*International Journal of New Media Studies (IJNMS), ISSN: 2394-4331*
*Volume 11 Issue 1, January-June, 2024, Impact Factor: 8.879*

# Agro-Meteorological Drought Analysis in Hisar District from 2000 To 2022

**Darshna[1], Sudhir Malik[2]**

[1]Research Scholar, Department of Geography, Baba Masthnath University, Rohtak
[2]Professor, Department of Geography, Baba Masthnath University, Rohtak

**ABSTRACT**

**The recent recurring water scarcity in the Hisar region has alarmed the scientific community and the policy makers alike. The absence of appropriate scientific work to analyse the recurring pattern of the drought, and the relation between meteorological, hydrological, and agricultural drought has further perplexed the decision makers. This study attempts to use the range of indices on drought monitoring and different software such as Q-GIS and Erdas Imagine.This information has been tabulated and converted into pictorial representation to illustrate the intensity and frequency of the droughts. It presents an intelligent information base to assist the decision makers and mitigation analysts in taking decisions for drought mitigation action. It was concluded that blocks (Barwala, Uklana, Narnaund, Hansi-I and Hansi-II) there was no severe drought condition in the district during the study period. It varies from block to block in each year. Meteorological drought analysis was carried out at district level and it was analyzed that in 2002, 2006 and in 2009 rainfall was deviate than normal rainfall. . It was observed that hydrological drought in pre-monsoon and post- monsoon was varying.**

**Keywords— Drought, NDVI, RAI, hazard, vulnerability and risk**

## INTRODUCTION

Drought is a natural hazard with a slow and creeping onset. Drought may be defined as an extended period of month or years, when a region notes a deficiency in water supply, whether surface or underground water. Generally this occurs when a region gets below average precipitation. The starting of these phenomena is slow but can prolong for the larger period of time.

The severity of the drought is also difficult to the measurement. And the severity of this hazard can be increased for a long time period. This hazard impacts have on many other sectors such as economic, social and environmental. The information for drought is required for various planning purposes and can be reduced through mitigation and preparedness. Also this information is required to develop plans to deal with these extended periods of water shortage. Drought can be meteorological, hydrological and agricultural. At present drought recent technologies of remote sensing, satellite imaging, geographical information systems (GIS) and geographical positioning system (GPS) offer two principal advantages, if incorporated in drought research and mitigation. First, it allows long-term time-series studies and set of information that may prove invaluable in future assessments and decisions. Secondly, GIS/RS improves information accessibility and accuracy.Hisar district is one of the most important districts in Haryana with fast developing economy and frequent human activities. Rapidly decreasing water table created a crisis of drinking water. In some of the areas the poor people face the crisis of water problem from February/March to end of June.

