Supplements

Annex (1)

Average monthly precipitation amount in Saudi Arabia

During the period from 1985 to 2016.

Months / Station	January	February	March	April	May	June	July	August	September	October	November	December
Turaif	12.15	10.65	10.33	8.70	3.12	0.05	0	0	0.42	6.44	8.97	11.70
Arar	9.68	6.08	7.60	7.67	1.05	0	0	0.01	0.03	4.56	6.93	9.76
Guriat	9.90	4.02	7.83	3.57	2.24	0.05	0.14	0.61	0.26	2.70	4.54	9.03
Al-Jouf	11.83	6.81	5.89	5.16	1.70	0.11	0	0.05	0.47	5.91	8.40	9.35
Rafha	14.13	8.58	14.78	11.01	3.10	0.03	0	0.01	0	2.60	14.54	8.14
Gaisumah	21.25	12.53	16.25	14.76	3.29	0.11	0	0	0	3.11	20.60	20.32
Tabuk	7.55	1.756	4.48	2.11	4.26	0.25	0.05	0.66	0.19	5.16	6.52	5.46
Hafr Elbatten	27.05	11.53	11.78	17.97	2.47	0	0	0.05	0	2.65	21.87	14.69
Hail	23.87	7.340	14.78	14.65	5.45	0.08	0.14	0.05	0.08	6.06	12.52	7.65
Wejh	8.76	3.98	2.54	0.54	0.44	0.01	0.14	0.04	1.38	1.20	9.46	10.67
Qassim	19.37	9.40	18.51	24.60	7.39	0.01	0	0.31	0.13	3.15	24.16	14.24
Dhahran	17.44	10.80	15.61	5.47	2.77	0	0	0.46	0.3	1.45	18.22	18.70
Al-Ahsa	14.82	7.98	15.85	11.95	3.25	0	0.69	0.12	0.53	0.70	16.40	22.07
Madinah	6.76	2.70	8.78	9.73	4.47	0.14	0.57	3.70	0.28	3.07	12.81	7.09
Riyadh	15.26	6.52	18.08	37.87	4.08	0.14	0	0.33	0.00	1.06	16.08	15.02
Yenbo	7.45	1.28	1.16	0.40	0.05	0	0	0.07	0.04	4.43	7.12	11.95
Jeddah	10.97	3.30	3.55	0.66	0.17	0	0.43	0.56	0.08	1.02	23.71	11.20
Makkah	18.25	3.77	5.62	11.48	3.04	0.01	1.16	5.32	5.25	12.16	20.74	19.05
Taif	10.06	2.55	13.23	34.8	28.52	3.74	1.91	16.00	10.03	12.29	18.56	6.36
Al-Baha	9.07	1.50	11.06	32.95	23.94	5.90	10.14	11.00	2.50	7.21	8.33	4.55
Wadi Dawasir	1.50	0.51	5.16	10.43	3.69	0.11	1.97	2.66	0.00	0.66	1.768	2.50
Bisha	8.84	0.55	12.66	37.37	10.78	2.66	0.55	2.78	0.01	1.75	5.56	3.40
Abha	15.40	11.14	39.97	51.32	25.66	7.64	18.98	24.50	5.45	2.35	5.27	3.78
Khamis Mushait	7.18	4.01	21.71	43.45	31.92	17.05	22.39	26.82	3.73	4.26	5.23	1.38
Najran	3.1	0.94	15.39	20.25	9.17	3.11	2.49	9.85	0.14	4.04	5.81	1.20
Sharorah	0.86	2.50	15.59	16.34	3.86	4.11	3.94	7.13	3.88	1.48	0.51	0.35
Jazan	13.01	4.32	4.75	13.55	7.30	0.93	12.46	25.12	9.80	14.64	12.22	15.92

Source: General Presidency of Meteorology and Environmental Protection, Ministry of Economy and Planning Statistical Yearboo

FAO Irrigation and Drainage paper, Indian agricultural research institute New Delhi.

- Girba, Gehad Mohamed (1982): Joint Work and Results of Middle East Low and Sudan Low on the South –West of the Kingdom of Saudi Arabia. The Fifth Conference for Biological Sides. College of Science. King Saud University. Riyadh.
- Magames, Abd- AlAziz, (1988): Regional Divisions of the Characteristics of the Rain in the South- West of the Kingdom of Saudi Arabia. A study on Geographical Climate. Unpublished Master Thesis. King Saud University, Riyadh.
- Middleton, N, J. (1986). Dust storm in the Middle East. Journal of Arid Environments, vol. 10, pp 83–96.
- Ministry of Higher Education, (2000). The Atlas of the Kingdom of Saudi Arabia. 2nd Edition, Obeikan Library, Riyadh.
- Siraj, A, A. (1980). Aziad Weather, General Directorate Meteorology. Jeddah, Saudi Arabia.
- Al–Suilm, A, M, (2008), Volatility of Rainfall in the middle of the Arabian Peninsula during (1030–1349/1621–1930). Journal of Al–Darh, Vol. 4, Riyadh.
- World Meteorological Organization, (2010). A Statement of the Organization on Climate Change, (2009). Printed by the WMO. No.(1055).

Supplements

Annex (1)

Average monthly precipitation amount in Saudi Arabia
During the period from 1985 to 2016.

Source: General Presidency of Meteorology and Environmental Protection, Ministry of Economy and Planning Statistical Yearboo

and Climatic Geography. Riyadh.

