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Fog: Its Causes, Types, and Dangers in Saudi Northern Borders (A Climatic Study)

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Abstract

The current study investigates the recurrence of fog phenomenon in Northern Borders area of Saudi Arabia according to the Synoptic International Scale in terms of its types, causes, and the annual, seasonal, and monthly recurrence. The study also classifies the climate conditions co-occurring with the formation of fog in the area, as well as the potential traffic and health risks ensuing. For data resources, the researcher relies on the monthly weather data of climate phenomenon in Northern Borders in the areas of Tiraifand Arar in the period 2000-2015. The study adopts the descriptive-analytic approach and some statistical models for achieving the aims of the research.The research findings indicated that fogs in Tiraif occur most in the months of December and January, whereas in Ararfog occurs in November and February, the matter that led to numerous health and traffic problems in the area. Hence, the research recommends that the authors concerned take the measures and precautions required for dealing with accidents resulting from the fog.

Introduction

Fog is formed when water vapour is condensed on the surface of the atmosphere in the form of small drops the diameter of each is no more than 100 micron. Because of the smallness of these drops, they remain suspended in the air, the thing that limits visibility hence causing traffic accidents. In fog days, there are more incidents of traffic accidents which aggravates the economic situation since they necessitate exceptional measures and continuous lighting of streets ,to say nothing of the cost of repairs due to damages incurred. Visibility, on fog formation, is correlated with the rate of watervapour in the air: the higher the relative humidity, the less the visibility. Fog is different from Shaboorain that visibility in fog is less than 1000 metres, whilst in Shaboora, or light fog, it is more than 1000 metres (NaumanShahata, 135:1998).Problem of the Study The Northern Borders area of Saudi Arabia is characterized by annual occurrences of fog formations, the thing that reflects on man's life and health. Fog is one of the causes of chest diseases. Further, it blocks visibility, which leads to numerous traffic accidents since the suspended water drops work to disperse the light, which sometimes causes visibility to be as low as a few metres, thus arresting traffic and causing accidents. Therefore, this fog phenomenon has become the concern of traffic and transport system planners in most of world areas including the Northern Borders of Saudi Arabia.

Aims of the Study

1. Identifying the types of fog conditions according to the Synoptic Scale in Northern Borders area.
2. Determining the fog recurrence in the area.
3. Specifying the weather conditions attending fogs in the area.

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4. Finding out about the connection between the fog and traffic accidents, and its impact on human health in the area.

Methodology

The study adopted the descriptive-analytic approach, using the statistical modes following:

- The Descriptive Statistics for calculating fog frequency and the means of climate conditions accompanying fog.
- The One-way Anovaanalysis for specifying the differences in fog frequency in the area of study.
- The K-Mean Cluster analysis for classifying fog in the study areas according to rainfall and the climate conditions accompanying.
- The use of Pearson Correlation coefficient for identifying the correlation between the fog phenomenon and the number of traffic accidents as well as the rates of chest infections.
- Drawing and analyzing the GISmaps, using Arc Map.

Data Resources

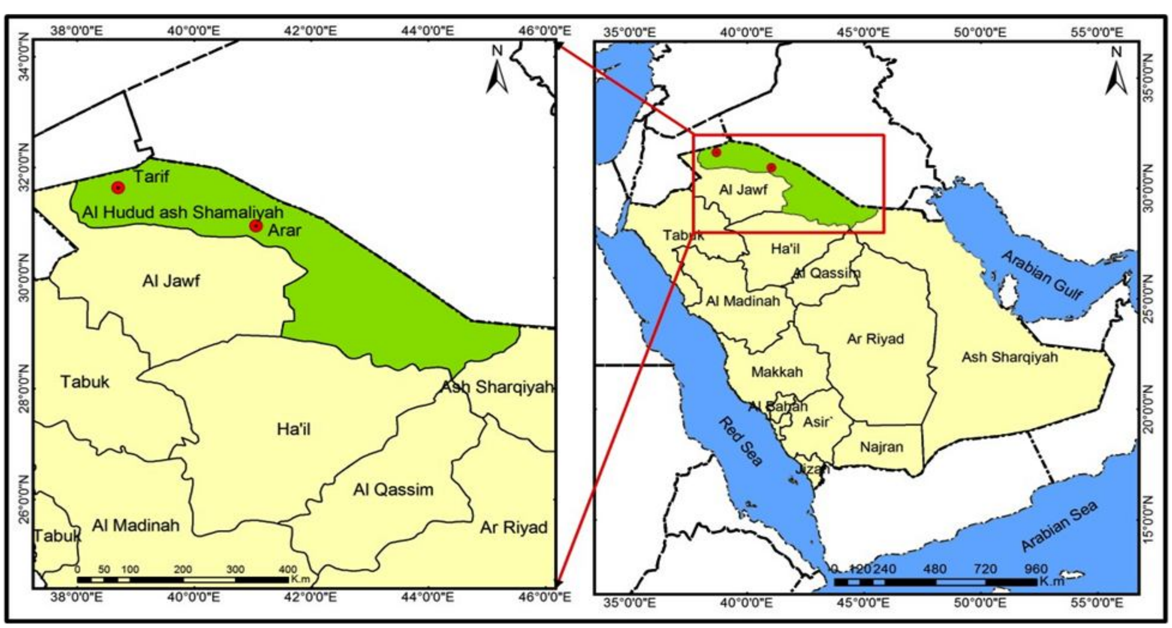
The monthly climate data for the weather phenomena in the areas of Tiraifand Ararin the period 2000-2015 has been provided by the General Directorate for Meteorology and Environmental Protection, Department of Information Supply, for studying the fog phenomenon and the distribution thereof in Northern Borders area (Table 1).