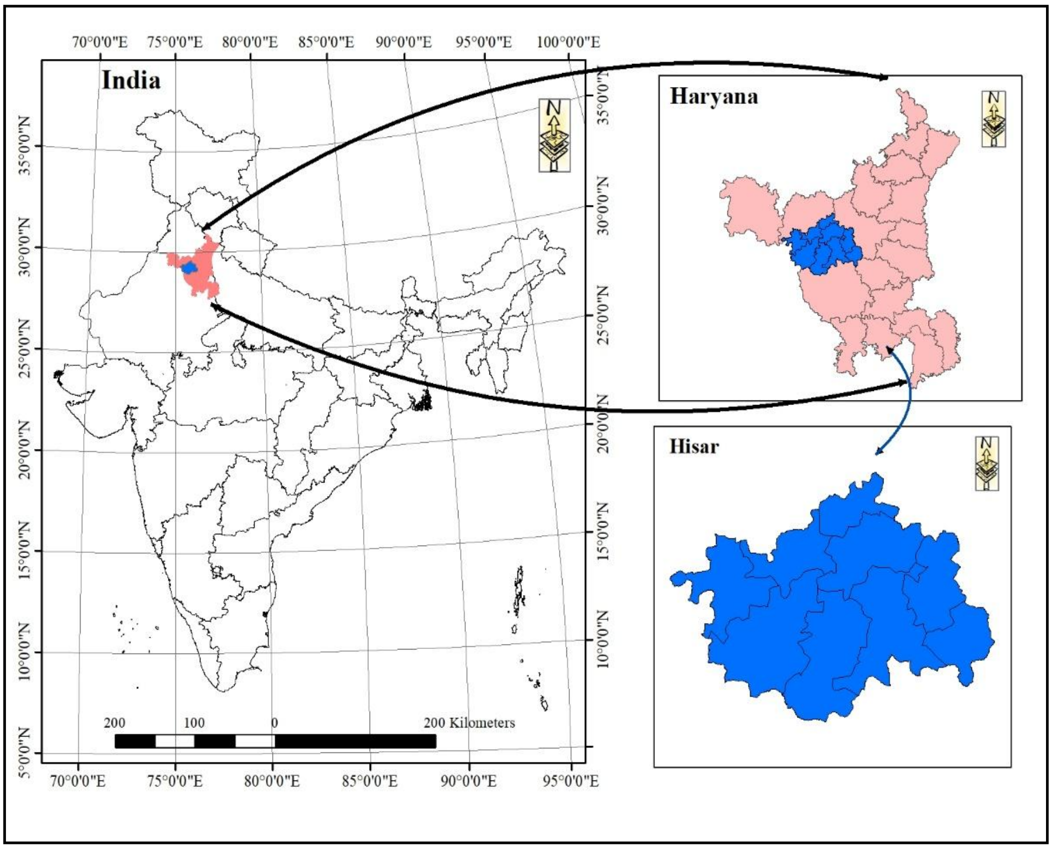
There are several manifestations of drought like late arrival of rains, early withdrawal, long break in between, lack of sufficient water in reservoirs and drying up of wells leading to crop failure and even un-sowing of the crops which ultimately curtail livelihood and may lead to migration. The proposed study will scientifically identify and assess the hazards and vulnerability on spatial scales, by using remote sensing and GIS techniques. The aim of the study is to develop a drought vulnerability map for the region which is not available till date and can serve as a major basis for management, planning and programmes monitoring framework.

### Study Area

Barwala, Uklana, Narnaund, Hansi-I and Hansi-II blocks of Hisar district occupies the east and west central part of Haryana state and suffers frequent scarcity of water in southern and south-western part so that north and north-east part would be studied. It is situated between 28°53’45” to 29°25’15” N latitudes and 75°13’15” to75°55’01” E longitudes, with a total area of 2099.16 km$^2$.

Most of the people in Hisar district are engaged in agricultural activities for their livelihood. The location map of the study area is shown in Figure-1. There is no any natural drainage system.

This area is comprised of old alluvial plain and sand dunes. The general altitude of the area varies from 203 to 225 m amsl and having a gentle slope towards south-westerly direction. The topographic pattern of Hisar district has close affinity with climatic aridity.




Source: Bhuvan Portal

**Figure 1: Location Map**

Temperature increases rapidly in the month of May. Temperature reaches up to 41˚ to 48˚C. Rainfall in the district is erratic in nature.

The soils of these blocks of Hisar are broadly classified in desert soil or sandy soil, sandy loam soil and loamy soil. The water table (unconfined) aquifers occurs from 10 m to 60 m depth below ground level in the district. The ground water in unconfined condition is abstracted through hand pumps, dug wells and shallow irrigation tubewells.

**Methods**

Methodology was based on three elements meteorological data and agricultural assessment by using digital enabled techniques NDVI.

**Meteorological Data Processing**

Prevailing literature has been reviewed in order to understand and select the suitable drought indices appropriate for study of drought in Hisar region.

**Deviation from normal**

The percent of normal precipitation is one of the simplest measurements of rainfall for a location. Analysis using the percent of normal is very effective when used for a single region. Resulted details of criteria were given in table1. Percent below normal was calculated as following:

$$\text{Percent by normal} = \frac{(\text{Actual }\,)}{\text{Normal}} * 100$$

**Table 1: Rainfall Anomaly Index**

| Criteria | Drought condition |
|---|---|
| +/-19% | Severely drought |
| 20 to 59% | Moderate drought |
| >60% | Normal |

**Normalized Difference Vegetation Index**
NDVI reflects vegetation vigour, density and biomass. It varies in a range of -1 to +1. Among all the available vegetation indices, it is a universally acceptable index for operational drought assessment. NDVI was derived as under;

$$\mathbf{NDVI} = (\mathrm{NIR} - \mathrm{Red}) / (\mathrm{NIR} + \mathrm{Red})$$

Where, near infra-red and Red are the reflected radiations in these two spectral bands.

