

**OCCURRENCES OF DUST STORMS AND THE
EFFECT ON HUMAN HEALTH**

by

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**Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of philosophy**

August 2016

ACKNOWLEDGEMENT

Praise to Allah for his guidance and blessing for giving me the strength and perseverance to complete this research.

I would like to express my deepest appreciation for my supervisor Prof. Dr. Habibah Hj Lateh for the guidance and constant motivation that has enabled me to complete my research work. I would also like to thank her for the opportunities that she has made available to me.

I would like also to give my gratitude and appreciation to the School of Distance Education for all the help that I was provided with during my study at the University Sains Malaysia.

I would like also to thank my parents, for providing me with the opportunity to pursue my goals and for their love and affection, which helped me through the difficult times I went through. Equal gratitude goes out also to my siblings and brothers.

In addition, I would like to thank my dear friends and family for all the motivation and inspiration throughout my study.

Finally, my greatest gratitude goes to my beloved husband and my precious daughters for their patience and supports throughout this study.

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ADS	Asian dust Storm
cm	Centimeter
°C	Degree Celsius
FMDM	Limited mixture distribution model
g	Gram
GDP	Gross domestic product
GAM	Generalized additive model
GIS	Geographic information system
IL-1 β	Interleukin-1 beta
IL-6	Interleukin 6
IFN γ	Interferon gamma
kg	Kilogram
km	Kilometer
KP	Klebsiella pneumonia
m	Meter
mm	Millimeter
mol	molecular weight
μ	Micro
MCP1	Monocyte chemotactic protein 1
MIP-1	Macrophage Inflammatory Proteins
N	North
NALP3	Cryopyrin protein
PEFR	Peak expiratory flow rate

PM	Particulate matter
SGS	Sequential Gaussian simulation
SPSS	Statistical Package for the Social Science
TNF α	Tumor necrosis factor alpha,
%	Percentage

KEJADIAN RIBUT PASIR DAN KESANNYA TERHADAP KESIHATAN MANUSIA

ABSTRAK

Kajian ini memberi penerangan tentang kepentingan satu fenomena semula jadi, ribut pasir, kewujudannya, arah dan kesan yang mendalam ke atas kesihatan manusia. Oleh itu, tujuan kajian ini adalah untuk mengkaji kesan ribut pasir ke atas kesihatan manusia. Metodologi kajian adalah berdasarkan kajian lapangan, unsur-unsur iklim dan fenomena debu di wilayah kawasan kajian dan berhampirannya telah dianalisis dengan menggunakan kaedah siri kronologi dan analisis pekali korelasi. Peta terperinci kawasan kajian dikumpulkan dari lapan stesen kaji cuaca yang terletak di sepanjang lingkungan utara ke elatan Iraq, yang juga terdiri daripada kebanyakan bentuk geografi di Iraq iaitu yang keadaan di kawasan tinggi dan rendah. Di samping itu, operasi statistik dan persamaan matematik telah digunakan untuk menganalisis beberapa elemen iklim. Soal selidik kajian telah diedarkan bagi menyiasat masalah kesihatan yang timbul, kemudahan kesihatan yang disediakan apabila ribut pasir melanda dan kesan ribut pasir terhadap penduduk yang tinggal di bandar Thi-Qar. Kajian ini juga menggunakan dan memperlihatkan dokumen daripada arkib pelbagai institusi kesihatan di wilayah Dhi Qar dan mengumpul data yang berkaitan. Data-data ini dibandingkan dengan data meteorologi yang diperolehi daripada Pertubuhan Meteorologi Iraq. Data meteorologi tersebut menunjukkan kekerapan pengulangan fenomena ribut pasir selama beberapa tahun. Selain itu, gambar dari pandangan atas kejadian ribut pasir yang berlaku di Iraq pada beberapa tarikh

telah digunakan. Hasil kajian mendapati bahawa elemen keadaan persekitaran, suhu, kekurangan hujan dan arah angin serta kelajuannya merupakan faktor utama peningkatan aktiviti ribut pasir di kawasan kajian. Hasil daripada taburan ribut pasir di lapan stesen kajian menunjukkan jumlah bilangan tertinggi hari ribut pasir dicatatkan di Al-Nasiriya mencapai 181 hari pada tahun 1978, di mana 68 hari daripadanya merupakan pada bulan Julai. Hasilnya juga menunjukkan bahawa jumlah mangsa yang dijangkiti dengan penyakit pernafasan pada tahun 2008 mencapai 145790 orang dari semua peringkat umur. Berdasarkan soal selidik, 92% daripada responden mengalami kesukaran pernafasan selepas dilanda ribut pasir. Hospital awam telah menyaksikan peningkatan beransur-ansur dalam sepuluh tahun yang lepas berkenaan jumlah pesakit yang mengalami sesak nafas dan kerap kali berlaku kematian selepas ribut pasir. Dapat disimpulkan bahawa peningkatan yang besar dalam bilangan orang yang dijangkiti dengan penyakit pernafasan menunjukkan sejauh mana pengaruh fenomena gumuk pasir dan ribut pasir terhadap penduduk kawasan kajian.

