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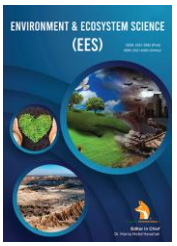


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*RESEARCH ARTICLE*

# RAINFALL ANALYSIS WITH REFERENCE TO SPATIAL AND TEMPORAL: A CASE STUDY OF JHUNJHUNU DISTRICT (RAJASTHAN)

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**ABSTRACT**

The current study aims to do rainfall analysis of Jhunjhunu district with reference to time and space for a period of 22 years by using quantum geographic information system (qGIS). The data collected were yearly rainfall and rainy days. These data were analysed in qGIS software. Inverse Distance Weighting (IDW) method of interpolation was adopted for the study. Thematic maps were generated. Rainfall maps displayed a growing tendency in rainfall amount while rainy days represented a slow increasing pattern. It was found that south, south-eastern and some part of north region of the Jhunjhunu get the utmost rainfall. However, north-eastern and western parts of the district receive the lowermost rainfall. It was observed that Khetri block received the highest rainfall during the average 20 years period. Though, Jhunjhunu block got the lowest rainfall during the whole period. Malsisar and Udaipurwati blocks got average rainfall. As ground water recharge rate is low in the study area, it is essential to collectively utilise surface water, available rainfall and groundwater for optimum irrigation and further agricultural management in the district. The rainfall analysis facilitated the understanding of the rainfall pattern which would be advantageous for strategic planning of efficient irrgiation and water availability in the study area.

**KEYWORDS**

Rainfall analysis; Jhunjhunu; GIS; Interpolation; two decades; Spatial and temporal distribution.

## 1. INTRODUCTION

Climate change have become a global spectacle. The impacts of changing climate on natural resources, agricultural production, environmental and human health are well known. Rainfall is a crucial climatic parameter. Extreme weather events occur due to rainfall variation such as flood and drought. Rajasthan is an arid state and it faces drought events several times. Agriculture is the main occupation for the livelihood of people. Food production fully lies on rainfall. Hence, systematic study of rainfall pattern with reference to time and space is the prime necessity. In the same line, research work have been carried out in several countries like Bangladesh, Brazil, Greece, Iran, Italy, Pakistan, Sri Lanka, South Africa and USA etc. (Lam et al., 2015; Monir et al., 2023; Nery et al, 2017; Varouchakis et al., 2018; Fung et al., 2022; Morbidelli et al., 2021; Ali et al., 2021; Upaka, 2019; Moeletsi et al., 2016). Rainfall analysis have been evaluated in India too (Praveen et al., 2020). States such as Assam, Gujarat, Karnataka, Orrisa, Rajasthan, and Tamil Nadu have been studied by various researchers (Hazarika and Sarma, 2021; Jain and Bhatt, 2022; Harsha, 2017; Panda and Sahu, 2019; Pradhan et al., 2019; Arvind et al, 2017). The present paper is an attempt to study the rainfall pattern of the Jhunjhunu district with respect to time and place. The study is focused on to identify the most sensitive zones of the study area with the help of geographic information system (GIS). The study has been conducted to analyze the variation in the average annual rainfall of Jhunjhunu district of 22 years from 2000 to 2021.

## 2. MATERIALS AND METHODS

Study area: Jhunjhunu district is located in the northern part of Rajasthan (Figure 1). It is bounded on the north by Jhunjhanu district, in the east by the state of Haryana, south by Sikar district. It stretches between $27^0$ 38'13.88" to $28^0$ 31" 11.09" North latitudes and $75^0$ 01' 30.74'' to $76^0$ 06' 1.47'' East longitudes. It has eight tehsils including Jhunjhunu, Malsisar, Buhana, Udaipurwati, Nawalgarh, Khetri, Chirawa, and Surajgarh. Major part of the district does not have a systematic drainage system except a strip in the centre of the district running north-west to south-east (part of Shekhawati river basin) and the remaining part of the district both in the east and west of the region forms 'outside basin'. The total geographical area of the district is 2928 square Kms. This stands at 1.73% of the total area of the state. There is no perennial river in the district. Katti and Dohan are only seasonal rivers. River katti originated from Khadela hill sides of Shrimadhopur tehsil of Sikar and enters near south-west of Udaipurwati tehsil running towards north-west direction and ultimately disappears in the sandy tracks of the Jhunjhanu district.