- AL.Blehed, A.S. (1986)) Rainfall Distribution and Variability in Saudi Arabia. J. Coll. . Arts, King Saud Univ. vol 13, pp 17-39.
- Al Mushayt, Amel Hussain Saeed, (2016): The Analysis of Weather and Climate Conditions Prevailing in the Southwestern Highlands of the Kingdom of Saudi Arabia. A study in Applied Climate. Unpublished PhD dissertation. King Saud University, Riyadh.
- El-seed, Abdel Malik Gasm (1994): An Application of Markov Chain Model for Wet and Dry Spell Probabilities in Malaki and Gaa Bani Malik in Southwestern of Saudi Arabia. The Fifth Geographical Symposium of Geography Departments. King Saud University, Riyadh.
- ……., (1995): Probability and Dependability of Rainfall in the Kingdom. Saudi Geographical Society, No.(21). King Saud University, Riyadh.
- ……., (1996). Seasonal Oscillation of Rain in the Kingdom of Saudi Arabia. Kuwait Geographical Society. No.(197), Kuwait.
- Al- Arishi, Aisha Ali Mohamed,(2008) : Storms and Their Impact on The Development in Jazan. A study on Applied Climate. Unpublished PhD, College of Education, King Khalid University, Abha.
- ……., (2009) : Rains in Jazan- Characteristics and Impacts of Rain on The Agricultural Development. Geographic Articles. Research and Translation Unit, Vol. (348). Kuwait Geographical Society. Kuwait University.
- Anthony, M. (1972) Summer Thunderstorms Over Southern California. Scripps Institution of Oceanography, La Jolla, University of California, San Diego, Calif.
- Maki, Aziz Mohamed (1971): Rains in the Kingdom of Saudi Arabia. Journal of Faculty of Arts. King Saud University, 2nd Vol, 2nd Year, Riyadh.
- Banoub, E, F. (1970) Sand storm and dust storm in the U.A.R, Meto. Department, Technical note no.1.
- Charles, J. (1969) Frequency and duration of thunderstorms in the cap Kennedy area. The space congress. Proceedings. Piper4.
- Dastane, N, G. (1978) Effective rainfall in irrigated agriculture.

- There is a variation in the quantity of rainfall between the regions of the Kingdom. The areas that are located in the south-western heights, represented in both Abha and Khamis Mushait stations are tops areas in terms of rainfall during summer and autumn.
- The north and middle areas of the Kingdom come first in terms of the recurrence of rainfall in winter, as in Qaisoma and Hafr-Al- batin stations.
- The most important area in terms of the recurrence of rainfall in autumn is Jazan, which is located the far south-west of the kingdom.

Recommendations:

Based on the findings and discussion of the research results, one could recommend for recommends the following;

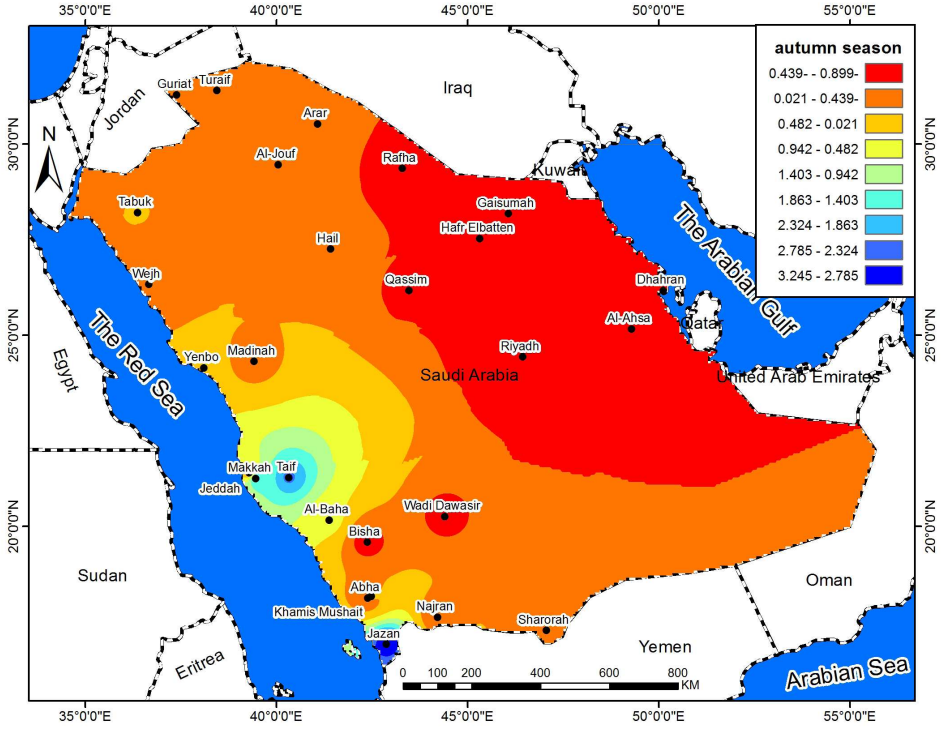
- Benefit from the quantity of rainfall in expanding green areas in cities.
- Lower the risks that result from the increase in rainfall by abiding to the regulations and laws that limit urban sprawling and ban construction in the courses of valleys.
- Raise the citizens' awareness of risks in the areas that witness a seasonal increase of rainfall.
- Take in consideration the directions of running valleys resulting from heavy rains, especially in west and south -west of the Kingdom when planning for land use.
- Conduct more studies on rain in the cities of the Kingdom of Saudi Arabia.
- The need for more studies related to the impact of rainfall in Saudi Arabia.

References.

- Alehaideb, Ibrahim Suleiman, (1993): The Rain Distribution in the South- West of the Kingdom of Saudi Arabia. Institute of Research and Arab Studies, Cairo, Egypt.
- …..... , (1999): The Climate of the Kingdom of Saudi Arabia. The Geographical Encyclopedia of the Islamic World. Third Volume, Section One. Islamic University of Imam Mohamed Bin Saud, Riyadh.
- ……, (2003): Introduction to Weather, Climate

Figure (7)

The Spatial Variation of the Recurrence of Rainfall According to the Autumn season.



Source: The Researcher's work depending on the data in table (5).

Results and Recommendations

Results.

From the analyses of temporal classification and spatial variation of rainfall over Saudi Arabia, several results have been presented.

- The most recurrent period of rainfall in the Kingdom is the one from April to August which represents both summer and spring.
- The period from November to February, which represents winter, comes second in terms of the recurrence of rainfall.
- The period from August to October, which represents autumn, comes third in terms of the recurrence of rainfall in the Kingdom.

It has positive values higher than the true one. Jazan comes in the first place where rainfall concentrates according to the third factor with a value of 3,246. During autumn, Jazan is exposed to an unstable weather due to the high temperature during the day and leads to the presence of air currents that carry water steam, the control of the southwestern wind which is affected by the expansion of India's Seasonal Depression, in addition to the impact of other local factors that result from the variation of temperature value and air pressure. Following Jazan are Makkah and Taif with a value that is more than (2,000◦).