OCCURRENCES OF DUST STORMS AND THE EFFECT ON HUMAN HEALTH

ABSTRACT

This study, shed light on the importance of a natural phenomenon, the dust storm, its birth, direction and its deep impact on human health. Therefore, this study aims to investigate the impact of the dust storm on human health. The research methodology was based on the field study, the climatic elements and dust phenomenon in the study area and neighbouring provinces were analysed. Detailed maps of the study area were collected from eight weather stations spread from the north to south of Iraq, which cover most of the geographical forms in Iraq ranging from high areas to low areas. Samples of sand dunes were analysed to get the most accurate results that help in solving the geographical problem. Survey questionnaires were distributed to investigate the health problems, facilities that are provided during these dust storms and the effect of dust storms on the residents of Dhi-Qar city. This study also used and screened documents from the archive of various health institutions in Dhi Qar province. These data were compared with meteorological data obtained from Iraqi Meteorological Organisation. The meteorological data showed the repetition frequency of the phenomenon of dust storm for several years. Apart from that, aerial photographs of dust storms that took place in Iraq on various dates were also used. The result of this study showed that climate elements, temperature, rain shortage and wind direction and speed were the main factors in increasing the dust storm in the area of study. The result of the dust storms distribution in eight stations under research

shows that the highest total number of days of dust storms recorded in Al-Nasiriya reaching 181 days in the period from (1971-2007), of which 68 days were in the year 1978. The result also showed that the total number of people infected with respiratory diseases in 2008 reached 145790 people of all ages. The survey results show that 92% of the respondents suffer from shortness of breathing after the dust storm. In the last ten years, public hospitals have received a large number of patients experiencing shortness of breath and sometimes deaths after dust storms. It can be concluded that this great increase in the number of people infected with respiratory diseases shows the extent of the influence that the phenomena of sandstorm and dust storms have on the population of the area under study.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The phenomenon of dust storms occurs in areas experiencing drought and covers a large area of the world. Dust Storms, sometimes called sandstorms, often occur in arid and semi-arid areas, especially at subtropical latitudes. The occurrence of dust storms has increased lately, having negative effects on people's health, local economy and properties.

This chapter discusses the background of the study, problem statement, objectives of the study, research questions, scope of limitations, significance of the study and definitions of key terms (glossary) used in this study.

1.2 Background of the Study

Iraq has a vast desert region covering 64,900 square miles (168,000 square km), almost two-fifths of the country. The southern desert is known as Al-Ajarah in the western part of the country and Al-Dibdibah in the east. Al-Ajarah has a complex topography of rocky desert, wadis, ridges, and depressions. Al-Dibdibah is a sandier region covered with scrub vegetation. Moreover, there is an elevation in the southern desert range between 300 and 1,200 feet (from 100 to 400 meters). A height of 3,119 feet (951 meters) is reached at the Mount of Unayzah at the intersection of the borders of Jordan, Iraq, and Saudi Arabia. The deep Wadi Al-

Bātin runs 45 miles (75 km) in a northeast-southwest direction through Al-Dibdibah. It is recognized as the boundary between western Kuwait and Iraq (Etheredge, 2011). Al-Nasyria city lies in the south of Iraq on the Euphrates River, and it is the center of Dhi-Qar governorate. The climate of this city is dry, with many sand storms hitting the city throughout the year. It is surrounded by a huge desert region, which is called the southern desert. Recently, the geomorphologic feature of this region has changed due to the climatic change phenomenon in the region. This has led to an increase in the frequency of the occurrence of sandstorms significantly during the last few years (Awadh, 2012). This was significantly reflected on human life and activities in general, particularly on health, prompting the need for researchers to study this problem in detail. A dust storm is a powerful windstorm that carries a huge amount of dust and other small particles into the air above, which causes the small particles to be suspended. Sandstorms are indicated by speed and visibility, that is, when visibility is less than 1000 meters, or 5/8 of a mile.