Geology: The district is mostly covered by blown sand. Apart from these, small isolated outcrop of the rocks of Delhi Super group and Malani igneous suite are found in Khetri, Udaipurwati, Buhana and Jhunjhunu blocks of the district. The Alwar groups of rocks are exposed in the south-eastern part (around Udaipurwati) and north-eastern part (around Khetri) with Ajabgarh group of rocks.

Topography: The topography of the district have a combination of hills and plains. It displays hilly area in the eastern and south-eastern part which belongs to Aravalli range, running in NE-SW direction. While, the rest part of the district has broad undulating plains. The general slope of the terrain is from south-east to north-west. The area is drained mainly by Shekhawati, Kantli and Chandrawati rivers with their tributaries like

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Udhapur, Ohagarh, Dongar, Sukh etc. The general topographic elevation in the district is between 250 m to 500 m above mean sea level in most of the blocks. Elevation ranges from a minimum of 259.6 m above mean sea level in Surajgarh block in the north-east part of the district to maximum of 1035.0 m above mean sea level in Nawalgarh in south-west part of the district.

Climate: The climate of the Jhunjhunu district can be classified largely as arid. It is characterized by very hot summers and very cold winters with commonly poor but sporadically good rainfall during south-west monsoon period. In May and June, the maximum temperature may sometimes go up to 48 $^0$C. Winter temperatures drop down to 3$^0$C to 4$^0$C. The potential evapotranspiration rates are quite high, especially during the months of May and June.

Rainfall: Average annual rainfall of the district is about 440 mm. The district received good rainfall in the year 2010. Rainfall is gradually increasing in preceding years. The general distribution of rainfall range is 300 mm to 500 mm covering maximum parts of the district. The annual average rainfall was 680 mm based on the data of available blocks while the highest and the lowest average annual rainfall were 991 mm and 566 mm in Malsisar and Chirawa blocks correspondingly.

Agriculture: According to Department of Agriculture (Extension), Zila Parishad, Jhunjhunu and Ministry of Agriculture (India), the major crops of the area are bajra, cowpea, moong, guar, wheat, gram, mustard oil seeds, fruits and vegetables etc.

Mineral: Jhunjhunu is fairly endowed with various minerals whose industrial use has immensely contributed to the economy of the district. Of these, the most important is the copper belt of Khetri from which mining has been carried out. The different minerals found in the district can be enlisted as copper, gold, silver, iron, cobalt, and limestone.

Mountains: The hilly area in south eastern part of district is characterized by hills of Aravalli range, running in north easterly direction. The highest peak, 1051 m high is in the south of Lohagar village bordering Sikar district. Hills are almost barren of vegetation except a few bushes of Acacia and Cactus. The undulating area with small, isolated hills having steep slope lies in the south-western part of district. The major portion of hills is found in Khetri and Udaipurwati tehsils. The general elevation above mean sea level rests between 300 and 450 m respectively. Quaternary level forms are represented by sand and colluvial deposits of talus and scree at piedment slopes. The desertic plain generally lying at an altitude of about 300 m and occupies the northern part of the district and is covered with sand dunes. The general slope of the area is from south to north. Sand dunes are drifting in nature. Sand shifting and active dunes are main hazards to cultivation. Soil erosion is the result of constant deforestation and mining activity which have resulted in baring the slopes.

