

# Study Of Rainfall Pattern In District Bikaner

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## Abstract

Ever since it first appeared at the dawn of time, water has been in an unchanging state. Over the years, not much has been added or subtracted. Water is always moving because of the oceans, atmosphere, cryosphere, and land. The exchange of water between reservoirs in the ocean, atmosphere, and land is known as the hydrologic cycle. There are issues with the quality of the water supplies that are available. Water consumption per capita is an excellent predictor of peoples' quality of life as well as their economic and social position. Human health and happiness are directly tied to the quality of the water used. By 2025, it is anticipated that more than half of the world's population would be at risk from water shortages. The motive of the study is to identify the most sensitive zones in the study area with the help of GIS and to study the correlations amongst the various weather stations rainfall data.

## Introduction

All living things require water, a naturally occurring resource. Everyone must have access to a sufficient, secure, and convenient source of water because it is essential to sustaining life. Human bodies are 60% water and plants are 90% water, respectively. In this way, water resources have been seen as significant reserves, and countries that are improving their infrastructure have also worked to understand the potential of these resources. Groundwater is essential for human consumption, habitat support, and river base-flow maintenance almost everywhere in the world. Because they were naturally filtered throughout their passage through the ground, they are frequently clear, colourless, and devoid of microbiological contamination and only require minimal treatment.

Like the weather, the rainfall varies throughout Rajasthan. Most of the rain falls in the southwest of monsoon between July and September. The average number of rainy days usually varies from 6 to 42 days, depending on the area. The average annual rainfall is between 200-400 mm and as low as 150 mm in very dry areas. In the southeastern part of Rajasthan, rainfall reaches 1000mm. There are parts in western Rajasthan that receive very little rainfall and on average; it is only 100 mm per year. The Aravalli range receives high rainfall and low temperatures throughout the year. Winter People enjoy the winter season in Rajasthan from December to March. During this period, light winds blow from the north and northeast. Temperatures range from 4 to 28 degrees Celsius. In places like Mt Abu and Churu, temperatures drop to 0 degrees Celsius.

The Bikaner region is so arid that some of the available rainfall is extremely low. Both summer and winter monsoon work here. In the summer the monsoon arrived in Rajasthan from two or more branches first the Arabian Sea Branch from the Arabian Sea, the Bikaner region receives very little rain because the monsoon branch corresponds to the width of Aravalli. And secondly the Bay of Bangol Branch from the Bay of Bangol, Bikaner received little rain from it and because the region is located in a shady rainy area on the Aravalli Range but the rainfall found in this branch is higher than the Arabian branch. In winter Bikaner receives occasional rain due to cyclonic disturbances in the west.

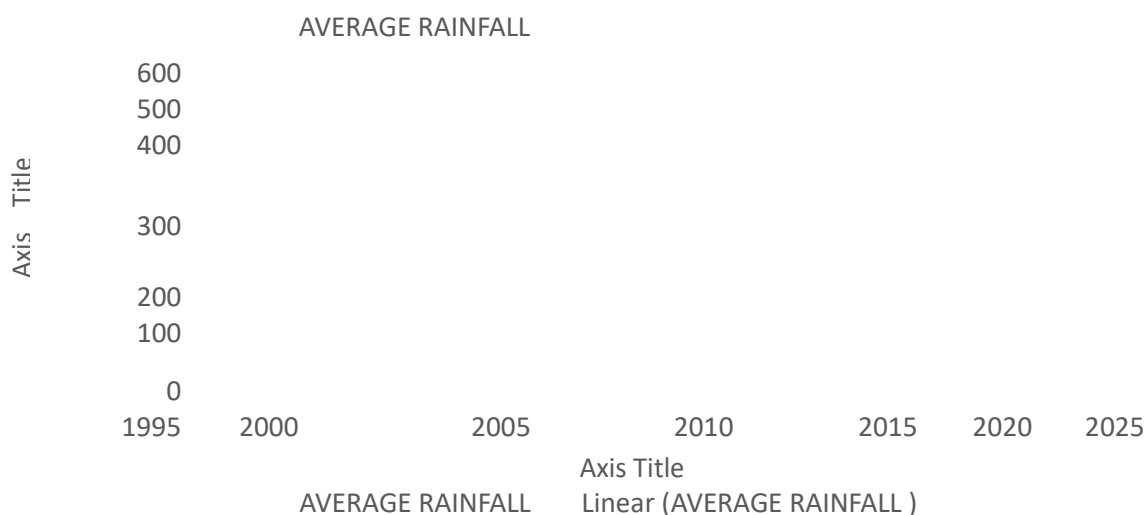
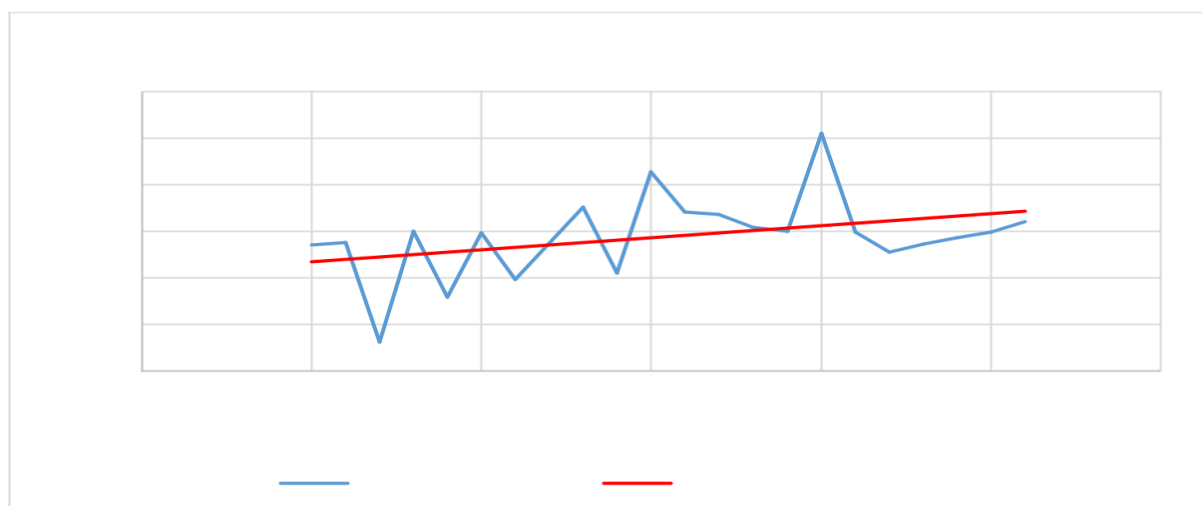
**Location and extent of the Bikaner district:**