Station	No. station	latitude (north),)	longitude (east))	Height (m)
Tiraif	40356	31.69	38.73	852
Arar	41357	30.91	41.14	555

The Study Area

The area lies to the north of Saudi Arabia as a north- west, south-east strip between latitudes 29,37'17" and 31,41'16" to the north, and longitudes 38,44'22" and 43,29'41" to the east. It is bordered from the north by Iraq and Jordan; from the east by Iraq; by the Eastern Region and Qaseemfrom south, and by Aljoaf andHaelfrom the west (Figure 1). Administratively it is divided to: the main area of Ararand three provinces: Rafhaa, Tiraiff, andArar. The area is characterized by a tropical climate. Maximum summer temperatures are 46, turning to as low as a littlebelow zero in winter. The annual rainfall, however, is so low it does not exceed 10m.

Figure 1: The study area



Definition of "Fog"

The fog phenomenon can be defined as the "low visibilityin the air to less than, or equal to, 1000 metres, because of water droplets or snow particles suspended in the air."The fog is a natural, climatic condition in the form of clouds coming close to ground surface, formed by warm air currents touching cold surfaces or vice versa- when cold air currents blow on warm surfaces. It is a form of condensation, containing minute water drops the diameter of each is no more than 1m. Fog dissipates at sunrise when air temperature begins to increase. It isthicker in cities than in rural areas due to dust and grime pollution where dust and grime cling to the water drops. As a rule, upon formation of fog, visibility becomes low which leads to accidents, particularly in the event of thick fogs. Owing to the risks involved in fogs, scientists have developed an international fog measure (from 0 to 9) relying on the naked eye for observation (Table 1-4) (Abu-alainain, 1985: 334-335).

There is a number of factors that collectively work towards the formation of fog. These are:

1. The high level of humidity in the air. Fog is formed in relative-humidity areas, especially in bodies of water and dense vegetation.
2. Light winds that help speed up the process of air cooling.
3.Sufficient condensation molecules.
4. Clear weather leading to dispersion of earth radiation which cools the air down to a dew form or below until condensation occurs (Iessa, 2006: 124-125).

Table (2): visibility through the various types of fog

Fog	International number	Maximum distance kind of see where things clearly
Opaque fog	0	50 m
Heavy fog	1	200 m
Show is very poor	2	500 m
Show poor	3	1 km
Rusk (Ajaj)	4	2 km
Show weak	5	4 km
Show moderate	6	10 km
Opaque fog	7	20 km
Heavy fog	8	50 km
Show is very poor	9	More than 50 km

Source: Abu-alainain, 1985: 334-335.

Causes of Fog Formation

Fog occurrence is correlated with the relative humidity, temperature, wind velocity, cloud cover, and weather thermal stability. The dew point occurs when air temperature is saturated with water vapour. This takes place when air, or the water drops clinging thereto, takes in more humidity. Water vapour enters the air in different ways: either through evaporation from water bodies or wet ground because of heat from sunlight, or because of water vapour resulting from vegetation, or when a cold or dry air current passes above a warm water surface. Water vapour may also enter the atmosphere by way of some human activities such as industry and transport (Nolan, 2010: 1-5).When air temperature nears the dew point, a little humidity condenses on the particles suspended in the air ,such as dust and snow, and turns into liquid state the matter that results in the fog or shaboora or dew phenomenon and may lead to cloud formation. On the whole, fog begins to form when air temperature is warmer than dew point (Environment Canada, 2014:65).

