Analysis of Rainfall pattern in different regions of India through a Statistical Forecasting Model projecting Climate Change

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Abstract - Precipitation concern has gained a great deal of consideration in the past century and there is a question of care about the international climate. South Indian region like Kerala and Tamil Nadu has been witnessing a drop in rainfall over the past 50 years. The current research aims to explore fluctuations in summer rains and explain how these changes will affect future economic welfare. For this measure, 31 stations have been decided and measured. A high quality database has been developed with large cross-sectional and longitudinal study. Statistical assessment of the data source highlight that. The pattern shows up largely negative, both at the annual and seasonal scale, but for the summer cycle where it tends to be positive. Over the overall reference period, both upward and downward patterns are important respectively for 19 and 37 percent of total station. Over the last 40 years, a declining trend is instead significant for 87 percent of the total stations.

Keywords - *climate, rain, prediction, analysis, tests*

I. INTRODUCTION

Climate includes multiple environmental factors such as time, temperature level, air pressure, wind direction, pressure, and precipitation. Weather is widely extended to "general climate" or "typical atmospheric conditions". The timeless duration lasts approximately 30 to 50 years, as described by the World Meteorological Organisation (WMO). Temperature, rainfall, and wind speeds are on the surface of soil. Environment refers to the status of the climate system. Climate shifts identify drastic differences in both the means of the environment or its irregularity, persisting for at least one year. This will happen years from now. Researchers analyse climates to establish variations or periods of temperature fluctuations and find other changes or modifications in the environment. In the era of dramatic climate changes, the climate records are recalculated every ten years. Over much of India's southwest summer monsoon rainfall period (June to September) is the main rainy season. Nevertheless, in the fall, we witness the height of the rains in southern India, Sri Lanka, as well as on the adjacent coasts. Therefore, the rainy season falls in the months of October and December in the Eastern Indian subcontinent. This time is called the February-April, or Southwest monsoon season. It is an unusually long stretch of rainy weather in the south-eastern areas of India. Past rainfall may be linked to agriculture in this period. A major decrease in farm industry over this area has been noted during seasons of below-normal northeast monsoon rainfall. This area is supported from strong prevailing winds from the southwest monsoon. While the southwest monsoon rains reduces, the blowing of the South Bay of Bengal triggers a prolonged rainy season. Low pressure troughs come over the South Bay of Bengal from time to time forcing negative air masses to move up into the Bay. With the low pressure areas in India is confined equatorial maritime climate, triggering rainfall in the southern zone. Southeast Asia gets 80% of year's cumulative rainfall during southwest monsoon season. During this time, the construction of oil structures and hurricanes over the Bay of Bengal and Arabian Sea had produced waves. Seas, mid-tropospheric cyclones and tropical cyclones produce more rainfall in Asia. Precipitation is found to be associated with the northward advance of the tropical convergence zone in peninsular India (TCZ). The rain forests are limited and it is known as the tropical moist forests. The 10–30 centimetres of rainfall in one or two days in and around the climate system and even on the west shore of India are normal during the monsoon season. The fourth report of the Intergovernmental Commission on Climate Change is suggesting that human action is primarily to blame for global warming, with an expected degree of human-made warming close to that of the pre-industrial period. This is a scientific fact which affirms that extreme weather events are becoming more common and one of the key reasons of this is global warming. The frequency of heavy rains during monsoon seasons indicates a growing pattern in the southwest part of the country. According to the IPCC report, the Indian subcontinent will adversely impacted due to the catastrophe caused by climate change. Climate will become more volatile, rainfall in some areas of the world will decrease and water demand will increase by 2020 due to rise in temperature (2007). Observe the long-term rainfall and temperature patterns and analyse their annual, seasonal and diurnal variations. Kothawale et al. (2010) explored temporal and spatial differences in annual and seasonal rainfall across India. Hot countries in the tropical regions recorded a rise in meteorological temperature trends. PANTER and KUMAR have concluded that there is a temperature rise of 0.57◦C per hundred years on an average