Dust that consists of a dust storm comes from areas, known as dust source regions which are abundant regions (Foda *et al.*, 1985). As an example, dry lakes or wetlands and deserts in and around Iraq all are sources of dust. When the wind is above 15 knots (17.3 miles per hour), dust gets suspended with sand particles. If the wind speed sustains itself for a considerable amount of time, it takes a while to settle down as these particles are so small, a dust storm is then created (Rashki, *et al.*, 2013).

The powerful wind passes over complex particles, these particles of sand begin to shake, and then later leap. Due to the repeated striking of the land, they become untied and shatter off into smaller particles of dust which then begin to move freely. With the help of the wind speed which causes the smallest particles to move freely, dust particles have a large number of particles moving through a variety of methods, such as suspension, saltation and creep (Squires, 2007). Another cause of dust storms is dry farming lands. Dry land farmers rely on rainfall to water their crops. This requires the farmers to stay engaged with certain practices to keep the soil moist. Such practices include leaving a field unplanted for a year after harvesting to allow the build-up of water in the soil and then adding a layer of dry earth on the field in an attempt to seal the underlying soil. These practices make dry land agriculture susceptible to dust storms. These methods are used by farmers around the world in dry regions (Goudie, & Middleton, 1992). The frequency of dust storms is a prominent feature of the climate in Iraq. This is because of the availability of the conditions that help the occurrence and movement of dust due to lack of rain, green plants, and soil fragility (Al-Shalash, 1988).

Soil loss is considered as the main reason for sandstorms. Nutrients, organic matter and soil fertility are transmitted next to the dust storm creation. Consequently, the place where a dust storm is generated loses its agriculture productivity. Young plants are destroyed and results in a loss of production yield during the dust transportation (Yaalon & Ganor, 1979).

Through the reflection and absorption of solar radiation, dust particles have radioactive impact on the climate. It can lead to brutally cold days or hot days depending on dust particle properties and where they are found in the atmosphere (Grigoryev & Kondratyev, 1981). Sand storms also contribute to air pollution and threaten public health. People with asthma and other respiratory disorders who breathe in dust particles suffer (Khalaf & Al-Hashash, 1983).

Studies on climate and its impact on the formation and modification of landforms gave its role in this field of studies. As a result of the relationship between landforms and climate, climatic geomorphology emerged as the closest branches of geomorphology to geography, because it deals with surface differences in the distribution of landforms and is linked to different climatic elements (Al-Shalash, 1988). Climate is one of the influencing factors on landforms as its impact is equal to the geological factor. Its effect and control on external processes cannot be ignored. Thus, the outer factors involved in altering and forming the earth's surface as their impact is not less than that of the internal factors.

The different climatic elements, particularly solar radiation, temperature, wind and rain have an important role in the formation of the manifestations of the earth's surface (Ghoneim, 1981). These elements have an impact on the geomorphic processes directly through varying daily, monthly and annual temperature range. Humidity and heat also have an effective contribution as well,

as wherever they combine, mechanical weathering becomes active. On the other hand, climate has a role in soil formation which is the result of the weathering process, and this will prepare good conditions for dust storm to be created after the earth surface exposed to strong wind and lead to elevate the dust (Al-Taqi, 1969).

The role of wind in the erosion, transport and deposition is obvious in dry areas characterized by low rainfall and high evaporation, which is reflected in the vegetation. This leads to a lack of organic matter in the soil, making it instable and easy to drift by the wind, which is active when the level of the surface is free from vegetation and natural obstacles that can limit its activity. Hence, sand dunes appeared increasingly in the study area as a phenomenon resulting from the influence of the climatic factors and the activity of wind erosion which has significant effects on the population and economic life.

Dust storms have increased in recent years, in the region in general and in the area under study in particular, which results in the appearance of symptoms of irritation of the respiratory organs (both upper and lower). This in turn causes patient crowdedness in hospitals and emergency rooms due to an increase in chest diseases and allergies. During dust storms, air gets filled with dust particles which people will be facing directly, either through inhalation or direct contact. Despite the frequent occurrence of dust storms in the region, this issue has not been studied scientifically in terms of its health effects. The size of the damage

certainly depends on the size of particles inhaled. The small particles have the biggest impact on the respiratory tract because they can pass through the nose and can reach deep into the respiratory tract, interior bronchi and alveoli.

