



## Research Article

# Analysis and prediction of rainfall using support vector machine (SVM) in the city of Najaf

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## ABSTRACT

This study depends on the utilize of Support Vector Machine (SVM) method to analyze and predict monthly rainfall in Najaf city, Iraq over the past ten a long time. Support Vector Machine is one of the foremost imperative instruments in classifying and analyzing information in multiple areas, counting climate and climate data investigation. The Climatic Inquire about Unit (CRU) information traversing the a long time 1901 to 2022 were utilized to analyze and foresee monthly rainfall. The comes about appeared shifting precision in predicting between distinctive months, as there were expansive contrasts between the anticipated and real values in a few months such as April, whereas the predict were more exact in other months such as March.

## 1. INTRODUCTION

Support Vector Machine (SVM) may be a effective classification and relapse apparatus that has found wide application in different areas, counting climate and climate information examination. In later a long time, SVM has ended up an vital device for precipitation investigation and climate alter determining due to its capacity to handle expansive sums of information and distinguish complex designs. The SVM strategy was to begin with proposed by V. Vapnik and A. Chervonenkis within the mid-1990s, and has since found numerous applications in machine learning and information examination [1]. This strategy is based on finding the ideal hyperparameter that partitions information into distinctive classes with the most extreme crevice. When connected to precipitation examination, SVM permits building models that can precisely anticipate precipitation sums based on authentic information [2], [3]. The application of SVM in climatology and meteorology is due to its capacity to handle complex and multivariate information. For case, ponders have appeared that SVM can be viably utilized to foresee regular precipitation and temperature [4], [5]. Thanks to this strategy, researchers can construct models that take under consideration different climatic components and their connections, which increases the exactness of forecasts [6], [7]. Other thinks about have affirmed the viability of SVM totally different perspectives of climate examination. For illustration, SVM has been utilized to foresee extraordinary climate occasions such as heavy rainfall and dry season [8], [9]. Besides, utilizing SVM to analyze information from climate stations permits spatial and worldly conditions to be taken into consideration,

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making expectations more dependable [10], [11]. SVM is additionally utilized to coordinated information from diverse sources, such as adj. perceptions and ground-based climate stations, to supply a more total understanding of climate forms [12], [13]. In a few cases, SVM is utilized with other machine learning strategies, such as neural systems, to progress forecast precision [14], [15]. Inquire about appears that the utilize of SVM can altogether move forward the quality of determining and examination of climate data, particularly in data-scarce and boisterous situations [16], [17]. For illustration, SVM has been effectively connected to foresee yearly and regular precipitation in districts with diverse climatic conditions [18], [19]. In expansion, SVM can take into consideration the nonlinear connections between distinctive climate parameters, which is particularly imperative for precise estimating [20], [21]. This makes SVM an irreplaceable device for precipitation investigation and estimating beneath climate alter [22]. The most objective of this think about is to analyze and anticipate the precipitation for each month over the past ten a long time in Najaf city in Iraq. The values of cruel outright blunder (MAE) and root cruel square blunder (RMSE) were calculated for each month.