Bikaner district is located in the northern part of Rajasthan. It is bounded on the north by Shri Ganganagar district, in the east by Churu and Hanumangarh, south by Jodhpur and Nagaur districts and west boundary is an international boundary with the Pakistan. It stretches between 27° 09' 31.05" to 29° 03' 14.17" North latitude and 71° 50' 59.01" to 74° 21' 59.21"

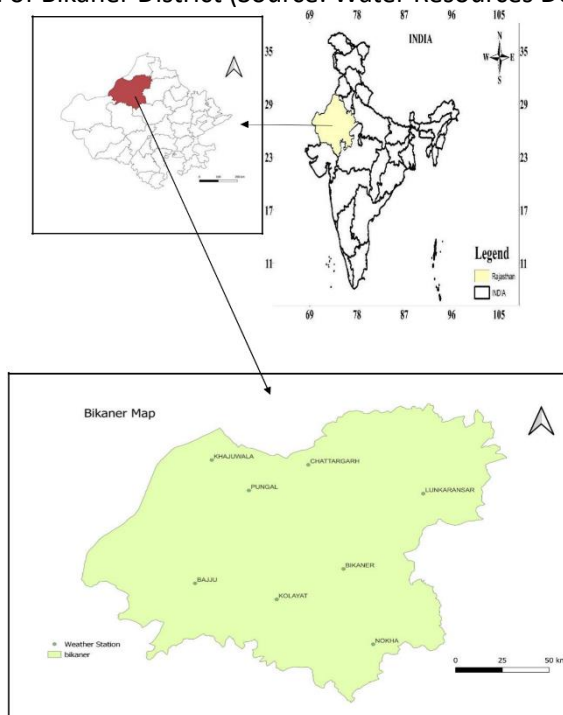
East longitude covering an approximate area of 30,279 sq kms. It has ten tehsils including Bikaner, Bajju, Chattargarh, Khajuwala, Kolayat, Lunkaransar, Mahajan, Nokha, Poogal, and Dungargarh. The district does not have a properly evolved drainage system, almost whole of the district is part of an 'Outside' Basin. Bikaner district is administratively divided into nine blocks.

**Rainfall:**

The rainfall is very limited and erratic. The general distribution of rainfall across can be visualized from isohyets presented in the Plate III where major part of the district has received average rainfall less than 500mm in the year 2010. Most of the rainfall, i.e., approximately 90% of the total annual rainfall or more, is received during monsoon period and non-monsoon rainfall is very limited or negligible. The annual average rainfall was 458.2 mm based on the data of available blocks while highest average annual rainfall is 595.4 mm in Dungargarh block. Lowest of minimum average annual rainfall was in Khajuwal block (288.0 mm). Lunkaransar block has received highest maximum annual rainfall of about 781.2 mm.



**Fig 2: Average Rainfall of Bikaner District (Source: Water Resources Department, Rajasthan)**



**Location and extent of the Bikaner district**

**Map of Bikaner District (in legend weather stations)**

**Methodology**

Annual rainfall and annual rainy days data of the Bikaner district from the year 2000 to 2021 is arranged in an excel sheet. Both data of excel sheet is represented in graphical form one is annual rainfall data and another is annual rainy days with a trend line. Years 2000, 2010 and 2020 data is saved in different three files so that the data is used in preparing the Bikaner district thematic map of three years. These three files are saved with the weather station and weather station’s latitude longitude so that it can be showed at its particular place in geographical map with the help of QGIS.

**Data processing with QGIS:**

QGIS (formerly Quantum GIS) is an open source geographic information system (GIS). This software is a free alternative to proprietary GIS software such as ESRI’s ArcGIS products which can be very expensive. QGIS incorporates similar functions and features as its proprietary counterparts and allows users to display, manipulate and create spatial data. The QGIS is open source and very simple software. There are two simple ways to import the point data into QGIS, depending on the type of data like shapefile, CSV file, excel spreadsheet.

**SHAPEFILE DATA**

A shapefile is a simple, nontopological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). The workspace containing shapefiles may also contain dBASE tables, which can store additional attributes that can be joined to a shapefile’s features. To import a shape file, click on the ‘Layer’ tab in the upper left hand corner of the screen, and select the ‘Add Vector Data’ tab. A window will then prompt you to navigate to your saved shape file dataset on your hard drive. Afterwards click ‘open’ and you should see your point data on the main display.

