Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; Sp 10(1): 406-411
Received: 04-11-2020
Accepted: 06-12-2020

Nagaratna Biradar
ICAR-Indian Grassland and Fodder Research Institute, Southern Regional Research Station, Dharwad, Karnataka, India

Akshata Kerur
ICAR-Indian Grassland and Fodder Research Institute, Southern Regional Research Station, Dharwad, Karnataka, India

Laxmi Tirlapur
ICAR-Indian Grassland and Fodder Research Institute, Southern Regional Research Station, Dharwad, Karnataka, India

Khem Chand
ICAR-Indian Grassland and Fodder Research Institute, Near Pahuj Dam, Jhansi, Uttar Pradesh, India

A Bheemappa
University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author:
Laxmi Tirlapur
ICAR-Indian Grassland and Fodder Research Institute, Southern Regional Research Station, Dharwad, Karnataka, India

Analysis of precipitation trend and farmers' practices to predict precipitation in North-Karnataka

Nagaratna Biradar, Akshata Kerur, Laxmi Tirlapur, Khem Chand and A Bheemappa

Abstract
Precipitation pattern is varying both spatially and temporally. Understanding precipitation pattern enables proper crop planning in a region and decisions about farming. Farmers rely on local practices to predict precipitation based on which they largely decide on their cropping pattern for the year. A study was conducted to understand precipitation pattern and farmers' practices to predict precipitation in northern transitional zone (zone-8) of Karnataka. Thirty years precipitation data (1989-2018) of this zone was collected from KSNDMC Bengaluru for analysis. Taluk wise annual precipitation trend was calculated using Mann-Kendall trend test. Farmers' practices were collected from four villages of Haveri district and were assessed for their scientific rationality. It was found from the study that there are no empirical evidences to show that precipitation is showing increasing or decreasing trend. Numbers of runs were found to be more in case of Bailhongal (17) taluk followed by Savanur (17) and Shirahatti (16) indicating more deviations of precipitation in these taluks. Farmers use various biotic and abiotic indicators for weather forecasting. Eighteen practices of farmers to predict rainfall were recorded of which 7 were based on biotic factors and 11 on abiotic factors. Among these practices, only 7 practices (2,3,5,8,9,13,17) were considered as scientifically rational by scientists. Study results are significant to understand the trends in precipitation at taluk level based on which crops would be recommended to the farmers. Farmers should also be educated to rely on only those practices which are scientifically rational to predict precipitation.

Keywords: Mann-Kendall, precipitation, run test, Sen's slope, significant, trend

Introduction

Weather is the only factor over which man has no control. It has an overwhelming dominance over the success or failure of crop enterprise. Changing pattern of precipitation deserves urgent and systematic attention as it affects both the availability of fresh water and food production (Dore 2005) [9].

Change in precipitation falls under the ambit of climate change which is vast. Variation in the distribution of this will affect the living components of the earth (Alhaji *et al.* 2018) [1]. Data on extent of precipitation is used to design water catchment structures, river basin management strategies and crop planning. Total annual precipitation, its intensity and distribution determines the nature and state of agriculture in a particular region. The distribution of rain varies greatly in time and space. The magnitude, frequency and intensity of rain varies between places, within a day, a month and a year. The detailed knowledge of these characteristics variation is crucial for planning the crops in a region and the full use of rainwater (Venkata and Asha 2018) [23]. Kumar and Jain (2010) [12] reported that higher or lower changes in precipitation would influence the spatial and temporal distribution of runoff, soil moisture, ground water reserves and would alter the frequency of drought and flood. Hence several studies have been carried out to understand precipitation probability, distribution and trend using long tern precipitation data (Chandniha and Kausal 2016 and Chandniha *et al.* 2017) [6, 7].

These studies help to know the trend and plan the agriculture. By knowing the trend one can further predict the atmospheric conditions at a given site. With increase in the observatories and synoptic weather stations, more data of rainfall, temperature, radiation and wind would be available that helps to predict weather more accurately.

Various organizations across the world predict weather elements and forecast weather conditions. Along with these farmers were practicing their own way of predicting the weather since time immemorial. Crop losses can be reduced substantially by affecting adjustments through timely and accurate weather forecasts.

