



## Medical Meteorology: the Relationship between Meteorological Parameters (Humidity, Rainfall, Wind, and Temperature) and Brucellosis in Zanjan Province

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### ABSTRACT

**Background:** Brucellosis (Malta fever) is a major contagious zoonotic disease, with economic and public health importance.

**Methods** To assess the effect of meteorological (temperature, rainfall, humidity, and wind) and climate parameters on incidence of brucellosis, brucellosis distribution and meteorological zoning maps of Zanjan Province were prepared using Inverse Distance Weighting (IDW) and Kriging technique in Arc GIS medium. Zoning maps of mean temperature, rainfall, humidity, and wind were compared to brucellosis distribution maps.

**Results:** Correlation test showed no relationship between the mean number of patients with brucellosis and any of the four meteorological parameters.

**Conclusion:** It seems that in Zanjan province there is no correlation between brucellosis and meteorological parameters.

## 1. Introduction

As an influential structural element of the earth, climate affects nature, humans, and all manifestations of life, and also a wide range of other areas including agriculture, forestry, hydrology, geology, industry, transportation, urbanization, health, diseases, and many other environmentally-related disciplines and daily life. Climatology encompasses a wide range of studies both in realm of nature and human habitat, and can control many human requirements such as food, energy, health, etc. The World Health Organization defines health as complete physical, mental, and social well-being and not merely absence of diseases.

Undoubtedly, certain aspects of well-being are sensitive to climate; for instance, cardiac diseases mainly affect people exposed to severe climate pressures, and excessively hot or cold weather (2).

Life and pathogens are both biological natural elements, and are directly or indirectly affected by the climate, ecosystem, and the environment. For thousands of years, scholars have been aware of the relationship between climate and diseases, and have tried to find cause and effect relationships to prevent or control diseases. Today, advances in knowledge have led to huge Steps in design and

use of climatology-aided prognostic systems. This requires both knowledge of climatology from a medical perspective and exploration of statistical relationships between climatic elements and diseases (1).

Malta fever is a major contagious zoonotic disease, and of special economic and public health importance. Human infection is normally associated with direct contact with infected animals or their products. Brucellosis is transmitted in three ways, including: skin abrasions and wounds coming to contact with secretions; waste, and tissues of infected animals or objects containing infected secretions; consumption of tissues, food or liquids containing brucella such as raw milk and dairy products, especially fresh cheese, cream, clotted cream. Cases of human brucellosis due to consumption of meat and meat products are less frequent than cases due to infected dairy products. However, meat, organs, and blood of all animals may contain brucella and inhalation of infected particles in animal barns and stables, or even in laboratory can cause the disease. Zanjan is among highly contaminated provinces in terms of Malta fever (4). Human mortality and morbidity are largely associated with weather patterns (3). Given the absence of studies on the effect of climate parameters on incidence of brucellosis, this study aims at exploring a possible relationship between the two.

## 2. Materials and Methods

This study was conducted in the province of Zanjan, with an area in excess of 21 thousand square kilometers, located in the northwest of Iran, between 35' and 33" to 15' and 27" north latitude and 47' and 10" to 49' and 26" west longitude from Greenwich meridian, with a mean height of 1500 meters from sea level. Within the province, Tarum is the lowest point (300 m from sea level), and Mahneshan town in Takht-Suleiman mountains the highest (2900 m from sea level). Also referred to as Zanjan plateau, Zanjan is one of the mountainous provinces of the country, and comprises seven towns including Zanjan, Khodabandeh, Abhar, Mahneshan, Tarum, Khoramdareh, and Idjrood (5).

Data relating to the spread of brucellosis over a four-year period from 2009-2012 were obtained from Zanjan province health center, and meteorological data since 1968 were obtained from Zanjan meteorology office. In accordance with study objectives of determining the effect of climate parameters on the incidence of brucellosis, zoning maps of mean temperature, humidity, rainfall, wind, and brucellosis were prepared in Arc GIS10 medium using Inverse Distance Weighting and Kriging technique. Geographical Information System (GIS) collects, edits, stores, updates, processes, and displays geographical data (8). Modern developments in spatial statistics, and replacement of random variable with regional variable has attracted researchers to the change in classical statistics, and development of GIS spatial statistics has led to widespread use of interpolation techniques in preparation of zoning maps. Interpolation focuses on creating a statistical model for the relationship between point data (6). Brucellosis distribution maps were compared to zoning maps of temperature, humidity, rainfall, and wind. The subject was studied more carefully using inferential statistics such as correlation coefficient and linear regression. Data on the number of patients with brucellosis and climate elements were analyzed as mean annual values.

Table 1 presents mean temperature in each of the seven provincial towns. Comparing brucellosis distribution and mean temperature zoning maps showed no relationship between the incidence of brucellosis and high or low temperature. The incidence of brucellosis was found high in both towns with high mean temperature (Tarum, Mahneshan, and Abhar) and low mean temperature (Khodabandeh and Zanjan) (Figure 6).