Fog is formed when water vapourso condenses in the atmosphere that it takes the form of water drops or snow crystals, becoming visible and having a basis linked to the ground. Therefore, air saturation with vapour, and the condensation of minute water particles are two major conditions for fog formation (Nolan, 2010: 1-5). Thickness of fog layer is measured according to how higher its peak than the sea or ground level.

This thickness can be more accurately measured by how high the warmest or driest mass of air which is above the cold air layer closest to the ground surface. This varies according to the air pressure above, since the fog mass can be dense if the air pressure above is high. Fog mass can also be less dense if the air pressure above begins to drop (Environment Canada, 2014: 65). Fog formation and density on ground surface is not easily predictable, since it does not have to occur in completely quiet winds. Some fog cases, studied at the end of the 18th century, were associated with troubled winds (Gultepe, 2007: 1122).

Analysis and Discussion

Types of Fog in Northern Borders Area: Outer land fog comes in various types, according to the location it is formed in: for example, the valleys fog, the mountain slopes fog, and cities fog. Peter Nolan (2010) classifies fog according to the manner it is formed: it can occur as a result of the air being saturated with water vapour, or through cooling the air until it has reached saturation point. So the agents causing air saturation with vapour, the speed of evaporation, and the factors affecting the cool air that is close to ground surface, are the determinants for classifying fog types which are as follows:

A. Fog of Evaporation: This includes:

1. Steam Fog

It is a fog resultant from intense evaporation from water to relatively cool air, so the state turns from saturation to condensation to fog. Evaporation fog can be noticed over water bodies and in tropical areas. Sometimes it occurs in warm areas or wet lands, or immediately after rains as is the case in Northern Borders.

2. Frontal Fog

As the name suggests, this is formed along the edges of two masses or fronts of air: warm rain evaporates, falling from a higher layer, through a drier air mass, in a lower layer, thus bringing about a state of water-vapour-saturated air, followed by a state of condensation of colder layers thus forming frontal fogs.

B. Fog of Cooling: This includes

1.Radiation or Ground Fog

Radiation or Ground fog is formed when the wet air touching ground is fully quiet. As a result of cooling, saturation occurs, followed by condensation, and then fog is formed. This takes place as a result of radiation at night time. When air is fully quiet, dew or frost is formed. At the slightest air motion, fog becomes deeper. If air motion further increases, fog disperses and clears up. As a rule, radiation fog occurs on flat ground. This can be noticed in the study area.

2. Advection Fog

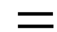
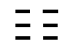
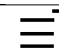
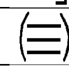
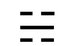
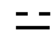
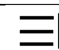
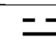
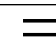
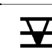
Advection fog is formed when wet air passes over a cold surface, thus effecting saturation and dew drops formed on ground. Further cooling of the air layer touching the ground results in high saturation rates. With the light air movement, air mixes up, leading to condensation on higher layers above ground level and so fog covers the whole area.

3. Mixing Fog

Mixing fog is formed when a wet ,warm air mass meets a wet, cold one. This mixture results in a temperature drop enough to effect saturation and condensation, yielding mixed fog. An example of mixing fog is when a person exhales in very cold days in a mist that he can see before his eyes (Nolan, 2010: 2-5).Oftentimes the Northern Borders area, particularly Arar, Tiraif, and Rafha, receives warning messages , by the early warning system of the General Directorate of Meteorology and Environmental Protection, of dense fog formation during night hours. The fog lowers visibility on highways and open spaces, endangering lives. The reason for these cases in the most is the drop in the temperature of the air that is close to ground so much so that it gets to zero or below, accompanied with a considerable increase in the rates of relative humidity during night time, especially in winter following rains where ground is wet the thing that renders it convenient to reach dew point and then the formation of dense fog. The Northern Borders witness annually a number of fog formation cases which has negative impacts on people's health and life since it limits visibility on roads leading to accidents.

Besides, it is one of the causes of chest diseases.For analyzing the fog phenomenon and the attendant climate conditions, the daily Synoptic climate data was used in the period 2000-2015. Synoptic measure specifies the climate state four times a day, every six hours. Each state is referred to by a certain Synoptic code, in addition to a code identifying each state as is shown in Table (3).

(3): Description of the total values of the phenomenon of fog

international Code Alsnobi	phenomenon Symbol	Description
10	Fog light	
11	Patches of light intermittent fog	
12	Connected to a layer of fog light	
28	Fog in the last hour	
40	Fog on the remote monitoring station	
41	Patches of fog	
42	Obscured skies and fog Say Fish at the last time	
43	Obscured skies and fog Say Fish at the last time	
44	Obscured skies and fog did not change its thickness in the last hour	
45	Obscured skies and fog did not change its thickness in the last hour	
46	Obscured skies and fog grew thicker in the last hour	
47	Obscured skies and fog grew thicker in the last hour	
48	Fog and obscured the sky	
49	Fog and obscured the sky	

Source: Federal Meteorological Handbook (2007, p.14).