across India. The warming is largely due to seasonal influences. There has been no major change in monsoon rainfall levels in the entire nation apart from a few locations, especially in Northwest India. On everyday temperatures, both daytime and night-time temperatures have seen to increase significantly over the last century. The Indo-Gangetic Plains of India experienced a substantial increase in annual average surface air temperature between 1875-1958 and a significant decrease in annual average surface air temperature between 1958-1997. It looks like the post-1958 warmth of the IGP was the result of lifestyle change, the promotion of farm job and the further extension of the national sprinkling water network. Research reveals that based on info collected over a century by the India Meteorological Department, India is getting 0.5 degrees warmer per century. We can see that this is numerous places of cooler regions in different parts of India. Future forecasts of the Indian Institute of Tropical Meteorology suggested the annual temperature increases at 3.0 to 5.0 degrees Celsius and rise of 5 to 10 percent in monsoon rainfall (NATCOM2004). By 20 to 30 percent, it is estimated that there will be more days of rainfall. Extreme temperatures and strong rains will persist into the end of 2100. A analysis based on daily precipitation data from over the past 50 years shows that central India has observed a significant growing trend in daily-peak rainfall events. Expanding water extractions integrated with evolving water needs have a potential effect on water management competition worldwide, particularly in dry regions as well as semiarid areas. In those regions, climate change is expected to bring more water shortages as well as add more impact from dry spells. Additionally this course will help in the design of safe water monitoring. The water market strategy appears to be an acceptable option for the economic consequences of droughts, even if the ecological effects on civilization may be detrimental. There is considerable advantage to the environmental water economy. Where environmental water is sold as if it were an asset. There are comparable benefits and even greater advantages gained for the approach used in Spain by joint task force participants. These individuals look for the change in the measure for soil monitoring worldwide. This is useful for applying the more versatile and systematic approaches to water allocation and water quality management. The demand on water supplies has been rising worldwide over the last few years. Water extraction rates have more than tripled throughout the century, three times higher than all human populations. Another explanation for the shortage of quality water in Singapore is the exploitation of water reserves. As predicted, 65 percent of foreign rivers and aquatic ecosystems have been experiencing moderate to extreme damages. Earth has changed a lot in its 4.6 billion years of history. Ancient temperature science is called paleoclimatology. These are pretty simple definitions. understand. It's focused on the premise that people will change the performance of others. That's how paleo climate experts propose that you find a layer of salt sandwiched in between two layers of sandstone. If you look up salt crystals worldwide, you'd discover that they happen only in certain regions which have comfortable weather and utterly dry conditions (like in the Middle East). rocks or stone (the past) at that location is very likely to be erosion. The rock hounds of today have been able to make out the clues left by the glaciers in different locations. Luhmann developed a long-term outlook on the growth of society. There's no wonder that the state of the Planet is not and will never be stable. According to plate tectonic theory, all of the present-day continents have evolved steadily over millions of years. Then the question is now "what really changed" and "where did the rocks go?" In Antarctica, fossils in rocks prove that the continent used to have warm climate. This alone is adequate to clarify why the World must have been colder in the past. It also assumes that Antarctica is continually sleeping at the southern part. By using some other proof, it can be positively confirmed that tropical regions were once near the equator. One of the complicated aspects is the weather. It is difficult to grasp it fully and forecasting it over a number of days is completely unlikely. The method is complicated due to the fact that various variable within the Earth's climate, such as temperature level, air pressure, wind velocity, humidity, clouds, and precipitation. The World Meteorological Organisation describes a weather pattern dependent on physical phenomena. To respond to the climate holistically, that is inclusive of the present and past climate into consideration. When the structure is complex and not all the data points can be observed precisely on all spatial and temporal parameters, it takes statistic language to obtain details. For the hypothetical method, we conclude that the probability is a possibility between 0 and 1. Data was analysed and hypotheses were drawn from that detail. There are long lasting effects of global warming. No, these photographs are not complete in any way. Next, there are ice ages 5 distinct ice ages. There have been battles in Earth's history. The final glacial epoch was 12,000 to 15,000 years before the present day. Numerous interglacial periods go on for nearly 2 million years. Any experts think that we are now undergoing an interglacial period instead of a warm period. Throughout the last glaciation in the United States (referred to as the Wisconsin Glacial Period in North America), the highest extent of ice was at about 40 degrees north latitude. This indicates that more than two-thirds of the Planet was already icy. Scientists have suggested that the temperature of the planet decreased by at least 5 degrees during the last ice age. This is also another example of how precarious global temperatures and climatic equilibrium is in modern time. There are also many concerns about the specifics of how glaciers formed during the Pleistocene Period. There is a growing hypothesis that Earth's orbit around the Sun is the secret to climate cycles in the Antarctic. Earth's orbit and rotation also change the amount of solar radiation produced by the planet. Environmental conditions, such as Earth's tilt, the form of its orbit and wobble

