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Automatic Crops selection based on Predicted Rainfall

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Abstract

The paper describes the development of a Automatic system which provides the information about the crop selections for sowing at the different rainfall scenarios namely normal, above normal and below normal monthly / Nakshatra period rainfall.

1.0 INTRODUCTION

Rainfall is the most important climate variable that affects the crops in the tropical rain fed regions. People wish to know whether there would be rainfall in the coming months or year. To fulfill this requirement, one needs a forecast, well ahead of the commencement of the crop season. Such rainfall forecasts can be used both by the farmers and the Government in planning for the ensuing year. This work is an attempt to analyze the available data for development of a system for rainfall forecast and crop selection, from taluka level to state level. This work thus introduces a novel concept called region bound model for Rainfall prediction.

Rainfall is known to follow set patterns that can be explained by statistical and mathematical procedures like trend, periodicity and serial correlation. Hence it would be possible to develop appropriate models for long range forecast of rainfall. However, rainfall patterns vary within a country and within a state, in view of its high variability both temporally and spatially. We are aware, that the long range forecasts issued by the India Meteorological Department need considerable downscaling for appropriate agricultural applications. On the other hand models using the historical rainfall patterns in individual sub-regions like taluka or district can be up-scaled up to a larger area like a state or a country. This proposed model uses local speculation to global speculation approach (this, we call incremental approach). The forecast of rainfall for individual talukas of a particular district will help in guiding the district level planners. The package provides graphs, charts and reports of the forecast rainfall and its comparison with the previous events. The proposed incremental approach is extended to handle the rainfall prediction in the whole of Karnataka state.

From literature on the Indian monsoon and long rage forecasting, it is noticed that, most of this work is on regional and national scales, and therefore average out the variability of rainfall at higher spatial resolution. Different forecast approaches are in use – from simple statistical procedures to Box-Jenkins models to tele-connections to Global Circulation models. Artificial neural networking procedures are also in use.

Mooley and Parthsarathy (1984) have clearly pointed out that monsoon rainfall trend is less and mainly random in nature based on their

historical rainfall data analysis. Rupa Kumar et al. (1992) have considered the linear trends of monsoon rainfall (seasonal as well as monthly) at 306 stations, well spread all over India during 1871-1984 and analyzed their spatial patterns. Based on this analysis, they have identified some broad contiguous areas showing statistically significant trends. They also observed that the monsoon rainfall tends to be more concentrated in August, in view of the significant positive trends over large areas in that month, particularly along the west coast and over central India. Cannon and McKendry (1999, 2002) have proposed an artificial neural network model to predict the Indian monsoon rainfall. Most of the works have used holistic approach. The large interannual, intra-seasonal and spatial variability of rainfall in the rainfed dry farming tract of India motivated us to look for an incremental approach, i.e., up-scaling from small regions to the larger regions particularly with regard to crop selection (Figure 1). In the present work, an algorithm is evolved for development of forecast for a specific Taluka, its historical rainfall data is analysed through trend, harmonic analysis and autoregression procedure (Agarwal, 1999; Venkatesh, 2004). For each Taluka, different models are developed and used for forecast of the ensuing season's rainfall, and accordingly crops selections are suggested. In the peninsular part, the farmer traditionally selects and sows crops based on the rainfall occurrence in various *Nakshatra* periods. Hence, these traditional periods are also adopted in this system. This paper explains the various components of the developed Software and its applications.

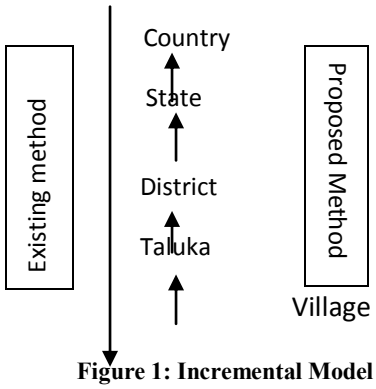

Figure 1: Incremental Model

2.0 THE PROPOSED SYSTEM

The proposed system is divided into five modules, namely: Administrator Module, Rainfall data entry Module, Predictor Module, Comparator Module and Crop Selection Module (Figure 2).