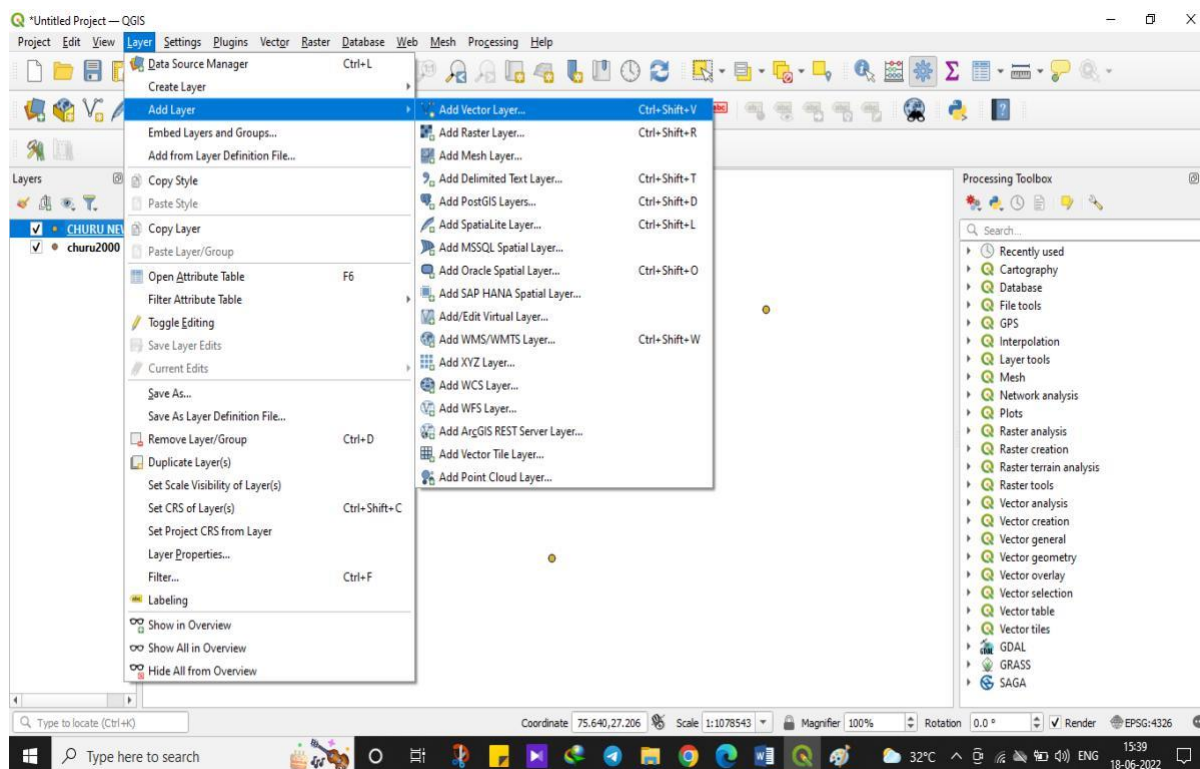


Figure 4: Add Vector Layer in QGIS

**EXCEL SHEET DATA**

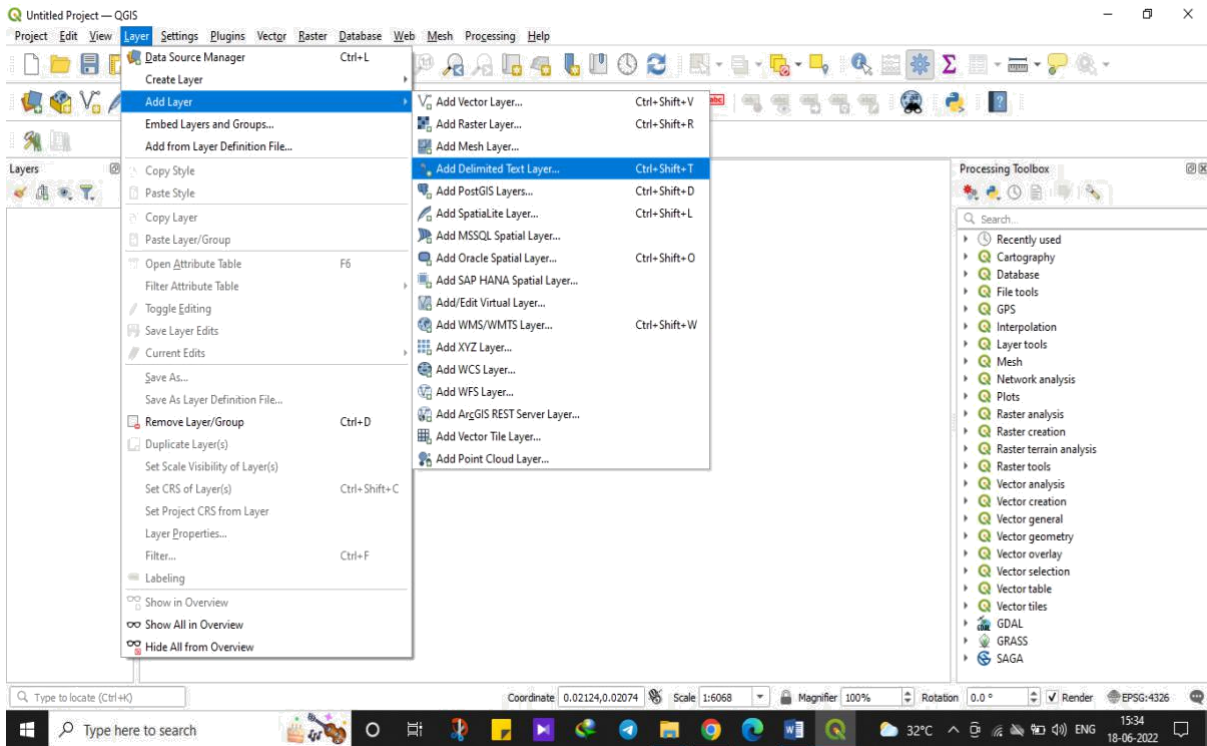
Spreadsheets are composed of columns and rows that create a grid of cells. Typically, each cell holds a single item of data. Here's an explanation of the three types of data most commonly used in spreadsheet programs:

1. Text data, also called labels, is used for worksheet headings and names that identify columns of data.
2. Number data, also called values, is used in calculations. By default, numbers are right-aligned in a cell. In addition to actual numbers, Excel also stores dates and times as numbers
3. Formulas are mathematical equations that work in combination with data from other cells on the spreadsheet. Simple formulas are used to add or subtract numbers. Advanced formulas perform algebraic equations.