Local indicators and local knowledge systems cannot be replaced with scientific knowledge, because they are holistic and specific to local situations, providing farmers and others with the ability to make decisions and prepare for the coming agricultural year. Mechanisms for integrating both traditional and scientific weather forecast systems would reduce uncertainties and improve farm management, as well as provide a basis for integrating scientific forecasts into existing decision processes of farmers. This paper along with the rainfall data analysis farmers' practices on rainfall predictions.

Methodology

The present study was taken in Northern-transitional zone of Karnataka (Zone 8). This zone consists of 14 taluks belonging to 4 districts of Karnataka. It comprises four taluks of Belgaum district, three taluks of Dharwad district, six taluks of Haveri district and one from Gadag district. This zone comprises an area of 1.194 Mha. The annual precipitation ranges from 619.4 to 1303.2 mm. About 61 per cent of precipitation is received in Kharif season. The elevation is 450-900 m and the soils are shallow to medium black clay and red sandy loam in equal proportions. The main crops grown are Rice, Jowar, Groundnut, Pulses, Sugarcane and Tobacco.

For this study precipitation data of 30 year period (1989-2018) was collected from Karnataka State Natural Disaster Monitoring Centre (KSNDMC), Bengaluru. Summary statistics for precipitation was worked out for all the taluks and categorised them to high, medium and low precipitation taluks. Trend analysis was examined in two phases i.e.at first stage monotonic increase or decreasing trend was tested using mann-Kendall trend test (Mann 1945 and Kendal 1995) [13, 11]. The rate of change was estimated with the help of Sen's slope estimation (Sen 1968) [19]. Mann KENDALL test is a statistical test widely used for the analysis of trend in climatology and in hydrologic time series. There are two advantages of using this test. First, it is a non- parametric test and does not require the data to be normally distributed. Second, the test has low sensitivity to abrupt breaks due to inhomogeneous time series. The data values are evaluated as an ordered time series. Each data value is compared to all subsequent data values (Alhaji *et al.* 2018) [1]. The significance of the results was tested at 95 percent confidence level. Similarly studies of precipitation trend using Mann-Kendall test were done by Vinay kumar *et al.* 2017, Jedhe *et al.* 2018 , Amoge Asfaw *et al.* 2018, Anju Tiwari *et al.* 2019 and Sayyad *et al.* 2019 [25, 10, 2, 4, 20]. Run test for randomness is carried out in a random model in which the observations vary around a constant mean. The observation in the random model in which the run test is carried out has a constant variance, and the observations are also probabilistically independent. The run in a run test is defined as the consecutive sequence of ones and twos. This test checks whether or not the number of runs are the appropriate number of runs for a randomly generated series. The observations from the samples are ranked in increasing order, and each value is coded as a 1 or 2, and the total number of runs is summed up and used as the test statistics. All the analysis for this study was done in xlstat software.

Indigenous methods of precipitation/rainfall predictions followed by farmers, called as Indigenous Technical Knowledge (ITK) were also collected. Savanur taluk was selected for collecting ITKs as it experienced highest deficit in rainfall consecutively for four years (2015 to 2018) in the study zone (zone-8). Four villages namely, Kunamellihalli, Mannangi, Mellangatti and Huralikoppi villages all belonging to Kunamellihalli rain guage station were selected as they experienced sever rainfall deficiency for two years (2017 and 2018). Primary data on indigenous traditional knowledge of the farmers on rainfall predictions were collected using checklist guided focus group discussions. In each village nearly 25 farmers were formed into a group and discussed with them about the different methods they follow to predict rainfall. So, about 100 farmers were contacted. A list of indigenous methods followed by farmers was prepared. An interview schedule was prepared to assess their scientific rationality and was introduced to 30 agro-meterology experts of which 23 responded. Experts were asked to rate ITKs based on the extent at which they perceive ITKs as scientifically rational. This rating was based on their knowledge and academic experience in the field. Based on their ratings ITKs were categorised into three groups using mean and SD (Mean+0.425*SD) Reasons given by experts against each ITKs were summarised and presented in the tabular form.

