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ASSESSMENT OF METEOROLOGICAL DROUGHT USING SPATIAL INFORMATION TECHNOLOGY

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ABSTRACT

Maps have been generated by integrating multi-source geo-referenced data sets in GIS platform. Measures have also been suggested for mitigation of drought in the vulnerable areas. Analysis of rainfall has been carried out for monthly, seasonal and yearly rainfall at Mandal level. Maps were prepared in GIS environment for annual, South West, North East, summer and winter rainfall for 457 mandals of Telangana region of Andhra Pradesh, India. Drought severity was assessed from the deficit of rainfall data by using the IMD methodology. Average annual rainfall was calculated for the years 2005, 2006, 2007, 2008 and 2009 which were found to be 1069.65mm, 798.20mm, 838.12mm, 969.66mm and 648.86 mm respectively. Percentage deviation from the corresponding average annual rainfall has been calculated during the above period as +17.92%, -14.54%, -7.19%, +6.54% and -26.87% and classified as Normal Rain, Drought, Drought, Normal Rain and Moderate drought respectively. It is concluded from the analysis that geo-informatics aided in obtaining useful information about the drought situation in a short time and in an economic way.

KEY WORDS: GIS, GPS, RS, Spatial Analysis, Rainfall, Drought.

1. INTRODUCTION

The critical problem in dry land agriculture is the uneven distribution of rainfall during the monsoon season and the gap between the occurrence of successive rainfall evens with the season. The total rainfall in a particular area may be either insufficient or is ill timed. The rainfall in particular area may be non-uniform over the crop period. The rainfall distribution of India is most uneven and vanes considerably from region to region, season to season and year to year (Harish Chandra et al, 2006). Palmer (1965) identified monthly index values for past dry periods to yield an equation for calculating drought severity in four classes. In an operational definition of drought it identifies drought from impact data (i.e. crop damage). It is widely accepted that combination of physical nature of area, amount of rainfall and water resource development leads to identify the drought pattern. Giridhar and Viswanadh (2008) carried out rainfall analysis in Palleru (K-11) sub-Basin using GIS. Shrivastava et al. (2000) analyzed rainfall data of 29 years (1967-1995) of Jabalpur, for annual, seasonal, monthly and weekly periods to evolve rainfall based cropping system. Drought indicates the deficit of rainfall, runoff, water availability, soil moisture, ground water, surface water and crop yield that have been the subject of many investigators from the previous century. Another study of rainfall in the northeast of Thailand made by Siripon and Mongkolsawat (2000) concludes that the unevenly distributed rainfall during the rainy season is found extensively and extends longer period in the southwest and the central part of the region. The National Commission on Agriculture (1976) broadly classified droughts into Meteorological drought, hydrological drought and agricultural drought. Meteorological drought is a situation when the actual rainfall is significantly lower than the climatologically expected rainfall over a wide area. Hydrological drought is associated with marked depletion of surface water and consequent drying up of lakes, rivers, reservoirs etc. Hydrological drought results if meteorological drought is sufficiently prolonged. Agricultural drought is the end effect of meteorological and hydrological drought and its severity is assessed from the crop yield. Periodical drought assessment in a region must be necessary to take up management measures. Subramanyam (1967) and Subramanyam et al (1974) considered drought as a shortage of moisture estimated through simple water budgeting procedure. The index developed for drought assessment was known as Moisture Adequacy Index (MAI), which is ratio of water deficit to over water need. Giridhar and Viswanadh (2006) studied and analysed meteorological drought using GIS for K-11 sub basin of river Krishna. Drought severity was assessed from the deficit of rainfall by using the IMD methodology from the historical rainfall data from 1992 to 2004. In the present study, GIS and GPS techniques were used for monitoring and assessment of droughts in Telangana Region. The study explores the drought analysis in Telangana through generation of maps showing vulnerable mandals to various types of drought using GIS. This is done by integrating multisource georeferenced datasets in a GIS platform. The final output comprises the spatial analysis products that are useful in the decision making process for drought assessment. Present study mainly deals with the application of Geomatics for spatial meteorological drought analysis for 457 mandals of 10 districts in the Telangana Region of Andhra Pradesh, India.

