ORIGINAL ARTICLE

SPATIAL ANALYSIS OF WELLS IN JABLEH PLAIN

| Reem Khaddour *[1] | Abbas Abdulrahman [1] | and | Ali M. Alasaad [1] |

[1.] Tishreen University | Department of Water Engineering and Irrigation | Faculty of Civil Engineering | Lattakia | Syria |

| Received January 01, 2020 | | Accepted February 03, 2020 | | Published February 09, 2020 | | ID Article | Reem-Ref.1-ajiras100220 |

ABSTRACT

Background: Groundwater is an important topic and one of the economic activity bases. It has multiple uses such as potable water, crop irrigation, and animals watering. **Objective**: Identifying the wells' spatial distribution pattern helps to determine the magnitude of the pressures on the ground, analyze their distribution trends and dispersion patterns using GIS, and support decision-makers with plans to mitigate this problem. **Results**: The study revealed that the distribution of the value of the wells are located within the critical value [Critical Values] [-2.58, + 2.58]. Therefore, they are not of statistical significance, i.e. within the region of acceptance. So, we accept the initial hypothesis [null hypothesis] and reject alternative hypothesis. Furthermore, the wells' distribution pattern is randomly clustered with a high level of confidence, while, the wells' distribution pattern in the study area is random. **Conclusion**: There was no effect of the earth structure on wells distribution in the area, and the distribution was random. GIS technologies demonstrated their efficiency in extracting various statistical coefficients.

1. INTRODUCTION

In fact, spatial analysis is a way to better understand our world, to know where phenomena are located and what is the meaning of their location, is a way to study the relationships between different spatial phenomena. Spatial analysis is a practical application of a modern geographic approach based on analysis by studying the place and relationships and by converting data into Information to use in making the best decision [1].

Spatial analysis is used in various fields, where can be used in human phenomena related to various fields such as demography [2], pollution [3], economic commodities, emergency and marketing, etc. Spatial analysis of environmental and natural phenomena such as the study of endangered animal sites, migration of animals, protection of biological life, environmental impact assessment, permeability of rocks, rivers, groundwater [4]. Various where such as the study and follow-up of beach erosion and factors influencing it chronologically are assisted mainly by geospatial data. Groundwater is an important natural resource, especially in arid and semi-arid areas, and is increasingly important when associated with populated areas where agriculture is the dominant economic activity.

The availability of water, such as springs and streams, is the leading factor for settling in that region. It provides for livelihoods and human interaction with the environment through the convergence of the three basic factors: water, land, and humans.

The continuous demand for water and the population's aspirations to draw excess water from the wells to meet their needs in agriculture and various daily uses have led to depleting water and lowering its efficiency. This created a significant problem related to meeting the demand for water, which makes specialists study the distribution of this water and its presence pattern, identify areas with excessive exploitation of groundwater, and provide solutions to this problem in the future. GIS technology contributes to illustrating wells' spatial distribution through production of maps that represent the distribution, and its characteristics and spatial patterns [5].

The research problem is about the huge and irresponsible depletion of groundwater through the excessive uncontrolled and unplanned use of groundwater wells, which has reduced its efficiency

2. MATERIALS AND METHODS

The research aims to identify the situation of spatial distribution of wells in the study area, analyze their distribution directions and dispersion patterns using GIS technology, and support decision-makers with future plans to mitigate the problem.

The research adopted the inductive approach that starts with collecting data to develop a conclusion, besides, the quantitative approach, based on using laws of statistical analysis such as the Nearest Neighbor Analysis, Mean Center, Directional Distribution, and the Standard Distance. To explain the pattern of wells spatial distribution in the study area and to achieve accurate and specific results using GIS.

*Corresponding author Author

2.1 Study site:

Jableh Plain is located in the Lattakia governorate. It covers an area of 7,500 hectares. The soil of this region consists of several layers, varying between agricultural soil, carbonate clay, sandy clay, and sandstone. It is considered one of the most important geomorphological phenomena on the Syrian coast where it is surrounded by the coastal mountains from the east, northeast, and southeast, and it is bordered by the Mediterranean Sea to the west. Documented wells are wide-spread in Jableh plain with 476 documented well of a total of 600 ones in the study area Figure 1.

The spatial distribution of geographical phenomena is the outcome of a group of relationships between different phenomena. Since the analytical studies are based on two matters: the distribution and relationships. The former is horizontal and the latter is vertical. If the distribution was the outcome of spatial relationships, we have to know the current distribution through the use of known measures that determine the properties of the geographical phenomena distribution, and its spatial directions in terms of dispersion, clustering, and solving a specific value [6].