## 2. RELATED WORK

Rainfall investigation and estimating are critical errands within the areas of climatology and hydrology. Different strategies, counting support vector machines (SVMs), are utilized to fathom these issues. This segment surveys a few ponders on the utilize of SVMs and other strategies for analyzing precipitation and climate data. Back vector machines (SVMs) have demonstrated to be an viable apparatus for precipitation determining. Inquire about appears that SVMs are able to precisely anticipate regular and yearly precipitation by bookkeeping for complex nonlinear connections between climate parameters. For case, [23] portrays the utilize of SVMs to anticipate regular precipitation in India, where the strategy appeared tall precision compared to customary strategies. Another think about [24] utilized SVMs to anticipate extraordinary precipitation occasions in China. The comes about appeared that the strategy is able to successfully identify periods of overwhelming precipitation and dry season, which is critical for water asset administration. In expansion, the creators note that SVMs permit spatial and worldly dependencies to be taken into consideration, which makes strides the precision of expectations. The application of SVMs to precipitation examination in combination with other machine learning strategies has moreover been examined in a few works. For case, [25] proposed a half breed approach that combines SVM and neural systems to progress estimate precision. This approach has demonstrated compelling in conditions of inadequately data and commotion. [26] investigated the utilize of SVM to combine data from diverse sources such as disciple perceptions and ground-based climate stations. This permitted us to pick up a more total understanding of climate forms and progress the precision of estimates. The creators famous that the combined utilize of information from different sources increases the unwavering quality of estimates and makes a difference to require under consideration distinctive climatic components. Inquire about moreover appears that SVM can be utilized to anticipate long-term climate alter. For case, [27] portrays the utilize of SVM to predict changes in climatic conditions in Europe based on authentic information. The comes about appeared that the strategy is able to precisely foresee changes in temperature and precipitation over a long period. Other machine learning strategies, such as neural systems and choice trees, moreover, discover application in precipitation examination. The work [28] proposed an approach based on the utilize of profound neural systems to anticipate precipitation in tropical districts. This strategy has appeared tall precision and solidness of forecasts, but requires huge computational assets and expansive sums of preparing information. [29] investigated the utilize of choice trees to analyze climate and climate data. The creators famous that this strategy permits one to successfully recognize connections between diverse climatic factors and construct precise estimate models. In any case, the strategy has impediments when preparing huge sums of information and within the nearness of complex nonlinear conditions. In expansion, [30] portrays an approach based on the utilize of a combination of machine learning strategies to make strides estimate precision. The creators proposed the utilize of outfit strategies such as irregular timberlands and angle boosting in combination with SVM and neural systems. The comes about appeared that the combined utilize of distinctive strategies can make strides the exactness of forecasts and diminish blunders. Other inquire about focuses on the application of machine learning methods to analyze climate information within the setting of climate alter. [31] examined the impact of climate change on precipitation in several locales of the world using SVM. The authors famous that the strategy makes it conceivable to require into consideration nonlinear conditions and distinguish long-term patterns in changing climatic conditions. It is additionally worth noticing investigate pointed at creating modern strategies and calculations for precipitation examination. For case, [32] proposed a unused calculation based on the utilize of SVM and hereditary calculations to optimize show parameters. This approach has appeared tall precision and effectiveness in anticipating precipitation in different climatic conditions. Other works examine the utilize of machine learning methods to analyze precipitation in combination with geographic data systems (GIS). [33] portrays the utilize of SVM in combination with GIS to analyze the spatial conveyance of precipitation in hilly ranges. This approach has permitted for more exact estimates and taken into consideration the topographical characteristics of the region. Moreover, essential are ponders that point to utilize machine learning strategies to analyze information from meteorological stations. [34] explored the application of SVM to analyze temperature and precipitation

data collected from different climate stations. The comes about appeared that the strategy can effectively handle expansive sums of data and construct precise prescient models. In expansion, [35], the application of SVM to figure precipitation beneath data-poor conditions was examined. The creators proposed using transfer learning methods to make strides the exactness of estimates in data-poor districts. This approach has demonstrated to be compelling and dependable in analyzing climate data beneath information-poor conditions.

### 3. STUDY AREA

Najaf is located at around  $32.0000^{\circ}\text{N}$  and  $44.3333^{\circ}\text{E}$ . It includes a hot leave climate (Köppen climate classification BWh), characterized by amazingly hot summers and mellow winters. Temperatures in Najaf amid the summer can surpass  $45^{\circ}\text{C}$ , with July and Eminent being the most sultry months. The region encounters exceptionally moo stickiness, making the warm seriously but dry. Winters in Najaf are gentle, with temperatures extending between  $5^{\circ}\text{C}$  and  $15^{\circ}\text{C}$ . January is ordinarily the coldest month. Najaf gets exceptionally small precipitation yearly, with an normal of  $100\text{--}200$  mm per year. Most of the precipitation happens amid the winter months, from November to February, whereas the summers are very dry. Figure 1 appear area outline of consider zone..



Fig. 1. Study area.

### 4. DATA

In our work, we used Climate Research Unit CRU data. The data is available from 1901 to 2022. The data is extracted and loaded automatically, and then converted from 3D to Excel using the MATLAB program to facilitate its processing in Python and the use of any model or analysis. The data is characterized by its high accuracy and great reliability. The primary purpose of CRU data is to support scientific research and climate modeling. These data are used to assess climate change, analyze trends, and predict future climate conditions. They play a key role in understanding the impacts of climate change on ecosystems and human activities [36].