Results and Discussion

Summary statistics for annual precipitation of zone 8 of Karnataka is presented in table 1. Among the taluks of zone 8, mean minimum precipitation is recorded in Hukkeri (600.14 mm) followed by Bailhongal (617.33 mm), Shirahatti (628.29 mm), Kundagol (637.49 mm). Highest average precipitation was observed in Belgaum (1231.64) followed by Hirekerur (825.52 mm), Dharwad (791.00) and Shiggaon (763.54 mm). Skew distribution indicated that Shirahatti (0.01) taluk has near to perfect symmetric distribution of precipitation compare to all other taluks.

Based on the criteria of mean±0425*SD, taluks were further categorised into high, medium and low precipitation, results of which are presented in table-2. Two taluks, Belgaum and Hukkeri belonged to high precipitation category. Six taluks viz., Chikkodi, Haveri, Shiggaon, Hubballi, Dharwad, Byadagi were grouped under medium precipitation category. Five taluks, they are Hukkeri, Bailhongal, Shirahatti, Savanur and Ranebennur taluks belonged to least precipitation category.

Table 1: Summary statistics for annual precipitation of zone 8 of Karnataka, India (1989-2018)

Taluks of Zone 8	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Hukkeri	332.60	1022.00	600.14	178.87	0.49	-0.33
Chikkodi	306.40	1049.10	724.96	164.86	-0.20	0.48
Bailhongal	375.60	1048.10	617.33	167.72	0.83	0.47
Belgaum	736.00	2017.30	1231.64	356.92	0.76	-0.13
Haveri	430.30	1223.80	733.28	184.39	0.49	0.15
Shiggaon	324.00	1125.60	763.84	187.76	-0.20	-0.42
Shirahatti	353.00	905.40	628.29	158.36	0.01	-1.01
Kundagol	298.90	1125.00	637.49	173.90	0.79	1.13
Savanur	330.50	1053.80	667.63	195.44	0.13	-0.78
Hubli	399.30	1564.30	732.95	259.27	2.01	4.68
Dharwad	387.90	1239.20	791.00	199.52	0.21	-0.02
Byadagi	335.40	1152.50	720.02	203.71	0.31	-0.52
Hirekerur	480.00	1212.70	825.52	221.95	0.12	-1.33
Ranebennur	336.40	1006.50	644.45	175.64	0.16	-0.51

Table 2: Categorisation of taluks based on precipitation

High precipitation taluks Mean+0.425*SD >804.21	Medium precipitation taluks (Between 804.20 to 669.85)	Low precipitation taluks Mean-0.425*SD <669.86
Belgaum (1231.64) Hirekerur (825.52)	Dharwad (791.00) Shiggaon (763.84) Haveri (733.28) Hubballi (732.95) Chikkodi (724.96) Byadagi (720.02)	Savarnur (667.63) Ranebennur (644.45) Kundagol (637.49) Shirahatti (628.29) Bailhongal (617.33) Hukkeri (600.14)

Results of Mann-Kendall and Sen's slope are presented in table 3. Annual precipitation showed decreasing trend in nine taluks. They are Hukkeri, Belgaum, Haveri, Shiggaon, Shirahatti, Savanur, Dharwad, Hirekerur and Ranebennur. Results obtained from Vijaykumar *et al.* in 2017 are in line with these results. Whereas, precipitation showed rising trend in five taluks namely Chikkodi, Bailhongal, Kundagol, Hubli and Byadagi. However, trends were not significant at 5 % confidence levels. Even though the average precipitation of Kundagol and Bailhongal are minimum and fall under low precipitation category among the taluks of zone 8, but precipitation shows increasing trend within the taluk as reflected by Kendals tau coefficients i.e. 0.1448 and 0.0783, respectively. Rate of increase in precipitation is reflected by Sen's slope and it was observed to be 2.1250 and 3.8571 for Bailhongal and Kundagol taluks, respectively. Belgaum (-0.1034) and Hirekerur (-0.0851) recorded highest average precipitation and belonged to high precipitation taluks of zone 8. But within these two taluks' precipitation is showing decreasing trend.