of its axis have negligible impacts on the energy that strikes Earth's surface region. Of these obstacles, snow won't thaw until next spring. Over the course of years, these thick snow was accumulating. This contributed to the creation of larger glaciers which migrated towards the equator. The glaciers served as ramp metres for the overall cooling effect on the environment. This was attributed to the fact that ice and snow had a far greater ability to reflect light than rocks, soil, and plant life. The glaciers allowed more light to be reflected back into space because of their high albedo. In this way, the glaciers rose further and the glacier got warmer. There will also be a greenhouse trend that will raise warming. The climate in Singapore has strong spatial variations and diurnal temperature variation. Studying weather trends in the area is a valuable way to monitor water supplies in the region. This climate information is extremely accurate, particularly with past, current and future data on precipitation occurrence. The definition of the precipitation prevalence or rainy days is essential to the sustainable resource production of the region as well as the protection of natural resources. To reliably forecast annual precipitation, it is important to know the rate of rainfall fall over a certain period. The definition of precipitation distribution is very important for rainfall length, frequency and pattern analysis. In this inquiry, the ultimate objective is not so much to study the properties of precipitation. This rain data are used for atmospheric modelling of Buishand (1978).

When probability distribution fitting is applied, the best model possible is immediately chosen. Since Upadhaya and Singh had evaluated return spell applying common probability distributions, it is feasible to evaluate it by different probability distributions (1998). The climate cooled, that is global glaciers progressed until they reached one-third of the planet. What took place over decades was the slow production of ice. In this way, Planet got into the latest orbital scheme that for some reason or the other, cooled the atmosphere of the earth. As the temperatures began to warm, the glaciers started to thaw. Milankovitch Theory doesn't provide a straightforward answer for exactly how and when the glacial epoch happens.

II. ANALYSIS AND CLIMATE FORECASTING

Rainfall data for 115 years (1901-2015) were collected from meteorological department site http://indiawaterportel.org/met data/. In India Rainfall seasons are classified into four seasons, viz. monsoon (June-September), pre-monsoon (March-May), post-monsoon (October-December) and winter season (January-February)

Student's *t*-Test

The *t*-test evaluates whether the methods of 2 teams are not statistically various from each various other (null hypothesis H_0: $\mu_1 = \mu_2$). It can be done both in the case of homogeneous or non-homogeneous sample differences. In the non-homogeneous case (Welch test), if n_1 and n_2 are the sample sizes and S_1 and $S_2$are the sample variances, then the degree of freedom tri-modal

Ward's Test

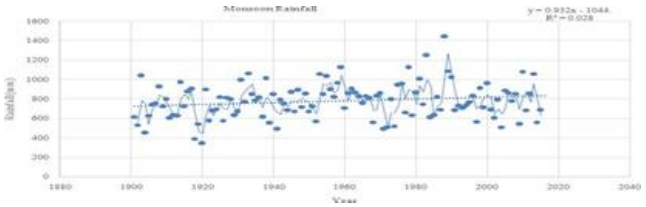
Ward's minimum difference approach is the most pre-owned clustering technique in environment study. It determines the methods of all variables within each collection after that calculates the Euclidean distance to the collection mean of each instance and finally amounts across all situations, decreasing the within-cluster amount of settled ranges. For a specific one-dimensional X random variable, assuming that it can be split.Table 1

Percentage of Stations with a Significant Positive or Negative Trend (Mann-Kendall Test)