### 5. SUPPORT VICTOR MACHINE

It may be a machine learning procedure utilized to classify and analyze data. SVM can be utilized to classify data into diverse classes by finding a hyperplane in a multidimensional space that isolates the diverse classes with the biggest conceivable edge. SVM begins by taking a preparing dataset that contains illustrations that have been previously classified into two classes (or more within the case of employing a multiclass SVM). Each include of the data could be a measurement in a multidimensional space. The SVM speaks to each information point as a point in this space [37][40][41]. The goal of the SVM is to discover the hyperplane that isolates the distinctive classes with the biggest conceivable edge. A hyperplane may be a surface in a multidimensional space that isolates the information into classes.

Edge of the hyperplane:

The hyperplane edge is characterized as the separate between the hyperplane and the closest information points from each lesson. The SVM looks for to maximize this edge to guarantee that the classification is most precise and solid [38].

Straightly non-separable information:

In case there's straightly non-separable data in its unique space, SVM employments a change work called Part to convert the information into a higher-dimensional space where it can be directly isolated [39].

The choice work is calculated from the taking after condition:

$$b + x \cdot w = f(x) \tag{1}$$

Where:  $w$  is the weight vector,  $x$  is the feature vector and  $b$  is the slope.

$$^2 \left\| \min_{w,b} \frac{1}{2} \right\| w \tag{2}$$

With restriction:

$$1 \leq (b + x_i \cdot y_i(w)) \tag{3}$$

Where:  $y_i$  is the classification of the sample  $i$ ,  $x_i$  is the feature vector of the sample  $i$ .

### 6. RESULTS

The rainfall data for each month over the past 10 years were analyzed. Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and Mean Squared Error (ME) values were calculated for each month. Table 1 shows the (MEA), (RMSE) and (ME) values were calculated for each month.

TABLE I. THE (MEA), (RMSE) AND (ME) VALUES WERE CALCULATED FOR EACH MONTH

Month	ME	RMSE	MAE
January	22.6	4.75	3.03
February	30.38	5.51	3.49
March	3.13	1.77	1.07
April	68.01	8.25	4.83
May	11.08	3.33	2.15
June	0	0	0
July	0	0	0
August	0	0	0
September	0.01	0.08	0.06
October	3.36	1.83	1.14
November	44.6	6.68	4.51
December	18.91	4.35	2.61

The results showed that the forecast accuracy varied between months, with some months such as April having the highest MAE, ME and RMSE values indicating a greater discrepancy between the predicted and actual values. On the other hand, some months such as March showed lower MAE, ME and RMSE values indicating a higher preaction accuracy.

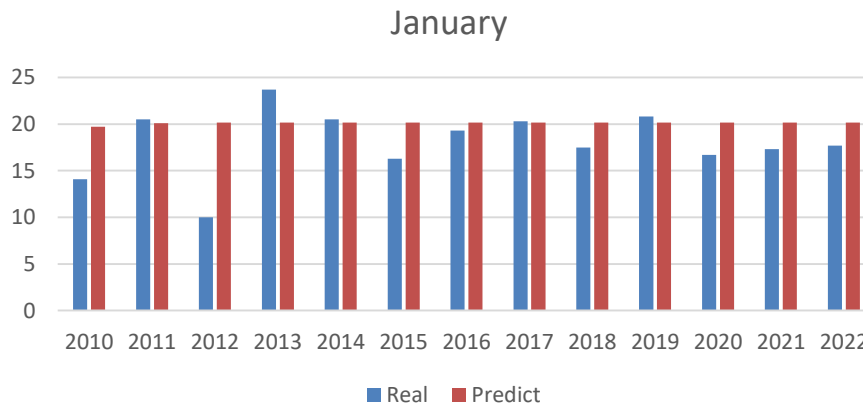


Fig. 2. The prediction rainfall for the period from 2010 to 2022 for January.