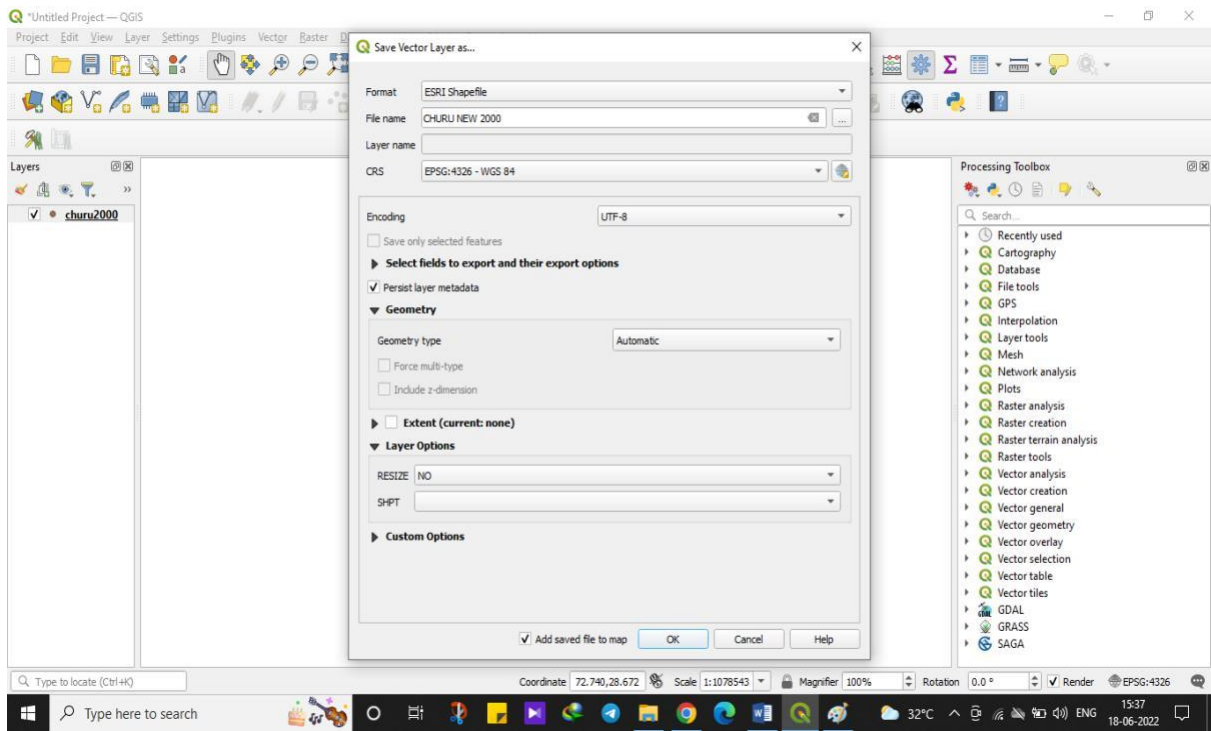
If the data for QGIS is in the form of an Excel spreadsheet, where the points have associated latitudes, longitudes and attribute data, we have to save it as a comma-separated value (CSV) file before trying to import it into QGIS. To import a CSV file, click on the 'Layer' tab in the upper left hand corner of the screen, and select the 'Add Delimited Text Layer' tab.

A window will then prompt you to navigate to your saved CSV file on your hard drive. Assign a layer name for the output point data. Select the 'longitude' field to represent the x-values and the 'latitude' field to represent the y-values. You may be also prompted to provide a map projection for the data (sometimes this is done automatically). If so, select the appropriate geographic coordinate system for your dataset. Then click 'ok' to load the x and y point data. The next step when loading a CSV file is exporting the loaded point data (from the previous step) to a shapefile. To do this in QGIS, right-click on the loaded point data layer and click the 'Export > Save features as' tab.

A window will then prompt you to pick the format of the file being saved, choose 'ESRI Shapefile'. Browse for a location to save the shapefile on your hard drive and assign the filename for the output shapefile. You will also need to specify a projected coordinate system for the output shapefile, in order to run interpolations on it in later steps. And lastly, check the 'Add saved file to map' box. Then click 'ok'.



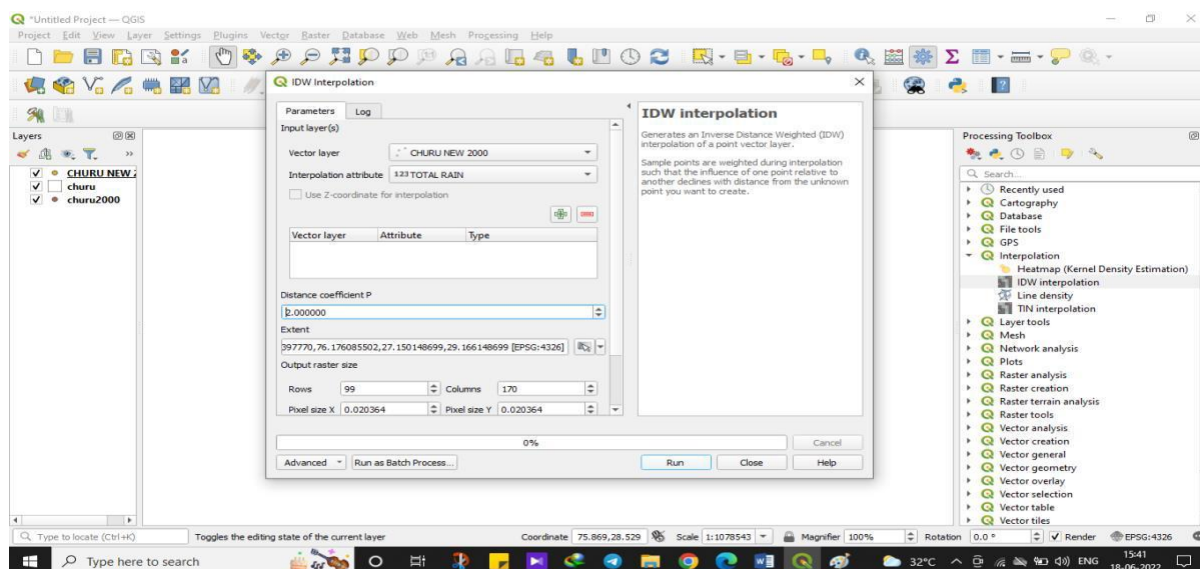
DText Layer in QGIS



ESRI Shapefile in QGIS

### Creating the IDW Interpolated Raster Surfaces

Interpolation is a commonly used GIS technique to create a continuous surface from discrete points. A lot of real-world phenomena are continuous – rainfall, elevations, soils, temperatures etc. If we wanted to model these surfaces for analysis, it is impossible to take measurements throughout the surface. Hence, the field measurements are taken at various points along the surface and the intermediate values are inferred by a process called ‘interpolation’. In QGIS, interpolation is achieved using the built-in Interpolation tools from the Processing toolbox.