Fog Frequency in Northern Borders

Fog cases in the area were identified and classified for the period 2000-2015,according to their Synoptic codes, for determining the dominant types in TiraifandArar.

Monthly Frequency of Fog

Table (4) and Figure (3) show the monthly frequency of fog in the area according to the International Synoptic Classification. Fog type is indicated by a respective Synoptic code, beginning with 10 and ending with 49. There were 601 cases of various kinds of fog in Tiraif during the period 2000-2015. The highest percentage 82% was, however, of light-fog cases bearing the number 10, whereas the fog that blocks the sky, in different fog-layer thicknesses between the codes 42-49, was of lower percentage, the salient case of which was "a blocked sky and a fog that became thicker within the last hour" which bore the code 47. This recurred at a rate of 10% during the study period. Fog cases in Tiraif were most in December and January ,both of which witnessed 345 cases during the study period, out of a total of 601 cases, that is at a rate of 57.5%. It is shown in the Table that fog cases begin to appear as of October and keep increasing gradually to a peak in December. Then they begin to decrease until disappearance by the end of May.

Table: (4) Monthly repetition of the phenomenon of fog northern border areaduring the period (2000-2015)

Station	**Code Month**	**10**	**11**	**12**	**28**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**Total**
Tiraif	January	140	0	0	0	0	0	0	8	0	3	6	14	1	0	**172**
	February	76	0	0	0	1	0	1	0	0	1	1	8	0	0	**88**
	March	37	0	0	2	0	0	0	0	0	0	0	0	0	0	**39**
	April	12	0	0	0	0	0	0	0	0	0	0	0	0	0	**12**
	May	5	0	0	0	0	0	0	0	0	0	0	2	0	0	**5**
	June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	July	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	September	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	October	18	0	0	0	0	0	0	0	0	0	0	0	0	0	**18**
	November	73	0	0	0	0	0	0	4	0	5	1	9	0	0	**92**
	Dec	130	0	0	0	0	0	4	3	0	7	4	26	1	0	**175**
	Total	491	0	0	0	1	0	5	15	0	16	12	59	2	0	**601**
	%	%82	%0	%0	%0	%0	%0	%1	%3	%0	%3	%2	%10	%0	%0	**%100**
Arar	**Code Month**	**10**	**11**	**12**	**28**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**Total**
	January	63	0	0	0	11	0	3	0	5	4	0	2	0	0	**88**
	February	25	0	0	0	3	0	2	0	0	0	0	0	0	0	**30**
	March	4	0	0	0	1	0	1	0	0	0	0	0	0	0	**6**
	April	8	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**
	May	7	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**
	June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	July	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	September	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	October	9	0	0	0	0	0	3	0	0	0	0	0	0	0	**12**
	November	55	0	0	0	2	0	4	0	0	0	0	0	0	0	**61**
	Dec	73	0	0	0	8	1	13	0	2	3	0	1	0	0	**101**
	Total	244	0	0	0	25	1	26	0	7	7	0	3	0	0	313
	%	%78	%0	%0	%0	%8	%0	%8	%0	%2	%2	%0	%1	%0	%0	%100

Figure 2: Monthly Recurrence of Fog in the Northern Border Area

Table (4) shows the monthly fogfrequency in Araraccording to the Synoptic classification. Ararwitnessed, during the period 200-2015, 313 different cases of fog. The highest percentage, however, went to light-fog formations at a rate of 78%, bearing the code 10. The blocked-sky formations, with various fog-layer thicknesses, between the codes 42-49, were at a lower rate, the major one of which was “a blocked-sky state and a fog that decreased in thickness during the last hour”. This bore the code 42, and had a frequency of 8%. Most fog cases in Ararare distributed between November and February. This period witnessed 280 cases, that is, a rate of 89.5%. It can be noticed from the Table that fogs begin to appear as of October, and keep building up gradually to a peak in December . They then begin to gradually decrease until disappearance towards the end of May.

Seasonal Frequency of Fog

Table (5) and Figure (4) indicate the seasonal fog recurrence in Northern Borders according to Synoptic classification. Winter in Tiraif is the most season with fog .