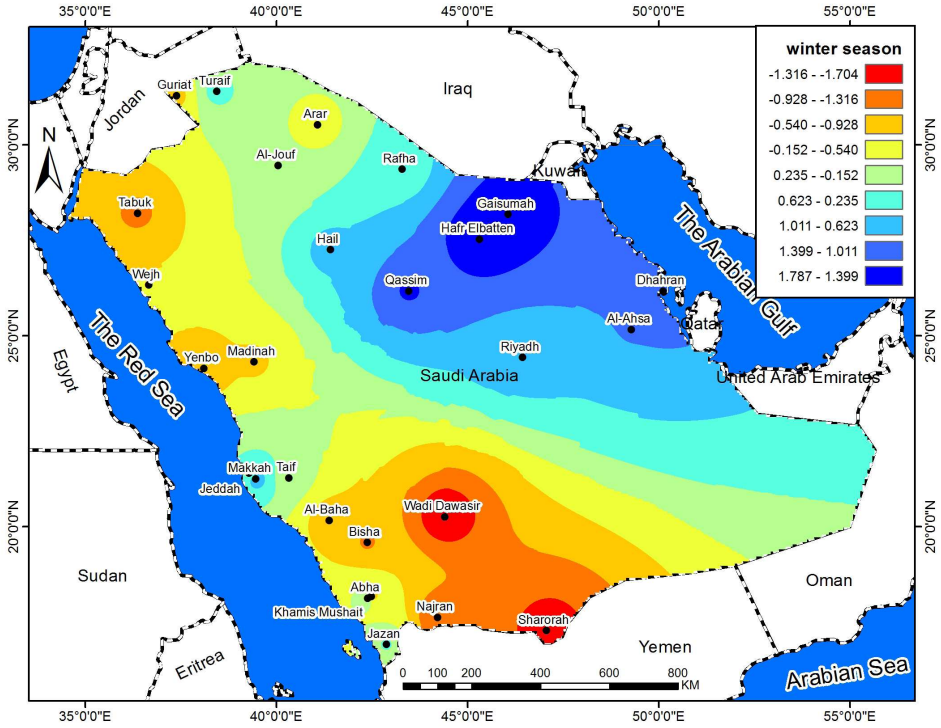
The second Category.

It includes the areas with positive values that are less than the true one. It includes Abha with a value of (0,642), Khamis Mushait (0,238), Yanbu (0,147) and finally Tabouk and Al-Jouf with values that range between (0,043) and (0,014). These areas are characterized by moderate rain due to the dominance of air instability in these regions.

The Third Category.

It includes all the remaining stations which have negative values that are less than zero. Riyadh station comes first among the areas characterized by less amount of rain during autumn according to the factor scores of the third factor, with a value of (-0,900), followed by Bisha in the second place with the value of (-0, 765), Wadi- al-dwasir (- 0,646) and Jeddah (- 0, 141). This is due to the weakness of air stability in these areas during autumn.

Figure (6)
The Spatial Variation of the Recurrence of Rainfall According to the Winter season.



Source: The Researcher's work depending on the data in table (5).

Spatial Variations of the Recurrence of Rainfall according to the Autumn season.

This factor comes in the last place in terms of importance and it is called "Autumn Season Factor". Despite the low contribution of this factor, but it highlights certain periods of concentrated rains. The factor scores of this factor as in (Table. 5), (Figure.7) come between positive and negative values. In the light of these values, the regions of the Kingdom could be divided into the following categories:

The First Category.

tops the other stations in the quantity of rainfall according to winter factor. This comes as a result of the penetration of some hurricanes from the Mediterranean Sea across the north of the Kingdom. Hafr-Elbaten station comes in second with a value of 1.752, and this is also because of the effect of India's Seasonal Depression that is formed in the east of Arabian Gulf because of the intensity of the solar radiation over central Asia. This leads to the control of the north-western wind which is active due to the development of the high altitude over the Mediterranean Sea (Abdel- Azim, 1998: 396). All these result in rainfall especially after crossing the bodies of water located in the west of the region. Gaisomah comes in third place, followed by Dhahran and Al-Ahsa with values range between 1,438 and 1,015.

The Second Category.

It includes the regions with positive values less than the true one, such as Mecca with a value of (0,929), followed by Riyadh with a value of (0, 770), Hail (0, 730), Abha (0,530), Rafha and Turaif (0, 300) and then Jazan with a value (0,268). This is due to the union of the East Low Depression with the air depressions coming from North Africa such as the Sudan Seasonal Depression over Sarowat Mountains that result in thunderstorms over the south-western regions of the Kingdom. The hot surface creates instability in the low parts of the air, which in turn stimulates the rising currents that carry water steam to the upper atmosphere and thus increasing the rainfall.

The Third Category.