Many studies have confirmed that dust is not only annoying to humans, but it has huge negative effects on health. The World Health Organization determined that dust storms that occurred in the desert of Africa in 1996 caused a pandemic (i.e., meningitis) which infected 250000 people and resulted in the death of 25000 people (Shirber, 2014). The reason for the spread of this infectious disease was that the dust particles carried the bacteria causing meningitis for long distances; when people inhale sufficient quantities of these bacteria, the possibility of being affected by this disease increases.

Recent research has also showed that dust particles can carry the remains of cells and fungi and that dust particles can transport dangerous kinds of bacteria (Garrison *et al.*, 2012). More than 40% is transported by small dust particles which can go deep into the human lungs when they are inhaled. This could lead to many health problems and acute respiratory infections. However, the connection between respiratory infections and dust storms should be documented by doing further research to study this connection. Research conducted in China and Taiwan showed that increase in emergency rooms and hospitals because of lung disease, nasal disease, heart disease, and conjunctivitis increase to a great extent during dust storms (Ueda, *et al.*, 2012). In addition, dust particles and the organic

and inorganic materials with high concentration these dust particles carry lead to the irritation of the upper and lower respiratory tracts. It may increase shortness of breath symptoms for patients with chronic chest disease. In healthy people, symptoms can also include allergies which can appear within two days after being exposed to dust storm (Ueda, *et al.*, 2012). However, it can be noted that allergy symptoms during a dust storm occurrence increase in patients with asthma and other respiratory allergies (Morman, & Plumlee, 2013). Some people may also develop a seasonal allergy which occurs when a dust storm happens. In addition, dust storms and intense dust cause negative health effects in more than one organ of a human's body. Therefore, all health measures must be provided in order to minimise these effects as much as possible and more research are needed to find ways of reducing the occurrence of dust storms.

1.3 Problem Statement

The occurrence of sandstorms in Iraq has significantly increased in the recent years due to many factors including climatic changes. The southern region of Al-Nasyria geomorphological features have been changed recently. These changes greatly contribute to the generating and occurrence of dust storms, notably drought and the role of the north- west wind. Hence, the combination of both climatic factors and the surface texture increases the occurrence of those storms. These dust storms have negative effects on human health and are a cause of respiratory allergic diseases. It affects several people who are the citizens of the area that has been hit by the sandstorms. Moreover, these dust storms also cause

economic issues, such as damages or loss of properties. Furthermore, the effect of these dust storms on human health can force people to stay at home, making them less productive and consequently affecting the gross domestic product (GDP) of the household of the Iraqi citizens.

However, dust storms might harmfully affect and contribute to raise many diseases such as asthma and respiratory tract related diseases or bronchial allergy. It also has deleterious effects on those who have a genetic predisposition or are already living with respiratory diseases. Many researchers have studied the effect of the sandstorms from environmental aspects on the surrounding areas (Foda *et al.*, 1983). However, less information has been known about its impact on the infected people with respiratory allergic diseases in the central and south region of Iraq.

Based on the above statement, this study will focus on evaluating and studying the effects of these sandstorms on people with infected respiratory allergic diseases and its impact on human health. The study also aims to evaluate the most important geomorphologic characteristics of Iraq southern desert. In addition, this research will investigate desert contribution to the sandstorms dust particles and molecules of fine dust loose from the soil and the impact of these storms on human health through the study of respiratory diseases.

1.4 Objectives of the Research

The objective of this study is to investigate and evaluate several key roles related to geomorphological roles of deserts and dust storms as well as the deleterious effects that they might have on human health. In particular, the main objectives of this study are:

1. To evaluate the geomorphology and soil components of the southern area of Al-Nasyria city and its contribution to sand storms in the area.
2. To evaluate the role of climatic elements: temperature, humidity, wind, rain, precipitation and their contribution to dust storms.
3. To analyze the effect of dust storms on human health and on the infected people with respiratory allergic diseases.

1.5 Research Questions

Given the research objectives, this research seeks to answer the subsequent questions with regards to the issues of dust storms around Al-Nasyria city:

1. To what extent does the geomorphology of the southern area of Al-Nasyria city contribute to the dust or sand storms in the area?
2. What are the roles of such climatic elements such as humidity, rain, wind, and temperature in the formation of dust or sand storms?

3. What is the effect of dust storms on human health and connection with respiratory allergic diseases and which elements support this effect?