Interpolation in QGIS

The interpolation method that will be used in the project is the IDW interpolation. Click on the ‘Processing’ tab and select ‘Toolbox’. The ‘Processing Toolbox’ panel will then appear on the right side of the map view. You will notice that QGIS draws tools from 8 different GIS sources including its own QGIS tool selection. The easiest way to find an appropriate interpolation tool is to type ‘Interpolation’ into the upper search column. Now choose Inverse Distance Power Interpolation and double click on the IDW Interpolation. The IDW Interpolation inputs window will then appear, which allows you to input the data layer being interpolated and customize the interpolation based on your needs. For the ‘Points’ input use the ‘Weather Station’ shape file layer. For the ‘Attribute’, select Annual Rainfall from the drop-down selection.

Use the default values for ‘Target Grid’, ‘Distance Coefficient’, ‘Inverse Distance Power’ etc. as they are appropriate for the data distribution in this study. And lastly, assign a location to save the output raster ‘Grid’, and check the ‘open output file after running algorithm’ check-box. Click ‘Run’. The IDW interpolation tool will then output a black and white interpolated raster surface onto the map area. Drag the grid layer below the point shape file layer and rename it by right-clicking on the raster grid and selecting ‘rename’. The next step is to assign a colour ramp to this reclassified raster layer. To do this, right-click on the ‘renamed file’ and select ‘properties’. Select the ‘Symbology’ tab, and then pick ‘Single band pseudocolor’ in the ‘render type’ drop-down box.

Then in the ‘Generate new colour map’ area, choose the ‘spectral’ colour ramp, check the ‘invert’ check-box, select the ‘Equal Interval’ mode and 6 classes. Assign a min value and max value, and then click the ‘classify’ button. This will create a 6 class colour which needs to be reclassified based on the values of the ‘reclassified grid’. After modifying the colour ramp values to reflect the correct range of values from the reclassified grid, click ‘apply’ and ‘ok’ and you will now have coloured map of the file. The last step of this mapping process is to create a polygon of the lake which will be used as a mask to clip the interpolation surface.

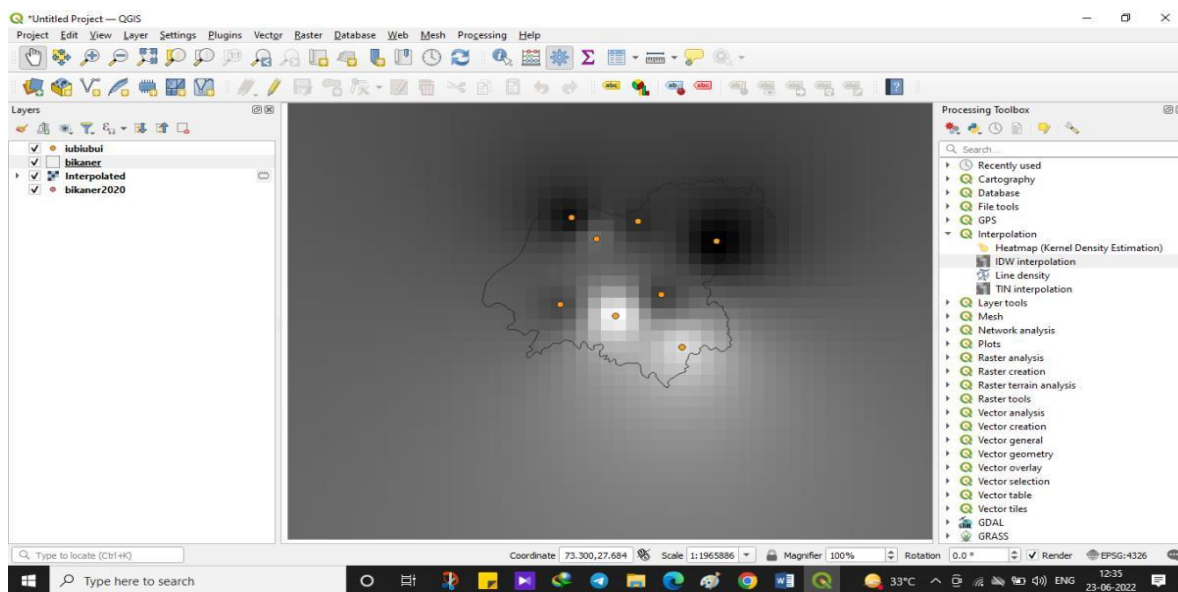
### Creating Clipping Polygon and Clipping Interpolation Surface

To create a clipping mask for the interpolation raster surface you have to digitize a polygon of the interested area boundary and then clip the interpolated surfaces with it, so that the interpolation does not extend onto land (which may have very different As concentrations compared to water). In order to do so, a new shapefile needs to be created. Under the ‘Layer’ tab, click on ‘Create Layer’ and then select ‘New Shapefile Layer’.

In the ‘New Shapefile Layer’ window, select the option to create a ‘polygon’ in the ‘type’ field. Then specify the correct projection for the shapefile. Seeing that this shapefile is just going to be used to create a clipping mask polygon, no ‘new attributes’ need to be assigned. Click ‘ok’. A window will then appear which allows you to specify a filename and location to save the new shapefile. Call is ‘Clip Polygon’, and save it. You will now

notice your new polygon shapefile in the list of layers. The next step will be digitizing a polygon of the interested area. Right-click on the 'Clip Polygon' layer and select the 'Toggle editing' button.