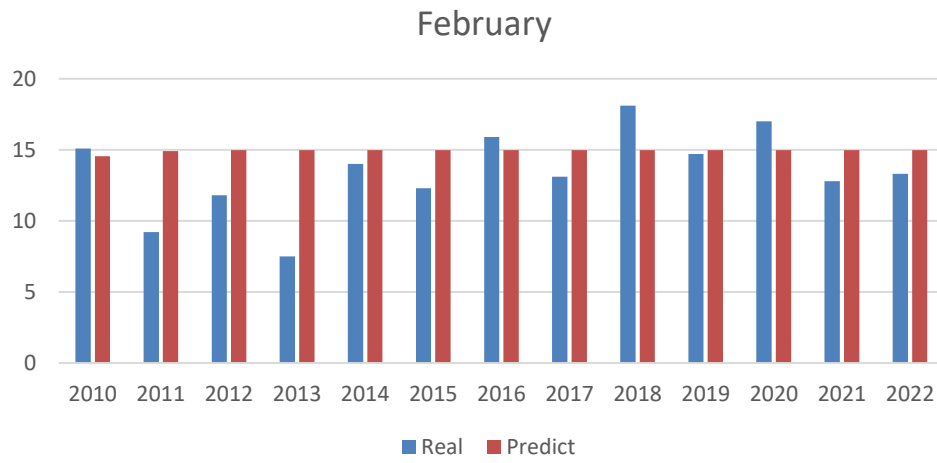


Fig. 3. The prediction rainfall for the period from 2010 to 2022 for February.

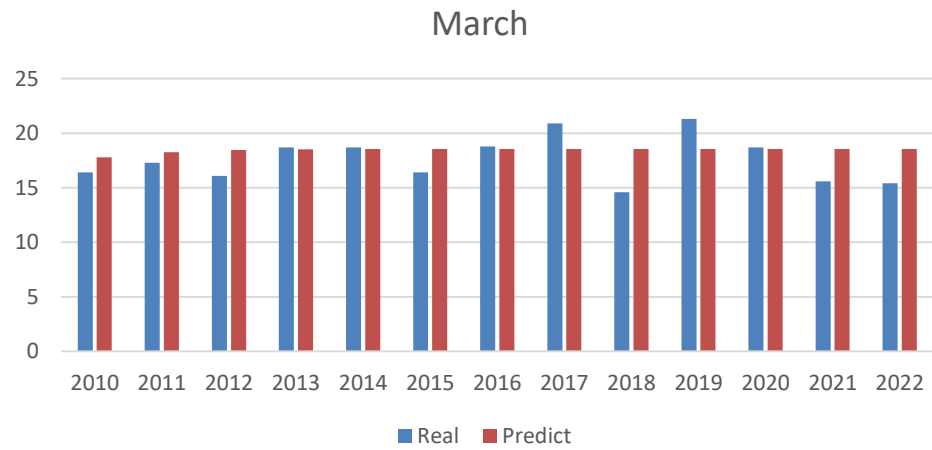


Fig. 4. The prediction rainfall for the period from 2010 to 2022 for March.

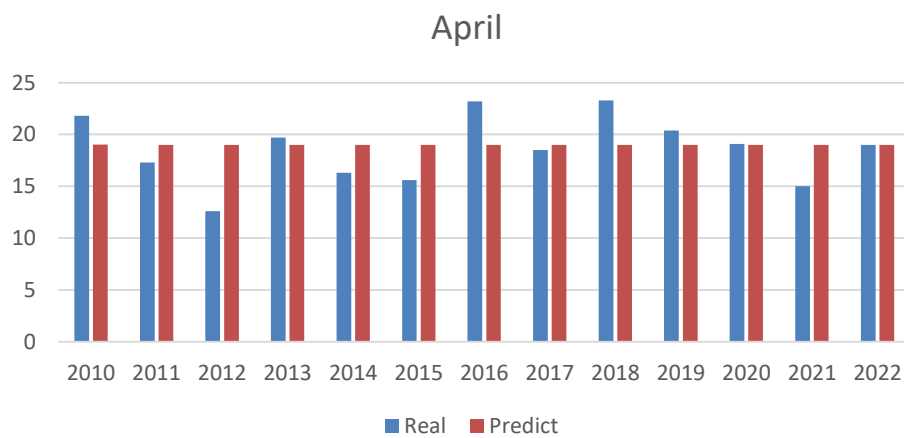


Fig. 5. The prediction rainfall for the period from 2010 to 2022 for April.

