficulty of covering all its valleys with morphometric studies, therefore, we focused on Horan valley as a case study.

Map (1) the location of the study area within Iraq

Map; (Gharbi & Byty, 2020, Ayed, 2021)

2. Medicinal plants in the area
Many species have been reported in the area and been widely used for alternative thereby; Matricaria chamomilla, Salvia officinalis, Echallium elateriam, Hyssopus officinalis, Inula viscos, Thymus vulgaris, Althaea officinalis, Mellissa officinalis, Capparis spinosa, Digitalis purpurae (Duke, 2007, Zohary, 1982, Haloob, 2016). Also aromatic herbs that used for both medicinal and beauty purposes such us; Glycyrrhiza glabra, Artemisis sp, Laurus nobilis, Mentha peperita, Rosa damascene (Das, et al., 2016, Courtney, 2009, Cavaliere, 2008, Abbo, et al., 2008). Some classified as poisons plants but has a specific active component that can be used medicinally like Papaver somniferum (Abboud & Waheed, 2017)

3. Terms related to humidity

Specific Humidity: It is the ratio of the mass of water vapor present in the mass of moist air, expressed as the number of grams of water vapor contained in one kilogram of natural air, and is calculated as in the following equation (Ayed, 2021):

\[ \text{Specific Humidity} = \frac{\text{water vapor mass}(gm)}{\text{moist air mass}(kg)} \]

Absolute Humidity: refers to the mass of water vapor present in a unit volume of air (g/ m³) (Harrison, 1965).

Dew point: The dew point is defined as the temperature at which the air humidity begins to condense, and it is most likely less than the air temperature, or equal to it when the relative humidity is 100%. Dew is formed when the thin layer of air that is in contact with a surface is cool enough and below the dew point. Air cooling leads to the formation of dew on the surface or fog in the air. if the dew point is higher than the freezing point, than frost may form on the surface, or ice crystals in the air. Fog and clouds occur when Large quantities of air are cooled below the dew point (Aldizy, 2013; Harrison, 1965).

Relative Humidity: Relative humidity is an accurate indicator of humidity, as it expresses the degree to which air is close to saturation with water vapor, and relative humidity is the ratio between the mass of water vapor that is actually present in a volume of air to the mass of water vapor required to saturate this volume of air at the same temperature. It is expressed as percentage, and relative humidity is important for being responsible for many weather phenomena such as; precipitation, winds moisture, clouds type and density, and the radiation that reaches the earth surface (Aldizy, 2013; Harrison, 1965).

4. Factors impacting humidity

Temperature directly proportionally related to humidity. Air that is exposed to high temperatures is more susceptible to the formation of humidity, the opposite is true, the humidity decreases with the decrease in the air temperature, this is true in the areas near water bodies and tropical rain zones. In the arid and semi-arid regions, the relationship between air humidity and temperature is inverse (Kuwagata, et al., 2012).

Water bodies, the relationship between water bodies and humidity is also a direct one. The increase of water bodies area, the greater the percentage of relative humidity (Musa, 2017).

Vegetation cover, humidity is also related positively to the flora in the surrounding area (Musa, 2017).

Wind speed, the higher the wind speed when passing over a water surface, the greater the amount of water vapor carried between the air atoms, which causes an increase in humidity. Atmospheric pressure and salinity also relate to humidity (Musa, 2017).

5. The impact of relative humidity on plants
Soil moisture, water is the carrier of salts and minerals which are vital for plants' lives. The nutrients are taken from the soil by roots, transported and distribute to the leaves to produce the needed energy through photosynthesis (Abusammor, 2005). The amount of water needed to be absorbed from the soil is considerable. For example, a tree species in moderate latitudes at the beginning of summer, loses 70-80 litre of water a day, some of which lose 200 litres of water during the day (Abusammor, 2005). Herbs have a unique ability to transport water, so they can put water in a continuous movement from 250-1000 times greater than their real weight. One hectare of plants can lose 100 tons of water from the beginning of spring to early autumn, and in the dry areas, the transpiration process is much intense in order to save on the process of water transformation or in order to reduce the loss of water, as the plants have formed special organs to face these natural conditions where they have well-absorbed roots and their leaves are very small or turned into thorns to reduce the water loss process (Abusammor, 2005).