Table 3: Results of Mann-Kendall test with Sen's slope estimator

Taluks of zone 8	Mann-kendall test					Run test		
	Mann-kendall statistics (S)	Kendall's tau	p-value (Two-tailed)	Sen's slope	Trend	No of Runs	z	P-value
Hukkeri	-59.00	-0.1356	0.3008	-3.9292	Falling	14	-0.72	0.24
Chikkodi	3.00	0.0069	0.9715	0.6667	Rising	15	-0.35	0.36
Bailhongal	34.00	0.0783	0.5560	2.1250	Rising	17	0.40	0.65
Belgaum	-45.00	-0.1034	0.4325	-6.0400	Falling	15	-0.16	0.44
Haveri	-25.00	-0.0575	0.6685	-2.3176	Falling	14	-0.74	0.23
Shiggaon	-25.00	-0.0575	0.6685	-2.0313	Falling	14	-0.74	0.23
Shirahatti	-27.00	-0.0621	0.6427	-1.2667	Falling	16	0.10	0.54
Kundagol	63.00	0.1448	0.2687	3.8571	Rising	14	-0.66	0.26
Savanur	-27.00	-0.0621	0.6427	-3.0667	Falling	17	0.40	0.65
Hubli	21.00	0.0483	0.7212	1.3385	Rising	10	-1.98	0.02
Dharwad	-9.00	-0.0207	0.8865	-0.4652	Falling	10	-2.17	0.01
Byadagi	23.00	0.0529	0.6947	1.9000	Rising	11	-1.86	0.03
Hirekerur	-37.00	-0.0851	0.5207	-3.2071	Falling	13	-1.11	0.13
Ranebennur	-17.00	-0.0391	0.7753	-0.9500	Falling	14	-0.72	0.24

Number of runs is the series of consecutive positive (or negative) values is presented also in Table 3. Number of runs is the series of consecutive positive (or negative) values. Numbers of runs were found to be more in case of Bailhongal (17) taluk followed by Savanur (17) and Shirahatti (16) taluks. It was revealed from Z test that probability of occurrence of positive and negative deviations in precipitation are random in 11 taluks of zone 8 except for Hubballi (10), Dharwad (10) and Byahatti (11) taluks number of runs are less compare to other taluks.

Indigenous rainfall forecasting methods (ITKs) followed by farmers along with the reasons given by experts are given in Table 4. They are categorised as biotic and abiotic methods. Seven ITKs are based on biotic methods and 11 ITKs are based on abiotic methods. Plants like neem and Baval as well as various kinds of insects –termite (Parmesan 1999 [5], Piyoosh and Bhavan 2015 [14], Sunita Kumari 2008 [22] and Ravishankar *et al.* 2008) [18], root grubs, dragonflies (Sunita kumari 2008 [22] and Ananadraj *et al.* 2008) [3], ants, frogs (Anandaraj *et al.* 2008 [3], Aparna and Pareek 2011 [5], Chinlampianga 2011 [8], Praveen *et al.* 2018 [16], Ranjit and Arman 2015 [17] and Sethi *et al.* 2001) [21] and crickets are used by farmers to predict rainfall. Trees are important predictors of rain with their flowering, fruiting pattern before onset of rains (Ravi Shankar 2008) [19]. Insects have mechanism to sense the atmospheric weather changes. They use tiny hair like receptors on their cuticle to sense pressure changes. Increasing the temperature to the thermal optima level causes acceleration of the insect metabolism hence their activity increase. Scientists have related these ITKs with increase in atmospheric temperature and humidity. Fog, wind direction, heat, emergence of rainbow, colour of sky, ring formation around the moon, rains during holi festivals are used to predict rainfall by farmers. Suitable explanations are given by scientists on claims made by farmers.