Therefore, specific indicators were used to show the characteristics of the spatial configuration of wells distribution in the study area in terms of their clustering, or positioning around a particular point, and the nature of their dispersion around the center, and the direction and patterns of this dispersion according to the scales of the Mean Center, Standard Distance, and Standard Deviational Ellipse. The most important relationships can be summarized to find the Mean Center of spatial distribution of points or the center of attraction for those distributions, or the geographical center of concentration [7]. The mean center (Figure 2) was derived using ARC GIS software with the following steps:

Arc Tool Box - Spatial Statistics Tools - Measuring Geographic Distribution -Mean Center. Figure 2 shows that the Mean Center of the wells drilled in the Jableh Plain is located approximately in the middle of the Jableh Plain due to the dense and almost regular spatial distribution of wells in the area. This proves the success of drilling wells with this distribution.

The Standard Distance measures the degree and direction of dispersion around the Mean Center. It measures the distance between the points and the Mean Center. It is represented on the map by drawing a circle where the Mean Center is its center and the Standard Distance is its radius [8]. Table 1 shows using Standard Distance analysis to calculate the range where the distances vary among wells locations from the mean distance according to the following steps:
Arc Tool Box - Spatial Statistics Tool- Measuring Geographic Distribution -Standard Distance

Table 1: the table presents the calculated Standard Distance.

OBJECTID	Shape_Length	Shape_Area	CenterX	CenterY	StdDistance
1	32256.1	82794841.33	-290241.3	131039.5	5133.79

The analysis shows that 40.25% of wells within the circle whose radius s the Standard Distance [5133] as shown in Figure 3. The Standard Distance has a direct relationship with the dispersion of points distribution where the greater the Standard Distance is, the more the variance and dispersion of the phenomena elements will be and vice versa. In other words, the greater the Standard Distance is, the greater the distribution dispersion will be, and the smaller it is, the more points are centered around the arithmetic mean.

Measuring the Standard Deviational Ellipse determines the oval-shaped dispersion direction of the elements of the phenomenon studied oval reverses the standard distance, by determining the dimensions of the two axes [X, Y] from the spatial mean separately. Using this property determines the direction of the spatial distribution of points within the area of the region which is neglected in geography to determine the axes of the distribution of the phenomenon and leverage it in planning procedures [9].

Following steps led to determine the distribution direction in the study area:

Arc Tool Box- Spatial Statistics Tools - Measuring Geographic Distribution -Directional Distribution
Figure 3 shows the actual direction of wells distribution patterns in the study area. It takes an oval shape that extends between the northeast and southwest, where the rotation value of wells distribution direction reached 4.76 degrees from the northern direction. Thus, the oval shape encircled 54.2% of the elements of this phenomenon (Table 2).

Table 2: the table presents the directional distribution.

Shape Length	Shape_Area	CenterX	CenterY	XStdDist	YStdDist	Rotation
30887.08654	54142476.42	-290241.2841	131039.4948	2533.340788	6803.946911	4.760575966

Average Nearest Neighbor: The spatial distribution of geographic phenomena is the core of geographic work, and a means of regional benchmarking between different distributions. The spatial engineering is one of the geographical work basics. Distribution is the necessary beginning for each geographical work. It means the arrangement and spatial organization resulting from the distribution of phenomena in the place according to a special pattern. The distribution is the sum of the locations of things in the place, and the spatial distribution of phenomena produces different forms, which is called "pattern" [10]. The Average Nearest Neighbor can be extracted in the ARC GIS program according to the following path:

Arc Toolbox - Spatial Statistic Tools -Analyzing Patterns -Average Nearest Neighbor
To find out the pattern of the phenomena distribution according to the Average Nearest Neighbor, the program analysis results show that the outputs of point distribution patterns that range from the dispersed irregular pattern whose result is close to 2.15 [Table 3] to the clustered convergent pattern whose result is zero. Between the two patterns, the pattern is random with a result close to 1. The closer the result to 2.15, this indicates that the phenomena distribution is ideal.

Table 3: The table presents the values of Average Nearest Neighbor.

Distribution pattern	Statistical coefficient value
convergent	0.09-0
Closely converged	0.49-0.1
Convergent random	0.99-0.5
random	1.19-1
faraway	2.15-1.2

Figure 4 shows the confidence levels ranging from [0.01-0.1] on the right side, and [-0.01, -0.1] on the left side.
For the analysis of the Average Nearest Neighbor [R], its value is 1.12, which means that the Average Nearest Neighbor has taken a random pattern because it falls between the values 1 and 2.15. Figure 6 reinforces this result by drawing a red square around the random pattern [dispersed]. Based on this, analyzing the spatial distribution of the wells in Jableh Plain area and figure 6 shows the following:
The values of Z SCORE for spatial distribution of wells in the study area were 5.02, which are within the range of critical values.
[- 2.58, +2.58]: They are not statistically significant, that is, within the acceptance area, so we accept the initial hypothesis [null hypothesis], reject the alternative hypothesis, and their distribution pattern is randomly convergent.
The results of the analysis showed a high level of confidence that the distribution of wells in the study area is a random pattern.
This pattern of distribution is due to poor planning of the wells network in the area by the decision-makers, as well as the lack of follow-up of farmers in the selection of drilling sites.