1.6 Limitations of the study

This research topic considered as new among other topics in the area of study as it investigate the health effects on the people during and after the dust storm. However, due to the large area of desert in Iraq, this research will cover and focus only on one specific region that is affected by the blowing of dust and sand storms. More particularly, this study will be limited to the dust storms which occur in the region of the southern desert of Iraq, especially at Al-Nasyria city. In addition, the research sample will be constitutes of the citizens of Al- Nasyria city only. In addition, the data weather were only from 1971 till 2007 due to the unsafe situation of Iraq, and because some of the station under this study were under terror crisis and were considered as wars zone since 2007. So it was inapplicable to get the weather data after that date from these stations. On the other hand, special approvals were needed to be issued from the government in order to have access to the full documents of deaths and patients. Also some critical security and political situation delayed and affected the research procedures in collecting the storm data or visiting the regions under this study. The relationship between the particle sizes on health was not conducted on this study due to the limited budget, and the difficulties in getting permissions from the authorities as most of these stations were considered as war area.

1.7 Significance of the Study

The increased frequency of dust storms in recent years and their impact on human health in this particular region has never been studied before. There are a wide number of studies on dust storms. However, these studies did not address the impact of the surface of the southern region area of Iraq on dust storms and on human health. Therefore, this study will help to understand the components of dust from sandstorms that hit the area under the study which in turn will help in a deeper understanding of storms and the possible method that can be used to stop the dust particles from travelling along these sandstorms.

This study will be very significant to the citizens of Iraq and in particular to the citizens of Al-Nasyria city. If there is a better understanding of these dust storms, a method can be formulated to overcome their effects. Although most dust storms are similar in structure, shape and how they occur, different areas have different terrains. Thus, classifying the types of synoptic patterns of these storms and identifying the impact of weather factors on the reoccurrence of dust storms will eventually lead to knowing when these dust storms will occur and how to avoid them.

In addition, due to lack of information and study in this area, it is essential to understand the geomorphologic operations and their impact on human life both in terms of health, social or economic aspects, whether negative or positive. Therefore, this research will be an action plan for those in charge of geographical

planning and health plans. In other words, this study will help such organizations to take advantage of all the positive aspects and reduce the risk of the negative aspects.

1.8 Research Theory

Geomorphology and General Systems Theory, this theory designed to serve the geomorphological science which considered as a one of very important science in geography. This theory reported that the earth types of shapes create by many types of structures and systems of erode, and this erode system contain a variety of erode and erosion factors which play its activity in create the earth relief. The theory method consider to some factors which meets together to be able to explain the erode and erosion process on rocks and how to reach the final geomorphological shapes and surfaces as well as the concepts which depends on configurations which means the basic constructing for relief. This systems affected by climates factors then they arranged according to climates zones.

Catastrophic Theory are the second method in this research and in facts its mathematical theory developed by Thom to determine and investigate the over occurrence of natural phenomena in natural and geographic systems (Caviedes, 1982; Poston, & Stewart, 2014). This theory reported that when there is negative or positive change and when this changing continues always that can create spontaneity interruption in the changing development especially on what related with climates factors. General accidents change of the earth surface means the

changing can still continue until infinity, or this changing related at the same time with its results on the earth surface. However, this effect or the results are so huge that lead to ending the changing or its results that will return the situation to its normal. The method of this theory applied as a mathematical relation to study the changing in the perfect distance between the work stations that may be changing to become suddenly inside bigger zone (Caviedes, 1982: Claude, 1989).

This was matched with this research in terms of developing the dust storms and how this become accelerated in the past years because it is affected by the natural factors (climates and geomorphological). Moreover, the effects of these storms on human health increased and especially for the peoples in the area of study. For the morphological systems theory match this research at its part related to the current geomorphological situation at the area of study and its effect to create the dust storms. Thus this theory is considered as the best theory that can propose a stable procedure that could lead to a reliable result more than other theories like Christaller theory and anthropisation theory (Raffestin, 1989). Fig 1.1 shows the conceptual frameworks of this research.