Trend Analysis Results

As for the identification of time series changing points,a preliminary graphical inspection is highly instructive and meaningful. The annual rainfall time series, averaged over the whole data set, is illustrated. Corresponding interpolated regression line is also plotted. The variability around the mean value, that is about 2800 mm, is rather pronounced, despite the smoothing effect induced by the average computation over a large area and a decrease in the annual average rainfall is evident, given the slope of the regression line. The slope of the yearly time series is about -35 mm/10 years, giving an estimated decrease of about 280 mm in the period 1901-2015, which corresponds to about 27% of the annual value, according to previous results found in similar geographical and climatic contexts. Annual time series histograms show similar trend patterns for the most part of meteorological stations, in agreement with the *t* -test and Mann-Kendall test results are defined Table 1 where the percentage of stations with a significant positive or negative trend is reported for 99, 95 and 90% confidence levels.

Stations	Positive Trend			Negative Trend		
	0.01	0.05	0.1	0.01	0.05	0.1
Annual	2	3	13	18	12	18
Winter	0	0	3	7	6	7
Summer	1	3	6	5	9	12
Monsoon	2	8	3	8	4	6
Post-Monsoon	1	13	2	11	5	8



During the period 1918-1999, negative trends are evident both at the annual in Fig. 3.2 and seasonal scale, excluding the summer in Fig. 3.4 trimester when a positive trend can be observed. The percentage of stations showing a significant trend is how ever moderate, coming to a maximum of 27% at the annual scale and at 33 and 4% respectively during the winter in Fig. 3 and summer trimesters. The magnitude of the trends is instead stressed and highly significant in particular time intervals of the reference period, as indicated in corresponding t -test and Mann-Kendall test. The period from 1944-1973 shows a generalized positive trend through out the year, with alarge number of stations with significant trends coming to a maximum of 81%during the monsoon season in Fig. 5 ($\alpha = 0.1$). The periods from1999-2010 shows instead a negative trend, which is particularly evident during the winter season, with a significant trend at the 90% confidence level for almost all of the time series.