5.1. The morphological adaptation to the reduced humidity

Humidity has a direct effect on the intensity of transpiration, which in turn determines in many cases whether the plant can live in a specific environment or not (Ibrahim, 2016). There is a belief that the western plateau area in Anbar governorate is a barren spot; the truth is otherwise (Mekalif, 2007). Most of western plateau areas are rich in shrubs and herbs, and despite its harsh and hot summer, cold weather in winter, which is represented by high temperatures in summer and low in winter, there are plants that have been adapted to these environmental conditions through (Mekalif, 2007): i) Storing water in some parts, such as leaves that have turned into a succulent shape, or thick stems, as in the Banana family or in its ground tubers as in the wild bulbs (Kelaif, 2020). ii) The presence of thick waxy materials between the walls of some parts of these plants to prevent water loss and moisture remaining in their vegetative parts (Mekalif, 2007). iii) The modifications in some of vegetative parts of some plants to reduce the transpiration process, such as metamorphosis of leaves into a needle or spiny shape (Mekalif, 2007). iv) Some seeds of adapted species pass a long dormant period that extends to five years to resist drought until appropriate conditions for germination occur (Mekalif, 2007). v) Some plants developed hairs or fluff on some parts of the plant to protect them from the burning sun rays (Mekalif, 2007). vi) Extending the roots of some plant species to great depths to obtain moisture, which may sometimes reach more than 7 meters, as in thorns, wormwood and meadows (Mekalif, 2007).

5.2. The importance of moisture to the plants’ growth

Atmospheric humidity and the amount of water vapor in the air directly affect some physiological processes in the plant, especially during the stages of flowering, fruiting and growth. The increase in air humidity means the reduction of plant transpiration and evaporation from the soil, thus reducing flowering and fruiting (Abdulwahab, 2017).

The appropriate conditions for pollination of plants also depend on the air humidity (Abdulwahab, 2017). High humidity of the air during the pollination process leads to the fall of flowers in some plants, in the other hand increased air humidity in relation to the field crops is of great benefit, whether in extending plant life or mitigating its vulnerability to accidental drought. Suddenly, this is especially observed when warm and dry winds blow on the plants (Abdulwahab, 2017).

Desert areas are known by low relative humidity so that its annual rate does not exceed (50%) and being less than (30%) during the day. Accordingly, desert plants have adapted to this environment (Mohammed, et al., 2006). For example, perennial plants have been subjected to many modifications that made them more suitable for desert environments. Some soft desert plants that grow in some depressions have water storage organs, they may be in leaves or stems or in tubers and bulbs or in rhizomes (Alrawi, 1964). As for the perennial woody desert plants, most of them have long and deep roots that help absorb moisture from deep points in the soil. For the thorny plants that, some of its parts became thorns, so the area of its vegetative parts
exposed to the atmosphere shrank when exposed to unsuitable conditions so that less evaporation occurs (Mohammed, et al., 2006).

5.3. Mechanism for preserving moisture by desert plants

There are several cases that illustrate mechanisms, including adaptations related to stomata number, distribution, and control of their opening and closing (Mohammed, et al., 2006). For example, *Cyperus conglomeratus* plant, which has several advantages, including; i) stomates are concentrated on the lower surface of the leaves, reducing the amount of water loss. ii) also, stomates are sunken, and this adds another dimension to maintaining the water content of the plant (Yaseen & Alyafee, 2015).

High root / shoot ratio helps in providing large quantities of water to the shoot system, which is a feature that actively contributes to avoiding drought. Moreover, spongy roots that conserve water, reduced leaf area is another important mechanism due to stress conditions helping the plant to reduce the quantities of water lost by transpiration as seen *Leptadenia pyrotechnia* and *Ochradenus baccatus*. In addition, branches of the plant are green to carry out the process of photosynthesis (Yaseen & Alyafee, 2015).

The fescue plant (*Aeluropus agopoides*), adapted phenotypic properties to face drought conditions, such as straight or serrated leaves which would reduce water loss significantly, having green stems to increase the efficiency of the photosynthesis process compensating the shortage in leaf area, as well as a number of anatomical characteristics. On the other hand, this plant is one of the herbs that excrete salts externally which makes it salt and drought tolerance (Kuwagata, et al., 2012; Yaseen & Alyafee, 2015).