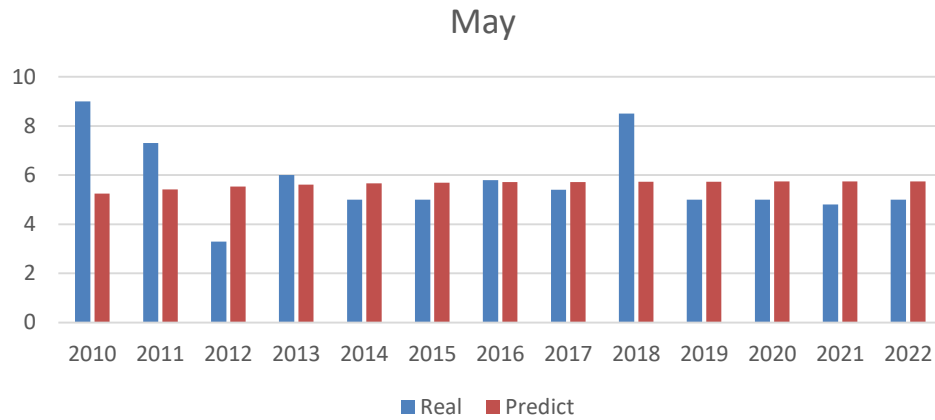


Fig. 6. The prediction rainfall for the period from 2010 to 2022 for May.

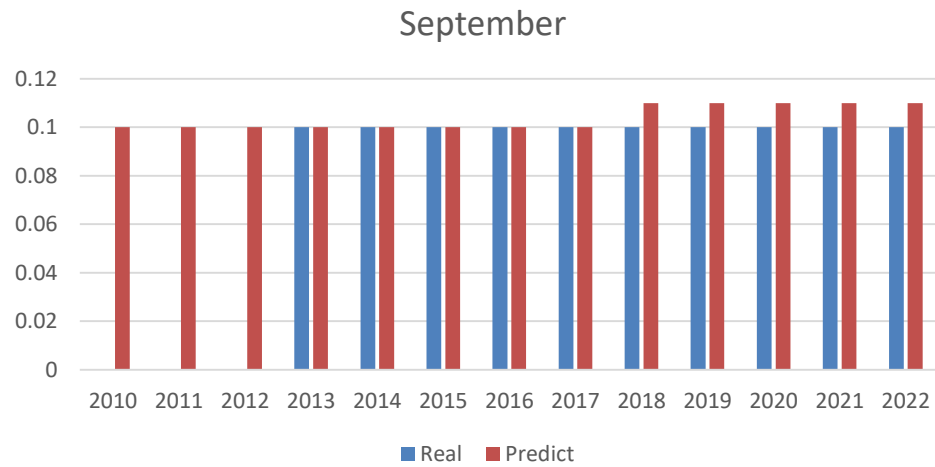


Fig. 7. The prediction rainfall for the period from 2010 to 2022 for September.

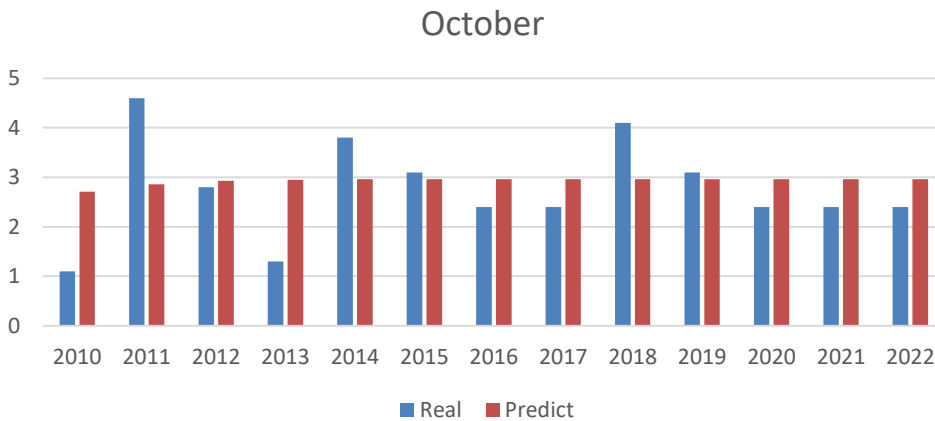


Fig. 8. The prediction rainfall for the period from 2010 to 2022 for October.