2. STUDY AREA

Andhra Pradesh state is located between 12°41' and 22°N latitude and 77° and 84°40'E longitudes. Geographically, Andhra Pradesh is divided into three Regions. The northern part of the plateau is the Telangana region is chosen as the study area. The Telangana region has an area of 114,840 square kilometres and a population of 35,286,757 (per 2011 census). Telangana has 41.6% of Andhra Pradesh state population as per the 2011 census. The region lies on the Deccan plateau to the west of the Eastern Ghats range, and includes the North Western interior districts of the Andhra Pradesh state. Telangana region consists of 10 districts: Adilabad, Hyderabad, Khammam, Karimnagar, Mahbubnagar, Medak, Nalgonda, Nizamabad, Rangareddy and Warangal. Telangana region has 457 Mandals and 10258 Villages.

3. METHODOLOGY

The methodology carrying out analysis of rainfall and drought for the period 2005 to 2009 for all 457 Mandals of Telangana region on Andhra Pradesh consists of several steps as outlined below. Daily rainfall data has been collected for a period of 2005 to 2009 from Bureau of Statistics and Economics (BES), Hyderabad. This data has been checked and processed for finding the missed rainfall data for various rain gauge stations and gaps were accordingly filled. Toposheets were collected from Survey of India, Uppal, Hyderabad. The base map of Telangana Region has been prepared from Survey of India Toposheet on 1:50,000 scale. District boundaries were delineated for all ten districts of Telangana region. Mandal boundaries were then delineated in each district of Telangana region of Andhra Pradesh in GIS environment. Geo-database using daily rainfall for all the Mandals and for all districts of Telangana region has been built in GIS environment. Ground control points have been collected using Global Positioning System for ground verification. Daily rainfall has been converted into monthly, seasonal in terms of South West, North East, Summer, Winter and yearly rainfall for all the districts of Telangana region at Mandal level for further analysis in GIS environment. Meteorological drought severity was assessed from the deficit of rainfall by using the IMD methodology from the historical rainfall data. Drought severity has been graded into five categories namely Drought, moderate drought, severe drought, normal rainfall and heavy rainfall. Drought scenario database at Mandal level for all 457 Mandals on monthly time scale has been prepared. Finally, maps pertaining to spatial distribution of meteorological drought have been prepared for the study area at Mandal level on monthly time scale in GIS environment for policy and decision making.

4. RESULTS AND DISCUSSION

Drought severity has been graded into five categories namely Drought, moderate drought, severe drought, normal rainfall and heavy rainfall. Drought scenario database at Mandal level for all 457 Mandals on monthly time scale has been prepared. Number of Mandals with drought severity grading for each district of Telangana region for each year of the period 2005 to 2008 have been arrived and corresponding maps pertaining to spatial distribution of meteorological drought have been prepared for the study area and presented in Figs 1 to 4. Total number of mandals in each category of drought classes viz., heavy rain, normal rain, drought, moderate drought, severe drought, in Telangana region for the years from 2005 to 2009 has been presented in Table.1. It has been observed that 69 mandals were severely affected and 225 mandals were moderately affected due

to drought in the 2009 year, which is the severely affected meteorological drought year in the period of study.

Table 1 Total number of heavy rain, normal rain, drought, moderate drought, severe drought Mandals in Telangana region for the years from 2005 to 2009

Drought Classification / Year	Heavy Rain	Normal Rain	Drought	Moderate Drought	Severe Drought
2005	225	114	81	35	2
2006	56	69	143	167	22
2007	80	97	150	119	11
2008	118	105	143	83	8
2009	58	45	60	225	69