Data collection, processing and analysis: Rainfall related data were taken from the Department of Irrigation, Government of Rajasthan (Water Resources Department). The last twenty two year's data (from 2000 to 2021) were collected from the department for the analysis. Annual rainfall and annual rainy days data of the Jhunjhunu district from the year 2000 to 2021 was set in an excel sheet. Both types of data of excel sheet was represented in graphical form with a trend line. The data of year 2000, 2010 and 2020 were used in preparing the thematic map of Jhunjhunu district of these three years with the help of Quantum GIS (QGIS). QGIS is an open-source geographic information system (GIS). Data were dealt in qGIS using interpolation technique to create continuous surfaces from discrete points. Inverse Distance Weighing (IDW) interpolation method was applied for the study. Maps were generated and they were employed for interpretations.

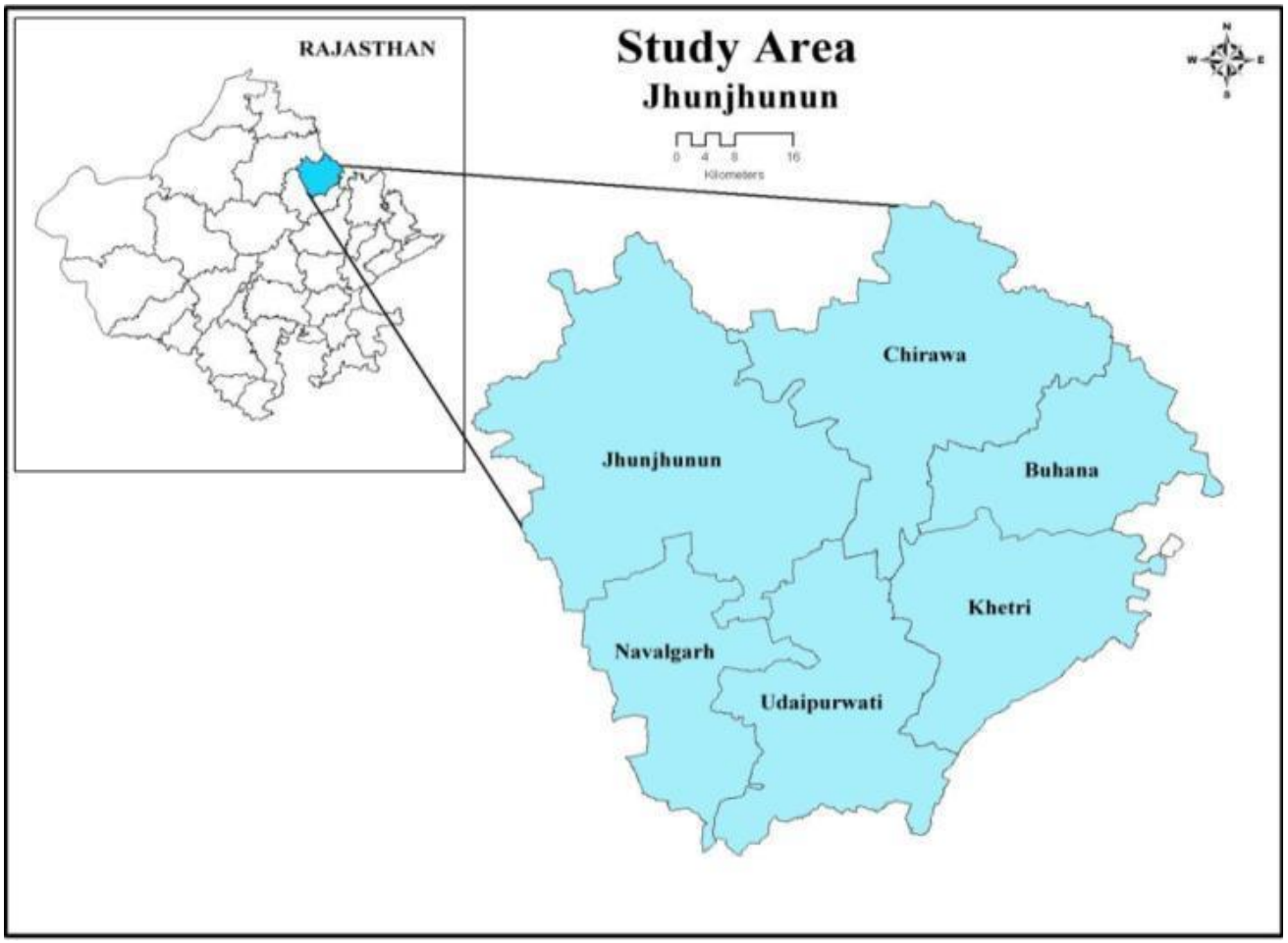


**Figure 1:** Location and map of Jhunjhunu District with weather stations.