Table 1 also presents mean rainfall in each of the seven provincial towns. Comparing brucellosis distribution and mean rainfall zoning maps showed no relationship between high brucellosis incidence rate (in towns such as Khodabandeh, Tarum, Mahneshan, or Zanjan) and rainfall. High and low rainfalls are observed in every district of these towns (Khodabandeh, Tarum, and Mahneshan), where brucellosis is the highest.

Thus, the incidence of brucellosis has no relationship with rainfall. Comparing rainfall in provincial towns and the incidence of brucellosis showed high incidence irrespective of rainfall. The incidence of brucellosis was found high in both towns with low rainfall (Tarum and Mahnesan) and high rainfall (Khodabandeh and Zanjan) (Figure 7).

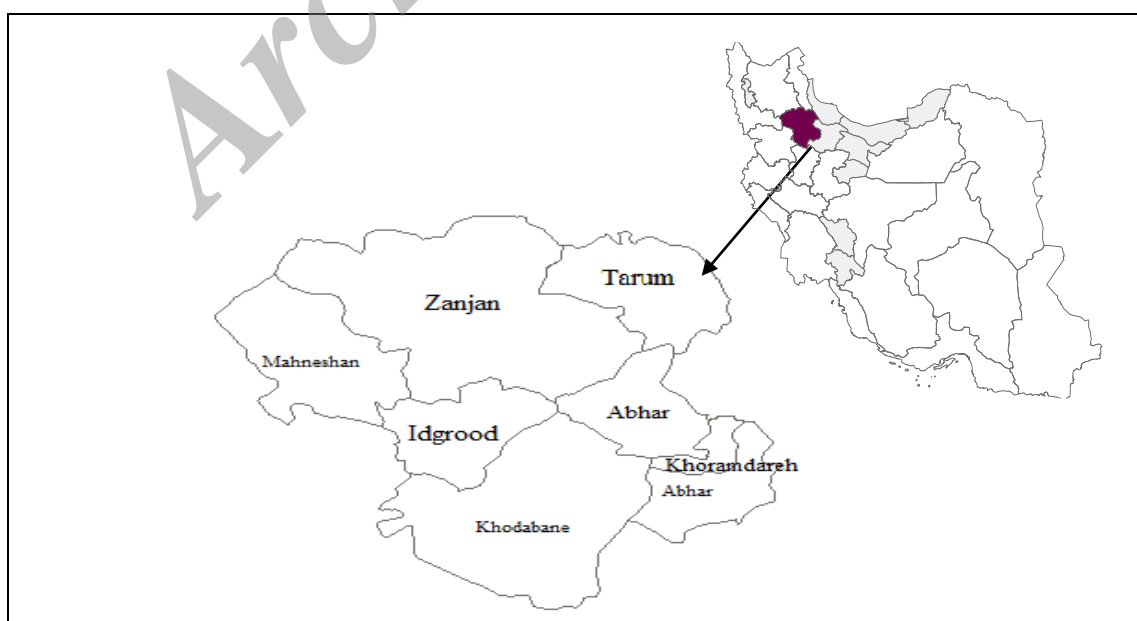
Mean relative humidity in each provincial town is shown in Table 1. Comparing brucellosis distribution and mean relative humidity zoning maps showed no relationship between relative humidity and high incidence of brucellosis in towns such as Khodabandeh, mahnesan, Tarum, Abhar, and Zanjan. High and low relative humidity is found in each of these towns. The incidence of brucellosis is high in both low relative humidity (Mahnesan and Khodabandeh) and high relative humidity (Tarum) towns (figure 8).

Zoning map of mean wind speed showed the lowest wind speed in Tarum and the highest in Mahnesan, Abhar, and Khoramdareh, and moderate speed in Zanjan and Idjrood. Comparing brucellosis distribution and mean wind speed zoning maps showed high incidence of brucellosis in low wind speed town of Tarum. The incidence of brucellosis was also high in towns with high wind speed (Mahnesan and Khodabandeh) and also moderate wind speed (Zanjan). Hence, the

Incidence of brucellosis has no relationship with mean wind speed (Figure 9).

The correlation coefficient and the relationship between patients and brucellosis in Zanjan province was determined using annual mean over statistical period from 2009 to 2012, with the following results:

- There was a poor correlation between mean temperature and the number of patients with brucellosis (13%), suggesting no relationship between them (Figure 10).
- The correlation coefficient between mean rainfall and the number of patients with brucellosis was found 0.05%, suggesting no relationship between these parameters (Figure 11).
- The correlation coefficient between mean humidity and the number of patients with brucellosis was found 0.03%, suggesting no relationship between these parameters (Figure 12).
- The correlation coefficient between mean wind speed and the number of patients with brucellosis was found 0.09%, suggesting no relationship between these parameters (Figure 13).