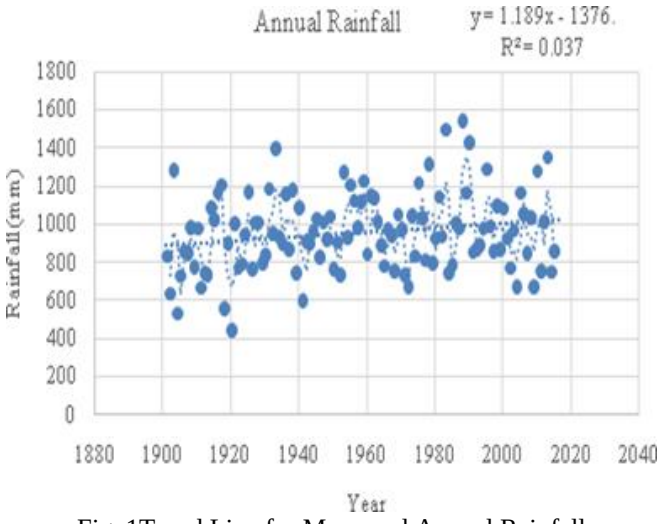


Fig. 1Trend Line for Mean and Annual Rainfall

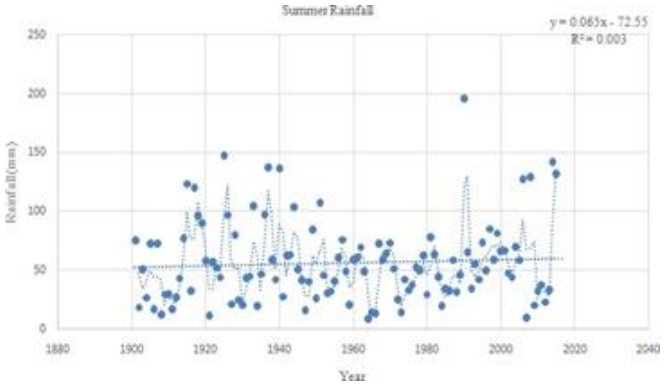


Fig. 2 Trend Line for Mean Winter Rainfall

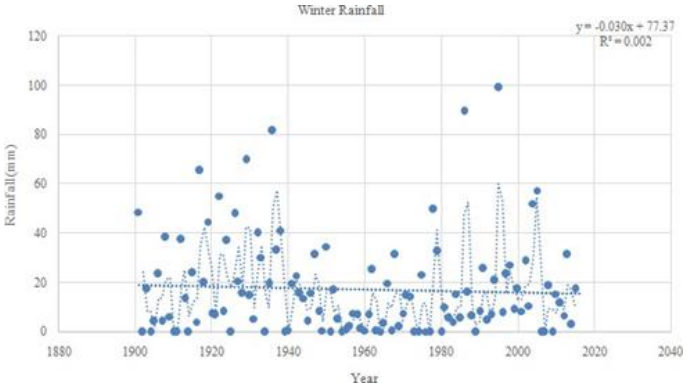


Fig. 3 Trend Line for Mean Summer Rainfall

It is interested and at the same time very troubling the patterns and the extent of the referral period. 1921 to 1983 indicates a general pattern positive based on 81% in the spring peak as indicated by Fig. 0.4x for $\alpha = 0.1$ This.

Negative growth in the US economy occurred during the years 1984 to 1998, with successive significant annual production swings within the 90% confidence interval. Due to the presence of fundamental reasons.seasonal patterns and minimal and median volume of seasonal rainfall. The findings of 3 merely doesn't include the general effect of the examined massive location. Pictures demonstrate the scientific roof of the dynamics of concentration, season, and annual precipitation. At present, a more thorough investigation of the involved physical procedures is desirable. After review, LUCC will be classified into statistical categories.

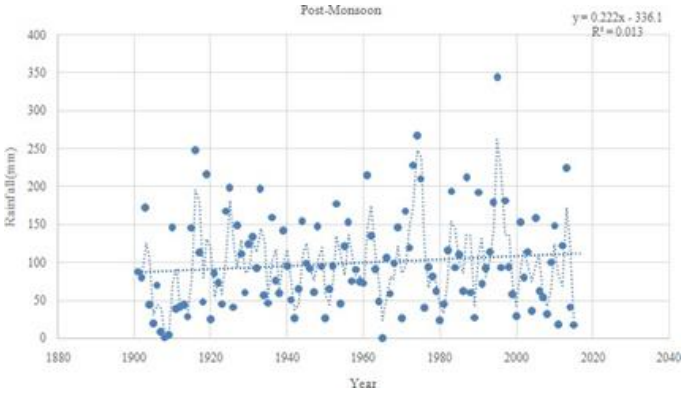


Fig.5Trend Line for Mean Post-Monsoon Rainfall

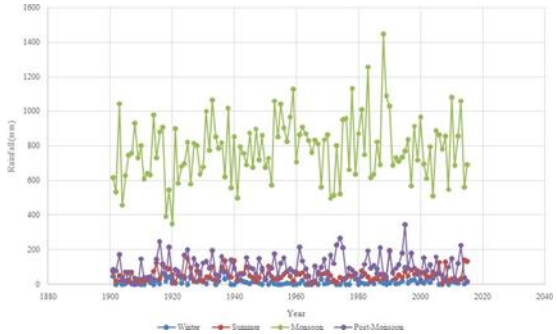


Fig. 6Time Series of Maximum and Minimum Seasonal Average Rainfall

III. CONCLUSION

The aim of this study is to collect some knowledge in the past to determine their growing influence over a large area over a long period of time (1901-2015). Until details were reviewed and coordinated, there were problems concerning the consistency of weather records. Just a single time appraisal confirmed 76 percent of the entire database, which makes a major role in advancement of time hierarchy modelling application. On long range, several regions are under strain, while on short range, some regions are experiencing a favourable climactic tendencies in summer. Skewed trends soon grew to unprecedented degree for nearly 95% of the atmospheric terminals. Therefore, it is proposed that the requests for more details should be made. Some places show a sizeable history of negative rainfall with a touch of hope.

IV. REFERENCES

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