## 3. Results and Discussions

The average rainfall and average rainy days of Jhunjhunu district are represented in Table 1. Jhunjhunu district received rainfall between the range of 300-650 mm in the last 22 years and the rainfall crosses this range only one time in these years. It was year 2010 when the rainfall was more than this range with nearly 767 mm. While, rainfall is very low in the year 2002 and it was nearly 169 mm. A gradual average annual rainfall increases in the last years could be observed in Figure 2. Hence, the mean annual rainfall of 488 mm to be considered normal rainfall in the study area. The mean rainy days were 25 days for the last 22 years with the maximum and minimum average annual rainy days as 33 and 12 in 2010 and in 2002 respectively (Figure 3).

**Table 1:** Average annual rainfall and rainy days of Jhunjhunu district from 2000 to 2021.

| Year | Average rainfall (mm) | Average rainy days |
|---|---|---|
| 2000 | 336 | 13 |
| 2001 | 487 | 22 |
| 2002 | 169 | 12 |
| 2003 | 525 | 23 |
| 2004 | 351 | 18 |
| 2005 | 333 | 26 |
| 2006 | 425 | 18 |
| 2007 | 486 | 27 |
| 2008 | 633 | 30 |
| 2009 | 291 | 18 |
| 2010 | 767 | 33 |
| 2011 | 633 | 32 |
| 2012 | 676 | 22 |
| 2013 | 518 | 31 |
| 2014 | 556 | 28 |
| 2015 | 516 | 31 |
| 2016 | 485 | 25 |
| 2017 | 540 | 24 |
| 2018 | 320 | 22 |
| 2019 | 694 | 27 |
| 2020 | 420 | 30 |
| 2021 | 574 | 32 |