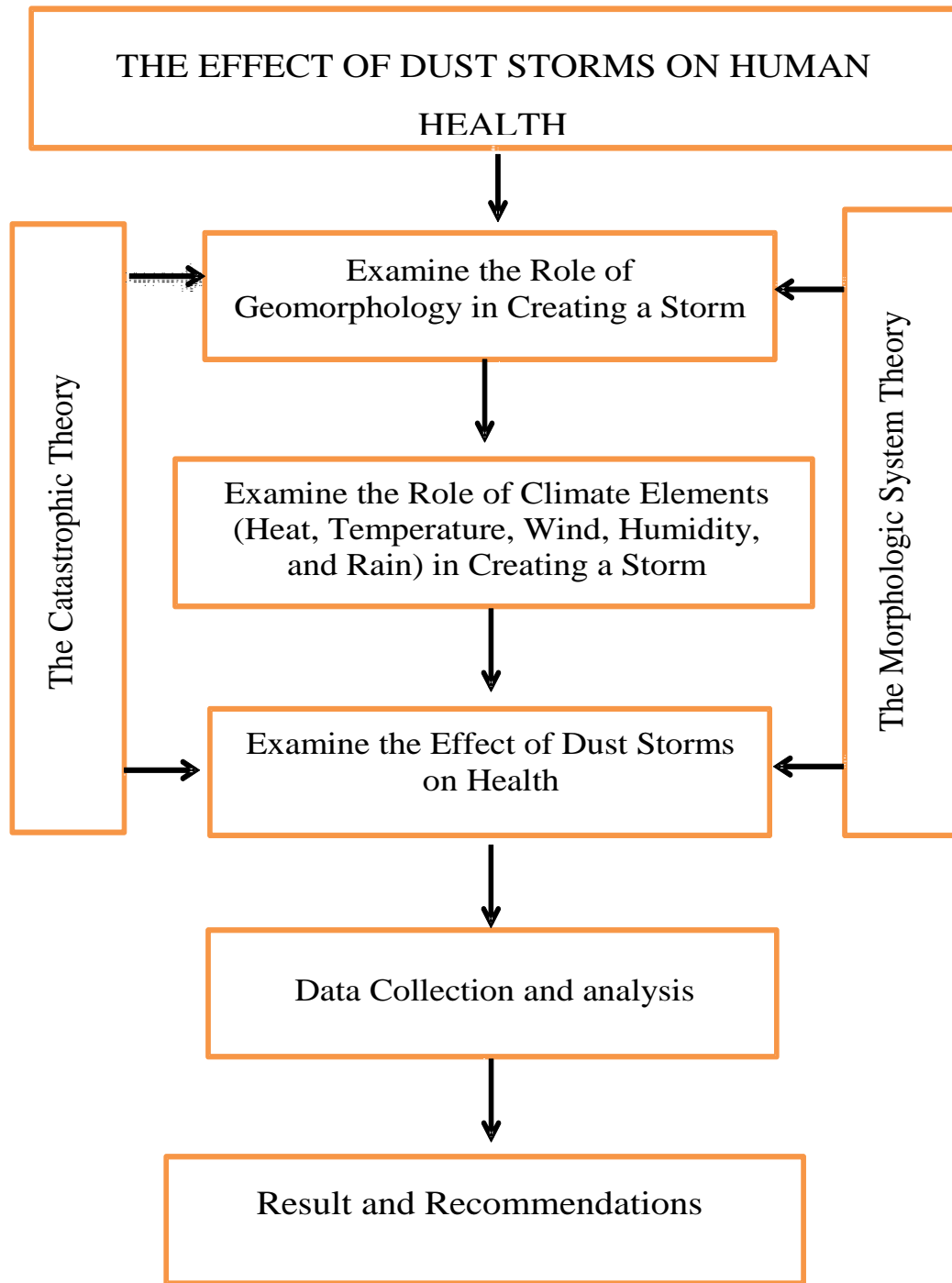


Figure 1.1 Conceptual framework

1.9 Definitions of Key Terms

Dust:

It can be defined as scattered dust particles whose diameters range from 0.05–100 micrometres and minute particles whose diameters are less than 1 micrometre.

Dust Storm:

They are small particles whose diameters do not exceed 100 micrometres and are formed with intense wind of about 8 metres per second and more remain stuck in the air.

Sand Storms:

They are big particles whose diameters are 250 micrometres and whose basic substance are of sand. Because the size of sand particles is big, the wind speed required to raise sand particles must be strong.

Saltation:

It is a movement of particles in a series of jumps.

Repetition:

It is a movement of particles in one jump.

Creep:

It is a movement of dust particles on the surface of the earth when particles are large and the wind is light.

Suspension:

It is the rise of dust particles in the atmosphere by wind currents.

