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Review and Analysis of Drought Monitoring and Management

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ABSTRACT

The study on drought analysis and warning can play a significant role in saving human lives and movable properties by informing the people in advance about the likely level of water and its duration at specific places. It also helps in organizing timely rescue and drought fighting measures in order to prevent or minimize the risk to drought hazard. Drought analysis and risk assessment is an important non-structural measure of drought prevention. The main objective of this study is to develop an advance warning system in the form of analysis of flood risks of incoming drought, so that an early warning can be given to the people likely to be affected and various hazard and risk affecting maps can be prepared in advance with an ease. For this a detailed analysis, survey and research has been carried out with a series of most locally useful software applications.

Keywords : Standardized precipitation index, drought duration

I. INTRODUCTION

Drought is an insidious natural hazard characterized by lower than expected or lower than normal precipitation that, when a season or longer period of time extended over, is insufficient to meet the demands of human activities and the environment. Drought is a temporary aberration, unlike aridity, which is a permanent feature of climate. Drought must be considered a relative, rather than an absolute, condition. It occurs in both high and low rainfall areas and virtually all climate regimes. Drought is often associated only with arid, semi-arid and sub-humid regions by scientists, policymakers and the public. In reality, drought occurs in most countries, in both dry and humid regions. Drought is a normal part of climate, although its spatial extent and severity will vary on seasonal and annual timescales.

Drought by itself is not a disaster. Whether it becomes a disaster depends on its impact on local people, economies and the environment

II. types of drought

Mainly, the types of Drought depending on the environmental conditions as that under

A. Metrological drought:

Meteorological drought is a natural is no direct relationship between precipitation and infiltration of precipitation into the soil. Infiltration rates vary, depending on antecedent moisture conditions, slope, soil type and the intensity of the precipitation event. Soil characteristics also differ: some soils have a high water-holding capacity while others do not. The latter are more prone to agricultural drought. This happens when the actual rainfall in an area is significantly less than the climatologically mean of that area. The country as a whole may have a normal monsoon, but different meteorological districts and sub-divisions can have below normal rainfall. The rainfall categories for smaller areas are defined by their deviation from a meteorological area's normal rainfall.

Excess: 20 per cent or more above normal Normal: 19 per cent above normal - 19 per cent below normal Deficient: 20 per cent below normal - 59 per cent below normal Scanty : 60 per cent or more below normal

Fig.1 metrological drought [source:google image]

B. Hydrological drought:

It is even further removed from the precipitation deficiency since it is normally defined by the departure of surface and subsurface water supplies from some average condition at various points in time. Like agricultural drought, there is no direct relationship between precipitations amounts and the status of surface and subsurface water supplies in lakes, reservoirs, aquifers and streams because these hydrological system components are used for multiple and competing purposes, such as irrigation, recreation, tourism, flood control, transportation, hydroelectric power production, domestic water supply, protection of endangered species and environmental and ecosystem management and preservation. There is also a considerable time lag between departures of precipitation and the point at which these deficiencies become evident in surface.

Fig.2 Hydrological drought [source:google image]

C. Agriculture drought:
It is defined more commonly by the availability of soil water to support crop and forage growth than by the departure of normal precipitation over some specified period of time. There sectors are related to the availability of surface and subsurface water supplies. It usually takes several weeks before precipitation deficiencies begin to produce soil moisture deficiencies leading to stress on crops, pastures and rangeland. Continued dry conditions for several months at a time bring about During drought, not only are inflows to recharge surface and subsurface supplies reduced but demand for these resources increases dramatically as well. a decline in stream flow and reduced reservoir and lake levels and, potentially, a lowering of the groundwater table. When drought conditions persist for a period of time, agricultural, hydrological and socio-economic drought occur, producing associated impacts. the direct linkage between the main types of drought and precipitation deficiencies is reduced because water availability in surface and subsurface systems is affected by how these systems are managed. Changes in the management of these water supplies can either reduce or aggravate the impacts of drought. For example, the adoption of appropriate tillage practices and planting more drought-resistant crop varieties can diminish the impact of drought significantly by conserving soil water and reducing transpiration. Earlier years of all-India drought 1987, 1979, 1972.

Fig.3 Agricultural drought [source:google image]

D. Socio-economic drought:
It is differs markedly from the other types of drought because it reflects the relationship between the supply and demand for some commodity or economic good, such as water, livestock forage or hydroelectric power, that is dependent on precipitation. Supply varies annually as a function of precipitation or water availability. Demand also fluctuates and is often associated with a positive trend as a result of increasing population, development or other factors. The interrelationship between these types of drought is illustrated in Figure 4. Agricultural, hydrological and socio-economic drought occurs less frequently than metrological drought.

Fig.3 Agricultural drought [source:google image]

III. current challenges in drought management

1. Drought intensity assessment and monitoring,

2. Drought declaration and prioritization of areas for drought management and,

3. Development and implementation of drought management strategies.

Each step in drought management needs holistic approach to ensure effective end result. Currently, drought management faces the following challenges among others……

(A) All contemporary knowledge, experience and information i. are taken on board, clear destinations identified and road maps drawn with milestones clearly marked off through a wide consultative process involving all stakeholders.

(B) The evolution and practice of standard procedures for declaration of drought including the time of declaration is promoted and the gravity of the risk and the vulnerability of various States are duly understood.

(C) Development of standard procedures for drought vulnerability assessment and generation of vulnerability maps in each state is undertaken.

(D) The critical areas for minimizing loss of lives, livelihood and property are addressed purposefully and systematically.

(E) Measures are put in place for drought proofing of chronically drought-prone areas.

(F) The India Drought Management Centre (IDMC) is set up.

