Review on Drought Risk Assessment by using Remote Sensing and GIS

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Abstract - *This study emphasizes the Drought Risk Assessment by using RS and GIS. Images can be taken from the NOAA-AVHRR OR LANDSAT 8 (TIRS) (8 km) standardized vegetation difference index (NDVI) and the meteorological derived uniform precipitation index (SPI) were used to drive drought-risk areas facing both agricultural and meteorological drought. Correlation and regression analysis was performed between NDVI, SPI, rainfall anomaly and food grain anomaly. The results of the correlation and regression of SPI and crop yield analysis showed that SPI could be used as an indicator of regional crop production. Since each factor; NDVI, SPI and detrended food grain yield anomaly had a favourable linear correlation with each other, it was noted that the above-mentioned factor can be used efficiently to monitor and evaluate food grain output, thus allowing suitable agricultural practices to minimize drought impacts.*

Key Words: Drought, NDVI, SPI, food grain yield Correlation, Risk assessment

1. INTRODUCTION

Many consider drought as the dryness, the most complicated but least understood of all-natural hazard that affects further individuals than any other hazards. A main aspect of integrated management of water resources should be planning before drought occurs. Management and its planning more significantly can be placed on the management issues as drought management and flood management.

1.1 Impact of Drought

Direct effects contains lower crop productivity, rangelands and woodlands, increment in the fire hazard, livestock and wildlife, fish habitation, lower water concentrations. The significances of these straight effects are demonstrated by subsidiary impacts for instance, the decrease in crops, rangelands, and forest productivity may lead in lower incomes for farmers and agribusiness, higher food and timber prices, unemployment, lower tax revenues due to lower spending...

1.2 Drought Risk Evaluation

- The evaluation of hazards, which may cause the disasters.
- Assessment of risk rising out of such event and
- Assessment of victims.

1.3 Drought Risk Evaluation and Management

Drought, owing to poverty, accelerates the degradation of natural resources for both human and livestock populations and puts serious pressure on public assets through relief measures. There is a strong link in a region between poverty and drought proneness. Widespread lack of severe food and fodder that adversely influence human and animal health and nutrition. The major drought is the lack of drinking water, which is accentuated by declining groundwater quality and diminishing water table resulting in large-scale migration.

1.3.1 Problems Statement

This is one of the key atmospheric disasters that have happened in nearly every climatic regions, and environmental and economic harms has been common in several countries, with unprecedented livestock death tolls. Drought damage is additional noticeable or projecting in fields where there is a direct risk to livestock.

1.4 Objectives

- Analyzing changes in vegetation cover with respect to precipitation variability.
- Identify regions with danger of drought by linking data from satellite with thematic information.

2. MATERIALS AND METHOD

2.1 Data Acquisition

Data were developed primarily from two sources, starting with satellite sources NDVI and secondly from ground precipitation station rainfall.

2.1.1 Characteristics of Satellites

The U.S. National Sea and Atmosphere Administration (NOAA) runs the satellite sequence NOAA which created a high resolution sensor (AVHRR) OR LANDSAT 8 (TIRS). The National Sea and Atmospheric Administration (NOAA), NASA have launched the pathfinder sequencer to generate longstanding information sets for studies into global change. From the initial 1.1 km^2 NOAA (AVHRR) information collection, the NOAA pathfinder dataset was produced as a 10-day maximum composite value (MVC) total at 8 km x 8 km pixel determination. Monthly MVC was then produced in any given month from 10-day composites. Due to its long term periodicity, worldwide analysis and free accessibility, the NOAA pathfinder OR LANDSAT 8 (TIRS) information was used in this research.

2.1.2 Meteorological

Meteorological information on monthly rainfall were gathered over a decay (minimum of 10-year period). Monthly rainfall has been used for maximum numbers of rain gauge stations to analyses the relationship From NDVI to rainfall as well as to obtain standardized precipitation index (SPI).