Table 4: ITKs on precipitation predictions

Sl. No.	Farmers' claims	Reasons of scientists
I	**Based on biotic indicators**	
1	If the Neem (*Azadirachta indica*) tree bears plenty of fruit and the `Baval' (*Acacia nilotica*) tree produces plenty of pods, then the total rainfall for the monsoon will be high	High temperature and high humidity during pre-monsoon may be favorable for higher fruit/ pod bearing. The hot and dry season during pre-monsoon leads to good flowering which is followed by good monsoon.
2	Termite emergence and movement in row indicate onset of monsoon	Just before the onset of monsoon (transition), atmospheric temperature decreases compared to that of soil (if no adequate pre-monsoon). Termites might sense humid atmosphere and in search of more moisture may come out from dry soil.
3	Emergence of root grub indicates time for land preparation activities for monsoon crops (second fortnight of April to first fortnight of May)	Higher soil temperature during summer is responsible for the emergence of this insect. Root grub become active with the arrival of the monsoon shower, if the monsoon is late, the beetle's emergence is accordingly delayed.
4	The direction in which dragonflies' fly indicates (dragon flies above the ground level up to 2-3 feet height) occurrence of rain in that direction	Generally, they fly either to find a suitable mate for mating or to find food. It might only indicate change in temperature and humidity – could be before and after rain.
5	Ants emergence from ground and transfer their eggs/pupae to other places indicates onset of rain	High temperature, humidity and soil moisture may be favorable for ants emergence.
6	Frog croaking in chorus - There will be rain	Frog croaking in chorus are observed during rainy season when soil is fully saturated and water logged. Croaking is for attracting mates.
7	If field cricket (*Gryllus pensylvanicus)* brings new soil particles out of its hole during the dry season- Rain is coming soon.	High temperature and humidity may be favorable condition which indicates possible rain.
II	***Based on abiotic indicators***	
8	Fog in the atmosphere indicates no rains.	Fog is cloud near the ground. Fog is also water vapor transferred into fog. Once the water vapor is exhausted as fog. No water vapor is available for further rain molecule to form water droplet. Hence no rain is coming. Fog occurs when there is subsidence (high pressure), and there is thermal inversion (temperature increases with height). Condition for rainfall is opposite.
9	Blowing of wind east to west indicate onset of rabi rains /post monsoon rains	North-East monsoon is only due to the winds blowing from North east/East. As the name indicates, the wind direction is basically from east/northeast during post monsoon season.
10	Continuous blowing of wind in any month from any direction will carry little rain	For rain to occur there should be vertical lifting of moisture due to heating. Continuous wind may disturb this process. Circulation is required for moist air to go up. Straight wind will not permit upward movement of air. So there is little chance of rain in such condition of persistent wind. This assumption is wrong.
11	During day wind blow from west and in evening wind blow from east results in dew formation next day	The water vapor received from the western winds, condenses due to sudden cold winds coming from the east during cold season. And other reason is when wind blows from west during day time, it will contain moisture. When wind blows from east during night, it will result in cooling and subsidence. When low temperature of night cools moist air that had been accumulated, it will give result into dew or fog.
12	Blowing of wind other than east indicate sporadic rains in the month of Apri-May.	Actually, by April wind direction from north east /east is shifting – comes from either south / southwest. Pre monsoon rains are due to the local convections (heat gradient) and hence, are sporadic and generally associated with westerly Pre monsoon winds.
13	More heat from February – May then heavy rain in monsoon is expected	Higher temperature during summer months results in higher evaporation and would reduce the atmospheric pressure over land considerably, which will cause convergence. Onset of monsoon can be good. Once the onset takes place, temperature goes down. Hence the idea cannot be valid for entire season. The trough is formed due to the differential heating between land mass and water bodies that is on the either side of the Indian coast. During the pre-monsoon season, there is a huge variation between temperatures over land and water.
14	Emergence of rainbow at west indicate onset of monsoon	Just before rain drops reaches the ground surface, they act as the prism and hence the rainbow seen in the west.
15	Pink sky with huge clouds will indicate rain during April and May months	There are cumulonimbus thunder clouds obstructing full view of sun. Sometimes chances are there for rainfall many times. Dispersion of sun light due to atmospheric water vapor causes the pinkish sky leading to the summer rains.
16	A ring formation around the moon indicates occurrence of rain Ring nearer to the moon: late occurrence of rain; ring away from moon: early occurrence of rain; direction where moon ring breaks indicates occurrence of rain in that particular direction.	It indicates movement of some weather system into the area. Rings are developed due to ice crystals in cirrus clouds, which may or may not be associated with rain causing clouds.
17	High sweating during day time- foretell rain in night	High sweating is due to high temperature and humidity which may cause rain. Due to high atmospheric temperature low pressure occurs, cloud accumulates causing the precipitation."Day time" is too long. If there is

		considerable sweating at 10 am to 11 am, there will be no rain. If the same happens after 1 pm to 2pm then rain occurrence likely in evening/night.
18	If it rains for one to two days and stops at the time of Holi it indicates there will be no or little rains during south west monsoons. -If it rains for more than 4 days continuously during Holi, it indicates more rains in the south west monsoon.	Monsoon process starts in summer. Southwest monsoon is part of global circulation. So farmer's observations have some meaning.