Figure 3: The Quarterly Frequency of Fog in the Northern Border Area

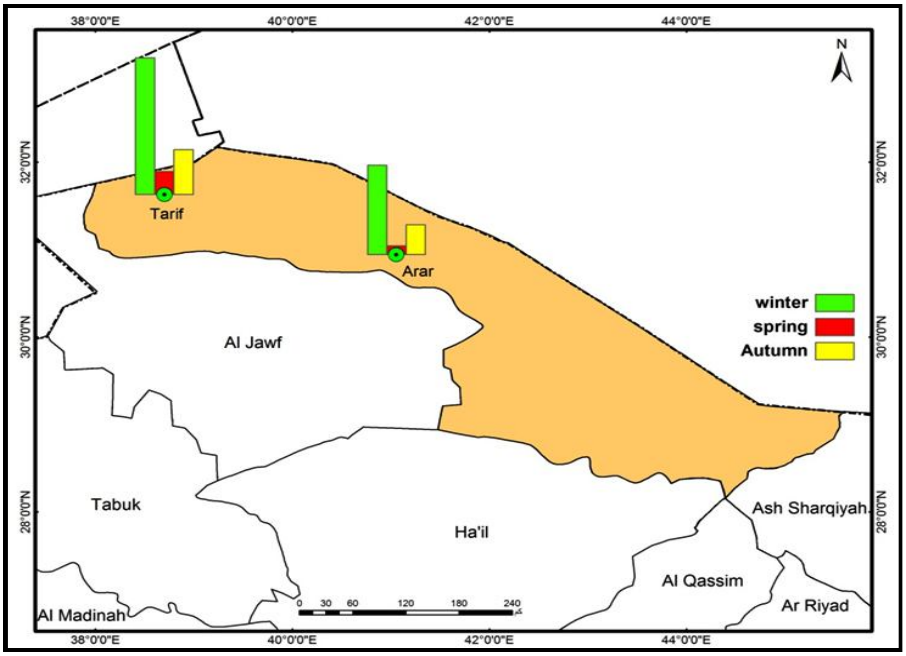


Table (6) contrasts the annual fog frequency, in its various forms, during 2000-2015. The year with most formations was 2014 (96), then 2013 (90), whereas 2005 registered the least occurrences (22). Table (6): A comparison of the annual repetition of the phenomenon of fog in the stations during the study period (2000-2015) Station A comparison of the annual repetition of the phenomenon of fog in the stations during the study period (2000-2015)

Station year	Tiraif	Arar	Total
2000	58	15	73
2001	34	17	51
2002	36	18	54
2003	48	36	84
2004	40	19	59
2005	13	9	22
2006	34	10	44
2007	28	12	40
2008	29	5	34
2009	23	11	34
2010	23	2	25
2011	34	28	62
2012	48	24	72
2013	50	40	90
2014	61	35	96
2015	42	32	74
Total	**601**	**313**	**914**

To find out about any statistically significant differences in fog recurrence in both areas, a one-way ANOVA analysis of the annual frequencies of fog in both Tiraifand Arar, as shown in Table(7).Table (7) shows that the calculated value of coefficient (F) is 16.709 which is more than its format value of 4.17 at the temperatures mentioned as well as it is statistically significant.

Its significance level is 0.000 which is lower than 0.05, which is indicative of there being statistically significant differences between annual recurrences of fog formations in both areas of study.These differences are interpreted according to variance of the site and height of the two stations: Table (1) shows that Tiraifstation lies at the altitude of 31 to the north. It witnessed 601 of fog formations. Arar, on the other hand, lies at the altitude of 30 to the north. It witnessed 313 fog formations. Further, it is 555 metres above sea level, and characterized by low air temperatures and high relative humidity and high water vapour pressure more than in Tiraifwhich is 852 meters above sea level.

Table (7): ANOVA variance between the annual repetition of the phenomenon of fog in the study area analysis During the period (2000-2015) (7): ANOVA variance between the annual repetition of the phenomenon of fog in the study area analysis During the period (2000-2015)

Source of variation	**Sum of squares**	**Degrees of freedom**	**(F)**	**The level of significance**
Between groups	2592.000	1	16.709	0.000
Within groups	4653.875	30	-	-
Total	7245.875	31	-	-

Fog Formation and Concomitant Climate Elements

For identifying the nature of climate elements concomitant with fog formation, in its various densities according to Synoptic classification, there was measured the mean of the elements of (wind velocity, lower temperatures, relative humidity, and water vapour pressure) in the study areas, as is shown in Table (8).

Table (8) indicates that the chance for fog forming is bigger, the less the wind velocity, and the less the lower temperature. In contrast, relative humidity rates get higher and so does water vapour in the air. This can be noticed from the Table when contrasting the formation of “light fog”, “blocked-sky state”, and “a fog that gets thicker”. This can be accounted for by that the drop in wind velocity prevents fog dispersion, making way for fog to form. Moreover, the drop in lower temperatures of the air touching earth’s crust helps the condensation of water vapour emanating from earth and hence the increase of the rate of relative humidity in the air close to earth surface, and attainment of dew point, then fog formation.