*Fig.1: The geographical location of Zanjan province.*

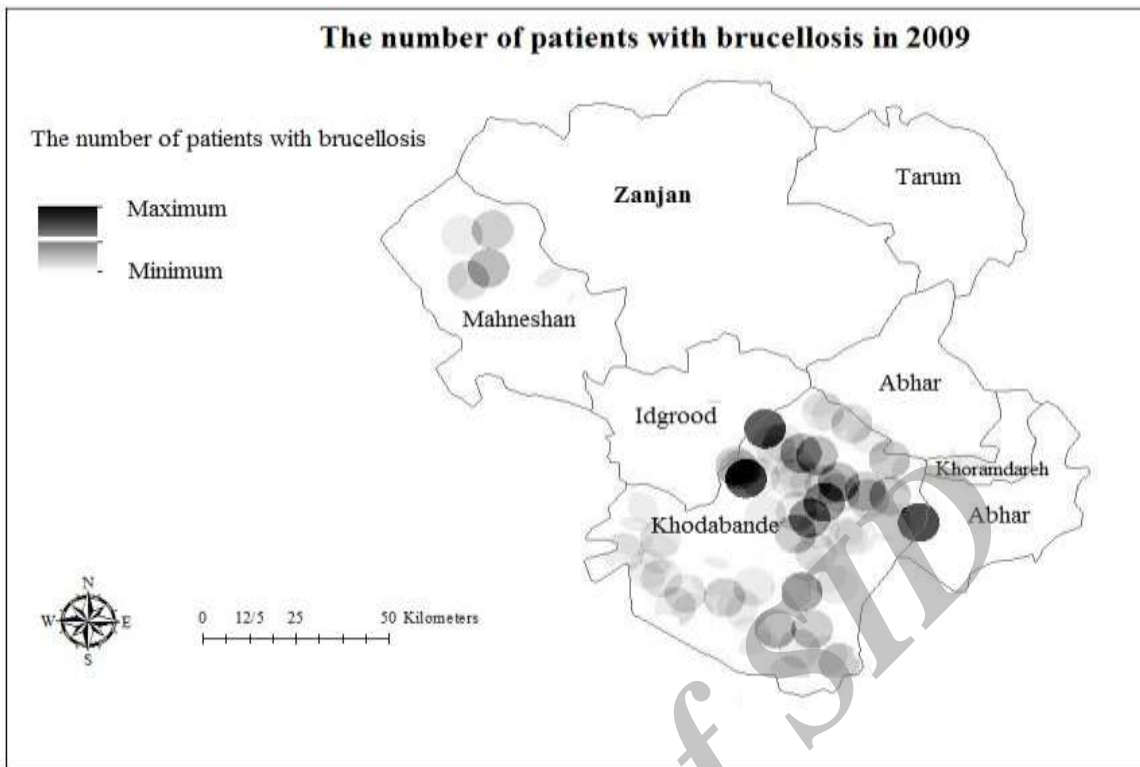


Fig.2: The Number of patients with brucellosis in Zanjan Province, in 2009.