2.1.3 Numerical Approach

Numerical information about crop yield can be used primarily to determine the relationship between the different parameters used in the research (such as rainfall and NDVI). Crop yield information can be gathered for at least minimum of 10-year period.

2.1.4 Ancillary Details

2.1.4.1 Toposheets

Minimum of 4 toposheets are required which can be drawn from the available websites at separate scales, it will be easy if they were projected in Albers Projection and can be suitably edited or mosaiced to get the different zones.

2.1.4.2 Landuse / landcover

Landuse and Landcover maps to be prepared. Landuse / landcover can be produced from 8-days composite surface reflection image which is downloaded from the different sources. Five main kinds of precipitation plants, irrigated plants, fallow land, bare soil and forest are to be shown on the generalized land cover map.

2.1.4.3 Rain Station Map

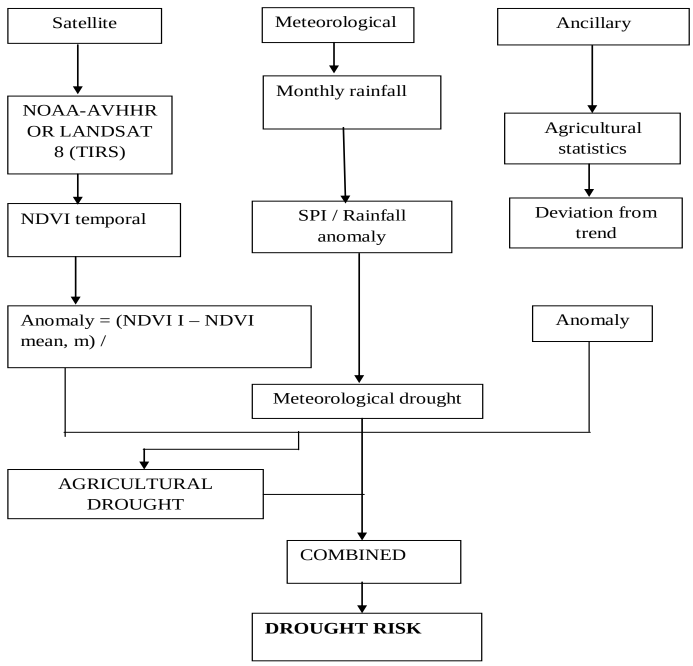
A Map is to be prepared from the LET/LONG file of the different precipitation station of the area. It can be used throughout the region to interpolate rainfall and SPI values.

2.2 Software Used

The different packages for GIS can be used to process and analyses the information. ERDAS 8.7, Arc GIS 9.0, ENVI 4.0, Arc view and Microsoft are excellent evidence measures.

2.3 Methodology

Correlation and regression techniques can be used to test for a correlation between NDVI and precipitation of the area. NDVI, SPI and crop patterns are then the abundance for the drought classification. The following flow graph demonstrates the methodology.



2.3.1 Pre-Processing of Satellite Data

NOAA-AVHRR satellite images have been radio-metrically corrected, but monthly NOAA-AVHRR NDVI pathfinder pictures of 8 km by 8 km of spatial resolution have been used; geometric correction is required.

(B1-128)X0.008

Where, B1 is the image's band 1;

The whole giving out of the NOAAOR LANDSAT 8 (TIRS) data has been done using ENVI 4.0.

(You can also use LANDSAT 8 (TIRS) after applying geometric correction)

2.3.2 Derivation of Vegetation Index (Post-Processing)

NDVI is universally defined as

NDVI= (NIR-Red)/ (NIR+Red)

Assuming the NDVI seasonal pattern and getting the average NDVI for both year which is computed by using following formulae

The average NDVI Yyears

= (NDVI6+NDVI7+………+NDVI10)/ 5

Where,

NDVI Y is NDVI for Y^{th} year and NDVI6, NDVI7………NDVI10 stand for NDVI of month in that selected year (if you are doing it for minimum of 10 years)

The Mean NDVI for 10 year is calculated using the following formulae

The Mean NDVI =

(Average NDVIy1+Average NDVI y2+…..+Average NDVIy9)/ 9

Where,

The Average NDVIy1……Average NDVIy9 stand for the yearly average NDVI value for 9 year.

