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Weather and Climate Forecasting System for Cultivation using Naive's Algorithm

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***Abstract*- Agriculture based advisory services and climatic information are more considerable in providing assistance for pastoralists and small farmers to manage climatic changes and risks factors to be adopted during changes. Moreover, there is some gap in providing climatic information that significantly addresses the requirement of pastoralists and farmers. Huge farmers rely over indigenous knowledge where experiences and indicators are utilized to forecast and observe weather conditions. When this prediction is inbuilt and implemented by many farmers, documentations, coordinators and so on for predicting weather, it should be accurate and reliable manner. This work concentrates on building a weather predictor system for farmers to identify the velocity flow that is needed during farming. This model includes Naives equation for performing this velocity prediction. The outcomes demonstrate that pastoralists and farmers utilize combination of biological and meteorological indications to predict weather conditions. Henceforth, it seems to be more crucial in providing assistance to enhance access to climatic information in various regions of India in vulnerable and poor resource communities.**

***Keywords*- Agriculture, Weather Prediction, Naive Equation, Indicators, Climatic Information.**

I. INTRODUCTION

In India, pastoralists and farmers over various regions may experience diverse kinds of weather information that passes over various rainfall onsets, expected rainfall distribution, cropping seasonal duration and weather events severity [1]. Based on analysis by Meteorological agencies, for instance, diverse kinds of climatic information based issues that range from daily weather prediction to seasonal predictions [2]. Here, rainfall onset was considered to be a most essential weather information factor for farmers and pastoralists. Amount of expected rainfall was considered information for farmers [3]. Weather events severity and drought occurrence are significantly important for farmers of India [4]. While most farmers are engaged in weather prediction information, they may seek more detailed information towards 1) intensity, amount, rainfall duration and plant guidance, ii) drought onset, duration and information regarding drought resistant and prior maturing crops and its variety, iii) drought, sun and rainfall prediction severity are considered to be the most essential factor for farm level decisions.

Information exchange with other farmers were considered to be a most cost-effectual source for predicting weather condition with appropriate reliability based on person interpretation who may attain information [5]. Various meeting were also an essential source of weather information in village side. However, agriculture extension system is ranked to be a reliable source for weather information dissemination [6]. Observations from this meeting and regular weather condition demonstrate that this information is well summarized and generally broadcasted in local language of every state in India [7]. This may increases the understanding towards pastoralists and farmers. Even though, weather information from printing media like newspaper is more detailed, they are useful and meaningful for various literate people from various communities.

These sources and types of findings regarding weather information are similar to that of prevailing investigations from these sites [8]. In various parts of India, for instance, above half of households are attained based on the weather forecasting information based on extreme events and some three quarters report generated related to weather information from conventional sources. As well, some investigators found that indigenous weather prediction are extensively heard between pastoralists in southern part of India [9].

Also, in various regions, radio was most common information source for weather prediction to perform cultivation. With three quarters of households based on radio and therefore makes it as a resourceful media for accessing climatic information for agriculture. Some households are heavily relied over relatives, friends and their observations for predicting weather for long or short run [10].

Conventional sources and knowledge information are some household factors for predicting extreme weather events and onset rain timing. The remainder of the work is organized as: Section II is methodology, Section III is numerical results and discussion and Section IV is conclusion with future extension and references.

II. CLIMATE FORECASTING

Pastoralists and farmers of India consider combination of animals, plants, meteorological, astrological, insect indicators to evaluate and identify weather conditions [11]. In this work, this work considers velocity flow with naive Equation to predict weather condition along with the essential categories like astrological, meteorological and biological factors. Various meteorological specifications are useful. In India, clouds are highly related to rain and people may give some local proverb as ‘ring around moon or sun may bring rain upon us very soon’ [12]. Two well known forms of clouds are nimbostratus and cumulonimbus. The former is a dark rain that carries cloud of bad weather and latter is cloud that may produces thunderstorms and showers. This is used for prediction in various parts of India [13].