Table (8): associated with climatic elements to be fog in the study area

Synoptic Code	**Description storm**	**Tiraif**				**Arar**			
		Wind speed	Minimum temperature	Relative humidity	Water vapor pressure	Wind speed	Minimum temperature	Relative humidity	Water vapor pressure
10	Fog light	7.29	4.59	73.13	8.77	6.66	8.16	82.83	12.52
11	Patches of light intermittent fog	-	-	-	-	-	-	-	-
12	Connected to a layer of fog light	-	-	-	-	-	-	-	-
28	Fog in the last hour	-	-	-	-	-	-	-	-
40	Fog on the remote monitoring station	7.00	8.00	80.00	11.30	6.00	4.58	88.86	10.44
41	Patches of fog	-	-	-	-	4.00	8.30	87.00	13.80
42	Obscured skies and fog Say Fish at the last time	7.33	3.67	83.00	9.47	6.19	7.93	92.63	13.10
43	Obscured skies and fog Say Fish at the last time	6.00	5.50	81.00	9.95	-	-	-	-

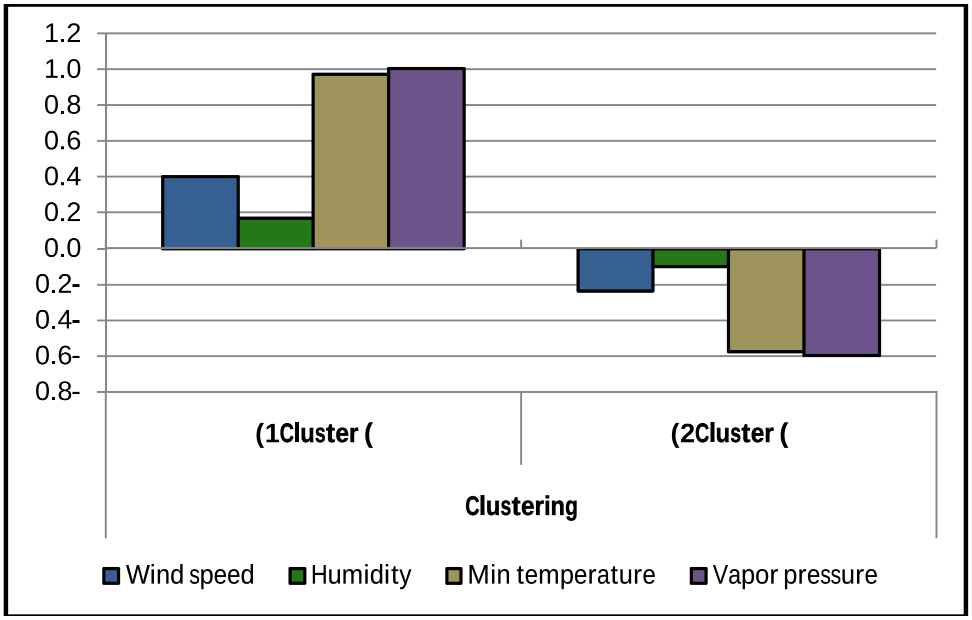
44	Obscured skies and fog did not change its thickness in the last hour	-	-	-	-	3.80	2.60	90.40	9.02
45	Obscured skies and fog did not change its thickness in the last hour	6.80	5.10	91.60	10.56	4.50	8.40	90.50	12.60
46	Obscured skies and fog grew thicker in the last hour	4.45	0.89	81.36	7.97	-	-	-	-
47	Obscured skies and fog grew thicker in the last hour	6.73	4.10	84.08	9.46	5.33	5.13	98.00	10.33
48	Fog and obscured the sky	6.50	2.00	81.50	7.35	-	-	-	-
49	Fog and obscured the sky	-	-	-	-	-	-	-	-

Classification of Fog Phenomenon According to Climate Conditions Causing Fog In the previous section, the climate elements causing fog were classified according to its various Synoptic types. Below is the classification of fog formations to three groups according to the concomitant climate elements such as wind velocity, air temperature, relative humidity, and water vapour pressure. This is detailed as follows:First: Classification of Fog in Tiraif According to Concomitant Climate Conditions The researcher used the K-Means Cluster analysis for classifying fog formations in Tiraifinto two groups according to the concomitant climate conditions, as shown in Table (9). Table (9) andFigure (4) show that fog formations can be classified into two groups: Group (1), registering the highest rate of 59%, is characterized by maximum rates of all weatherelements such as wind velocity, relative humidity, lower temperature, and water vapour pressure. Weather elements accompanying fog, in Group (2), which is the lowest ,registering 41%, are at their lowest .