Another mechanism is water storing, many plants exhibit the characteristics of succulents, these plants possess water cells in the branches, leaves and roots. Succulent plants have acid metabolism, and these plants avoid drought by closing the stomata during the day to reduce the effect of transpiration on Water content, while their stomata open at night to stabilize carbon dioxide. For more water absorption, plants produce a network of roots or produce roots that grow in the depths of the soil to obtain sufficient water like *Helianthemum lipii* and *Cyperus conglomerates* (Kuwagata, et al., 2012).

Some plants have the ability to withstand deficiency in their water content due to the abundance of what they need from the mechanical elements and also by thickening of their cell walls, or reducing water in the protoplasm itself, which makes them withstand severe drought without being damaged, and they contain a high percentage of restricted water. Water bound to colloidal substances in living cells to the point that it loses the characteristic of free water in terms of its ability to rapidly evaporate under the influence of atmospheric evaporation factors. The presence of restricted water makes the protoplasm always in a state of hydration that preserves its vitality in dangerous drought conditions (Yaseen & Alyafee, 2015).

6. Materials and methods

The study data were collected from the weather monitoring stations, in cooperation with the Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring, Climate Section, by providing unpublished data that has been collected from the monitoring stations around the investigation area. The obtained data were for the cities located in the targeted area of the western plateau namely; Al-Qaim, Al-Rutba, Anah, Heet, Haditha, and Ramadi for the years between 2010 to 2019. Excel program has been used for data interpretation.

7. Results and discussion

7.1. Heat and humidity data analysis for the study area

Temperature: table (1) shows the average temperature in the study area for the period from 2010 to 2019, there is a variation in the temperature measured in the stations located in the region. In
the western parts of the region the lowest temperature is represented by the Al-Rutba station. The temperature was 19.53 degrees Celsius in this station, then it rises in the north-western part of the region, represented by Al-Qaim and Anah stations, as the temperature reaches 20.94 and 21.06 degrees Celsius for the two stations respectively. Temperature then rises in the southeast direction to reach the Ramadi station, which has recorded the highest temperature in the region at 23.27 degrees Celsius.

Table (1)

| Year | Al-Rutba | Ramadi | Heet  | Haditha | Anah  | Al-Qaim |
|------|----------|--------|-------|---------|-------|---------|
| 2010 | 21.07    | 24.53  | 23.92 | 23.05   | 22.53 | 22.44   |
| 2011 | 18.35    | 22.30  | 21.57 | 20.59   | 20.00 | 19.86   |
| 2012 | 19.49    | 23.38  | 22.63 | 21.65   | 21.12 | 21.01   |
| 2013 | 18.81    | 22.23  | 21.65 | 20.77   | 20.25 | 20.18   |
| 2014 | 19.21    | 23.32  | 22.52 | 21.50   | 20.93 | 20.80   |
| 2015 | 19.55    | 23.51  | 22.69 | 21.66   | 21.11 | 20.97   |
| 2016 | 19.70    | 23.30  | 22.64 | 21.70   | 21.14 | 20.99   |
| 2017 | 19.72    | 23.30  | 22.56 | 21.58   | 21.00 | 20.82   |
| 2018 | 20.14    | 23.79  | 23.12 | 22.24   | 21.77 | 21.66   |
| 2019 | 19.25    | 23.03  | 22.29 | 21.35   | 20.79 | 20.67   |
| Average | 19.53 | 23.27  | 22.56 | 21.61   | 21.06 | 20.94   |

Figure (1) also shows the average temperature in the study area for the same period, and it is noted that the highest annual temperature was recorded in 2010 for all stations and the Ramadi station surpassed the highest temperature of 24.53 degrees Celsius, while the lowest annual temperature was recorded in 2011 for all stations as well. The lowest temperature in Al-Rutba station was 18.35 degrees Celsius. Annual temperature in the study area fluctuates having ups and downs in certain directions, thus temperature is one of the most important factors that help the biodiversity and the dominance of a certain type of plants in certain regions in the study area.
Figure (1) the average temperature in the study area

Table (2) illustrates the average monthly temperature in the stations of the study area, and it is noticed that the monthly temperature varies more than the annual, especially during summer.