Then click the 'Add Feature' button to start creating the polygon. Start digitizing the polygon by clicking on the edge of the interested area and following the boundary all around the area. Use as many digitizing points as possible to ensure an accurate polygon. Once you have finished digitizing your polygon, right click on the last point. A window will appear that will allow you to specify an id for the polygon, assign it a value of '1'. Then click 'ok'. Now that we have our Area polygon, we can save the edits made to the shapefile and close the editor. Click on the 'current edits' button and select the 'save for all layers' button. Then right-click on the Clip Polygon shapefile layer and click on the 'Toggle editing' button to stop editing the polygon.



**Figure 8:** Bikaner shapefile in QGIS

Now we are ready to clip the 'Reclassified grid' using the 'Clipping Polygon'. To do so, search for the tool 'Clip grid with polygon' in the processing toolbox, and open it. In the 'clip grid with polygon' tool window, assign the 'Reclassified Grid' as the input raster layer and the 'Clip Polygon' as the input polygon. Specify an output filename 'Bikaner map' and click run. You will notice that the reclassified grid is now clipped, but the default original greyscale colouring has returned. There is a quick way to re-symbolize the clipped raster with the appropriate colour ramp.

Right-click on the 'reclassified grid', which still has its intact colour ramp and open the properties menu. Click on the 'export colour map file' button, and save the text file to hard drive. Then re-open the properties menu for the 'Bikaner map' raster, select the 'style' tab, and then pick 'Singleband Pseudocolor for the 'render type'. Then click on the 'load colour map from file button' and open the saved text file from the earlier step. You will now notice that your legend is back to the original format.

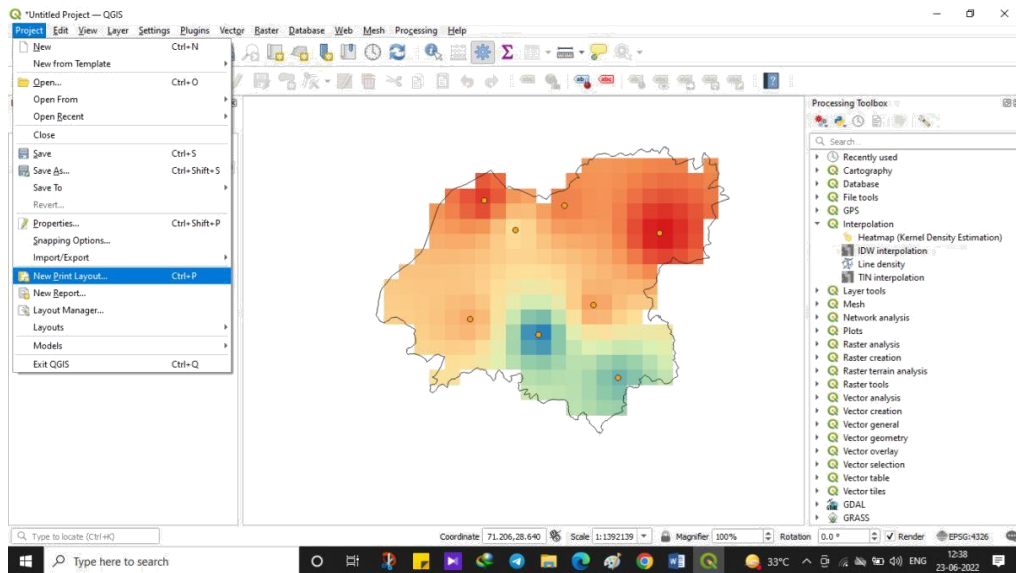
And now the map is complete and ready to be checked for accuracy. When you inspect the As concentration point values and the interpolated surface value under each point (looking at the legend), you will see that all the points fall in the correct interpolated value range area, indicating a good interpolation job. Now that the IDW interpolation map is complete.

**Exporting the Final Maps**

Under the 'Project' tab, select "New Print Layout'. Assign a 'Create Print Layout' that will be used for the new print composer (For example: 'BIKANER MAP 2000'). Under the 'Layout' tab, you can add a number of map elements to the print composer including the actual map, a legend, scale bars, etc., depending on the nature and purpose of the final map.

Make sure you zoom to the layer extent of the Bikaner map 2000 first before adding it as a map to the print composer, text editing for the 'label' is done in a text editing box on the right hand side of the print composer window. There is a wide variety of graphics editing tools within this print composer, so feel free to explore and play with them before exporting the final map.

The last step of this will be exporting the map and for this there are a number of formats available to export the final map as, which including: JPEG file, PDF or as an SVG file. To export the map, click on the 'Layout' tab and select the 'Export as Image' tab. Assign a file name to the exported image like PNG, JPG, JPEG file etc., and click save.