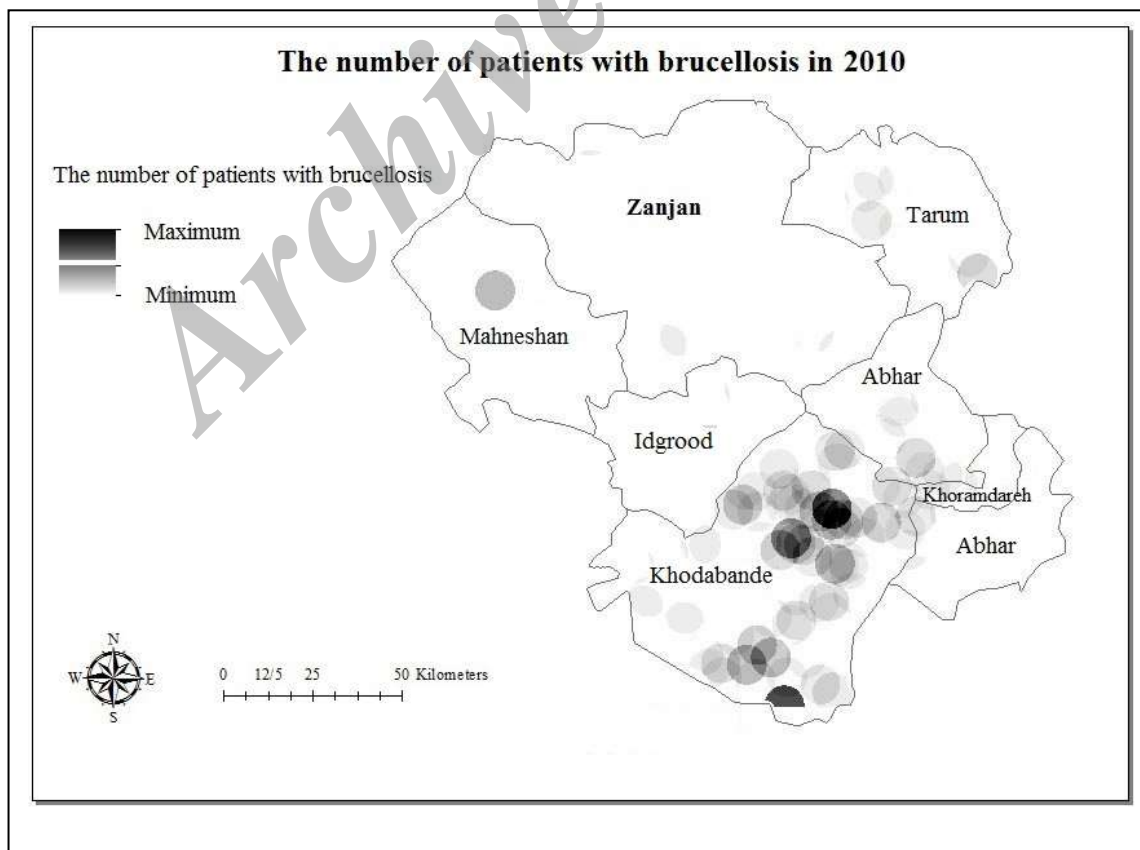


Fig.3: The Number of patients with brucellosis in Zanjan Province, in 2010.

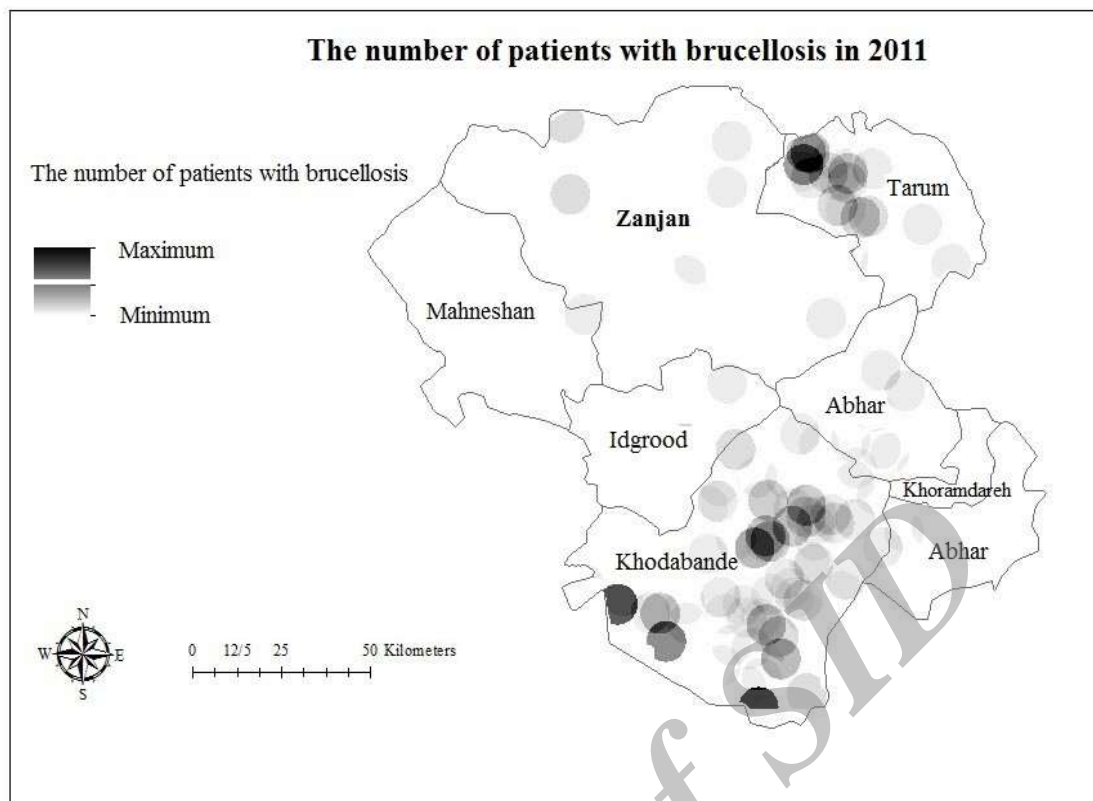


Fig.4: The Number of patients with brucellosis in Zanjan Province, in 2011.