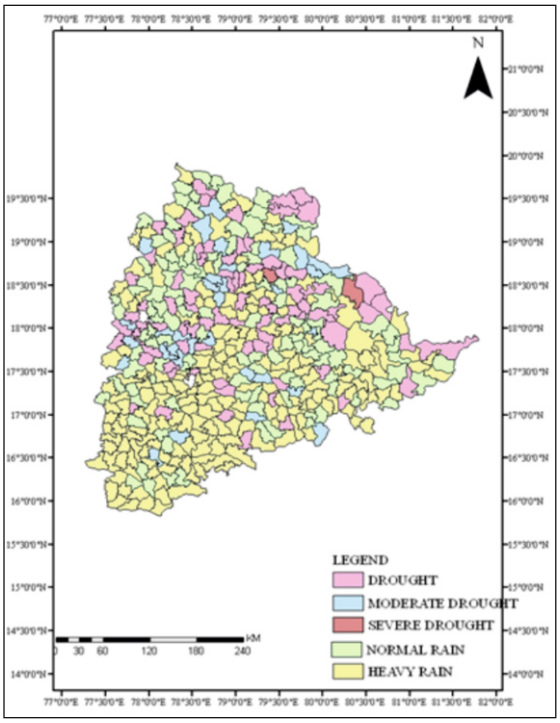

Fig 1 Mandal wise grading of drought in the year 2005 for Telangana region of A.P.

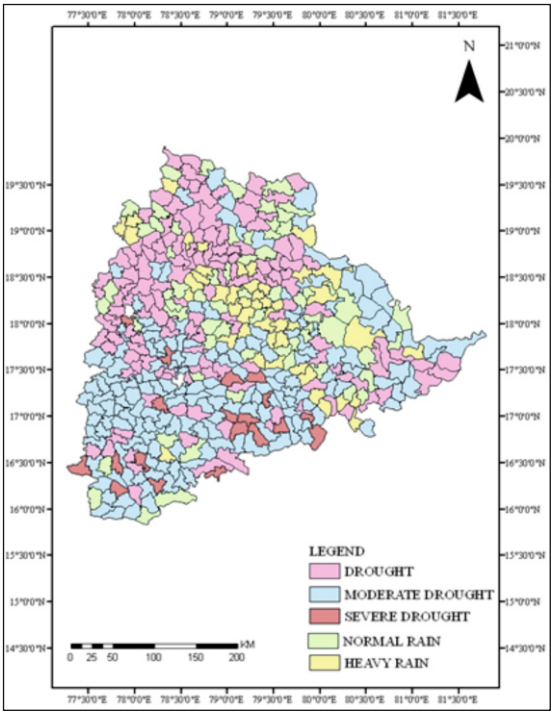

Fig 2 Mandal wise grading of drought in the year 2006 for Telangana region of A.P.

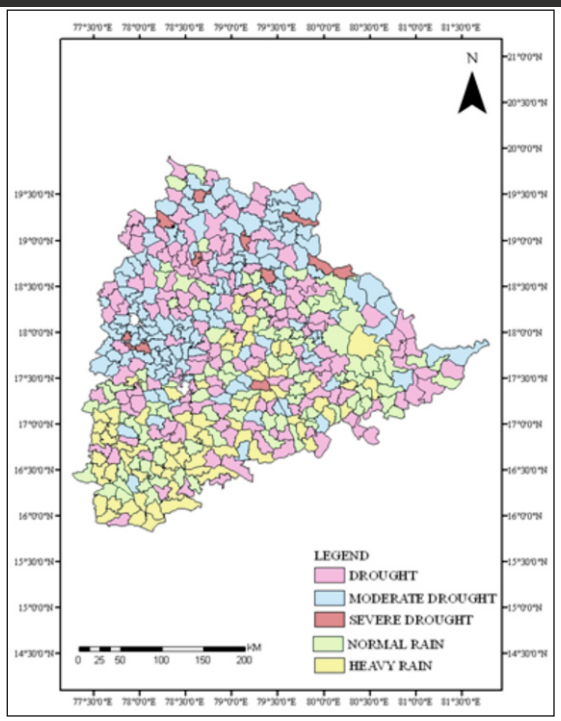

Fig 3 Mandal wise grading of drought in the year 2007 for Telangana region of A.P.