Export map in QGIS

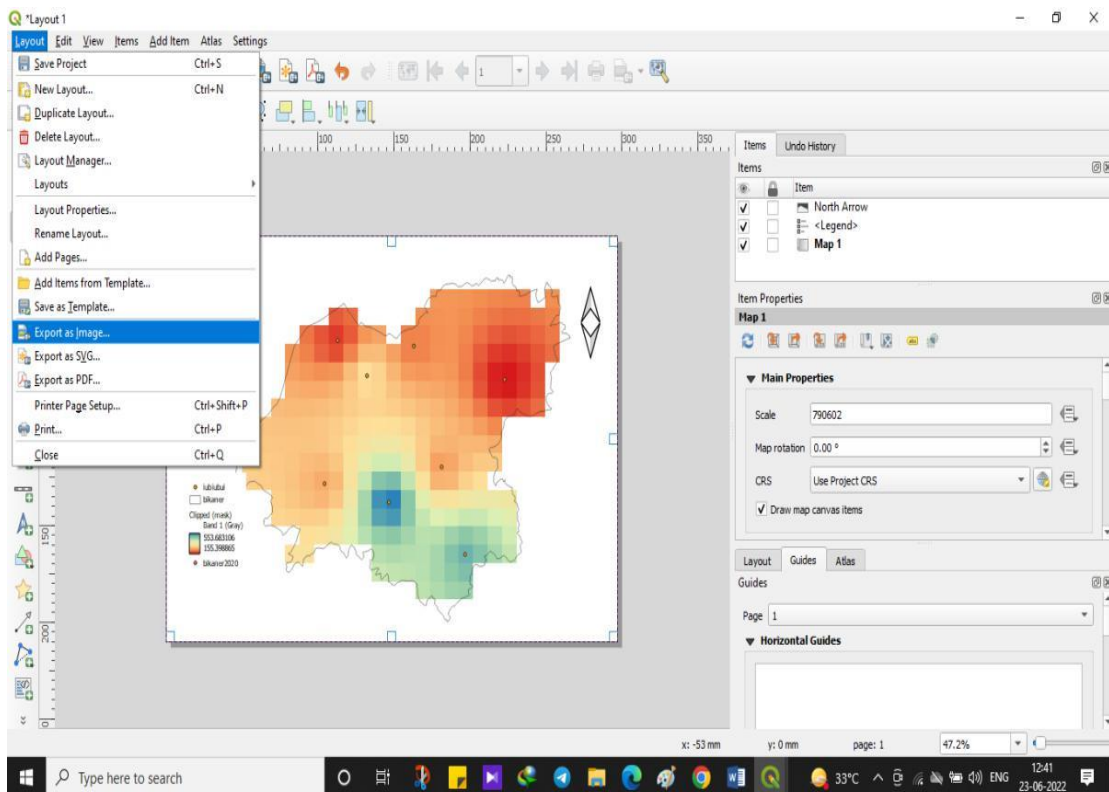


Fig 10: Export map as an image in QGIS



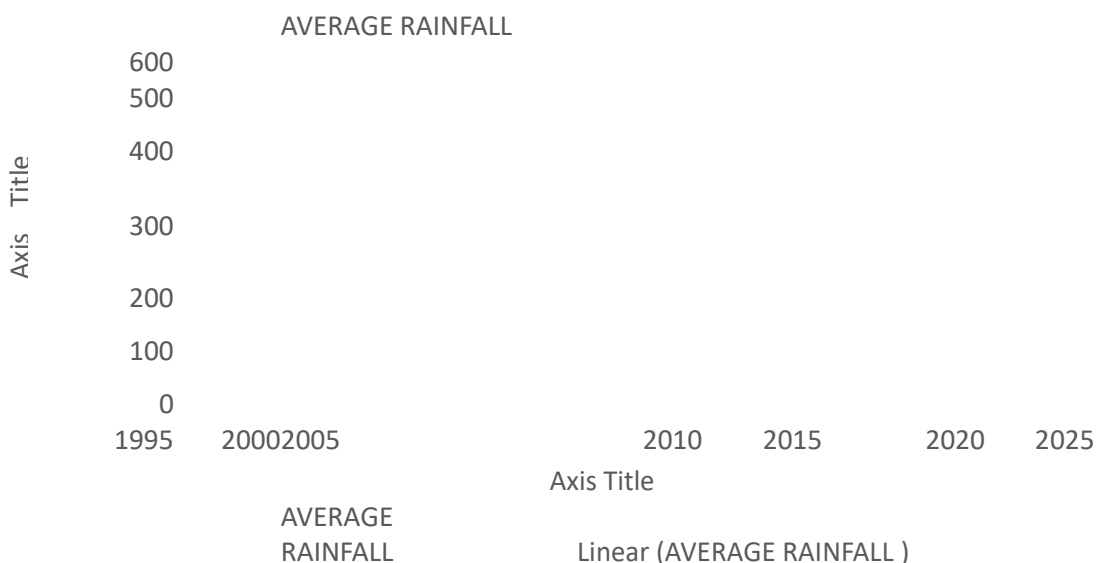
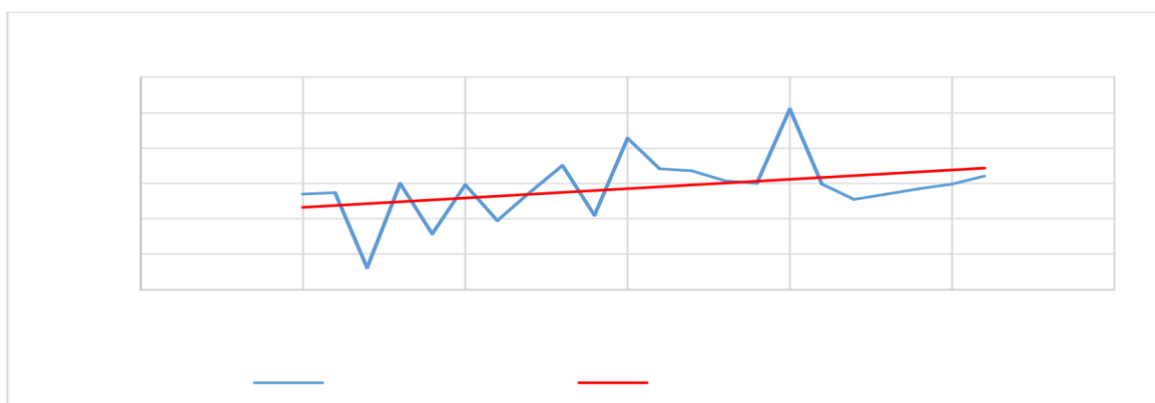
**Results and Discussion**

YEAR	AVERAGE RAINFALL	AVERAGE RAINY DAYS
2000	270	12
2001	275	17
2002	61	7
2003	300	18
2004	158	12
2005	296	20
2006	195	14
2007	274	19
2008	351	23
2009	209	15
2010	427	22
2011	341	21
2012	336	19
2013	308	22
2014	299	21
2015	510	30
2016	298	20
2017	254	19
2018	271	14
2019	285	23
2020	298	22
2021	321	21