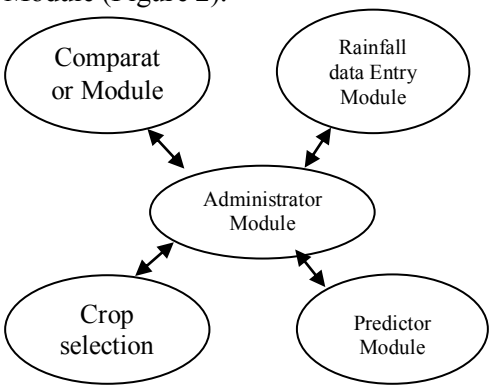

Figure 2: Functional Diagram of the proposed system

2.1 Administrator Module

This module provides the security for the data and deals with the granting of permission and revoking of users, and therefore is the vital part of the system. The administrator module takes care of user accounts, facilitates updating data, editions to crop lists, the cities and the addresses. Granting permissions to users involves the user name and the password information, which are supplied by the system administrator. Modifying of account is also done by the system administrator.

2.2 Rainfall Entry Module

The Rainfall data entries are divided into four different categories, namely, Monthly Rainfall, *Nakshatra* Rainfall, Weekly rainfall and Daily Rainfall. The entries can be made as per data availability; if daily data are entered, the data for other periods will be computed as required. Interactions in this module are given in Figure 3.

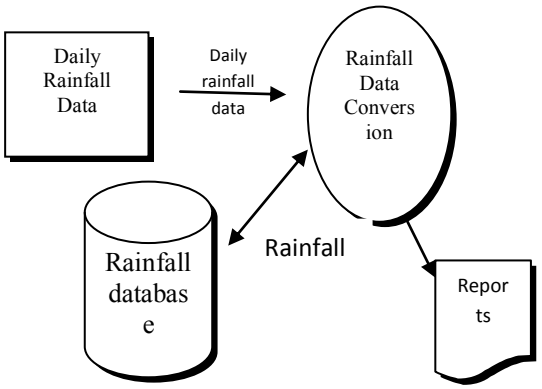

Figure 3: Rainfall data Entry Module

2.3 Predictor Module

This module uses the algorithms for the processes involving trend, serial correlation, harmonic components and autoregression analysis as mentioned earlier – with appropriate reference to Aggarwal (1992), to forecast monthly, *Nakshatra*-period and weekly rainfall. The database of the particular month or *Nakshatra* is accessed, and the data are converted into vectors. The prediction is done by using these vectors, which are input to the algorithms. These vectors are stored into a temporary database to generate reports such as graphs, charts etc. The details of the predictor module are given in Figure 4 and detailed process is given in Algorithm 1.

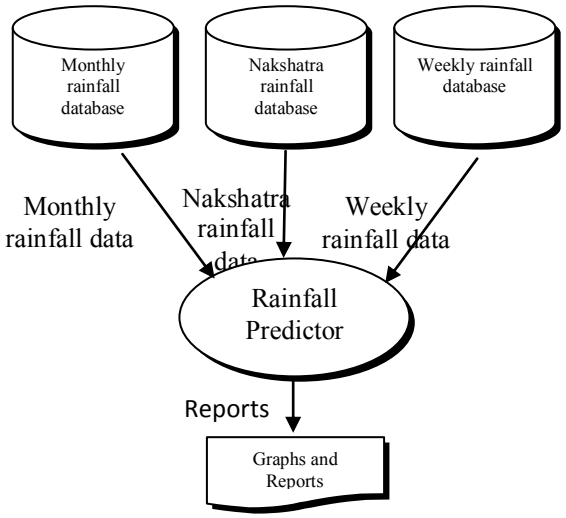

Figure 4: Predictor Module

2.4 Comparator Module

The comparator module uses the rainfall forecast and compares with the actual rainfall in a given year, i.e. year to year, month to month, week to week and *Nakshatra* to *Nakshatra,* as required by the user.

a) year_ to_ year

This comparison takes two parameters as inputs namely, *from-year* and *to-year*. It calculates the sum of all the months rainfall data *from-year* to *to-year* using monthly database. Finally, the average of this sum is calculated. This may be termed as mean annual rainfall, or the normal. Comparison of the annual rainfall of a selected year is made with the normal. The result is stored and displayed as per the user's requirement, as a report or graph.

b) *months to months*

In this method of prediction, three parameters are used namely, *from-year, to- year* and month. It extracts the data from the monthly rainfall database for a specified month to calculate the normal for the month. Comparison of rainfall in the month of any year is done with the normal.

c) *week to week*

In this method, weekly analysis is done in place of the monthly, mentioned above. Weekly normals are calculated and data of any year is compared with it.

d) Nakshatra to Nakshatra

In this comparison, three parameters are supplied they are *from-year*, *to- year* and the *Nakshatra*. This is similar to the above two, except that the procedure is for *Nakshatra* period. Comparison of rainfall is done for that particular *Nakshatra* period with the normal for the same Nakshatra period computed from the database.

e) Actual vs. Forecast

The data of estimated/forecast of rainfall and actual rainfall are extracted form the database for a given year and comparison is made. The various types of reports are generated such as Graph, charts etc. The aforesaid activities are depicted in Figure 5 and detailed process is depicted in Algorithm 2.