| Year     | Al-Rutba | Ramadi | Heet   | Haditha | Anah  | Al-Qaim |
|----------|----------|--------|--------|---------|-------|---------|
| January  | 6.15     | 8.49   | 7.95   | 7.03    | 6.73  | 6.82    |
| February | 8.13     | 11.00  | 10.41  | 9.45    | 9.11  | 9.17    |
| March    | 12.85    | 16.23  | 15.58  | 14.57   | 14.15 | 14.13   |
| April    | 18.90    | 22.79  | 22.00  | 20.96   | 20.47 | 20.41   |
| May      | 24.81    | 29.33  | 28.41  | 27.33   | 26.70 | 26.51   |
| June     | 29.12    | 34.13  | 33.26  | 32.28   | 31.45 | 31.12   |
| July     | 31.42    | 36.53  | 35.74  | 34.87   | 34.01 | 33.66   |
| August   | 31.38    | 36.24  | 35.45  | 34.56   | 33.70 | 33.34   |
| September| 27.72    | 31.93  | 31.18  | 30.25   | 29.55 | 29.27   |
| October  | 22.24    | 25.78  | 25.08  | 24.17   | 23.70 | 23.60   |
| November | 13.57    | 16.42  | 15.82  | 14.89   | 14.53 | 14.54   |
| December | 8.08     | 10.38  | 9.84   | 8.95    | 8.63  | 8.71    |
| average  | 19.53    | 23.27  | 22.56  | 21.61   | 21.06 | 20.94   |

Figure (2) The difference in temperature between Ramadi and Al Rutba stations was 5.11 degrees Celsius in July. The temperature for the two stations was 36.53 and 31.42 degrees Celsius for the two stations, respectively. The difference during winter decreased to 2.34 degrees Celsius between Ramadi and Al-Rutba stations, which recorded temperatures of 8.49 and 6.15 degrees Celsius, respectively. The decrease in the difference between the stations during winter is an indication of the decrease in the daily and monthly thermal range. This has a very important impact on biodiversity, especially as the area is located within arid and semi-arid regions.

![Temperature variation during the year](image-url)
Relative humidity: Table (3) shows relative humidity in the study area for the period from 2010 to 2019, in percentage. It is noticed from the data given that Anah station recorded the highest value in relative humidity as an average of 39.12%, while the lowest value was recorded in Ramadi station amounted to 36.72%, as for the distribution pattern The spatial level of relative humidity rises in the north-western parts of the study area, represented by Al-Qaim, Anna and Haditha stations, then it is followed by the western areas represented by Rutba station, while decreases in Ramadi station at the eastern regions.

Table (3)

| Year  | Al-Rutba | Ramadi | Heet  | Haditha | Anah  | Al-Qaim |
|-------|----------|--------|-------|---------|-------|---------|
| 2010  | 33.25    | 33.30  | 34.10 | 33.97   | 34.57 | 34.19   |
| 2011  | 38.38    | 35.46  | 36.63 | 36.92   | 38.07 | 38.18   |
| 2012  | 37.84    | 34.95  | 36.61 | 37.24   | 38.10 | 38.01   |
| 2013  | 39.48    | 39.08  | 39.79 | 40.06   | 40.92 | 40.70   |
| 2014  | 40.35    | 37.14  | 38.89 | 39.83   | 40.96 | 40.96   |
| 2015  | 37.59    | 36.23  | 37.81 | 38.55   | 39.07 | 38.74   |
| 2016  | 35.40    | 35.25  | 35.99 | 36.19   | 36.97 | 36.93   |
| 2017  | 34.28    | 34.31  | 35.66 | 36.02   | 36.79 | 36.80   |
| 2018  | 40.79    | 40.78  | 41.77 | 42.02   | 42.32 | 41.96   |
| 2019  | 42.37    | 40.65  | 41.94 | 42.33   | 43.47 | 43.46   |
| Average| 37.97   | 36.72  | 37.92 | 38.31   | 39.12 | 38.99   |

The distribution of air humidity in the study years, Figure (3) demonstrate that the lowest humidity percentage was recorded in 2010 for all stations in the study area, but the lowest value was in Al-Rutba station, which was 33.25%.