For one decay, to derive the NDVI anomaly we can use the following formulae:

NDVI max I = (NDVI 1^{st}, NDVI 2^{nd}…….NDVI n^{th})

Where, NDVI max I is the maximum NDVI in I^{th} year and NDVI 1^{st}……NDVI n^{th} is NDVI in month 1 to NDVI in n month of I^{th} year.

2.3.3 Rainfall Data

Monthly precipitation records have been split into different station spreadsheets, where as rain gage data are dimensions of points (average satellite values over pixel fields). The Geostatistical method of interruption was conducted with an 8 km grid and seasonal rainwater charts were prepared for 10 years in order to create a connection between these two kinds of information to get average precipitation situation map for the last 10 years, an average of 10 years of rainfall-interpolated maps can be prepared.

2.3.4 NDVI and Rainfall Relationship

The relationship constant between NDVI and monthly precipitation were evaluated. The coefficients of NDVI / rainfall correlation are calculated for 1st and 2nd month time lags to take this interval into concern and evaluate the true peak correlation between NDVI and rainfall. In order to see rainfall-based variability in vegetation, temporary patterns of rainfall and NDVI were also analyzed. To analyses which of these shares are a strong connection, the different correlations between precipitation and the peak NDVI & between precipitation and average NDVI were calculated.

2.3.5 Meteorological Drought and Standardized Precipitation Index (SPI)

For 12 months index from January to December, SPI is an index designed to quantify the shortage in rain at distinct time scales. 1 Month SPI reflects conditions in the short term and can be used strongly associated with soil moisture; 3^{rd} month is seasonal month SPI offers rainfall estimates; 6th and 9th month SPI shows medium-term rainfall pattern trends; Thus, for the period 10 years, every years 3^{rd} month for different rainfall stations was calculated using monthly rainfall information, Only for season cultivation (June – October). To interpolate the SPI values, the reverse distance weighted (IDW) technique was used. IDW interpolated explicitly assumes that things closer to each other are more alike than those performed that are more distant from each other. Thus, the interpolated maps are reclassified into various groups of severity of drought. Interpolated September month maps have been selected it moves to be reclassified as month SPI normal i.e. July. The key months for significant kharif plants in the region are must know.

2.3.6 Rainfall Anomaly

From a decay, rainfall anomaly was calculated to show meteorological drought for the increasing season June-October. Anomaly of rainfall was calculated as;

RFA i = [(RF i-RFµ)/ (RFµ)] X100

Where, RFA i is Rainfall Anomaly for i^{th} year

RF i is Seasonal Rainfall for i^{th} year

RFµ is Mean Seasonal Rainfall

Climatological drought is described as if the periodical precipitation usual over a region is less than 75% of its long-term average value, according to the Indian Climatological Department (IMD). In addition, the weather is categorized as mild drought when precipitation is 25% lower than usual, slight drought with 50 percent lower than ordinary rainfall and serious drought with 75 percent lower than ordinary rainfall. The same criterion as outlined in IMD was used to classify the meteorological drought.

2.3.7 Crop Yield Anomaly

Because NDVI benefits from plant reflective and absorptive appearances in the red band and near-infrared band ratios of the electromagnetic spectrum used in the crop and efficiency of undergrowth research, plant yield has also been connected with NDVI. For the yield trend, the yield pattern over the past 10 years was calculated to see the yield trend based on the district has been calculated. The following formulae shows calculation of the trend, followed by the calculation the yield anomaly. In that particular year, to derive anomaly in crop production, the years in which growth was missing an average yield were calculated. It is same as that of NDVI anomaly calculation, yield anomaly was calculated.