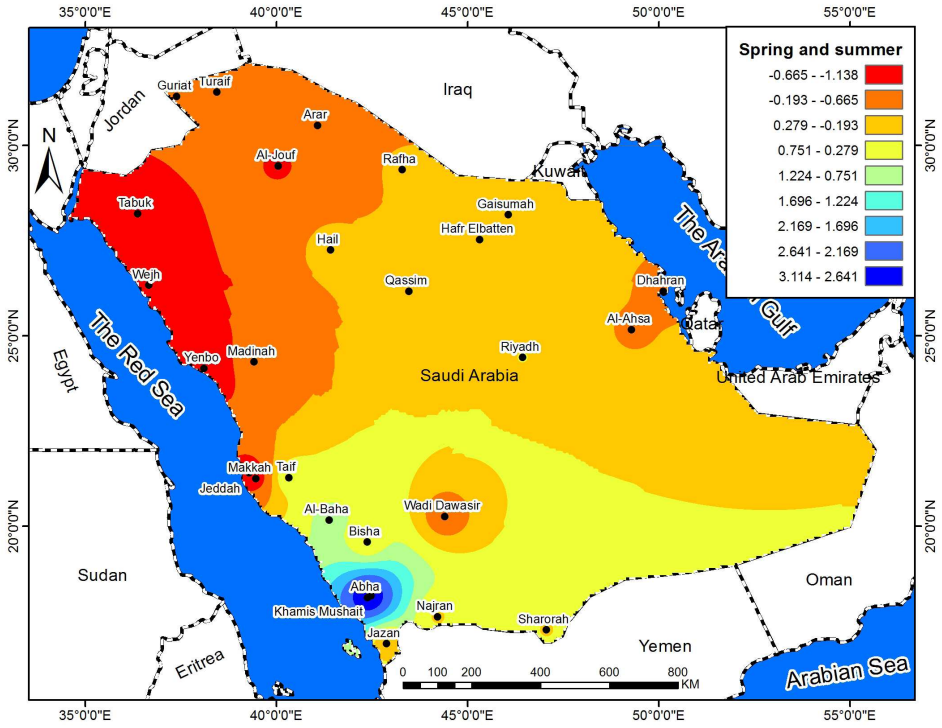
It includes the regions that have weak negative values less than zero. These regions include, Wadi-Dwasir, Sharorah, Najran, and Al-jof with values less than (-1,00). These regions are ranked first with the least quantity of rainfall during winter. The regions that follows are: Khamis Mushait, Yenbo, Bisha, AL-Baha, Guriat, Madinah, Rafha and Arar with values ranged between (- 0, 900 and – 0,300). Most the south-western regions are generally characterized by less recurrence of rainfall during winter due to being remote from the effects of air depressions and their position in the rain shadow, behind Asir Mountains as in Sharorah and Najran stations.

20.	Jazan	-0.081-	0.268	3.246

Source: Factor Analysis Outcomes.

Figure (5)

The Spatial Variation of the Recurrence of Rainfall According to the Spring and summer.



Source: The Researcher's work depending on the data in table (5).

The Spatial Variation of Rainfall Recurrence according to the winter season.

This factor, which is called winter season because of the recurrence of rainfall, comes second in importance. Its scores -as shown (Table. 5), (Figure. 6) have either positive or negative values; according to which the regions of the Kingdom could be divided into the following categories:

The First Category.

It includes Gaisomah station, which with a very high value of 1,788,

(-0,696 and -0, 049). The decline of rainfall on these regions is due to the fewer occurrences of thunder storms in summer, especially the north regions which are characterized by a stable climate during summer and spring because it far from the impact of summer air depressions.

Table (5)

Selected rainfall stations and Factors Scores in the Kingdom of Saudi Arabia.

Number	Station	Fac 1	Fac 2	Fac 3
1	Turaif	-0.406-	0.355	-0.146-
2	Arar	-0.627-	-0.328-	-0.268-
3	Guriat	-0.638-	-0.625-	-0.413-
4	Al-Jouf	-0.696-	-0.151-	0.014
5	Rafha	-0.159-	0.397	-0.717-
6	Gaisumah	-0.049-	1.788	-0.520-
7	Tabuk	-0.834-	-1.006-	0.043
1.	Hafr Elbatten	-0.075-	1.752	-0.510-
2.	Hail	-0.086-	0.731	-0.259-
3.	Wejh	-0.900-	-0.531-	-0.204-
4.	Qassim	0.198	1.438	-0.525-
5.	Dhahran	-0.229-	1.261	-0.627-
6.	Al-Ahsa	-0.215-	1.015	-0.597-
7.	Madinah	-0.490-	-0.599-	-0.197-
8.	Riyadh	0.283	0.770	-0.900-
9.	Yenbo	-1.139-	-0.829-	0.147
10.	Jeddah	-0.913-	0.086	-0.141-
11.	Makkah	-0.809-	0.929	2.023
12.	Taif	0.692	0.038	2.435
13.	Al-Baha	0.891	-0.779-	0.642
14.	Wadi Dawasir	-0.543-	-1.705-	-0.646-
15.	Bisha	0.332	-0.970-	-0.765-
16.	Abha	3.133	0.530	-0.552-
17.	Khamis Mushait	2.848	-0.974-	0.238
18.	Najran	0.242	-1.310-	-0.356-
19.	Sharorah	0.274	-1.551-	-0.437-

to the Scores of each factor that have been determined previously:

The Spatial Variation of the recurrence of rainfall according to the First Factor

It is called "summer and spring factor" and is regarded the most important factor because it witnesses an increase in rainfall rate. This factor scores range between positive and negative as shown in (Table. 4). Based on this fact, the regions of the Kingdom are classified into categories- (shown in Table.5) - as follows:

The First Category:

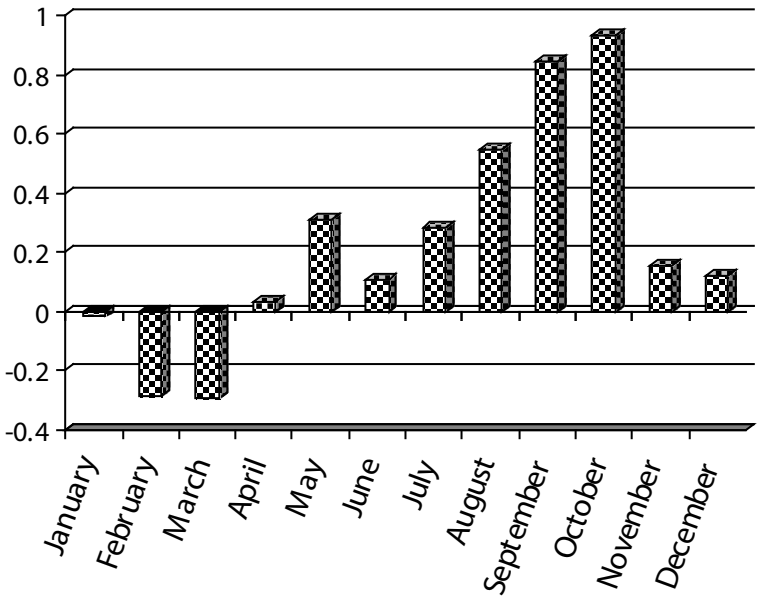
It includes the regions that contain positive values that are higher than the true one, which are Abha and Khamis Mushait stations with very high positive values (3,144) and (2,848), respectively. Hence, Asir tops the Kingdom regions in the quantity of rainfall in both summer and spring seasons, and this is due to the seasonal effects associated with the annual sun movement that is vertical or semi- vertical on the area, in addition to the effects of India's Seasonal depression on the heights on the south-west of the Kingdom. This approves the second hypothesis which claims that the southwestern regions of the Kingdom have the most recurrence of rainfall during summer.