1.10 Thesis Structure

The first chapter consists of the introduction and the background of the study as well as the statement of the problem and objectives. Chapter two addresses the previous studies that are related to this study to cover the sand storm effects and what causes these storms from a geomorphological perspective. Chapter three discusses the methodologies that will be used to identify the extent of the impact of dust storms on the area under study. The effect of the climatic and natural factors in the formation of the storms and changes of features of the geomorphological area will also be evaluated. In addition, the effects of these dust storms on human health, especially through increasing allergic respiratory diseases will be discussed. More particularly, the study is concerned with the individuals who are affected by these storms using data collected from sufferers of these diseases in the study area by the Ministry of Health. Chapter four contains the results of the collected data. Chapter five discusses the results in an attempt to evaluate the impact of dust storms on human life, namely humans'

health. Finally, the conclusions and recommendations will be presented in chapter six.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the important related studies to the research subject. It discusses the geomorphological and climatically studies as well as some dust storm studies. It also discusses some studies regarding the effects of environment on human health. Moreover, this chapter reviews information about medical geography and its relation to disease, treatment and health and its link to geography. The third part will briefly explain the main theories used in this research.

2.2 Reviews on Previous Studies

The main concern of this section is to review previous studies about sand storm in order to extend the view about this problem and conducting more comprehensive research. Dust storm considered as important aerial phenomenon which has direct effects on human and environment (Hock, 1984). Many of scientists have studied this phenomenon including all its sides and using many different methods. These studies varied in accordance with the specialization of each study. They studied the effect of environment on energy and communications and what is its importance to human in these studies. Their interests focused on studying specialization of the dust and the weather.

2.2.1 Geomorphology Studies

Al-Asadi (1991) conducted a research about Sandy dunes in Al-Almuthanna province of Iraq. They found that the reason for this phenomenon is the natural factors such as geological build, exiguity of hills, land properties, lack of plants, dry weather and geomorphology operations. In addition, the human factors such as wrong environmental practices, agriculture operations, destroying of plants and other which affect the environment and resulted in sandy dunes. They also stated that the geomorphology operations in the area as a result of severe windy baring operations and sediments have huge effect on the sandy dunes. Furthermore, they also found that there are many factors that affect the existing and distributing of sandy dunes in the district of study such as topographic situation and declining of the surface from western south towards eastern north. They concluded that all these factors have helped the area from geomorphological aspects to stirring the dust storm.

In another study by Al-Rikaby (2011), they studied the weather and its effect in composing surface phenomenon in Dhi Qar province. They found significant differences in weather elements and its phenomenon and this indicates that the weather has changed in the area which resulted in increasing the wind stripping ratio and this increased the frequency of dust phenomenon. In fact, the clearest effect they found was in the weather is through creeping in composing and modulating surface shapes of the soil in the district of the study, sandy dunes phenomenon and dust phenomenon which resulted into negative effects on

different human activities. This specified the clear appeared effect in the district of the study through creeping on neighboring districts such as agriculture areas, aggregation channels, antiquarian areas, touristy areas, transportation roads and this was associated with increasing the incidences of dust phenomenon more often and by all its kinds. They confirmed that this had affected human lives and defused breathing diseases such as asthma and allergy in addition to eyes diseases. They concluded that the weather by its different elements represents a system and any default or changes in it will have great effects on land's surface. The effect of weather on the land surface's types was clear by the creeping of sand dunes in the district of study area due to the windy weather. They concluded that the changing of weather's elements and its phenomena such as pressure and air mass have great role on affecting these elements in addition to the local factors. Temperature degrees (minimum and maximum) also have an effect in increasing the physical air's activity and this will increase the wind role in transferring or destroying the ground surface level which lack plants' covering into dry sand. Therefore, the climate affects the ground surface level structure and arranged it from geomorphological side to prompt the dust storm. Also there is strong connection between climates elements (temperature, wind, etc.), in the reoccurrence of the dust storm and this relation will be investigated in the current research. The study by (Al-Darraji, 2006) conducted to study the effect of weather on the formation of wind storm in Al-Ayth district in Al-Door city and its environmental effect. Also, the study included the effect of wind formation in making up the sand dunes with studying the ground precipitation. The study

showed the role of weather factors in this field and its role on the chemical and physical properties of air. On the other hand, the study showed the effect of weather elements in composing of ground surface level and its effect on dust storm.

2.2.2 Climates Studies

There is a strong relationship between the dry land and rain limitation with dust storm. The low amount of rain will cause dry land, and the small dust particles will be carried away by the wind and cause a dusty storm (Novlan *et al*, 2007). Middleton (2013) believed that almost all types of natural hazard occur in dry lands, but climate hazards considered as a higher relative importance in these highly dynamic environments. Here, reviews of climate hazards research are presented with a specifically dry lands focus, distinguishing between hazards that are a direct manifestation of atmospheric processes and those that are indirectly driven by atmospheric conditions.