Cloud appearance may specify higher probability of rainfall. Some indigenous meteorological indications are used to identify onset rainfall in India. This includes appearance of cloud direction, clouds, wind strength, extremely high night temperatures, thunder and lightning at night without no rain, lesser dew appearance over grass and plants. With these sites, dark cloud appearance is rated as finest meteorological specification to identify rainfall onset. Slightly changing meteorological specifications are reported in these investigations. However, above 70% of households are indentified with higher temperature as finest indicator to identify rainfall onset [14].

Excess warming and heat towards end of dry season specifies higher likelihood towards normal rainfall, while higher temperatures during night may specify rainfall likelihood for next day. Swirl and strong winds may specify an imminent rainfall onset, whilst continuous lightening in the evening during dry season is also the specification of short rain seasonal onset [16].

Pastoralists and small holder farmers may have certain meteorological specifications for rainfall cessation [15]. In India, some meteorological specifications towards rainfall cessation may include appearance of huge mist in night and morning, extremely clear sky, cold morning and evening, more appropriate drizzles and nights. As an average, farmers possess knowledge towards six diverse indicators, n which at least four indicators are utilized to make proper agriculture decision based productions. Some meteorological specification towards rainfall may include high frequency of lightening during rainfall, lighting strikes with high incidences and mild temperature during day. For every indicator of rainfall cessation, there are some farmers that make crucial productive changes and decisions based on planting, storage facilities, post harvest handling that may includes exploration of market opportunities for production.

A. Varying Velocity Model

This investigation considers prediction model of long term with velocity, i.e., optimal flow of natural factors like weather that may changes over time indeed of being constant. Various prediction approaches like TREC [10] utilizes linear extrapolation over time. Moreover, these constraints may prevent prediction of various moving patterns that shows sweeping or vortexes motions. To handle these issues, this work concentrates on Naives equation for computing optimal flow. This assumes a crucial part in changing velocity, i.e., optimal flow in non-linear way. While in combination with previous studies, NE may provide some sequential data that provides realistic motion. Some investigations based on prediction methods like computer vision have provided integration of optical flow and NE computation [17].

To resolve this NS equation, there is two another constraints considered. This is owing to Naives equation with two independent variables, pressure and velocity. Henceforth, mathematically, subsequent equation is essential to compute and to determine these variables. For resolving this crisis, some equation has to be considered. It is extremely essential to consider fluidity of rainfall. In case of numerical fluid dynamics, one essential factor is that fluid incompressibility. This model provides a relationship between outflow changes and inflow changes of rainfall in same quantity for all computational grids. It is specified by continuity equation that is zero. Even though, these constraints are considered is more limiting, with extensive level of essential fluid pattern like tornadoes, typhoons and hurricanes that are considered. Moreover, it was familiar that various numerical methods show higher complexities in considering compressible fluid direction. This additionally consumes higher amount of time to resolve the non-linear equations with tuning factors [18].

Generally, fluid moves are in three dimensions. This work considers 2D data flow by considering the vertical changes which are constant. For instance, weather prediction phenomena like convection show towards vertical variation. This work limited with 2D data; certain weather prediction approaches may employ 3D data for computation. In this work, consider vertical variation of weather factors like constant, when compared with horizontal variation this may be ignored then. However, this work completely uses 2D data with common systems like sensors and radars. Henceforth, this NE is implemented for 2D continuity data.

B. NE computation

This work provides an outline for mathematical computation. Initially apply Helmholtz decomposition that shows vector field in non-dimensional form which uses scale field as in . (1):

$$w = u + \nabla q.$$

This equation provides vector fields which was a sum of gradient and conserving fields. This may facilitates operator P. This gives vector field to divergence part $u = Pw.\, 'u'$ is zero divergence. $\nabla . u = 0$ is incompressible fluid assumptions. Multiply it in both the sides is given as Eq. (2):

$$\nabla . w = \nabla^2 q$$

This is known as poisson equations with scalar fields ‘q’ with boundary conditions. Solution to this equation was provided with computational projections as in Eq. (3):