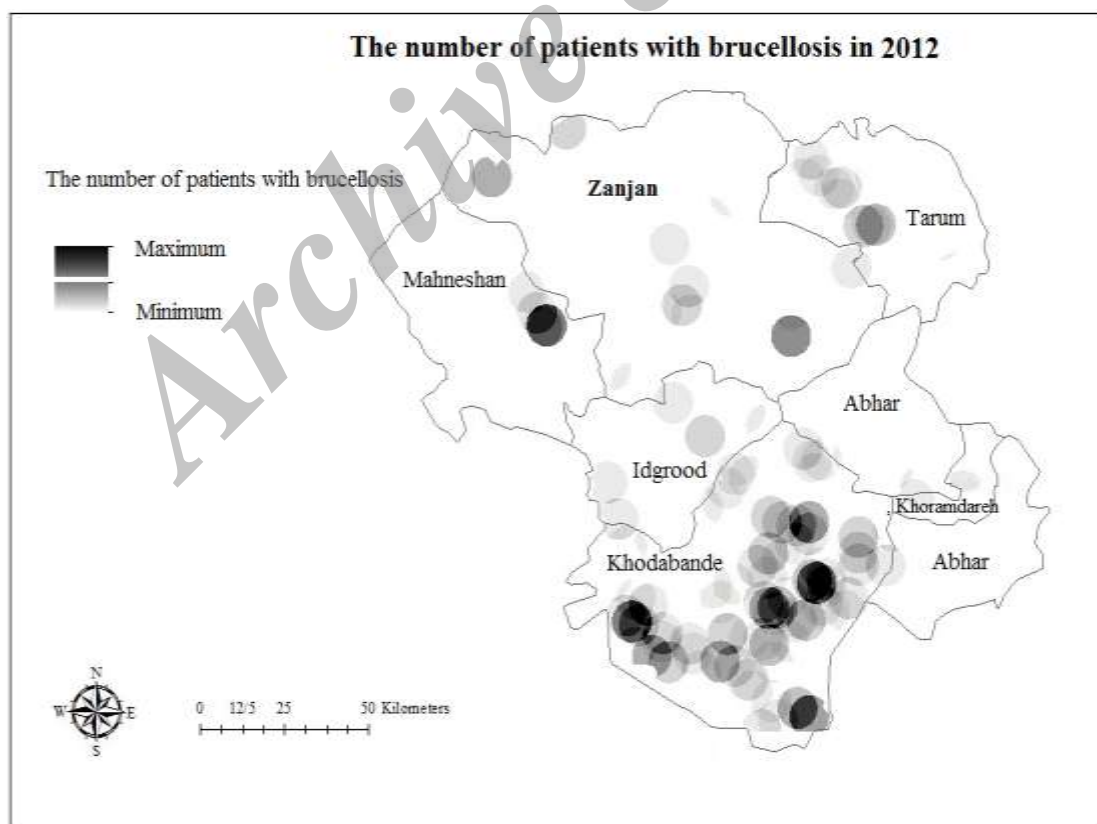
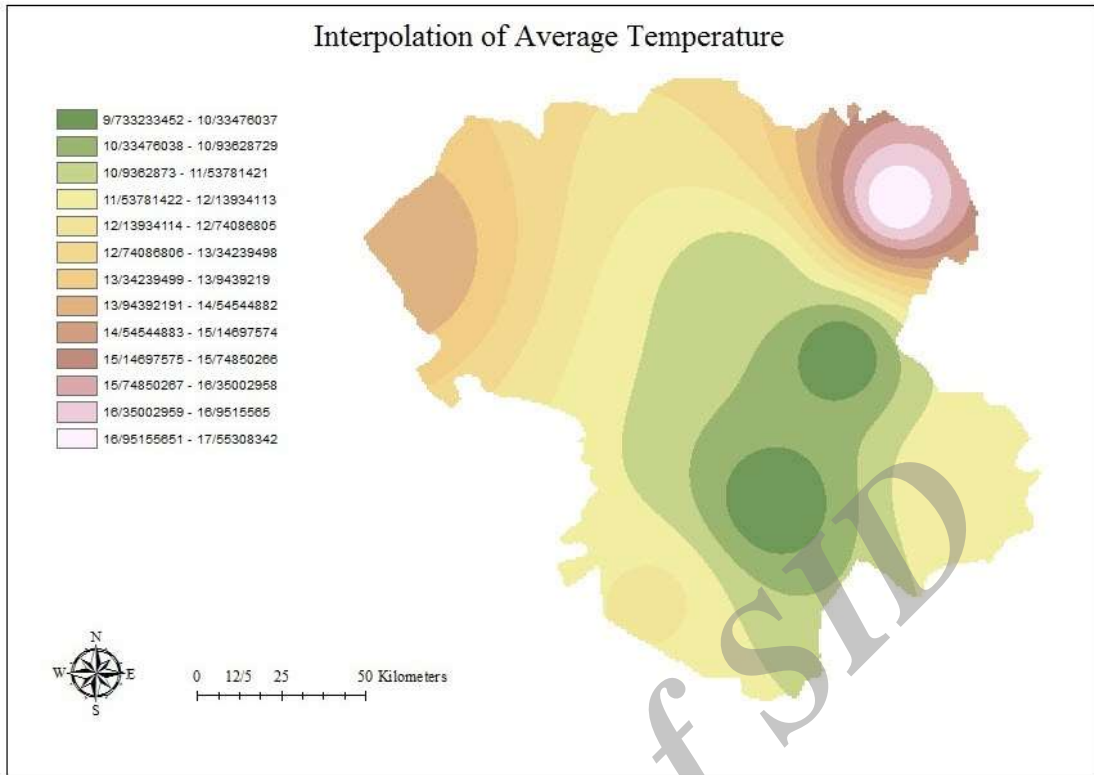
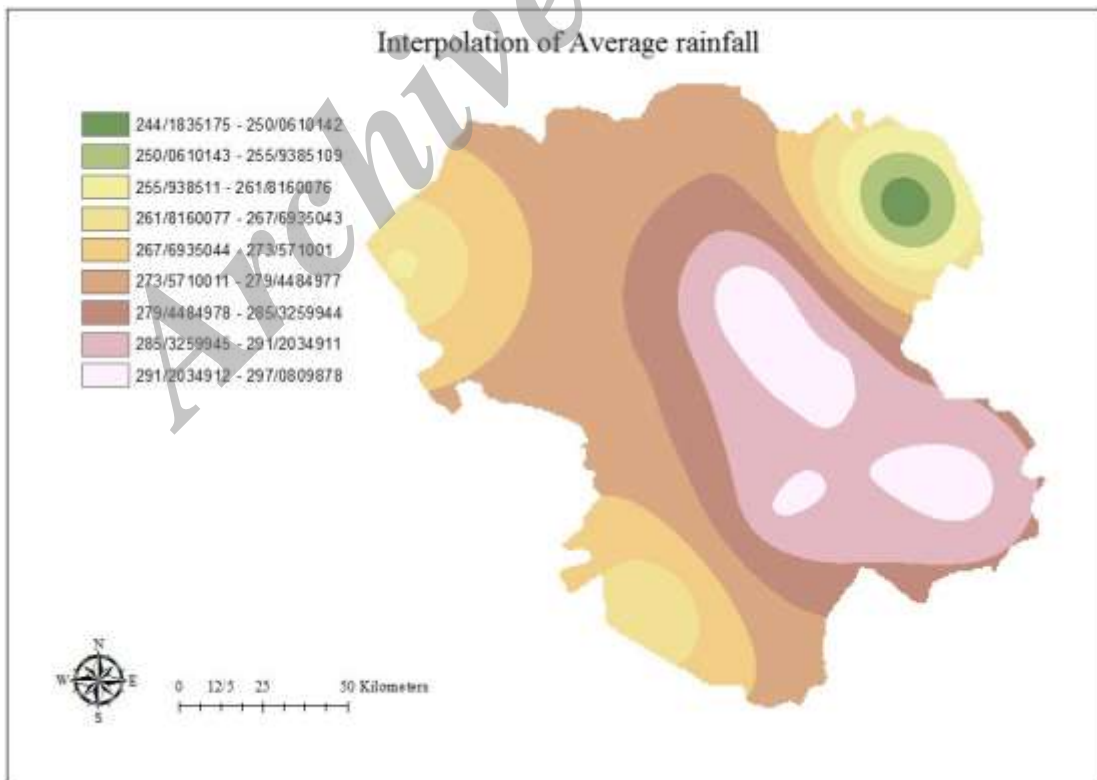


