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NIAS Discussions

NATIONAL INSTITUTE OF ADVANED STUDIES (NIAS)

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Drought Severity in the Drier Regions

Assessment and Mapping of Karnataka

By

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Dr Jayasree Vaidyanathan has a PhD in Hydro-meteorology and specialisation in remote sensing and Geographic Information Systems. Her research interests are on looking at how climate and man-made changes affects hydrological functions of river catchments, flood and drought modeling, how cities cope with water stress and also on water, sanitation and hygiene in rural areas and in urban slums.

Droughts are one of the major disasters that impact the amount of water available to crops. Being an insidious hazard of nature, they are often referred to as creeping phenomenon. They are part of any climate and its impacts vary from region to region. Due to this, it is difficult to provide a precise and universally accepted definition of drought, and no single definition of drought will work in all circumstances.

This is why policy makers, research planners and others have more trouble in recognizing and planning for drought than they do for other natural disasters. Drought has extensive spatial dimension and thus has serious implication on the socio-economic stability of a region. As it is not possible to avoid droughts, a

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detailed monitoring of droughts on spatial and temporal scale is essential to avoid such disaster for sustainable economy.

Being a natural hazard as well as a disaster (Paulo et al 2012), drought is characterized by its severity, duration and areal extent. Together with these, characteristics such as frequency and vulnerability are also important as these characteristics are beneficial in developing drought policies, monitoring systems, mitigation strategies and preparedness plans. Mapping of drought disaster is one of the adaptation plans to the consequences of increasing climatic variability and changes.

India's one sixth of the geographical area is under drought, affecting 12% of its population. During the last century, India witnessed worst droughts in the years, 1917-18, 1965-68, 1986-87, 2002, 2009,2012 (Manual on drought management 2009) and 2014-2016. Studies have shown that the severity of drought is increasing in the recent times due to failing monsoon, climate change and anthropogenic activities. Drought disasters have become a national priority for Indian Government particularly as climate change causes erratic monsoon. Drought prone areas are mostly found in arid, semi-arid and sub-humid regions which experience very less average annual rainfall. Recent consecutive droughts in the country have highlighted country's increasing drought frequencies and continued vulnerability to the hazard (Joseph et al 2016).

In terms of total geographical area prone to drought Karnataka is ranked next only to Rajasthan in India (Nagaraja et al 2011). In the state, there are two distinct belts both in North and south where droughts are common. North Karnataka districts are very much vulnerable to droughts which occur almost every other year. Sandwiched between Western and Eastern Ghats and lying on Deccan plateau, the area receives less rain because of its location in the rain shadow region. The people in this region are vulnerable owing to frequent droughts which bring devastating effects on agriculture and livelihood as well as economy of the region. Consequent droughts in the recent past have resulted in huge economic loss to the state. In spite of frequent drought occurrences in the region, there are no comprehensive and integrated contingency plans for drought mitigation. Therefore, it is important to understand the drought characteristics and mapping of the same from a large scale at least at Taluk level to make the interventions more effective and meaningful.

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The present study focuses on drought assessment with an aim to understand the drought vulnerability estimates and map the drought duration and severity in North Interior Karnataka region. The region, comprising of seven districts namely Bagalkot, Bijapur, Bidar, Raichur, Koppal, Gulbarga and Yadgir occupy almost 54493 sq.km is highly drought prone. An attempt has been made to analyse rainfall characteristics to define drought

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vulnerability of the area. Mostly semi-arid, with hot, dry climate, region receives about 650 mm of rainfall in about 50 days. Recurring prolonged droughts have caused consequences and impacted the human systems. Study is intended to understand rainfall characteristics that define drought conditions and classify into climatic types in terms of rainfall availability as well as drought characteristics. Drought classification is based on analysing on intensity, duration, frequency and severity for a given period using the methodology developed by Ponce et al (2000). This method is advantageous to define climatic types into a wide range of classes across the climatic spectrum.

Detailed analysis of rainfall and drought characteristics were carried out using time series of daily rainfall data from 175 rain gauge stations for about 45 years (data period 1970-2014) of the study area. These data were obtained from Directorate of Economics and Statistics, Government of Karnataka, India Meteorological Department, Bengaluru and from Water Resource Development Organization, Karnataka. Rainfall descriptive, variability, percentage occurrences of drought incidences was derived. Areal rainfall was estimated using Thiessen polygon method. An isohyet map generated to understand the spatial trend in rainfall. Drought estimates were arrived at and they were classified into various severity classes using climatic spectrum provided by Ponce and Pandey (2000)

Drought intensity, duration, frequency and recurrence intervals were estimated and droughts were classified into various severity classifications using climatic spectrum. Drought conditions were interpreted for each of these locations and the severity map is prepared using geographic information system and areal extent of severity was estimated.