$$u = Pw = w - \nabla q.$$

This may be applied to projector operator to both sides of NE, this may attain velocity equation as in Eq. (4):

$$\frac{u}{t} = P(-(u.\nabla)u + \lambda \nabla^2 u + f)$$

Where $Pu = u; P\nabla p = 0$. It is considered to be an independent variable of pressures that may be disappeared. This may significantly diminishes processing complexity. This is measured to be a non-linear iteration step. This provides fundamental computation to stabilize fluid solver. This commences with velocity solution. This may sequentially resolves every term over right hand side. The timing solution with $t + \Delta t$ is provided with last velocity. $u(x, t + \Delta t) = w_4(x)$. This may solve external factors $'f'$. consider a force that may not significantly changes with time step and provided in Eq. (5):

$$w_1 = w_0 + \Delta t f$$

This is a finest approximation for force effect over field with time step Δt. With an assumption of $p\nabla p = 0$, external force 'f' like coriolis force may be eliminated. The step may provide advection towards fluid. Some disturbances in fluid may be propagates with $-(u.\nabla)u$ expression. This may provide NE to be non-linear.

This method possesses various benefits that are unconditionally stable. The observations is that maximal value in newer fields this may never be larger value that the previous values. This is extremely simpler to be implemented. This may be practically performed over tracer and linear interpolation. Therefore, this is more stable and easier for implementation.

III. Numerical Results

Here, simulation has been done in MATLAB environment. Various rainfall features are considered and ranked based on normalization. Also, five diverse models like NN, SVM, BT, RF is considered for predicting error rate. Here, Absolute error, mean square error are computed. Table I and Table II are parameters related to this investigation. Table III and Table IV shows bias computation and accuracy of proposed model.

Table I. Ranking with normalization

Features	Rank	Normalization
Dir10s	88	0.5
Dir 10	88	0.9
Direction 31	86	0.8
Direction 30	80	0.9
Ws10s	87	1.0
Ws10	8791	0.9
Ws32	101	0.8
Ws31	94	0.8
Ws30	87	0.7
Direction 32	91	0.8
momf	91	0.8
t	54	0.8

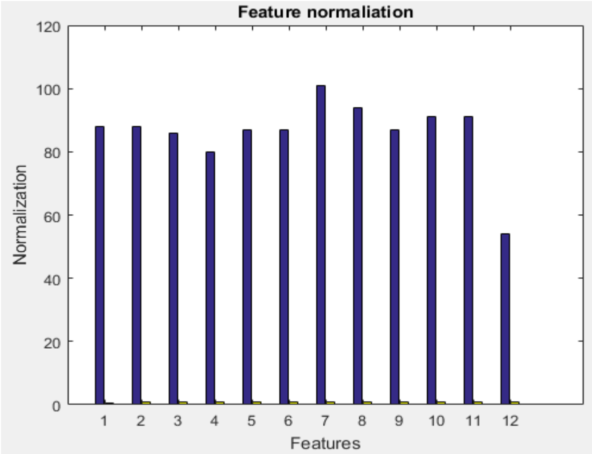

Fig 1. Feature normalization

Table II. Error Prediction

Methods	Bias	MAE	RMSE	AE
NN	-0.6	5.3	9.8	8.3
SVM	0.09	5.6	9.4	7.6
BT	0.0014	4.9	8.9	7.4
RF	0.0245	5.6	10.9	9.4
NE	0.0010	4.5	8.5	7.2