The Second Category:

It includes the regions that contain positive values lower than the true one such as Al-Baha station with a value of (0,891), followed by Taif station (0,692). This category also includes Bisha (0,332) because it is close to the impact of India's Seasonal Depression. Moreover, it includes Riyadh station with a low value of (0,283) and both Sharorah and Najran with low values (0,274 and 0,242), respectively.

The Third Category:

It includes all regions with negative values less than zero, with the lowest value recorded in Yenbo Station with (1,139), which is considered to be one of the least regions to receives rainfall in summer and spring due to its distance from the seasonal effects of rainfall. It is followed by Jeddah station with a value of (-0,913) and wejh and Tabouk stations with values of (-0, 900and (-0, 834), respectively. Then followed by Makkah (-0, 809), Al-Jouf, Arar, Al-Guriat, Wadi-Dawasir, Madinah, Turaif, Hail, Hafr-Albatten, Jazan and Gaisomah with values between



Second: Recurrence and spatial variations of rainfall over the selected meteorological stations

In the current study, the quantity of rainfall in the Kingdom of Saudi Arabia has been spatially classified according to the study stations distributed in the different regions of the Kingdom, which is based on the outcomes of the Factor Analysis represented by the Eigen Values, Communalities and Factor Loading.

The study based its spatial variations of the recurrence of rainfall in the Kingdom on the findings of the Factor Analysis through Factor Scores which are standard values that show the extent of factor concentration in specific geographical areas of the Kingdom. These values alternate between positive values and negative ones, where the increase in the positive values of the factor means more appearance of the characteristics of the factor and its different variables., the characteristics of the factor with its different variations in the geographical area (the Kingdom areas). On the other hand, the negativity of the values signifies the weakness impact of the characteristics of the factor in the geographical area, from where the original data has been taken. The following is an analysis of the spatial variation of the recurrence of rainfall according

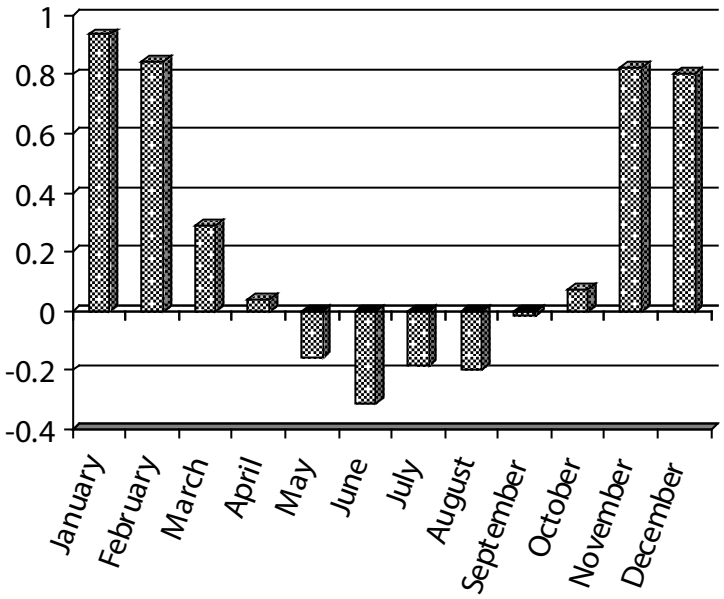


Figure (4)
Classification of rainy months based on The Third Factor.

▪Variable No. (1): For January. This variable comes in the first place in its correlation with the second factor with a saturation value of (0,935).
▪Variable No. (2): For February. It comes next in its correlation with the second factor with a Value 0,845 saturation value.
▪Variable No. (11): For November. It comes with a Value 0,825.
▪The variable No. (12): For December. It comes with 0,801 saturation value.

Based on the correlation between the above four variables and the second factor, it is obvious that the period from November to February is the second period for the recurrence of rainfall, which is linked to winter and hence this factor is called "Winter Period". It is considered the second period in importance of rainfall.

2. The Third Factor:

This factor comes third in importance as it includes 1,903 Eigen Values and a variation ratio of 15,856% out of the analyzed average of the original variables. The low average of participation of this factor does not decline its importance in interpreting the received information in the original variations, but it has a property of being separate from the rest of the axis to illustrate the recurrence of the suspended rainfall phenomenon in the rest of the year. The factor is associated with positive variables as shown in the previous table (Table.4) and (Figure. 4). These factors could be divided according to their saturation value with the third factor according to their correlation which is 50%. They are:

- Variable No. (10): For October. It comes in the first place in its correlation with the third factor with a Value 0,934.
- Variable No. (9): For September. It comes second in correlation with the third factor with a Value 0,845.
- Variable No. (8): For o August. It comes fourth in correlation with the third factor with a Value 0,545.

Based on the correlation between the variables above and the factor, it is clear that rainfall is active in the period between August and October, which is linked to autumn; and hence it is called "Autumn Season Period". It the third in the quantity of rainfall.

Figure (3)

Classification of rainy months based on The Second Factor

Table (4)
Rotated Factor Matrix

Months	Component		
	1	2	3
January	.018	.935	-.018-
February	.169	.845	-.283-
March	.852	.290	-.291-
April	.891	.039	.034
May	.866	-.158-	.308
June	.862	-.313-	.110
July	.847	-.181-	.282
August	.771	-.195-	.545
September	.405	-.014-	.845
October	.000	.076	.934
November	-.194-	.825	.153
December	-.394-	.801	.120

It is clear that the above variables are the strongest variables that are linked to the factor, which indicates that rainfall quantity in the Kingdom increases between March and August (summer and spring periods); therefore, the factor is called which is the main period for rainfall quantity.