The pattern of humidity distribution took a different vector from the rest of the years, and this may be due to the phenomenon of drought and high temperature in this year. The highest humidity percentage recorded in 2019 for all stations, having its peak in Anah station at a value of 43.47%. A clear fluctuation in the values of relative humidity between years and stations, this is one of the most important factors that lead to diversity in vegetation cover, distribution
pattern and the dominance of certain species that have adapted themselves to the conditions available in the study area. The monthly distribution of relative humidity, Table (4) and Figure (4) show that it ranged from 19.16 in Ramadi station in July to 64.50 in January in Anah station, and this is a very high disparity in humidity and a wide range that would greatly affect the nature of the vegetation cover.

| Year | Al-Rutba | Ramadi | Heet | Haditha | Anah | Al-Qaim |
|------|----------|--------|------|---------|------|---------|
| 2010 | 62.09    | 61.17  | 61.99| 63.93   | 64.50| 63.97   |
| 2011 | 55.82    | 54.21  | 55.24| 56.89   | 57.37| 56.78   |
| 2012 | 44.11    | 43.33  | 44.46| 45.41   | 45.81| 45.23   |
| 2013 | 33.68    | 34.88  | 36.28| 36.49   | 36.69| 35.97   |
| 2014 | 27.03    | 26.64  | 28.15| 28.04   | 28.83| 28.68   |
| 2015 | 22.08    | 19.98  | 21.34| 20.94   | 22.27| 22.69   |
| 2016 | 22.16    | 19.16  | 20.73| 20.47   | 21.94| 22.47   |
| 2017 | 22.67    | 20.29  | 21.72| 21.42   | 22.97| 23.61   |
| 2018 | 24.63    | 22.77  | 23.86| 23.21   | 24.59| 25.16   |
| 2019 | 33.35    | 31.64  | 33.09| 32.79   | 33.54| 33.52   |
| Average | 47.90 | 47.13  | 47.82| 48.25   | 48.62| 48.14   |

Figure (4) humidity around the year in the study area

The highest values were recorded in January for all stations, 63.37, 64.50, 63.93, 61.99, 61.17, and 62.09% for the stations of Al-Qaim, Anna, Haditha, Heet, Al-Ramadi and Al-Rutbah, respectively, while in July the humidity reached 22.47, 21.94, 20.47 and 20.73, 19.16 and 22.16% for each of Al-Qaim, Anna, Haditha, Heet, Al-Ramadi and Al-Rutbah stations, respectively. Al-Qaim station during summer months, has the highest rate in terms of relative humidity, while for the rest of the year Anah station surpassed the values of relative air humidity. From figure (5), it is seen that the monthly distribution of both relative humidity and
temperature, have an inversed relationship. During winter months the region have high humidity and low temperature, this impacts soil moisture and thus plant growth and explains the diversity in the vegetation cover in the study area. Many plant species in the region, such as herbaceous plants and seasonal shrubs, including wormwood, wild thyme, chia, bitter melon, aloe vera, sage and truffles flowers during winter and springtime. When high temperature, and low humidity occur in summer, the plant species begin to decline due to the lack of humidity. Until most of the species disappear, only plants that have adapted themselves to resist drought conditions and lack of moisture continue to grow, such as cactus.

![Figure (5), monthly distribution of both relative humidity and temperature](image)

8. Conclusions and recommendations

From the above, it can be said that humidity is an important factor in medicinal plants growth and diversity in the study area, as well as one of the most important factors responsible for the spatial distribution pattern of plants and the predominance of some species in the study area, and their morphological difference from same species growing in other territories. And therefore, climate change that is remarkably affecting both temperature and humidity, will result in the change of both morphology and distribution of medicinal plants in the western area of Iraq.
9. References

[1] Abbo, S. et al., 2008. Experimental harvesting of wild peas in Israel: implications for the origins of Near East farming. *J Archaeol Sci*, p. 35:922–929.

[2] Abboud, A. S. & Waheed, H. K., 2017. The importance of medicinal plants and their uses in ancient civilizations.

[3] Abdulwahab, K., 2017. The impact of climate change in the relative humidity in Iraq. *Education collage press*, pp. 265-286.

[4] Abusammor, H. Y., 2005. *Biological geography and soil*. Amman: Masir press.

[5] Albarakat, M. M., 2016. *The spatial variant of soil characteristics in Alwarkaa, and its effect on crop production*. s.l.:Di-kar universty.

[6] Aldizy, S. A., 2013. *the ancient and modern climate of Iraq*. Baghdad: books and document house.