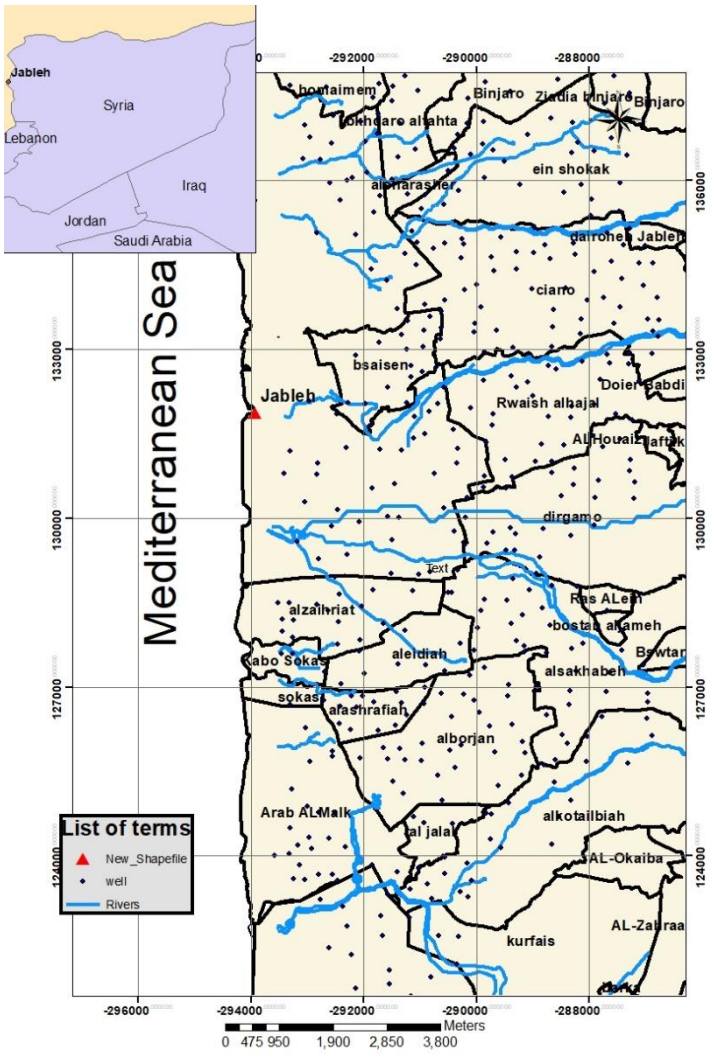

Figure 1: The figure presents the wells Distribution in Jableh Plain.