Figure (2)

Classification of rainy months based on The First Factor**The Second Factor.**

This factor comes second in terms of of importance as it includes 2,899 Eigen Values and its average variance is 24,154% out of the average of variances explained in the original variables. This factor is linked to a number of positive variables with a correlation that is 50% as the previous table shows (Table.4) and (Figure.3). These four variables could be divided according to its Value with the second factor as follows:

and this is called “Factor Loading”, which are values that show the link between the variables from one side and the factor from the other side. Varimax Rotation is used to determine the relationship between the factor and the variables. and it considered one of the most important ways to rotate the saturations values because it aims at maximizing the variances sum of the squared of factors saturations by assigning to each variable to one saturation that is higher than one factor (near to the true one), and lower than another factor (zero or near to zero). The increase in the correlation between the factor and the variable signifies the variable’s dependency on this factor. Accordingly, the correlation between variables with the derived factors is identified -as appears in (table 4)-as follows:

1. The First Factor:

It is considered the strongest one because of the increase of “Eigen Values” which reach (5,379) and it is also characterized by the high variation ratio which reaches (44,826%) out of the analyzed average of the original variables. It also includes many positive variables that correlate with the factor by more than 50% (Figure. 2). These seven variables are:

- Variable No. (4) (For of April), It is considered the most important factor that correlates with the factor, with a high Value (0,891).
- Variable No. (5) (For May), It comes in the second place in its correlation with the factor with a Value 0, 866 saturation degree.
- Variable No. (6) (For June), It comes third with a Value 0, 862 saturation degree.
- Variable No. (3) (For March), It has a Value 0,852.
- Variable No. (7) (For July), This variable is linked to the first factor with a Value 0,847.
- Variable No. (8): (For August), It is also linked to the first factor with a Value 0,771 .

Table. (2)
Factors and the Variations' Ratios for Each Factor.

Component	% of Variance	Eigen Values	Cumulative %
1	44.826	5.379	44.826
2	24.154	2.899	68.981
3	15.856	1.903	84.837

Source: Factor Analysis Outcomes.

Table (3) shows the results of communalities which represents one of the outcomes of the Factor Analysis that indicates the contribution of each variable in the derived factors that have been identified. The table shows that August has the value of 0,930, which is the highest percentage value. This explains that the percentage of the basic information in this factor has been interpreted in the three Derived factors, as well as for the other factors, which have a great part in contributing in the variation as shown in the table (3). Hence, this gives a clear proof that a big part of the variation data has been included in marked factors.

Table (3)
Communalities Contributions in factors.

Months	Extraction
January	.874
February	.822
March	.894
April	.796
May	.870
June	.852
July	.830
August	.930
September	.878
October	.879
November	.742
December	.812

Source: Factor Analysis Outcomes.

It is clear from the Factor Analysis that any of these Derived factors depends basically on the relationship between it and the studied Variables

also been done. Thus, this study is considered to be one of the applied climate studies that present a clear analysis of the quantity of rainfall in the Kingdom of Saudi Arabia.

Data Analysis.

First: Temporal Variation of Rainfall

The thirteen regions of the Kingdom are identified, and the monthly average of rainfall is determined (Appendix 1). The study uses Factor Analysis in analyzing the data relying on "Cut off point" which is determined on the base of "Eigen Values" which is more than one. Three factors have been investigated (Table, No.2). The first factor is the most significant one because it has "Eigen Values" that reach (5,379) and it also contains (44,826%) out of the percentage of the variance explained in the original variables. Then these values decline in the second factor and reach (2,899) "Eigen Value" with a percentage of (15,856%). The third factor which is the last one representing the stop point with 1,903 Eigen Values and 15,856%. Contrast Ratio. Thus, three important factors have been determined that could mark the rainfall quantity in the Kingdom, and they represent 84, 837% of the proportion of cumulative percentage (out of the percentage of the variance explained in the original variables).

of the Kingdom; coastal region in which the prominent differences between Eastern coast and the West coast has been highlighted, and the mountain region align with Tehama plains.

- Ayisha, Arishi, (2008): The researcher investigates the effect of thunderstorms on the environmental development in Jazan and the most seasons affected by thunderstorms that cause rainfall in Jazan, because the rainfall increases in summer, especially in the south. The finding of the study is that thunderstorms in Jazan negatively affect people's lives by causing landslides and rocky falls which block roads, in addition to the impact of thunderbolts and heavy rain that cause torrential floods on the region different environmental developments.
- ……., (2009). This study investigates the rainfall in Jazan. It shows the prominent characteristics of rainfall in the region and time and space variation of the rainfall during seasons of the year. It concludes that the mountain section in the region received more quantity of rainfall and affects the west parts due to the flow of torrents through vales which stretch from the east to the west. Furthermore, the study tackles the effects of rainfall on the region agricultural development.
- Mushait, Amal (2016): The Analysis of Climate and Weather in the Mountains of the South-western of Kingdom of Saudi Arabia, a study on Empirical Climate. The study investigates the weather conditions, rainfall quantity and the average link with the weather storms in the South-western Mountains of the Kingdom. The study covers Abha, Khamis Mushait and Al baha. Finally, the study detects the problems and risks that might happen because of this air phenomenon.

After reviewing the previous studies, the current study has benefit from the above studies in different fields is regarding to characteristic of dry climate. This study is based on the quantity side which in turns based on accurate statistics like the Factor Analysis from which the quantity of rainfall in the Kingdom has been classified. An accurate classification according to the time factor which is connected to the months of the year and the spatial factor which is linked to the regions in the Kingdom has

in the Possibility of Rainfall and Dryness in Malaki and Gaa Bani Malik in South-western of The Kingdom. The significant result of the study is that the value of rainfall in Malaki differs monthly and the difference decreases at the end of winter and at the beginning of summer, whilst in Gaa Bani Malik the value rainfall differs monthly and the differences decline at the beginning of autumn and spring.