Table (9): rating fog phenomenon in Tiraif depending

Variables	**Category**	
	Group (1)	Group (2)
Wind speed	7	7
Relative humidity	82.6	64.5
Degrees minimum temperature	9.4	8.2
Water vapor pressure	4.4	4.8
Total	Group (1)	Group (2)
%100	%59	%41

Figure (7): Clusters of Fog phenomenon in Tiraif depending on the associated weather

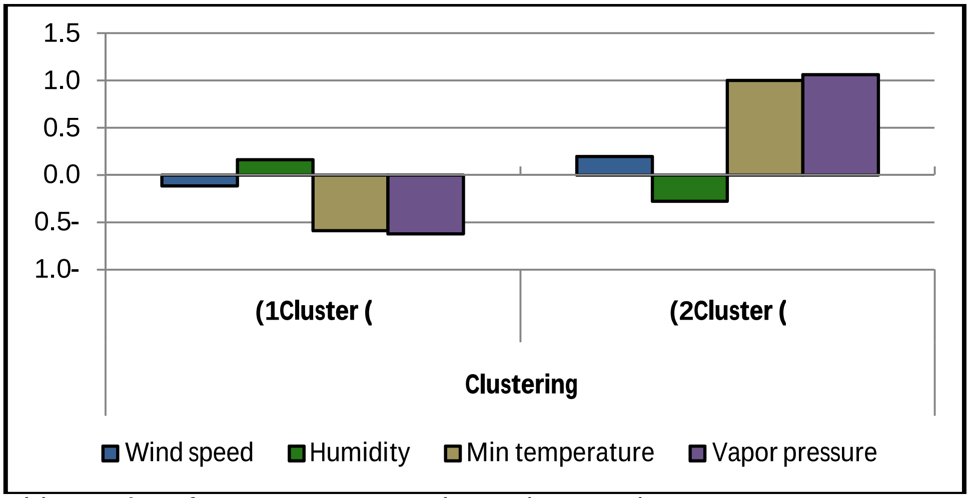


Second: Classification of Fog in Arar According to Concomitant Weather Conditions The researcher used the K-Means Clusterfor classifying fog formations in Ararinto two groups according to concomitant weather conditions, as is shown in Table (10) which shows ,together with Figure (5), that fog formations in Ararcan be classified into two main groups. Group (1), which has the lowest rate of 22%, is characterized by a drop in wind velocity and in lower temperature and water vapour pressure accompanied with high levels of relative humidity. Group (2), with the highest rate of 78%, is characterized, however, by high water vapour pressure, and high lower temperature ,together with a slight increase of wind velocity accompanied by a noticeable drop in relative humidity.

Table (10): Rating fog phenomenon in Arar depending cases associated with the weather

Variables	**Category**	
	Group (1)	**Group (2)**
Wind speed	8	6
Relative humidity	67.9	89.5
Degrees minimum temperature	12.1	12.3
Water vapor pressure	10.1	7.0
Total	Group (1)	Group (2)
%100	%22	%78

Figure (8) Clusters of Fog phenomenon in Arar depending on the associated weather



Risks Resultant from Fog Occurrence in Northern Borders:

A. Fog and Traffic Accidents:

The major meteorological criteria directly affecting the users of roads and their safety are: snow, rains, ice, winds, and fog. As compared with other phenomena, fog is relatively rare. Fog occurrence is not easy to predict since fog varies in density and occurrence location. It moves horizontally and vertically from a place to another, covering small and large spaces, and it can clear up quickly. Fog accidents have recently become a topic of interest in Saudi Arabia where this problem featured in the areas witnessing cases of dense fogs. To find out about whether there is a connection between traffic accidents in the study area and fog formation phenomenon, the researcher conducted an analysis of Pearson Correlation between the two variables as follows: It is clear from Table (11) that there is no statistically significant correlation between fog frequency in Northern Borders and frequency of traffic accidents: the correlation coefficient is 0.457, which is an average correlation, but is not statistically significant where the level of significance is 0.075 which is higher than 0.05. The researcher argues , as is shown in the table, that traffic accidents are on the increase, the thing that points to other related factors. In addition to the impact of fog formations, one can argue that individual car accidents during fogs are not exclusively caused by fogs. As for multiple accidents, however, fogs can be a major cause. Table (11): Annual frequency of cases of fog in the northern border area of traffic accidents correlation (During the period (2000-2015) **:**