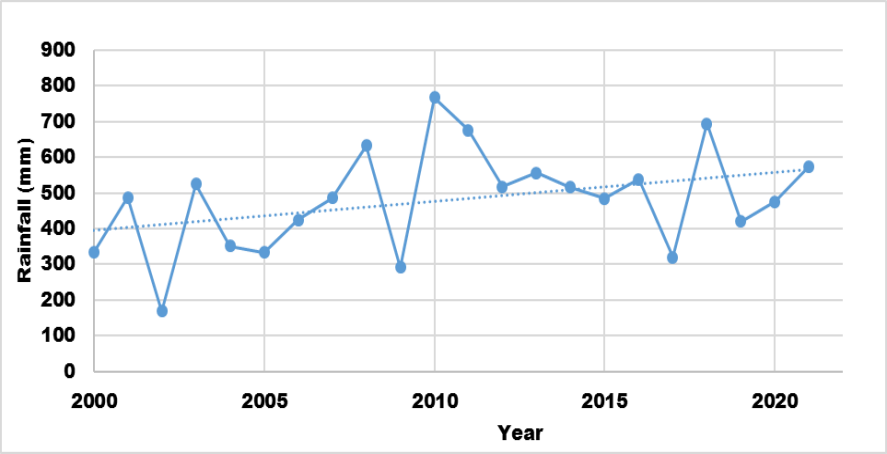


**Figure 2:** Average annual rainfall of Jhunjhunu district from 2000 to 2021.

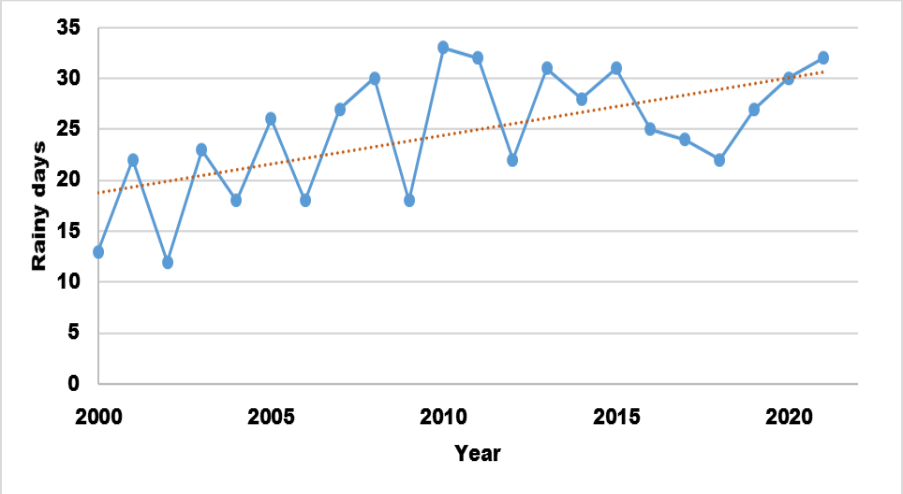


**Figure 3:** Average rainy days of Jhunjhunu district from 2000 to 2021.

Rainfall distribution map of year 2000, 2010 and 2020: There were five weather stations in Jhunjhunu district in year 2000. Figure 4 shows rainfall distribution in Jhunjhunu district in the year 2000. Here, rainfall is being decreases when going center to north-west direction of Jhunjhunu district. Khetri block got the highest rainfall during the whole year and Nawalgarh block was on second position. Malsisar, Buhana and Udaipurwati block got the lowest rainfall during the whole year.

Jhunjhunu district have seven weather stations in 2010. The thematic map (in Figure 5) demonstrates that rainfall distribution in weather stations of Jhunjhunu district is being decreases when going west to north-east direction in the year 2010. Malsisar block received the highest rainfall and Khetri block was on second position. Buhana, Chirawa and Nawalgarh blocks got the lowest rainfall. Jhunjhunu and Udaipurwati blockss got average rainfall.

In Jhunjhunu district, there were eight weather stations in 2020. Surajgarh is the latest weather station. In the year 2020, rainfall distribution in Jhunjhunu district is also being decreases when going north-west to south direction of Jhunjhunu district (Figure 6). Chirawa, Khetri and Jhunjhunu blocks got the highest rainfall during the whole year. Nawalgarh, Buhana and Udaipurwati blocks got the lowest rainfall during the whole year.

From the thematic map of twenty years period, rainfall distribution in weather stations of Jhunjhunu district is being decreases when going north-east to west direction (Figure 7). Khetri block received the highest rainfall during the average 20 years period. Jhunjhunu block got the lowest rainfall during the whole period. Malsisar and Udaipurwati blocks got average rainfall.

Figure 8 is the thematic map of year 2021 rainfall distribution. It was detected that rainfall distribution in weather stations of Jhunjhunu district is being decreases when going east to north-west direction. Udaipurwati block got the highest rainfall. However, Jhunjhunu and Malsisar blocks got the lowest rainfall during the whole year. Khetri block got average rainfall.