Results of scientific rationality of ITKs are given in figure-1. Seven ITKs belonged to highly rational category. ITKs related to termite (2), root grub (3), ant (5), fog (8), wind blow from east to west (9), more heat during Feb-March (13) and high sweating during day time (17) are highly rational ITKs. Only three ITKs with serial numbers 4,6,14 are moderately rational. Direction at which dragonfly flies (4), frog croaking (6) and rainbow in west (14) are considered moderately rational. Remaining 8 are least rational ITKs.

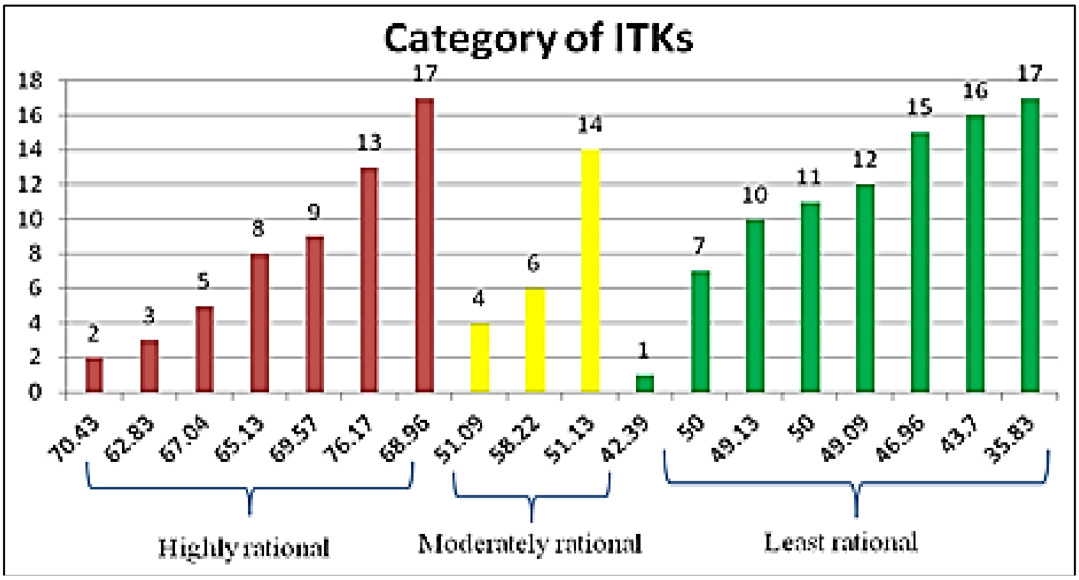

Fig 1: Categorisation of ITKs based on scientific rationality

Conclusion

Results of the study revealed that Hukkeri, Bailhongal, Shirahatti, Savanur and Ranebennur taluks belonged to least precipitation category. Results of Mann-Kendall and Sen's slope indicated that in Hukkeri, Belgaum, Haveri, Shiggaon, Shirahatti, Savanur, Dharwad, Hirekerur and Ranebennur rainfall showed decreasing trend. Whereas, precipitation showed rising trend in five taluks namely Chikkodi, Bailhongal, Kundagol, Hubli and Byadagi. In Bailhongal (2.1250) and Kundagol (3.8571) precipitation increasing at higher rate compare to other taluks. Hence there is a need to take water conservative measures in the areas where rainfall is showing deceasing trend.

Acknowledgement

The authors are thankful to the KSNDMC (Karnataka State Natural disaster Management Centre) for providing the precipitation data used in the study and to ICAR-NASF for funding the project.