**Table:** Bikaner district Average Rainfall and Average Rainy days

### 21 Bikaner District Average Rainfall Data and Rainy Days

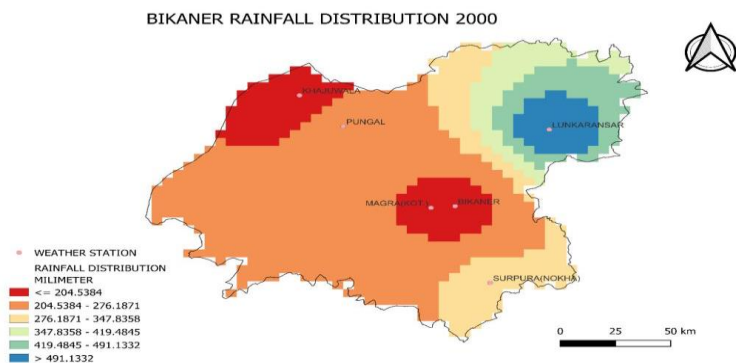
With the help of average rainfall data we can say that Bikaner district received rainfall between a ranges of 200-500 mm in last 22 years and only one time the rainfall crosses this range in these years. In the year 2015 the rainfall is more than this range with nearly 510 mm and in the year 2010 rainfall is very low and it goes nearly 180 mm. Bikaner is close to 300mm average to be considered normal rainfall in the region. With the help of average rainy days data we can say that Bikaner district rainfall days are between a ranges of 10-30 in last 22 years and average rainfall data show a gradual increases in the last years in the region. Average rainy days are consistently following an increasing pattern.



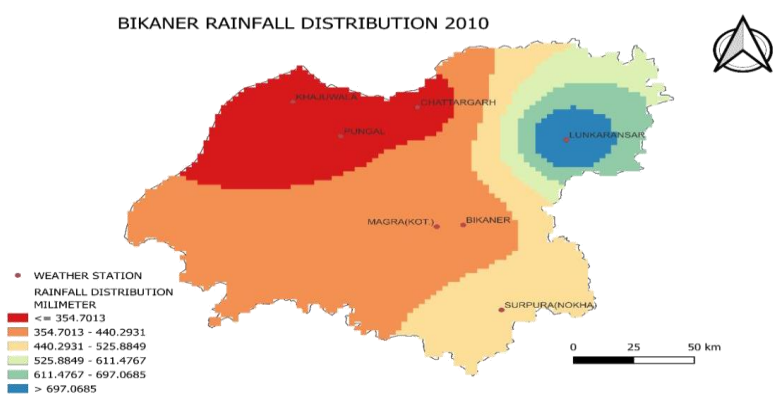
**Figure 10:** Bikaner district average rainfall data

### Bikaner Rainfall Distribution 2000

In Bikaner district there are six weather station in 2000. If we go through the complete rainfall distribution data of Bikaner district for year 2000 as per above Thematic map, we found that in the year 2000 rainfall distribution in Bikaner district is being decreases when going east to west direction of Bikaner district. Lunkaransar block get highest rainfall during the whole year and Nokha block is on second position. Bikaner and Khajuwala block get lowest rain fall during the whole year while Pungal block get average rainfall.



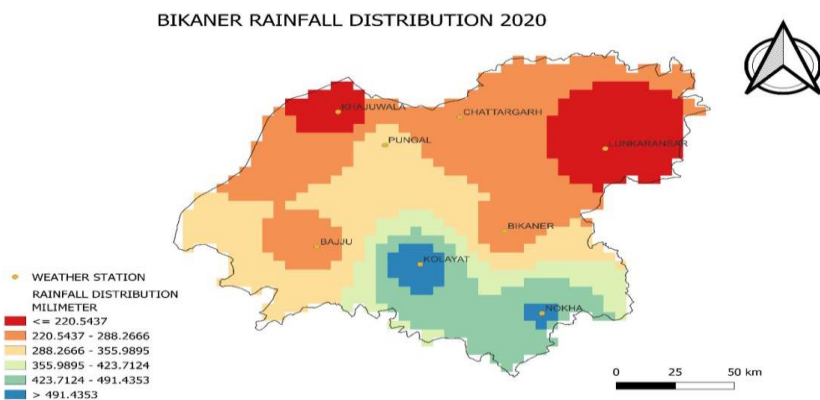
Bikaner thematic map 2000  
**Bikaner Rainfall Distribution 2010**



In Bikaner district there are eight weather station in 2010. If we go through the data of complete rainfall distribution at each weather station as per above Thematic map, we found that in the year 2010 rainfall distribution in weather stations of Bikaner district is being decreases when going east to west direction. Lunkaransar block get highest rainfall during the whole year and Nokha block is on second position. Khajuwala, Pungal and Chattargarh blocks get lowest rain fall during the whole year. Magra and Bikaner blocks get average rainfall.

Bikaner thematic map 2010

**Bikaner Rainfall Distribution 2020**



Bikaner thematic map 2020

Bikaner district there are nine weather station in 2020 and Bajju is latest weather station. If we go through the complete rainfall distribution data of Bikaner district for year 2020 as per above Thematic map, we found that in the year 2020 rainfall distribution in Bikaner district is also being decreases when going south to north direction of Bikaner district. Kolayat and Nokha blocks get highest rainfall during the whole year. Lunkaransar and Khajuwala blocks get lowest rain fall during the whole year. Bikaner, Chattargarh and Bajju blocks get average rainfall throughout the year.

### Conclusion

The present study reveals that rainfall pattern of Bikaner is increasing with the time as the study depicted. The trend of rainfall pattern is shall ergative but have increased in spells especially including pre monsoon shower. Despite having increase in precipitation the recharge rate of water is shell low due to high temperature and low permeability of the soil. The introduction of IGNP canal is in various reason of the Bikaner supports micro climate condition which helps to a consequent increase in trends of rainfall in coming years so far.

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