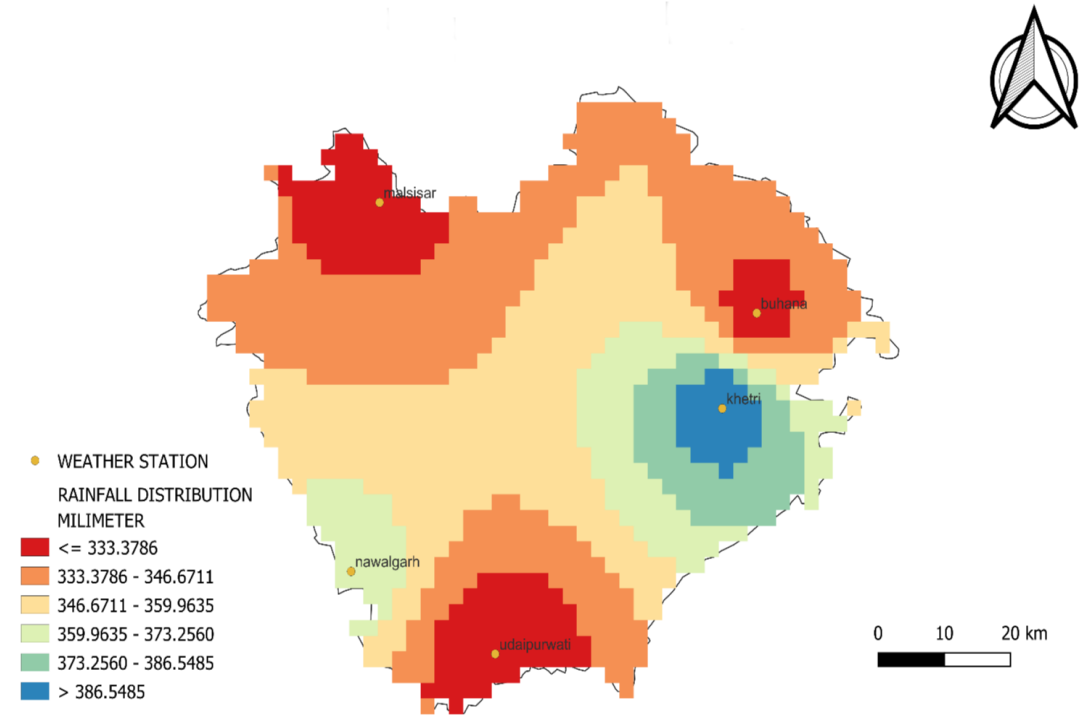


**Figure 4:** Jhunjhunu district thematic map 2000.

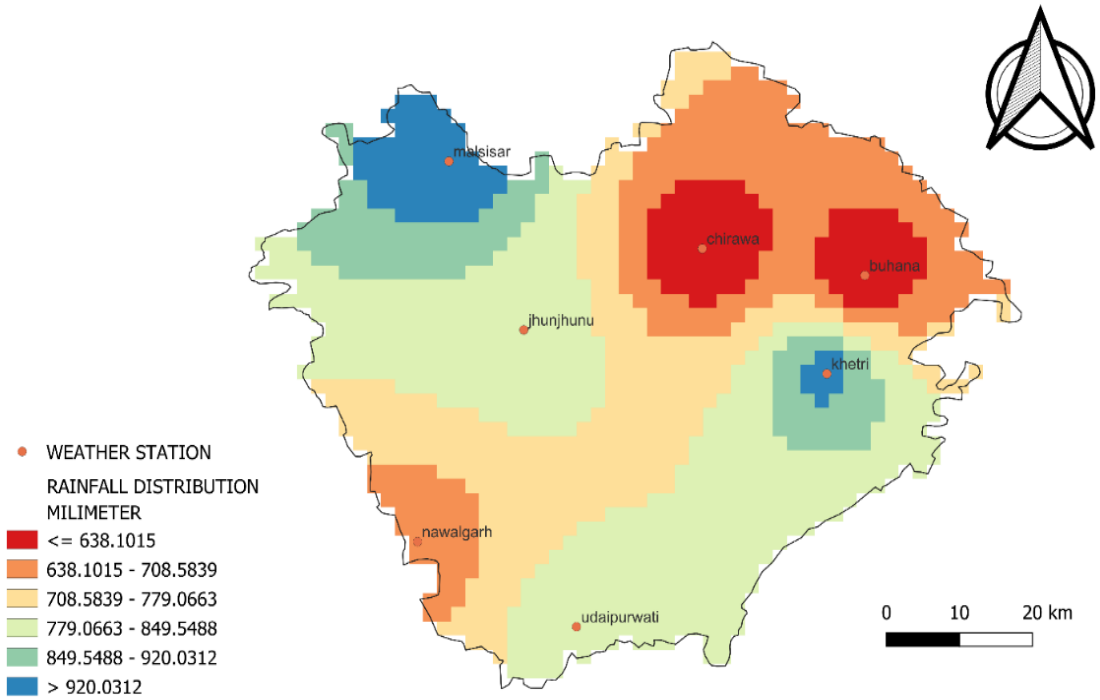


**Figure 5:** Jhunjhunu district thematic map 2010.

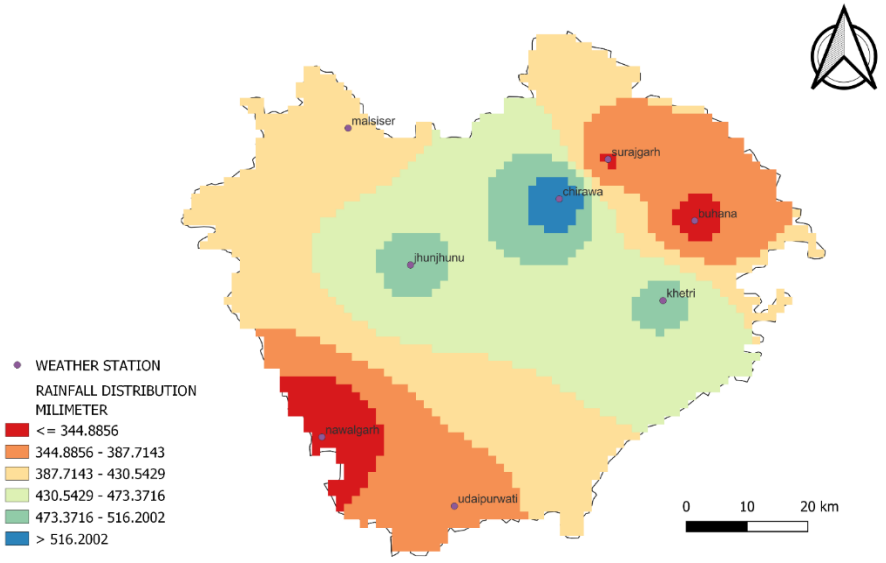


**Figure 6:** Jhunjhunu district thematic map 2020.

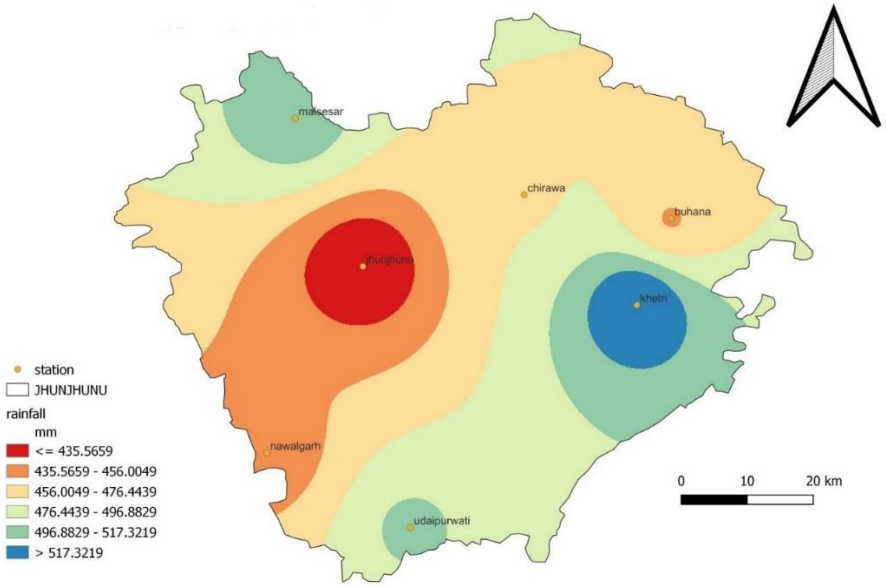


**Figure 7:** Thematic map of rainfall distribution of Jhunjhunu district from year 2000 to 2020.

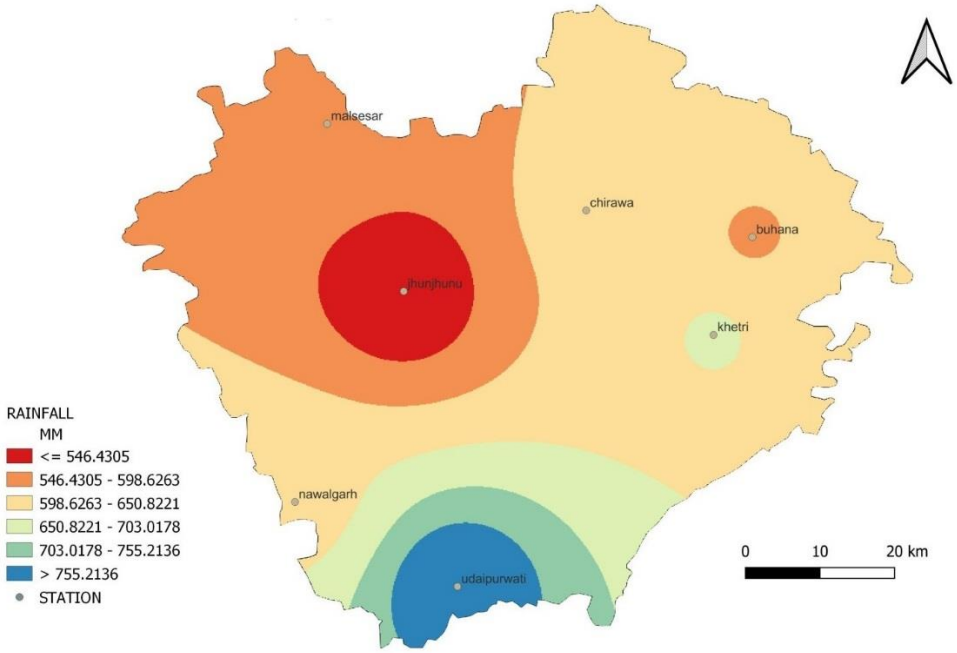


**Figure 8:** Jhunjhunu district thematic map of year 2021 rainfall distribution.

## 4. Conclusion

Spatial and temporal evaluation of rainfall pattern using GIS approach have been done in the present study. The analysis of the twenty years rainfall data of Jhunjhunu district shows an increasing trend in rainfall quantity as well as a sluggish growing pattern in rainy days. It was found that south, south-eastern and some part of north region of the Jhunjhunu get the maximum rainfall. However, north-eastern and western parts of the Jhunjhunu district receive the lowest rainfall. The rate of ground recharge is less in Jhunjhunu district because of low rainfall and high temperature. Hence, the combined use of surface water, available rainfall and groundwater is essential for better agricultural management and irrigation in the district. The analysis helps to understand the rainfall pattern in the Jhunjhunu region and to plan the irrigation plants for efficiency and water availability in the region.

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