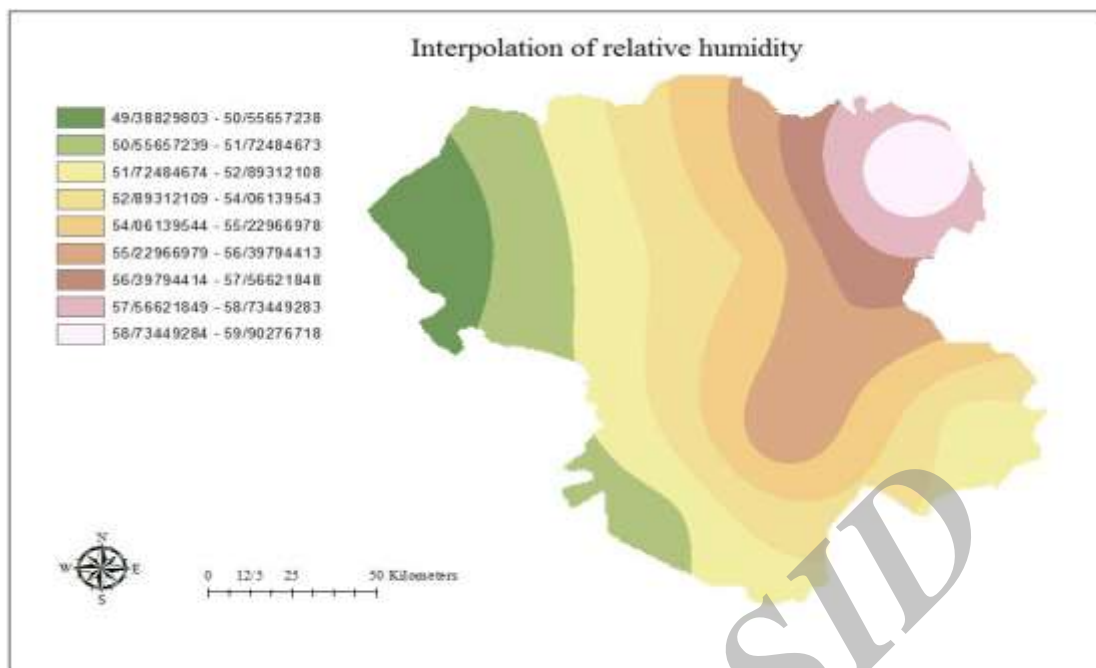
Fig.5: The Number of patients with brucellosis in Zanjan Province, in 2012.