References

1. Alhaji UO, Yusuf AS, Edet Celestine O Oche, Agbo EP. Trend analysis of temperature in gombe state using mann Kendalls trend test. J of Scientific Research Report 2018;20(3):1-9.
2. Amogne Asfaw, Belay Simane, Ali Hassen, Amare Bantider. Variability and time series trend analysis of rainfall and temperature in north central Ethiopia: A case study in Woleka sub-basin. Weather and Climate Extreams 2018;19:29-41.
3. Anandaraja, Rathakrishnan, Ramasubramanian, Saravanan, Sugandhi. Indigenous weather and forecast practices of Coimbatore district farmers of Tamil Nadu, Indian J Traditional knowledge 2008;7(4):630-633.
4. Anju Tiwari, Mohd Shoab SK, Chandniha Lalit Pal, Prabhakar AK, Amit Kumar. Application of non-parametric tests for long term trend analysis of rainfall over north-eastern region in India. J of Agrometeorology 2019;21(3):379-381.
5. Aparna Pareek, Trivedi PC. Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India, Indian J Traditional knowledge 2011;10(1):183-189.
6. Chandniha SK, Kansal, Ml. Rainfall estimation using multiple linear regression based statistical downscaling for piperiya watershed. Chhattisgarh. J of Agrometeorology 2016;18(1):106-112.
7. Chandniha SK, Kansal ML, Mishra PK. Water resource planning and management using robability distribution. J Of Agrometeorology 2017;19(2):176-177.
8. Chinlampianga. Traditional knowledge, weather prediction and bioindicators: A case study in northesten Mizoram, North-eastern India, Indian J of Traditional Knowledge 2011;10(1):207-211.
9. Dore MHI. Climate change and changes in global precipitation pattern-What d we know?. Environ 2005;31:1167-1181.
10. Jedhe SH, Kadam US, Mane MS, Mahale DM, Nandgude SB, Tokal RT. Trend of rainfall and temperature in Konkan region of Maharashtra. J of Agrometeorology 2018;20(1):80-88.

11. Kendall MG. Rank correlation methods, 4th editor. Charles Griffin 1995.
12. Kumar V, Jain SK. Analysis of long term rainfall trend in India. Hydrological Science J 2010;55(4):325-332.
13. Mann HB. Non parametric test against trend. Econometrica 1945;13:245-259.
14. Piyoosh Rautela, Bhvana Karki. Weather forecasting: traditional knowledge of the people of Uttarakhand Himalaya. J of Geography, Environment and Earth Science International 2015;3(3):1-14.
15. Parmesan C, Ryrholm N, Stefanescu C, Hill JK, Thomas CD. Poleward shifts in geographical ranges of butterfly species associated with regional warming, Nature, 1999;399:579-583.
16. Praveen, Sreenivasa Rao, Sudha Rani. Rationality and validity of ITKs on general agriculture by tribal farmers in Telangana Region, Int J Curr Microbiol App Sci 2018;7(11)34-39. https://www.ijcmas.com/7-11-2018/N.%20Praveen,%20et%20al.pdf
17. Ranjit, Armaan. Indigenous technical knowledge associated with disaster management and fisheries related activities in the higher flood affected district (Dhemji) of Assam, India. Indian J of Traditional knowledge 2015;14(3):107-4015.
18. Ravi Shankar, Pochaiah Maraty, Murthy VRK, Ramakrishna YS. Indigenous rain forecasting in Andhra Pradesh. Central Research Institute for Dryland Agriculture, Santoshnagar, Saidabad PO, Hyderabad 2008.
19. Sen PK. Estimation of regression coefficient based on kendalls tau. J American. Stat. Assoc 1968;13(2):80-85.
20. Sayyad RS, Dakhore KK, Phad SV. Analysis of rainfall trend of Parbhani, Maharashtra using Mann-Kendall test. J of Agrometeorology 2019;21(2):239-240.
21. Sethi SN, Sundarya JK, Panigrahi A, Subhash Chand. Prediction and management of natural disasters through indigenous technical knowledge, with special reference to fisheries Indian J of Traditional Knowledge 2001;10(1):167-172.
22. Sunita Kumari. Indigeneous technological knowledge of tribal farmers in agriculture of Jharkhand state. (M.Sc. Dissertation, Acharya Ranga Agriculture University, Hydrabhad) 2008.
23. Venkata Sai, Asha Joseph. Trend analysis of rainfall of pattambi region kerala India. Int. J Curr. Microbial. App. Sci 2018;7(9):3274-3281.
24. Vijaykumar M Devappa, Vishwakiran Yadrami, Sanket Biradar, Santosh Shiragannavar, Santosh Talawar. Study of rainfall trends and variability, a case study of belgaum district. International J of Current Engineering and Scientific Research 2017;4(6):60-68.
25. Vinay Kumar HM, Shivamurthy M, Lunagaria MM. Rainfall trend analysis and adaptation strategies to manage climate-induced crisis in coastal zone of Karnataka, India. J of Scientific Research & Reports 2017;13(5):1-11.