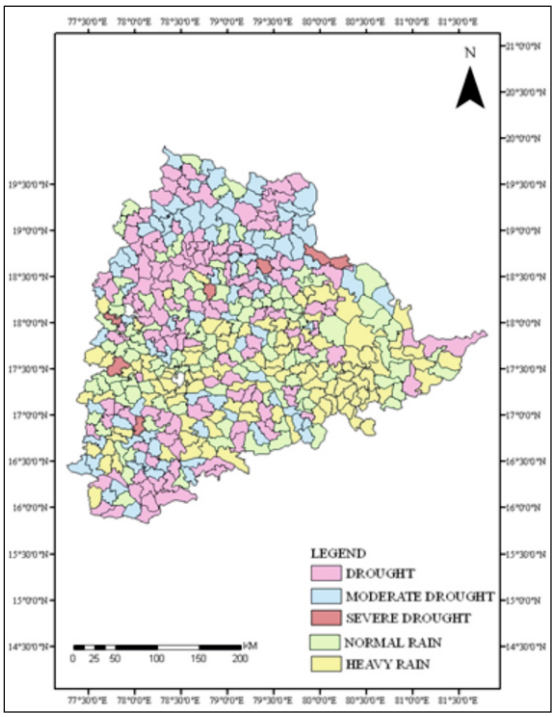

Fig 4 Mandal wise grading of drought in the year 2008 for Telangana region of A.P.

5. CONCLUSIONS

GIS has been found to be effective and efficient in the delineation of district boundaries as well as the mandal boundaries of Ten district of Telangana region. Spatial geodatabase using daily rainfall for all the 457 Mandals in GIS environment was developed. Spatial analysis of rainfall has been carried out for monthly, seasonal and yearly rainfall for all the districts of Telangana region at Mandal level. Maximum Rainfall was encountered at Khammam district is 1435.73mm in 2005 and Minimum rainfall was encountered at Mahaboobnagar is 416.73 mm in 2006. Number of Mandals with drought severity grading for each district of Telangana region for each year of the period 2005 to 2009 have been calculated and corresponding maps pertaining to spatial distribution of meteorological drought have been prepared for the study area. Total number of mandals in each category of drought classes viz., heavy rain, normal rain, drought, moderate drought, severe drought has been calculated. It has been observed that 69 mandals were severely affected and 225 mandals were moderately affected due to drought in the 2009 year, which is the severely affected meteorological drought year in the period of study. Present study demonstrated that Geomatic

tools are effective and powerful to carry out spatial analysis of meteorological drought.

REFERENCES

1. Giridhar. MV.S.S. (1995) "Validation of satellite derived drought assessment through water balance approach at Mandal level" an unpublished M.Tech thesis, Indian Institute of Technology, Kharagpur.
2. Giridhar. M.V.S.S. and Viswanadh G.K (2006) "Meteorological drought analysis using GIS" procs of the International conference on Geomatics for rural development – Achieving synergy between technical and social systems, during 5-8th June 2006, organized by research & development cell, JNTU, Hyderabad and Geomatics cell.
3. Giridhar. M.V.S.S. and Viswanadh G.K (2008) Rainfall analysis in Palleru sub-basin using GIS, International Journal of Applied Engineering Research, Nov, 2008.
4. Harish Chrandra, H.C. Sharma, B.P. Yadav and Pradeep Kumar (2006) pattern or rainfall in district Udham Singh Nagar", Proceedings of 2nd International conference on Hydrology and Watershed Management during 5-8 December, 2006 Volume: I pp:228 - 236.
5. Palmer, 1965: Meteorological Drought, Office of climatology. Washington D.C., U.S. Weather Bureau, Research paper No. 45, 58pp.
6. Shrivastava, S.K. Upadhyay, A.P.; Sahu, A.K. and Dubey, A.K. (2000). "Rainfall characteristics and rainfall based cropping strategy for Jabalpur region". Indian J. Soil Cons.,Vol. 28 (3);. Pp 204-211.
7. Siripon, K., and C. Mongkolsawat, 2000: Spatial and Temporal Analysis of Rainfall Pattern in Northeastern Thailand: Application of GIS. Journal of Remote Sensing and GIS, Association of Thailand, 1(1), 1-18.
8. Subramanyam, V.P. (1967), "The problem of incidence and spread of continental drought", WMO report no: WMO/IHD-2, Geneva, p.52
9. Subramanyam, V.P. and Sastry, C.V.S.(1969), "Climatic analogues for the dry regions of India" Tropical Ecol. Vol.10, No.1, pp:34-54.