## RESULTS AND DISCUSSION

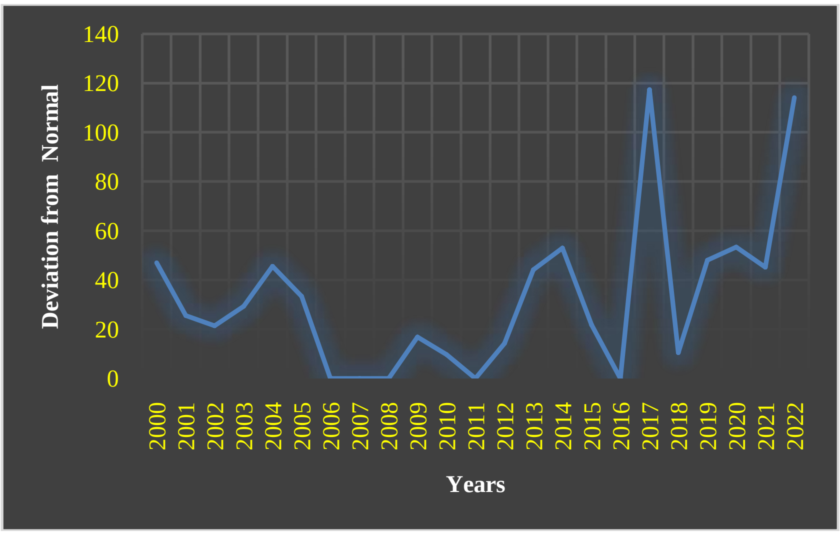
Outcome of the analytical study on different aspects of meteorological, hydrological and agricultural drought in blocks of Hisar region in Haryana is presented in the following sections:

**Meteorological drought**
Results of "Percent by normal" indicate the increasing frequency of moderate droughts occurrence in the district as given in table 3. It calculated simple standard deviation method and using the datasets from 2000 to 2022. During the year 2002, 2009 and 2012, the district experienced severe meteorological drought since the district received only 52.9%, 53.2% and 53.2% rainfall, respectively and this rainfall is much lower than the normal rainfall (>60%) expected during monsoon season.

**Table 3**: **Rainfall Deviation from 2000 to 2022**

| Years | Rainfall Deviation | Years | Rainfall Deviation |
|---|---|---|---|
| 2000 | 47.07194646 | 2012 | 14.2763618 |
| 2001 | 25.53964091 | 2013 | 44.1221991 |
| 2002 | 21.41478446 | 2014 | 52.9406843 |
| 2003 | 29.26784145 | 2015 | 21.8245759 |
| 2004 | 45.56889102 | 2016 | 0 |
| 2005 | 33.33274806 | 2017 | 117.388078 |
| 2006 | 0 | 2018 | 10.4279001 |
| 2007 | 0 | 2019 | 47.9918079 |
| 2008 | 0 | 2020 | 53.3325842 |
| 2009 | 16.8905745 | 2021 | 45.2152964 |
| 2010 | 9.67105565 | 2022 | 114.087934 |
| 2011 | 0 | | |

Source 2: NASA/Climate/Datasets




Source 2: NASA/Climate/Datasets

**Figure 2: Rainfall deviation from normal**

**Rainfall Anomaly Index (RAI)**

Rainfall anomalies showing the meteorological drought situation of the district which signifies the trends of rainfall. This trend indicating the amount of rainfall in comparison to the mean annual rainfall. Historical data series anomaly resulted that the years 2000, 2002 and 2014 had severe metrological drought like condition whereas the years 2010, 2021 and 2022 had abundant rainfall as given table 5. RAI calculated as given in equation as following:

RAI= $-3x\left[\frac{N-\bar{N}}{\bar{M}-\bar{N}}\right]$ (to the negative anomalies years)

where

N = yearly rainfall in (mm)