- ----------, (1995): Rainfall Probability and Reliability in the Kingdom. This study is built on the probability of the maximum rainfall in the south-western of the kingdom. Moreover, the study investigates the variation of quantities that is used in agriculture from region to another one. The study recommends the importance of relying on the short periods of time monthly or seasonally to link agricultural possibilities with the rainfall probabilities.
- ----------, (1996): Seasonal Fluctuation of Rainfall in the Kingdom. In the above study, it comes out that the variation factor is the best factor to measure the seasonal fluctuation for any region. The study recommends that research should be done to know about seasonal rain variations because of its negative effects on land use.
- Ibrahim Al-ehaydib, (1992): The Distribution of Rainfall in the South-West of the Kingdom. This study aims to know the effective factors in the quantities of rainfall. One of the most important results is that the distribution of rainfall in the South-West of the Kingdom is not alike and the relationship between the rainfall and the height factor differs due to the place of the stations. The stations located on the Western edge of the Western slope of the mountains receive heavy rains than other stations.
- ----------, (1999): The Climate of the Kingdom of the Saudi Arabia. The effective factors and local effective factors that influence the air phenomenon such as the geographic, astronomical and terrestrial location and other external factors such as air blocks and jet currents have been investigated. The study also investigates the characteristics of climatic elements and the distribution of climatic regions in the Kingdom. Moreover, it sheds light on three climatic regions, the inner plateaus region which contains the inner regions

July up to the middle of August.

- Aziz, Maki (1971): The Rainfall in the Kingdom of Saudi Arabia. This study investigates the factors that affect the seasonal and annual distribution of rainfall. It comes out of with the result that the South-western part of the Kingdom is characterized by a heavier rainfall compared to the other parts of the Kingdom.
- Anthony, M. (1972): Thunderstorms in the South of California. This study highlights that the basic season in the distribution of thunderstorms is connected with the frequent rainfall and happens during the rainy summer as in Arizona. Thunderstorms also occur because of the expansion and the low that is linked with the seasonal wind and thunder lighting happened due to the north-eastern tropical cyclones which move to the west coast of Mexico.
- Dastane, (1978): Effective Rainfall in Irrigated Agriculture, an empirical study in India. The study explains the concepts of the effectiveness of rainfall and its significance. It also highlights the most effective factors on rainfall, how to increase the effective rain, the groundwater and the steps to be followed in irrigating lands.
- Gehad Girba, (1982): Joint Work and the Results on the Eastern Mediterranean Depression and Sudan Depression in the South-western of the Kingdom Of Saudi Arabia. The study explains that the joint work between the two depressions is the cause of the early spring rainfall and the seasonal summer rains in the south –west of the Kingdom and that the air conditions which cause the rainfall in Asir Mountains are the same air conditions that allow the winds of sand in the centre of the kingdom.
- Abdul-Aziz Almagams, (1988): Regional Divisions of the Rainfall Characteristics in the South-western of the Kingdom. The study explains the effective factors on rainfall and it also identifies the regional distributions of the characteristics of rainfall in the south-west of the kingdom. The study comes out with the division of south –west of the Kingdom into four rainy regions and it recommends the significance of making empirical agricultural researches between rainfall and agriculture in the south-west of the Kingdom.
- Abdul Malik Essayed, (1994): The Application of Markov's Module

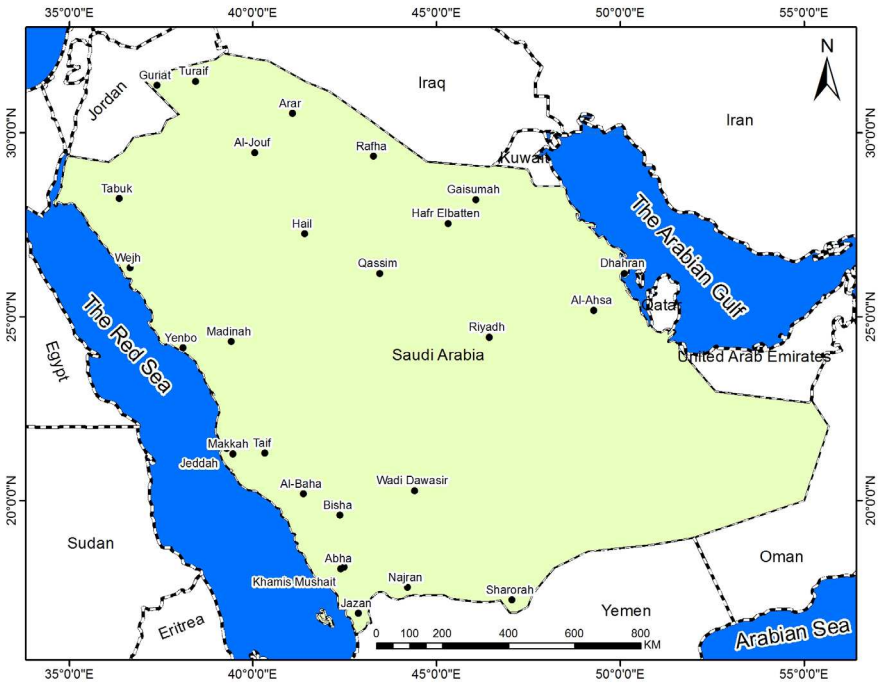
Theoretical Framework and Previous studies.

Deserts are places of the world where a combination of conditions result in an extremely dry and arid biome. A cording to the united states geological survey, define desert as palace that qualifies as either arid receives less than 25 cm of rain por year An extremely arid is defined as an area that regularly as more than 12 consecutive months without any rain at all.

Geographically the low rainfall amounts deserts experience come from a combination of climate and geography. Most of the arid climates are lie south and north of the tropical rain forest of the equator, between 15 and 35 degrees of latitude, in an area where air circulating out of the equatorial zone warms and absorbs moisture from the land beneath. Therefor low and unpredictable precipitation is primary characteristic dry climate as well as desert receive in a few, have rainfalls rather than many high rains spread out over the course of the year.

Saker (1966) developed a dynamical model for terrain rainfall in the west of Gator in India, depending on linear equations that helped him to know the quantity of rainfall in the area. He was considered a model for many researchers who were interested in the study of rainfall. One of the prominent researchers is Gregory who used the variation factor in his study about rainfall fluctuation in Sierra Leone. Many researchers applied his study on the Arab dry and semi-arid regions. One of them was Eltom (1966) who conducted a general study on rain fluctuations in Sudan and he used the standard deviation equation as a percentage of the average, There are many studies that have been conducted on rainfall for example:

- Charles, N.(1969).This study is deemed to be one of the first studies that have been Cond Miss acted on the area of rainfall. It shows the frequency of thunderstorms in Cape- Canadian and Florida. It is based on data of thirteen years and it indicates that thunderstorms could happen unexpectedly during the day and may continue to seven days. Moreover, the study divides the thunderstorms annual occurrence into four periods, two of which are characterized by a rise in the average of thunderstorms. The first period starts from March to the end of April, while the second period starts in the middle of



Source: revised by author based on data provided by Ministry of Meteorology and Environmental Protection, Kingdom of Saudi Arabia.