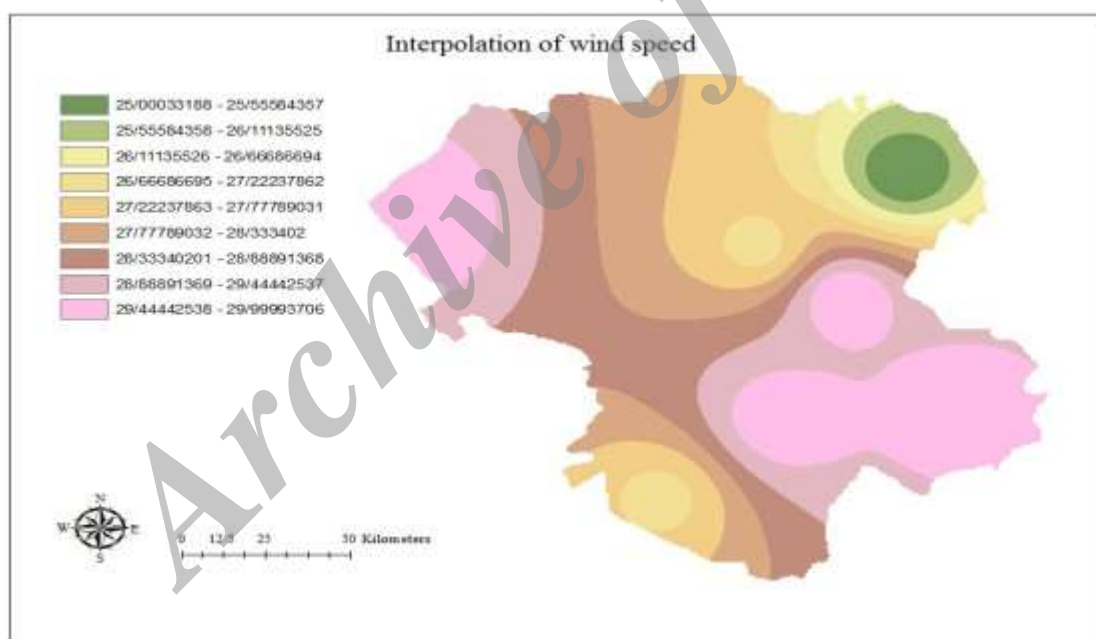
**Fig.6: Interpolation of Average Temperature (Centigrade Degree).**



**Fig.7: Interpolation of Average Rainfall (Millimeter).**



*Fig.8: Interpolation of Average Humidity (%).*



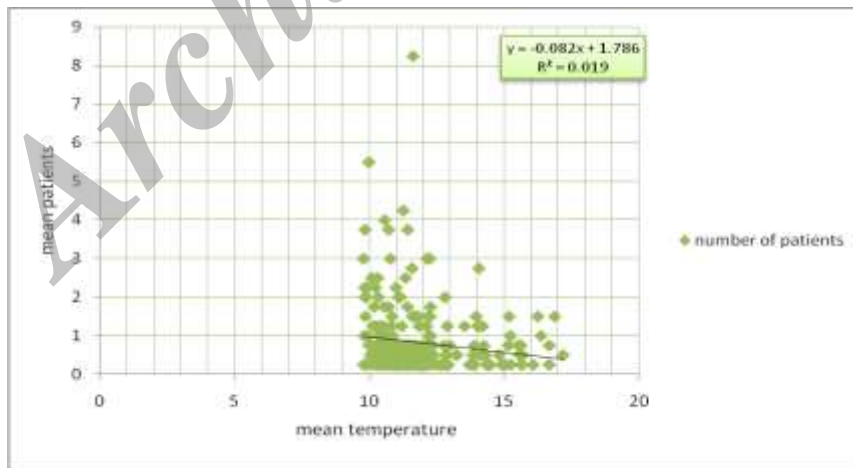
*Fig.9: Interpolation of Wind Speed (Km/h).*

**Table1: Mean meteorology parameters in towns.**

Towns	Mean Temperature (Centigrade Degree)	Mean Rainfall(Millimeter)	Mean Humidity (%)	Mean Wind Speed (Km/h)
Zanjan	13-10	291-273	55-50	26-28
Khodabandeh	12-9	291-255	55-50	26-29
Abhar	16-9	291-267	57-54	28-29
Khoramdareh	12-10	291-279	55-51	28-29
Idgrood	12-10	291-273	55-51	28-29
Mahnesan	13-12	273-255	51-49	28-29
Tarum	16-12	273-244	58-54	25-27