[7] Alfahdawi, S. J., 2012. *Wheet production change for the period between 2000-2001 in Alanbar*. s.l.:Alanbar universty, faculty of litrature.

[8] Alrawi, A., 1964. *Wild plants of Iraq with their distribution*. Baghdad: Govt. Press.

[9] Anon., n.d. s.l.:s.n.

[10] Ayed, A. M., 2021. The relationship of Humidity with the Growth of Some Desert Medicinal Plants in the Western Plateau / Al-Anbar Governorate. *unpublished article*.

[11] Cavaliere, C., 2008. Drought reduces 2007 saw palmetto harvest. *HerbalGram*, p. 77: 56–7.

[12] Courtney, C., 2009. The effects of climate change on medicinal and aromatic plants. *HerbalGram (American Botanical Council)*, p. 81: 44–57.

[13] Das, M., Jain, V. & Malhotra, S., 2016. Impact of climate change on Medicinal and aromatic plants: Review... *Indian Journal of Agricultural Sciences*, pp. 1375-82.

[14] Duke, J., 2007. Medicinal plants of the Bible. *CRC Press, Atlanta*, p. 488 pp.

[15] General Authority for Meteorology and Seismic Monitoring, C. S., 2019. *unpublished data [Interview] (2 2 2019)*.

[16] Gharbi, M. A. & Byty, A. H. W. A., 2020. Assessment of Drinking Water Validity in Rutba – West Anbar according to feeding Resources,. *dirasat: human and social sciences vol 47, no 2*.

[17] Haloob, A., 2016. A new record for the flora of Iraq: limonium meyeri (plumbaginaceae). *Indian Journal of Plant Sciences ISSN2319–3824*, p. 2319–3824.

[18] Harrison, L. P., 1965. Fundamental Concepts and Definitions Relating to Humidity, in Wexler, Fundamentals and Standards. *Humidity and Moisture*, Volume 3, pp. 3-69.

[19] Ibrahim, W., 2016. *Humidity impact*, Hama: Agricultural magazine, vol56.

[20] Joda, J. H. & Abuayana, F., 1986. *the roles of human and natural geography*. Beirut: Alnahda press.
[21] Kelaif, S. N., 2020. Nature collection, arid environment. [Online]
Available at:
read://https://mawdoo3.com/?url=https%3A%2F%2Fmawdoo3.com%2F%25D8%25A8%25D8%25AD%25D8%25B9%25D9%2586%25D8%25A7%25D9%2584%25D8%25D8%25A8%25D9%258A%25D8%25A6%25D8%25A9%25D8%25A7%25D9%2584%25D8%25B5%25D8%25AD%25D8%25B1%25D8%25A7%25D9%2588%25D9%258A%25D8%2598%25D8%25B1%25D8%258B%25D8%25A7%25D9%2586%25D8%25A7%25D9%2585%25D8%25B1%25D9%2588

[22] Kuwagata, T. et al., 2012. Influence of Low Air Humidity and Low Root Temperature on Water Uptake, Growth and Aquaporin Expression in Rice Plants. Plant and Cell Physiology, 53(8), p. 1418–1431.

[23] Aljaberi, M., & Zain Al Abideen al Moussawi. (2020). Sexual Size Dimorphism in Hyla Savignyi Audouin, 1827 (Anura: Hylidae) from Nasiriyah Province, Southern of Iraq. Al-Qadisiyah Journal Of Pure Science, 25(1), Bio 7 -13

[24] Mekalif, A. A., 2007. Agricultural usage impact on soil characteristics and natural vegetation in some oases in the western desert of Alanbar. Anbar: Alanbar university.

[25] Mohammed, H. J., Rustum, B. H. & Kadum, K. Y., 2006. A list of medicinal plants tolerant to dryness, salinity and high temperature in Iraq. Ministry of environment, p. 2.

[26] Musa, A. H., 2017. Analytic Climatology. Damscus university, faculty of literature: the arabic collection press.

[27] Yaseen, B. T. & Alyafee, K. A., 2015. Plants adaptation in Qatar. Environmental studies centre, pp. 14-18.

[28] Zohary, M., 1982. Plants of the Bible. A complete handbook to all the plants with 200 full-color plates taken in the natural habitat. Cambridge University Press, Cambridge, p. 1–220.