Annual frequency of cases of fog in the northern border area of traffic accidents correlation (During the period (2000-2015)

data year	Fog cases	Traffic accidents	Infected	Deaths	correlation	Significance
2000	73	4180	891	106	0.457	0.075
2001	51	3999	1448	139		
2002	54	4187	865	107		
2003	84	4169	975	168		
2004	59	3994	672	102		
2005	22	4034	604	158		
2006	44	5668	510	172		
2007	40	6805	2939	487		
2008	34	6160	575	147		
2009	34	6799	646	153		
2010	25	9449	884	123		
2011	62	10016	788	134		
2012	72	13316	685	133		
2013	90	14132	669	135		
2014	96	11478	680	135		
2015	74	13076	732	156		
Total	**914**	**121462**	**14563**	**2555**		

B. Fog and Chest Infections

Fogs pose a threat to people's health as a consequence of the diseases resultant from change of weather conditions, drop of temperatures, and fogs that carry viruses and bacteria. Due to high humidity, there are more and more cases of infections related to respiratory system as well as allergic complaints. This is but common in the light of weather changes particularly in winter where fog may lead to inflammation of the upper respiratory systemresulting in breathing problems as well as causing of fatigue, laboured breathing, and buzz in the ears. In the event of infection getting worse, things may go even further and develop into low blood pressure, imperfect sight and hearing, sense of congestion and irritation of mucus menbranes, sore throat, and inflammation of the trachea (Alrrand, 2016). For identifying if there being a correlation between rates of chest infections and fog formation in the study area, the researcher conducted a Pearson Correlation analysis of the two variables as follows:

It is evident from Table (12) that there is a statistically significant correlation between frequency of fog formation in Northern Borders and the numbers of those consulting the clinics of chest infections (Annual Statistical Book, Ministry of Health: 2006-2015). The correlation coefficient was found to be 0.856, which is a high correlation, and was statistically significant, rate of significance being 0.002, which is less than 0.05. The researcher argues that the spread of fog phenomenon in Northern Borders area adversely affects human health, especially those suffering from asthma, because relative humidity in the air gets higher than 40%, this being accompanied by an acute drop in temperatures, which aggravates asthmatics health condition. It further leads to the formation of mold and rot inside houses, which worsens the health condition of asthmatics (Aladli, 2016).

Table (12): Annual frequency of cases of fog in the northern border region and the number of cases of thoracic diseases during the period correlation (2006-2015) order region and the number of cases of thoracic disease

Data Year	Fog cases	Cases of tuberculosis infections	Auditors Chest Diseases	correlation	Significance
2006	44	15	25844	0.856	0.002
2007	40	26	17436		
2008	34	22	20311		
2009	34	22	25866		
2010	25	17	29460		
2011	62	13	23306		
2012	72	13	10310		
2013	90	13	9893		
2014	96	19	10101		
2015	74	13	13996		
Total	**571**	**173**	**186523**		

Conclusion

This study of fog phenomenon, its causes, types, and dangers, in the Northern Borders area in Saudi Arabia shows that the area of Tiraifin the period 200-2015, registered 601 cases of fog formations, the highest percentage of which (82%) were light-fog formations. The study also shows that the fog cases are concentrated in the two months of December and January, registering 345 cases during study period at a rate of 57.5%. This case begins first in October, gradually increasing until it reaches a peak in December. The area of Arar, however, registered 313 cases, the highest percentage of which were of light-fog cases with a rate of 78%. However, the blocked-sky fogs registered a low rate. In addition, most of fogs in Arar are distributed between the months of November and February: there were 280 fog cases, that is 89.5%. Fog cases begin as of October and gradually increase until the peak in December. Winter is the most season of the year with fog formation in the study area: in the study period, there were 433 cases in Tiraif with a rate of 72%. Autumn comes second where fog formations occurred 110 times, followed by spring with 57 cases. Summer, however, registers no cases. In Arar, there were 219 cases during the study period at a rate of 70%, with autumn coming second place, then spring, with no cases in summer.

The study finds also that fog phenomenon occasioned several traffic problems , owing to blocked visibility, such as car accidents and traffic jams, to say nothing of health problems such as chest infections.

Hence, the study recommends the following:

1. Supporting researches related to detailed climatic studies, for facilitating the conduction of climatic studies and weather forecasting.
2. Exchange of expertise with international meteorological organizations to make use of their experience concerning fogs.
3. The need for the authorities concerned to make citizens aware of potential fogs for the prediction thereof and the prevention of the risks involved.
4. Taking the measures and precautions required ,on the part of those concerned, for confronting accidents caused by fogs.

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