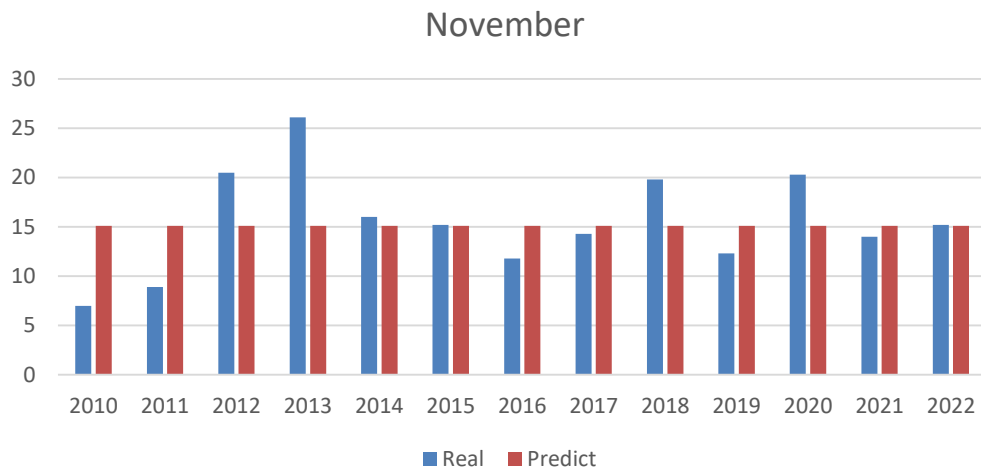


Fig. 9. The prediction rainfall for the period from 2010 to 2022 for November.

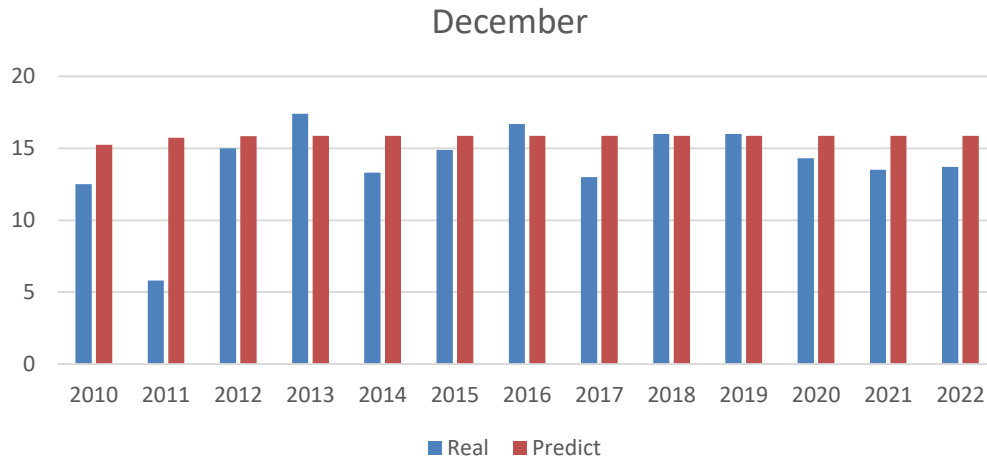


Fig. 10. The prediction rainfall for the period from 2010 to 2022 for December.

And for the months June, July and August there was no Rain.

## 7. CONCLUSIONS

The study concluded that the Support Vector Machine (SVM) strategy may be an effective and effective tool for analyzing and predicting rainfall within the city of Najaf. By analyzing authentic climate time arrangement information, SVM illustrated a tall capacity to handle complex and multivariate information, which contributes to progressing the exactness of climate forecasts. In spite of the fact that the precision shifted between diverse months, the positive comes about upgrade the esteem of utilizing SVM in this field. The comes about appeared that a few months such as April were more challenging in terms of forecast precision, highlighting the got to move forward models and create information handling strategies. These challenges are openings for advance investigate to create more complex and precise models utilizing progressed machine learning strategies. The applications of SVM in climate data examination are not restricted to predicting precipitation as it were but can be extended to incorporate the investigation of extraordinary climate occasions such as surges and dry seasons. In expansion, SVM can be utilized in conjunction with other procedures such as neural systems to move forward the precision of estimates. This study is critical from both a logical and viable point of view, because it contributes to the improvement of prescient apparatuses that offer assistance in water asset administration and rural arranging. It too contributes to distant better; a much better; higher; stronger; an improved an improved understanding of the impacts of climate alters on rainfall, which makes a difference in making educated choices at the environmental arrangement level. It is suggested to conduct encourage considers creating more progressed and exact models, and to utilize more comprehensive and differing data sets

to progress the quality of expectations. It is additionally prescribed to apply these models in other locales with diverse climatic conditions to confirm their viability and generalize the comes about. In conclusion, the think about demonstrates that the Back Vector Machine (SVM) method is an viable device in foreseeing precipitation and analyzing climate information, which opens the entryway to more inquire about and viable applications in this imperative field.

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### Conflicts of Interest

The paper highlights that there are no conflicts of interest, either personal or professional, that influenced the research process or outcomes.

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