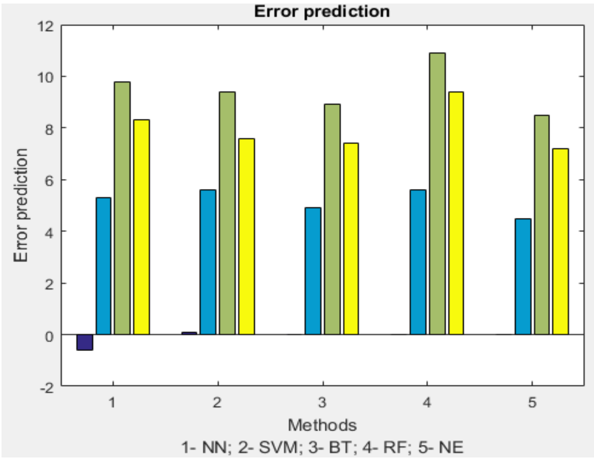

Fig 2. Error prediction

Table III. Bias computation

Methods	Bias	MAE	RMSE	AE
Model I	7.2	9.6	13.4	11.1
Model II	0.0013	4.9	8.9	7.4
Model III	0.0010	4.5	8.5	7.2

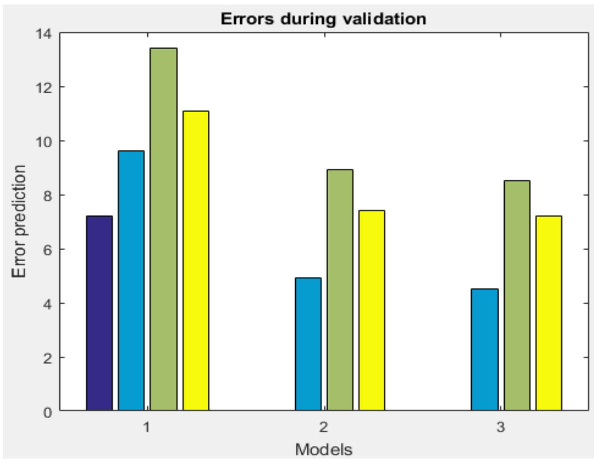

Fig 3. Errors during validation

Table IV: Accuracy computation

Methods	P	R	Acc	Error
Model I	0.6	0.75	0.6	0.3
Model II	0.7	0.8	0.8	0.9
Model III	0.9	0.81	0.8	0.13

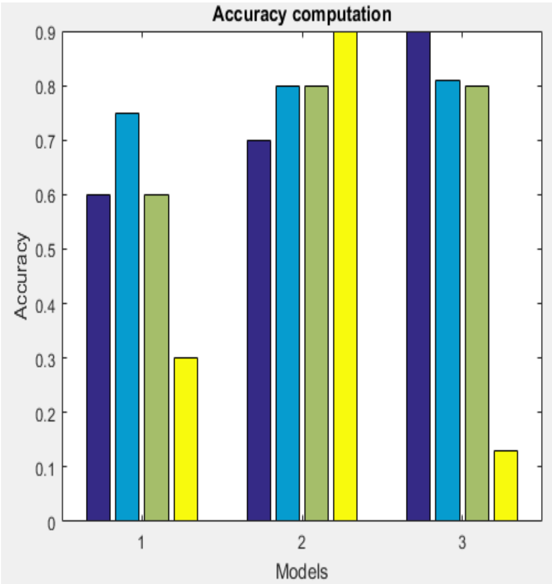

Fig 4. Accuracy prediction

Fig 1 depicts normalization factors related to weather prediction features. Various features are considered and corresponding normalized values are identified. Fig 2 depicts error prediction by comparing five diverse approaches. However, the proposed NE shows better results with reduced error. Fig 3 depicts error prediction with existing models. Fig 4 shows accuracy computation based in NE model.

IV. Conclusion

Climatic variation may seriously influence agriculture. It may be extremely vulnerable to various drastic changes and variability's. Superior knowledge towards weather and climatic information are merged to form an agro based services and shows higher potential towards enhancement of farmers ability to handle climatic variation and to adopt climatic changes. This may include climate management based risks in agriculture. Appropriate climatic information services, efficiency and effectual weather prediction information and system dissemination are crucial to attain proper decision making. Some seasonal weather predictions may provide downscaled and offer generalization. Therefore, it is less effectual in resolving the needs of farmers. Here, naive equation is used to identify the significance and velocity of flow towards prediction. This is explored based on information knowledge for making proper decision in India.

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