Yield trend Y_t = (a+b) ....Equation (1)

Where Y_t is yield trend

Yield anomaly Y_a= $((Y_i-Y_t)/ (Y_t))$ X 100.................. Equation (2)

Where Y_a is yield anomaly;

Y_i is yield anomaly in i^{th} year;

Y_t is yield trend in 10 years

2.3.8 Relation between SPI, NDVI Anomaly and Food Grain Yield

Agricultural regions and taluka-wise NDVI anomalies have been masked from the entire research region have been linked with taluka-wise SPI and crop yields for Vijayapura agricultural areas. Linear regression between anomaly of NDVI and food grain results in state-wide irregularity, irregularity of food grain and SPI, difference between NDVI and SPI were calculated to assess the effect of precipitation on crop yields leading to drought in agriculture.

3. DERIVING THE RESULTS

3.1 Seasonal NDVI and Rainfall Patterns

Taking into account overall precipitation of the decided decays (most probably the Kharif season) and NDVI trends for the whole study region are to be simulate. the rainfall details for a decay which are collected from different locations are collected on time schedule.

The NDVI values as they are derived from NIR and Red wavelength, the wavelengths of NOAA-AVHRR pathfinder and the Landsat 8 Operational Land Imagers (OLI) & Thermal Infrared Sensor (TIRS) are correlated and the matrix for NDVI can be prepared. It is also possible to analyses the seasonal pattern of rainfall and NDVI from the matrix .

3.2 Spatial NDVI Anomaly Patterns and Rainfall Anomaly Patterns

This analysis is helpful to understanding the precipitation and its effect on the condition of the vegetation. Whenever Vegetation indicates a healthy reaction in locations with excellent precipitation, and NDVI values are high in these locations relative to low precipitation regions.

3.3 Drought Risk Classification

Final drought risk acquired through the integration of risk produced by agricultural and meteorological drought. These classifications have been incorporated using the Rainfall, Rainfall Anomaly Range, NDVI Range, NDVI Anomaly Range ,Food Grain (Regression), Oil Seed (Regression) and it displays the percentage region impacted by the combined danger. We can have different regression equations and we can correlate them with each other to form the different matrix. Based on the percentage and the regression values we can classify the draught as Very High Risk, High Risk, Moderate Risk, Slight Risk and No Risk.

4. CONCLUSIONS

The primary objective is to define the connection between rainfall and NDVI and see how satellite, meteorological and other ancillary data can properly delineate drought risk regions. The study relies on the rainfall details as different have different rainfall intensity and the pattern. In the areas where we are having adequate rainfall for those we will be having NDVI values, where the precipitation is higher than the beginning moisture which is elongated a limiting feature and with enhanced precipitation NDVI rises very slowly.

The first research question as well as the purpose of the rainfall-NDVI relationship, the research found that the temporal variation of NDVI is tightly related to precipitation and that a powerful linear connection exists between NDVI and the rainfall (monthly or periodical precipitation) is within a certain range. It has also been discovered that precipitation has a favorable relationship with NDVI and that rainfall / NDVI relationship has also been discovered to be powerful in limiting water fields, which indicates that they are the more likely to drought. While many studies have examined the establishment of a relationship between precipitations / NDVI, demonstrating that is a good measure of foliage vitality, efforts to unite various variables to identify a risk zone have yet to be made to better describe a risk zone.

The anomaly of NDVI and Rainfall gives the situation of precipitation and the corresponding values of NDVI. We can say that the NDVI value is based on precipitation, but even we get favorable rainfall anomaly in an anomaly index, because it depends on how we manage the rainwater. Even though we have plenty of rainfall, and if we don't handle it properly, we may get adverse anomaly with NDVI. Thus, a general result shows that risk regions can be adequately evaluated through the inclusion of different information generated and thus organization plans can be ready to cope with the risk.

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