$\bar{N}$ = average yearly rainfall

$\bar{M}$ = average of the ten highest yearly historical series

**Table 5: Rainfall Anomaly from 2002 to 2022 (in descending order)**

| Years | RAI (Negative) | Years | RAI (Positive) |
|---|---|---|---|
| 2002 | -8.34 | 2016 | 0.06 |
| 2014 | -6.69 | 2005 | 0.23 |
| 2000 | -6.69 | 2011 | 1.22 |
| 2004 | -5.37 | 2020 | 2.37 |
| 2006 | -5.21 | 2018 | 4.02 |
| 2009 | -4.38 | 2008 | 4.19 |
| 2007 | -2.57 | 2003 | 4.52 |
| 2019 | -1.91 | 2013 | 5.02 |
| 2001 | -1.74 | 2010 | 5.18 |
| 2017 | -1.41 | 2022 | 7.76 |
| 2012 | -1.41 | 2021 | 11.58 |
| 2015 | -0.42 | | |

Source 2: NASA/Climate/Datasets

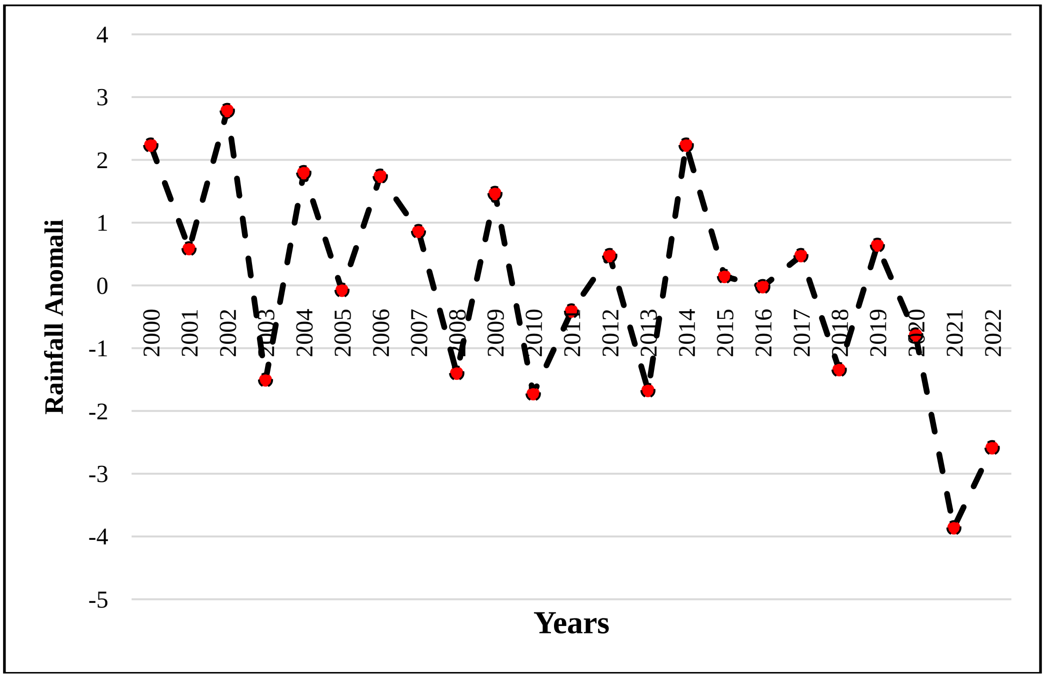



**Figure 3: Rainfall Anomalies (2000-2022)**

Early season monsoon rainfall was as low as 13.5% of the rainfall in July 2002, 8.1% in 2009 (Table 4) which is crucial since the district having large area i.e. 92% under agricultural activities. The period from 2020 to 2022 had the greatest variant in the rainfall as shown in figure 3.