Sources of data **and Methodology.**

This study is based on the following Sources of data:

- Statistical Annual Book during 2002-2017 Ministry of Economy and Planning.
- Department of Metrology and Environmental Protection in the Kingdom, Climatic data of rainfall in 27 stations, during the study time (1985-2017).
- Ministry of Municipal and Rural Affairs, Topographical maps, of the Kingdom.

Factor Analysis has been applied and it is considered to be one of the most precise and advanced statistical methods used in the process of statistical data that helps the researcher in Geography in specifying the spread of this geographical phenomenon. It aims to classify the seasonal of rainfall as well as spatial variation of rainfall over Saudi Arabi

3	Guriat	OEGT	40360	37	16	56E	31	24	27N	503.90
4	Al-Jouf	OESK	40361	40	05	55E	29	47	19N	668.74
5	Rafha	OERF	40362	43	29	49E	29	37	17N	444.10
6	Gaisumah	OEBA	40373	46	07	49E	28	19	08N	357.60
7	Tabuk	OETB	40375	36	36	25E	28	22	35N	768.11
8	Hafr Elbatten	OEKK	40377	45	32	00E	27	54	00N	413.0
9	Hail	OEHL	40394	41	41	28E	27	26	04N	1001.52
10	Wejh	OEWJ	40400	36	28	37E	26	12	19N	23.73
11	Qassim	OEGS	40405	43	46	03E	26	18	28N	646.71
12	Dhahran	OEDR	40416	50	09	39E	26	15	34N	16.77
13	Al-Ahsa	OEAH	40420	49	29	11E	25	17	53N	178.17
14	Madinah	OEMA	40430	39	41	55E	24	32	53N	625.60
15	Riyadh	OERY	40438	46	44	18E	24	42	40N	619.63
16	Yenbo	OEYN	40439	38	03	50E	24	08	24N	10.40
17	Jeddah	OEJN	41024	39	08	54E	21	40	42N	3.58
18	Makkah	OEMK	41030	39	46	08E	21	26	16N	240.35
19	Taif	OETF	41036	40	32	56E	21	28	44N	1452.75
20	Al-Baha	OEBA	41055	41	38	35E	20	17	41N	1651.88
21	Wadi Dawasir	OEWD	41061	44	40	49E	20	26	30N	701.02
22	Bisha	OEBH	41084	42	37	09E	19	59	28N	1161.97
23	Abha	OEAB	41112	42	39	39E	18	13	59N	2093.35
24	Khamis Mushait	OEKM	41114	42	48	23E	18	17	58N	2055.93
25	Najran	OENG	41128	44	24	49E	17	36	41N	1212.33
26	Sharorah	OESH	41136	47	06	29E	17	28	04N	724.65
27	Jazan	OEGN	41140	42	35	05E	16	53	49N	7.24

Figure (1)

Locations of the selected meteorological stations

Saudi Arabi has an extremely dry climate and water supply deficit, the spatial and temporal distribution quantity and duration of rainfall in the arid and semi arid zones of the country are highly variable. The rainfall in Saudi Arabi is an important as a main major factor source of water in the country. This factor affects directly and indirectly people's activities and living styles causing traffic risks, health conditions, and citizen's movements as it decreases their daily activities such as picnics shopping and visits. Study of Temporal Classification and Spatial Variation of Rainfall over Saudi Arabia. is there for very important not only for economy but also for population.

This study is based on the investigation of the rainfall records of 27 stations from the Kingdom stations as shown in (table 1) and (figure. 1). It classifies time and place of rainfall quantity during the seasons of the year in order to shed light on the most affected regions. This study is considered to be one of the most significant studies in the area of tropical climate, because of the problems accounted to this phenomenon nowadays, and also because of the shortage of studies been conducted in this area.

Objectives of the Study.

This study aims to highlight following objectives.

- To present the classification of rainfall over Saudi Arabia according.
- Analysis the spatial variation of rainfall over the Saudi Arabia.
- To address some recommendations that may be helpful to understand the seasonal variation of rainfall as well as the places that witness a highest quantities of rainfall.

Table (1)

Selected meteorological stations in the study area

Number	Station			Station Symbol			Meridians		Latitude	Height
		ICAR	WMO	DEG	MIN	SEC	DEG	MIN	SEC	METER
1	Turaif	OETR	40356	38	44	22E	31	41	16N	852.44
2	Arar	OERR	40357	41	08	26E	30	54	08N	548.88

.Rainfall in the Kingdom of Saudi Arabia (Temporal Classification and Spatial Variation)

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Abstract

Rainfall is regarded as one of the most important climatic factors. The kingdom of Saudi Arabia is characterized by Its vastness and diversity of topographic features, that result not only the variation in seasons of rainfall, but also in its spatial variation of rainfall.

This study aims to analyze the quantities of rainfall and to show the time and spatial variations in 27 different meteorological stations distributed in 13 different regions in the kingdom of Saudi Arabia. Factor Analysi has been used in this study, in which three main factors are identified for rainfall. The first factor was connected with spring and summer, while the second one dealt with winter, and the third one with autumn.

Regarding spatial variation, Abha and Khamis Mushait stations were connected with the first factor. Gaysoma Station and Hafr-Albatin were linked with the second factor and Jazan is linked with the third factor. This study came out with several findings and recommendation.

The Theoretical Framework of the Study

Introduction.

The Kingdom of Saudi Arabia is located Southwest Asia. It occupies about four- fifths of the Arabian Peninsula with a land area of approximately 2000, 000 (km2). It is located between latitudes 16◦, 32◦ North and longitude 34◦, 56◦ East, As the Tropic of cancer Passes Across it from east to west. This location is one of the most dried and arid regions in which the rainfall never exceeds 50 ml.