About a billion poor inhabitants of rural dry lands, whose livelihoods are directly dependent on the physical environment, face particularly high levels of risk from climate hazards. Some of these risks are widely predicted to become more frequent, more widespread, and/or more intense with climate change in many parts of the world during the twenty-first century. Recognizing the particular characteristics of these hazards is an essential precursor to the development of dry land-centered policy options that can help modification and

preparation strategies and hence improve the well-being of populations in these dry lands (Oreveris, 1980). From the previous points, it can be concluded that large number of dry lands people, their livelihoods are directly dependent on the physical environment of these areas. This environment is primarily driven by its changing climate and notable for numerous climate-related natural hazards that together result in a highly variable and generally low natural rate of ecosystem.

Dry lands also lag behind the rest of the world in terms of human well-being and other indicators of development. These traits are related via the disaster risk-poverty connection. In general, regions of dry land are typically characterized by high levels of risk, where the poor people are often placed to cope badly with, in addition to the probability of hardship and contributing to the difficulties of escaping from poverty. These high risk levels frequently are due to natural hazards such as pest outbreaks, extremes of climate, harvest failure and/or livestock mortality common outcomes. Reviewing climate hazards identifies several divergent forces that affect dry land populations and landscapes. However, the frequent, intense and widespread extreme climate events make the understanding of dry land hazards essential to understand its effect on the societies. The ability to adapt to hazard events will be critical for poverty reduction and environmental sustainability across the world's massive dry lands.

Al-Asadi (1991) in his study in Iraq, confirmed that the wind blows the air from the surface towards low pressure area. He found also the northern west

direction for the winds is more frequent in most of weather stations in the country and its frequency was 11.6% in the first degree, although the frequency percentage of low pressure air reduces in hot season. This kind of winds reach Iraq contains the dust and this resulted into the occurrence of more wind storm. Al-Dardery, (1998) in his study found that the frequency percentage of northern west winds is 26.8% from the total of the winds in the study district. He also found these winds become active during June till August and the activity percentage through this period was 56.8% and the higher percentage for its activity was in June by 60.8%, while the frequency of wind reduces into lower level in January 28.8% because of air depressions increases and its activity. He also confirmed that Al-Basra station recorded the highest wind frequency percentage per year by 36.3% and this percentage will be lower towards the north from this station. He also showed that the northern west wind is higher in Iraq in hot months, especially in the sedimentary plain and the frequency percentage in June and July was 62.6% and 99.7% respectively, while in November this ratio reduces to 30.1%. However, in Iraq, the yearly frequency percentage of wind was found 18.1% in the mountainous area, 21.4% in western highland, while the sedimentary plain recorded the highest ratios of 43.2%.

Ismail (1999) in her study found that the main weather station in Iraq have recorded a higher frequency percentage for the northern west winds because of Iraq's location into the east of Zagros highland, which is a resource of northern west winds in June and July and August. Also the researcher found that the air

stations have recorded the highest frequency percentage of winds in Al-Rutba district by 36.8% and the lowest in Al-Hay district by 18.5%.

Another study by Ismail & Al-Moussawi (2000), found that the directions pattern of winds are different based on the location, time of the year, frequency percentage and also between weather station and another within one district. The study result showed that during the summer months the northern west winds are higher than other months, and have recorded yearly frequency percentage of 21.7%. Moreover, Al-Basra station (south of Iraq) has recorded a frequency percentage of 36.3%, while Al-Sulaimaniya station (north of Iraq) has recorded less frequency percentage by 3.4%.

Results by Al-Hasnawi (2002) were compatible with other previous studies. His result confirmed that in Iraq, the winds blowing in all directions and by different percentage, but the winds were higher in the northern west district from other districts throughout the year. These winds showed higher percentage recording in stations of Al-Basra, Al-Nasiriya, Diwaniya, Al-Hay and Baghdad and by yearly frequency percentage of 17.7%. While the northern west winds gave a higher recorded percentage in July by 29.8 % due to the Indian air depression in the season is towards east or southern east of the country and the highland air moves from the west. On the other hand, Alizadeh (2014) investigated the wind of 120 days and the activity of dust storm over the Sistan Basin. He asserted that the meson scale features play an essential role to create