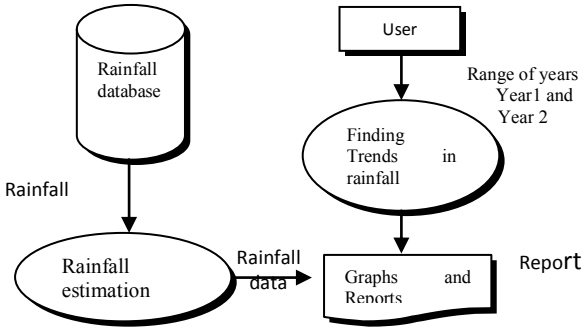

Figure 5: Comparator Module

2.5 Crop Selection Module

The vectors contain the forecast and normal rainfall data, which are obtained from predictor module. Crops database contains name of the crops and rainfall status.

The rainfall status is used as primary key for the Crop Database. Depending upon the rainfall status and the soil type, the crop selection is made for the given month or the given *Nakshatra*, and thus crop data report is generated. The crop selection process is depicted in Figure 6.

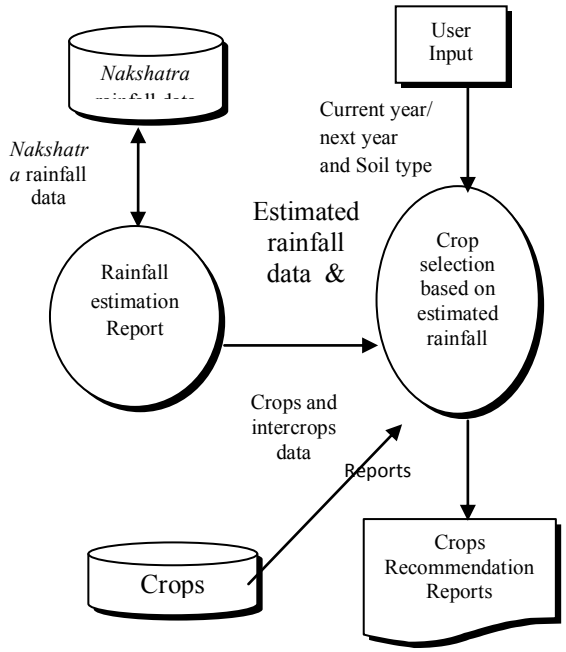

Figure 6. Crop Selection Module

Algorithm-1: Crop selection algorithm based on Nakshatra

The crop selection algorithm provides the information about the crop selections for sowing at different scenarios namely above normal, normal, and below normal rainfall.
Input: Crops and Intercrops from crops database
Output: Crops list for different Rainfall scenarios
Start
Step 1: Extract crops and intercrops from the crops database
Step 2: Select the crops and intercrops for the different Nakshatras
Step 3: Send message for crops depending upon the rainfall status, to sow or not to sow, based on estimated rainfall and rainfall status.
End

Box 1: Crops Recommendation Based on Rainfall

Crop	Intercrops
Bajra	Groundnut + Redgram (4:2)
Greengram	Bajra + Redgram (2:1)
Groundnut	Bajra + Castor (2:1)
Sunflower	
Cucumber	
Heerekai	
Redgram	
Chilley	
Castor	
Sesamum	
Navane	
Onion	

Status **Nakshatra:** MRIGASHIRA
Period: JUNE 8 TO JUNE 22
Rainfall Status: Above Normal

3.0 Conclusion

A methodology for analyzing the historical rainfall data of monthly and *Nakshatra* periods is developed for their long range forecast one season ahead. Accordingly, it can be used to decide on the crop selection. This system is useful for not only for forecasting, but also for analytical comparison with the past data. One of the most important features of this system is that, it recommends the regional crops depending upon the rainfall status in various *Nakshatra* periods -the method traditionally followed by the farmers. Regional data is used in the analysis, which is considered to be a novel approach for forecast and up-scaling to state level.

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