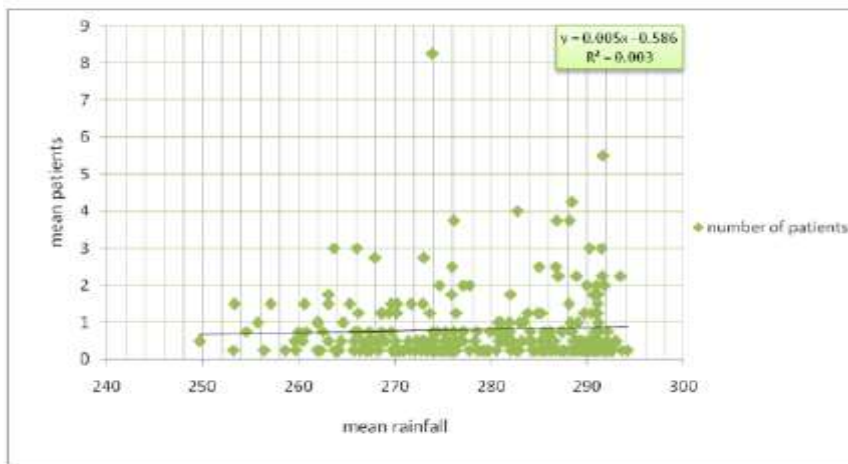
**Table2: Relationship between meteorological parameters with patients.**

Meteorological parameters	correlation coefficient	
Mean temperature(Centigrade Degree)	$y=-0.082x+1.786$	R=0.1378
Mean rainfall (mm)	$y=0.005x-.586$	R=0.0547
Mean humidity (%)	$y=0.016x-0.091$	R=0.0316
Mean wind speed (km/h)	$y=0.0791x-1.4383$	R=0.098

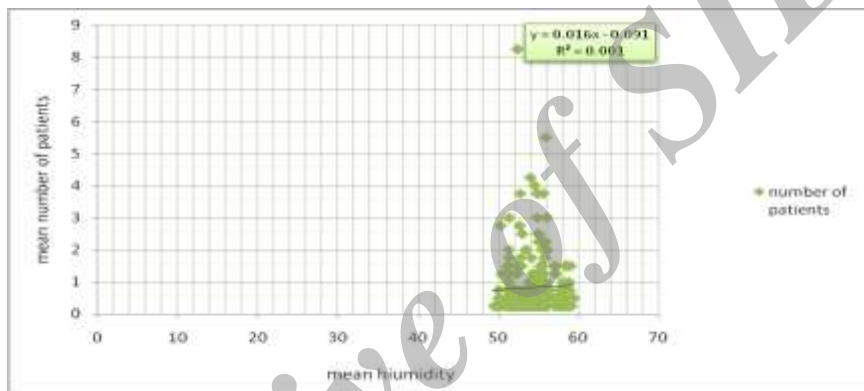


**Fig.10: Relationship between mean temperature (Centigrade Degree) and the number of patients with brucellosis.**

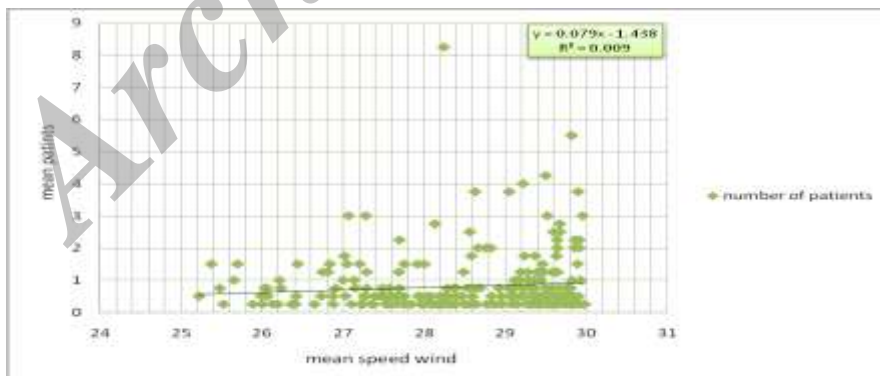




**Fig.11: Relationship between mean rainfall (mm) and the number of patients with brucellosis.**



**Fig.12: Relationship between mean humidity and the number of patients with brucellosis.**



**Fig.13: Relationship between mean wind speed (Km/h) and the number of patients with brucellosis.**

#### 4. Discussion and Conclusion

This article addresses the relationship between climate parameters and the number of patients with brucellosis. According to correlation test

between the mean number of patients with brucellosis and the mean temperature, rainfall, humidity, and wind speed, and also comparing

Zoning maps of these parameters and brucellosis distribution zoning map, there is no correlation between these four climate parameters and the number of patients.

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