(G) Organization and development of a centralized data base at state level and at nation level related to drought intensity assessment, drought declaration, vulnerability assessment and drought management are undertaken on priority. Grievance Management Systems are put in place for ensuring that benefits reach the intended beneficiaries.

(H) Application of ICT is promoted not only to create the databases, but also for effective monitoring the measures being taken. Effective use of e-mail, Video Conferencing, mobile phones for reducing time lag in traditional systems is encouraged.

(I) Remote sensing technology and data warehousing is promoted to study historical and future trends of the drought occurrence and its effects.

(I) There is institutional participation and use of collective expertise in the drought intensity assessment/drought declaration/drought vulnerability assessment. Expert advisory systems are set up for providing advice to the affected population to mitigate the effects

(J) A common policy is evolved to dovetail short-term relief measures into long-term interventions being handled in different Ministries/ Departments for comprehensive and all-inclusive Drought Management.

(K) Global and National best practices in Drought Management are identified and adopted.

IV. IMPECT OF DROUGHT:
One of the sectors where the immediate impact of drought is felt is agriculture. With the increased intensity or extended duration of drought prevalence, a significant fall in food production is often noticed. Drought results in crop losses of different magnitude depending on their geographic incidence, intensity and duration. The droughts not only affect the food production at the farm level but also the national economy and the overall

food security as well. Their impact is also felt due to:

- Deficit in ground water recharge.
- Non-availability of quality seeds.
- Reduced draught power for agricultural operations due to distress sale of cattle,
- Land degradation.
- Fall in investment capacity of farmers, rice in prices, reduced grain trade.

V. NEW APPROACHES AND METHODS:

A fresh look needs to be taken for greater research and development efforts focused to new tools and approaches as well as the required paradigm shift in technology development with the involvement of the clients and stakeholders. The new approach may comprise of the following areas…

Development of early warning and expert systems mobilizing farmers On-farm research and PTD in farming system research perspective long-term strategy for development with emphasis on: Prevention, mitigation and preparedness for drought Integrated watershed management rainwater harvesting Soil and crop management approaches are under.

v Observed data:

- Timing of droughts
- Drought intensity
- Drought duration
- Spatial extent of a specific drought episode
- Analysis of the risk of the phenomenon and its likely effect on agricultural production.

A. Timing of droughts:

According to the British Meteorological Office (Crowe 1971), an absolute drought begins when at least 15 consecutive days have gone by with less than 0.25 mm of rainfall on all days and a “dry spell” is a period of at least 15 consecutive days none of which has received 1 mm or more.

B. Drought intensity:-

- Presentation of current rainfall data along with long-term average rainfall:
- Presentation of current rainfall as a percentage of long-term average rainfall:
- ♦ Using different thresholds of current rainfall as a percentage of long-term Average rainfall:
- ♦ Computing drought indices and using the indices in a comparative mode to depict

C. Drought intensities:

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VI. crop moisture index

The Crop Moisture Index (CMI), developed by Palmer (1968) subsequent to his development of the PDSI, uses a meteorological approach to monitor week-to-week crop conditions. CMI defined drought in terms of the magnitude of computed abnormal ET deficit which is the difference between actual and expected weekly ET. The expected weekly ET is the normal value, adjusted up or down according to the departure of the week’s temperature from normal.

D. Standardized precipitation index:

Standardized Precipitation Index (SPI) to quantify the precipitation deficit for multiple time scales. In SPI calculations, the long-term precipitation record for a desired period is fitted to a probability distribution. If a particular rainfall event gives a low probability on the cumulative probability function, then this is indicative of a likely drought event. The cumulative probability gamma function is transformed into a standard normal random variable Z with mean of zero and standard deviation of one so that the mean SPI for the location and desired period is ze Positive SPI values indicate greater than median precipitation, while negative values indicate less than median precipitation. SPI represents the amount of rainfall over a given time scale, with the advantage that it also gives an indication of what this amount is in relation to the normal, thus leading to or to the definition of whether a station is experiencing drought or not.

SPI VALUES	DROUGHT INTENSITY
2.0 +	extremely wet
1.5 to 1.99	very wet
1.0 to 1.49	moderately wet
.99 to -.99	near normal
-1.0 to -1.49	moderately dry
-1.5 to -1.99	severely dry
-2 and less	extremely dry

Table 1.Drought intensity value

One of the advantages of the SPI is that it can be computed for multiple time scales(i.e., 1-, 2- ,3- . . .72 months), thus allowing for comparisons between time periods. This can be an excellent communication tool to the public and to policy makers. In addition, these various time scales can be useful in assessing effects on different components of the hydrologic system (e.g., stream flow, reservoir levels, and ground water levels).

E. Drought duration

Information on drought duration depends not only on the onset of drought, but equally on when exactly the droughts end. In some years, it might appear that drought had been relieved through a light shower, but in effect the drought could persist because of a subsequently long dry period.

F. Spatial Extent of a Specific Drought Episode:

The Spatial extent of specific drought episodes is best described using mapping tools. One of the good examples is the Drought Monitor which was developed for the United States and represents a weekly snapshot of current drought conditions Droughts are also classified according to their severity, from 1 (moderate) to 4 (exceptional) (Wilhite and Svoboda, 2000). One of the useful ways to represent the spatial extent of droughts is to map the average frequencies of dry spells which can be computed from the dry spell lengths:

F = N (Di). 100
M
Where,
N (Di) is the number of occurrences of dry spells
D for a prescribed period I
M is the number of years of data

VII.CONCLUSION:

Future plans should examine more fully a process for dealing with water use conflicts, declaring “limited” or regional water conservation emergencies and providing more detailed guidance in the development of local and user specific water shortage management plans. Future planning for drought management should allow for full participation by public water systems, industry, the agricultural community.

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