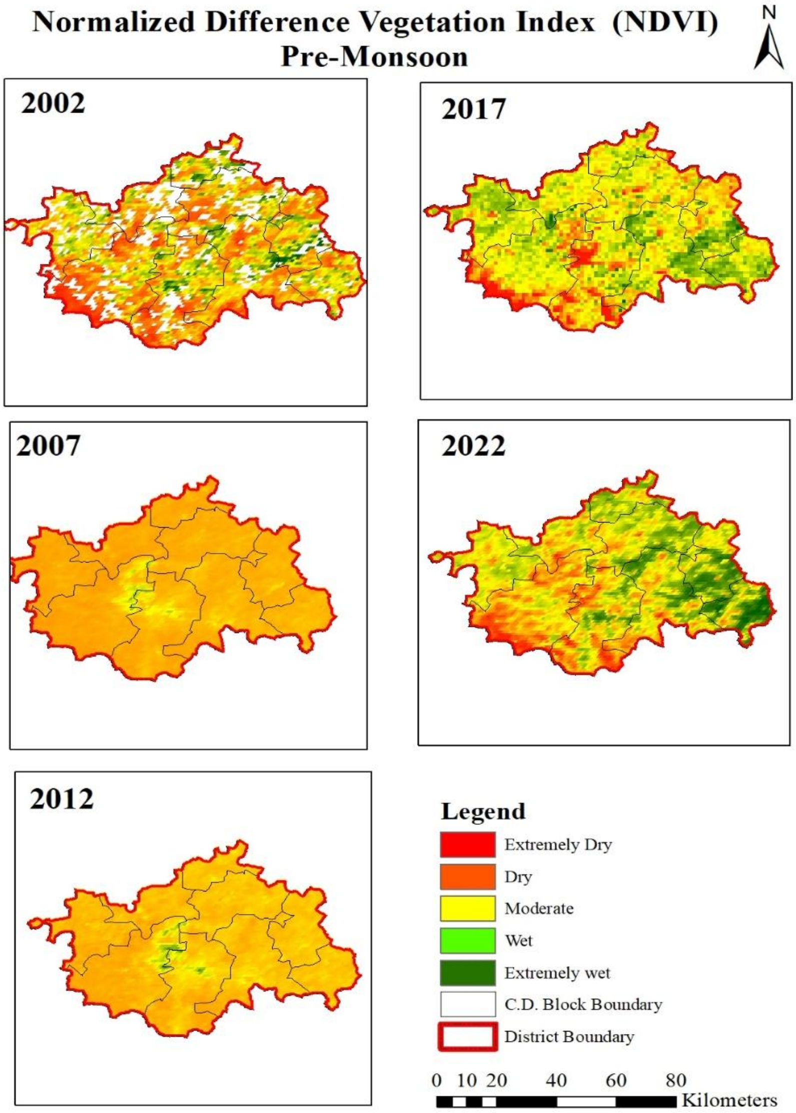
**Agricultural Drought**

NDVI Anomaly images indicated changing drought conditions spatially during the study period 2000 to 2022. NDVI Anomaly characterized by three colours, red colour is indicated for severe drought condition, yellow colour is indicated for moderate and green colour for healthy vegetation condition as given in figure 5 and figure 6.

**Pre-Monsoon Agricultural condition**

It was analysed that pre monsoon condition of agriculture field dried up or bare land without soil moisture that signifies the poor NDVIspecifically in Hisar-I and Adampur C.D. block.

It signifies the extremely dry condition whereas in year 2007 and 2012every block had dry condition according to NDVI values that signifies the drought condition in the entire Hisar district. In other years Uklana and Narnaund CD block had good condition of vegetation respective of other blocks as given in figure 5.