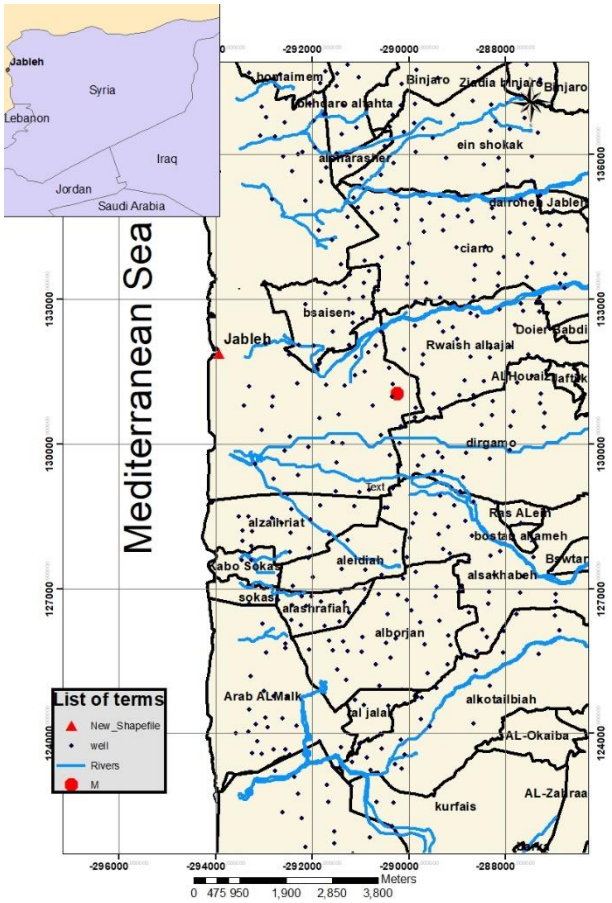

Figure 2. The figure presents the average center of wells in the Jableh plain

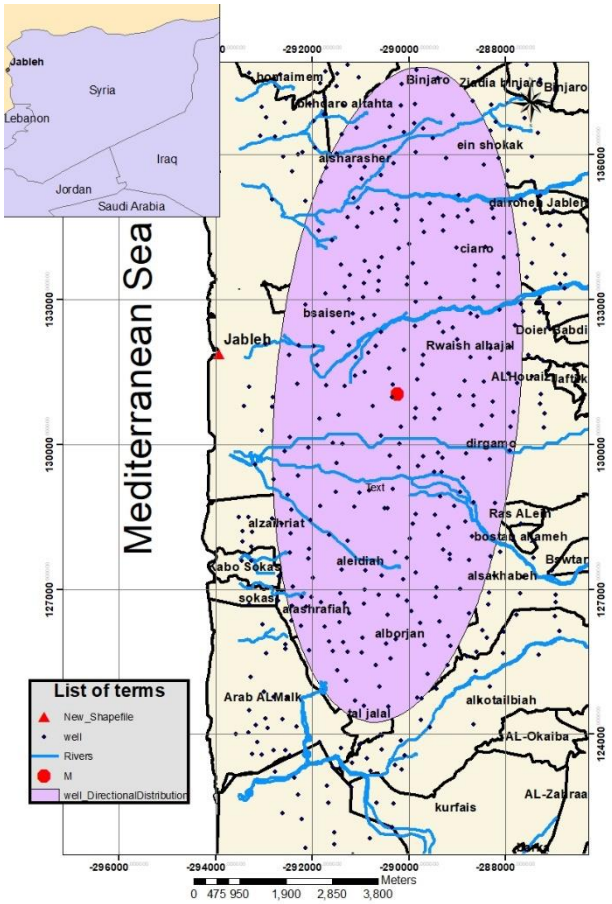

Figure 3: The figure presents the wells directional distribution in Jableh Plain.

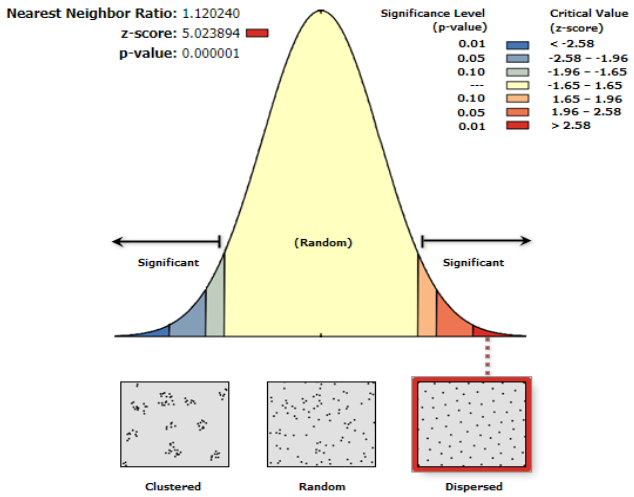

Figure 4: The figure presents the results of Nearest Neighbor Ratio of Wells Distribution.

3. CONCLUSION

There was no effect of the earth structure on wells distribution in the area, and the distribution was random. GIS technologies demonstrated their efficiency in extracting various statistical coefficients and thus reaching the final pattern of wells distribution in the area, where the Average Nearest Neighbor illustrated the distribution outcome which is a random dispersed distribution. This random distribution of wells is due to the fragmentation of agricultural properties in the Syrian coast to small properties. This creates the urgent need to encourage and stimulate the planning entities and their engagement with farmers to solve all problems and organize the wells sharing queues. The random pattern is one of the most difficult distribution types for the state because providing services is very costly in this setting. In addition to the high transportation costs and long delivery times, it is also an indication of the absence of government planning.

Acknowledgment: Wells should be re-surveyed and registered, as the current statistics indicate the existence of 600 wells, taking into consideration that reliable information is available for 476 wells only. Focus on the redistribution of wells in the area and get rid of the random distribution pattern. Introduce spatial statistics technologies into water resource planning policies in other regions, such as Tartous Plains, Ghab Plain and the Syrian Upper Mesopotamia for optimal management of these resources.

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Cite this article: Reem Khaddour, Abbas Abdulrahman, and Ali M. Alasaad. SPATIAL ANALYSIS OF WELLS IN JABLEH PLAIN. *Am. J. innov. res. appl. sci*. 2020; 10(2): 59-63.