Drought impacts are complex, location specific and therefore the interventions also should be locale. In India, most of the Government interventions are carried out at district or zilla Panchayat level. This method of drought classification allow mapping at station level which may be across administrative boundaries, which would encompass mitigation planning at micro-level.

Statistical parameters of daily rainfall series indicate that rainfall is highly variable in both space and time. The region receives an average annual rainfall of 629 mm in about 46 days. Variability of rainfall is very high in north western districts like Bijapur, Koppal, Bagalkot receiving an annual rainfall of 539, 558, and 576 falling within 43, 38 and 50 days. Eastern districts, Gulbarga and Yadgir get about 668 (within 49 days) and 731 (in 56 days) of rainfall. Bidar in the northern part receives comparatively higher rainfall. Coefficient of variation is very high in the study region with maximum variations occurring in eastern districts. While annual minimum rainfall varied from 101.5 to 372.6 mm,

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annual maximum ranged between 638 mm to 1285 mm among stations. Analysis of inter-annual, inter-seasonal, intra-annual and intra- seasonal rainfall patterns showed pronounced variation in rainfall pattern with annual rainfalls following the monsoonal pattern. Isohyet map shows the rainfall gradient towards north and east.

Each of the stations falls under semi-arid type with very few arid climates. Annual rainfall variability indices show that almost 88% of the stations have more than 55% dry periods compared to the wet ones. Average drought parameters, the intensity and duration showed that Bagalkot district had an average intensity of about 0.54 with variations between 0.33 and 0.88. Drought duration averaged to 2.37 years with return period of 3.57 years. Bijapur district had an average intensity 0.59 varying from 0.2 to 1.11, with average duration of 2.26 years. In Bidar, average drought intensity recorded 0.52 varying between 0.31 and 0.99, while average duration was 2.3 years and return period was 4.2 years. Gulbarga and Yadgir showed similar patterns with average drought intensity 0.77 and 0.77, average duration 2.58 years and 2.94 years and return periods of 4.0 years and 4.5 years respectively. Drought characteristics varied similarly among Raichur and Koppal districts.

The classification of drought intensities based on climatic spectrum showed that drought intensities of moderate (less than 0.625) category were the highest followed by severe (0.625-1.250) and then extreme

(more than 1.250). In Bagalkot district, out of 231 drought events, 70.5% were moderate, 19.9% were severe and 9.6% were extreme. Bidar had 259 drought events, 73.4% moderate, 20.8% severe and 5.8% extreme droughts. Bijapur had 458 drought events, 68% being moderate, 19,8% severe and 12.2% extreme. Raichur and Koppal had almost 71% moderate, 20% severe and 9% extreme events. Gulbarga experienced 390 drought events, out of which 68% were of moderate intensity and 20.1% were severe and 11.9% was extreme. In Yadgir districts, 361 events were recorded, with 64.8%, 21.1% and 14.2% classified as moderate, severe and extreme intense. All the stations in the study area had very few high intense droughts which were observed for 10-15% of the time period. However, events having intensity <1.0 occurred for most of the time.

Overall categories of drought show that the most severe and frequent droughts occur in northern part of the study region. Northern and western portions of the study area are under severe drought conditions. Extreme drought conditions persisted in the central region. Moderate drought severity occurred only in very few locations. Out of the total area, about 50.4% area was under extreme drought, 41.1% area under severe drought and 8.5% area under moderate drought.

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impact and geographical range) in the coming years. Decadal average rainfall index also point towards higher drought instances in the future. The overall outcome of the study could be of valuable in understanding severity, extent and drought pattern that can be used by scientists and water management professionals while planning drought mitigation measures.

About NIAS Wednesday Discussions…

The NIAS faculty meets every Wednesday morning for academic discussions on various topics. As envisioned by Raja Rammana, the Founder Director of NIAS, and pursued by his successors, the Wednesday meetings present the ongoing research, work-in-progress, and new/innovative ideas from the research studies of the faculty and the young researchers.

This Forum provides an excellent space to present one's work and also receive feedback and comments. Besides NIAS faculty and doctoral scholars others from outside the Institute also take part in these discussions.

Prof. Sangeetha Menon (smenon@nias.iisc.ernet.in) coordinates these meetings.