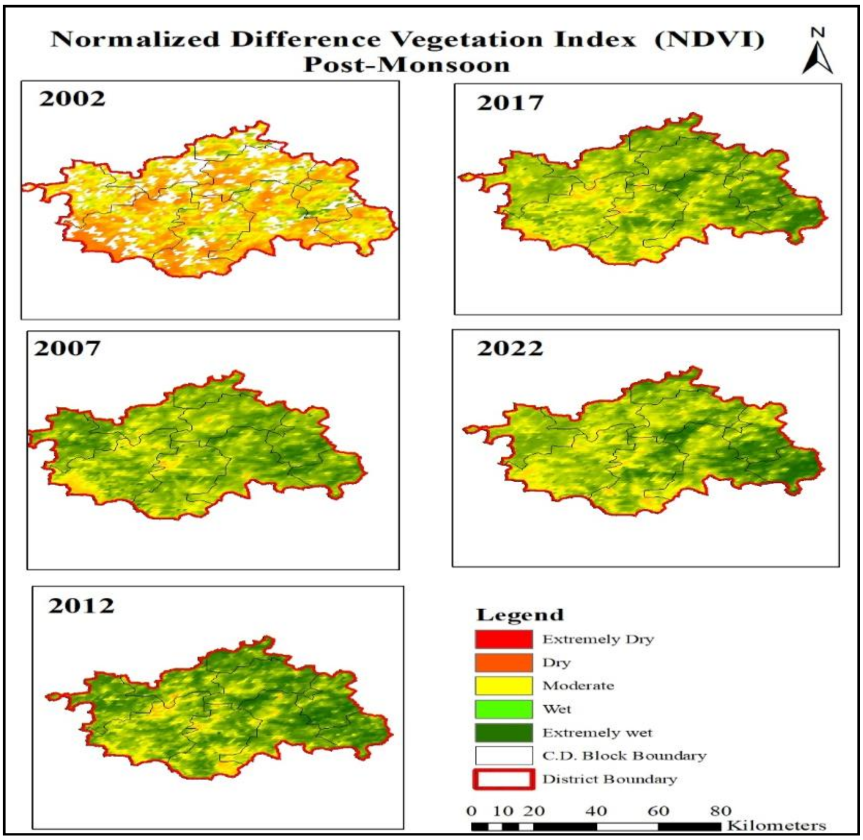



Source: Awifis and MODIS

**Figure 5: Agricultural condition during Pre-Monsoon**

**Post-Monsoon Agricultural condition**

NDVI anomaly is one of the basic techniques to analysis the crop̓s health status and resulted that the year 2002 was the year where after monsoon vegetation health was in dry condition. NDVI Anomaly images indicated changing drought conditions spatially during the study period 2000 to 2022. Results obtained for NDVI irregularity for September month of every after five years from 2002 to 2022 are displayed in and defined that eastern part of the district was in good vegetation condition after monsoon season.




Source: Awifis and MODIS

**Figure 6: Agricultural condition during Post-Monsoon**

## CONCLUSION

The usages of digitally enabled techniques was helpful for different study areas and preparedness resulting in better prioritization of action at spatial and temporal action. The techniques have vital use in different areas of drought prone. It was observed that drought occurrence at an interval of 3 to 4 years characterized its temporal revisit. Agricultural drought occurrence was less in comparison to meteorological drought because of irregular and unpredictable monsoon.

## ACKNOWLEDGMENT

I am Darshna, Research Scholar Department of Geography, Baba Mastnath University, Rohtak doing my PhD Degree from the same department and there was no conflict during the research study. I thanks to Dr Sudhir Malik HoD & professor, Department of Geography for their continuous support and guidance throughout the research work.

## REFERENCES

[1]. ACSAD Drought Vulnerability in the Arab Region (2011). Case study – Drought in Syria, Ten Years of Scarct Water 200-2010.

[2]. Lloyad B., Hughes, M., Sauders A. (2002). A Drought Climatology for Europe. Int. J. Climatol 22: 1571-1592 (2002).

[3]. Bhuiyan C. (2004). Various Drought Indices for Monitoring Drought Condition in Arravali Terrain of India, Proceeding of the 20th ISPRS Conference.

[4]. Singh C. S., Garg P.K., Ghosh S.K., (2012). Mapping of Agriculture Drought Using Remote Sensing and GIS, International Journal of Scientific Engineering and Technology,vol-1, issue no. 4, pp 149-157.

[5]. Central Ground Water Board (2007). Ground Water Information Booklet Hisar district, Haryana.

[6]. Hisar district Gazetteer; 1883-1884.

[7]. Kogan F.N., (1995). Application of Vegetation Index and Brightness Temperature for Drought Detection; Advances in Space Research, pp 91-100.

[8]. Singh, D., Singh S., Shekhar C. & Rao, V.M.O. (2010). Agroclimatic Features of Hisar Region, AICRP on Agrometeorology, Department of Agril Meteorology, College of Agriculture, CCS HAU, Hisar-125004.

[9]. Vashistha D., & Arya V.S. (2012). Drought Analysis using Geo-Spatial Techniques for Hisar District, Haryana. International Journal of Science and Research (IJSR)-ISSN (Online): 2319-7064.