DROUGHTS: CAUSES, DISTRIBUTION AND CONSEQUENCES

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Summary

Drought is one of the most damaging environmental phenomena. In general, drought is a temporal reduction of environmental moisture status relative to the mean state. Because of the complexity of drought, it is often studied only by separate aspects of the phenomenon (e.g. meteorological drought, soil drought, etc.). Hence, approaches to drought identification are variable. The theory of drought identification, which permitted assessment of location, intensity, and duration of drought from study of environmental moisture status dynamics, was developed at the end of the 1960s. The verification and development of drought theory require monitoring of numerous environmental parameters. Remote sensing of the earth surface in arid areas is valuable for this purpose.

The nature of drought as a complex environmental phenomenon is not completely revealed yet. The known main regional causes of droughts are often considered outside the context of their global causes. The latter depends on the global dynamics of the atmosphere and ocean general circulation, particularly in the tropics. Some observed droughts may be explained from the effect of long-term abnormal ocean surface temperature on general circulation. There is an opinion that long-term droughts, e.g. in the Sahel, are intensified by regional feedback mechanisms. At present, we are not able to satisfactorily predict the beginning, duration, end, or recurrence of droughts. Confidence in drought prediction on a timescale of a month to a season is based on regional abnormal precipitation or abnormal ocean surface temperature in the tropics, revealed by model calculations. Probability drought prediction is, however, quite well developed.

The global warming of the twentieth century is characterised by growing annual

precipitation over the land mostly outside arid areas. Some arid areas of Africa suffered from sustained reduction of rainfall over several decades of the late twentieth century, and recurring droughts. Drought is one of the most hazardous phenomena for human beings. Simultaneous large-scale droughts in different areas directly impair food supply for a considerable part of the world's population. In human-developed arid areas, droughts intensify desertification.

1. What Is Drought?

Drought is one of the most damaging environmental phenomena, doing enormous damage to humankind. Thus, it is no mere chance that the international scientific community pays much attention to the study of drought. Minimising only the disastrous impact of droughts will provide, as the founder of astronautics K.E. Tsiolkovskiy said, "a heap of grain and an ocean of power." Despite a great number of works dealing with droughts, their nature is not finally clear. The methods for predicting droughts are also far from perfect.

In defining drought it is particularly important to distinguish between dryness and drought. Dryness is a constant feature of an arid area caused by the climate. The total area of arid climates is estimated at about 42% of the Earth's land. Drought, on the other hand, is a temporary phenomenon related to the failure of usual precipitation. It always results in temporary loss of water and plant resources.

Perennial drought occurs only in extra-arid climates. The term *seasonal drought* characterises seasonal reduction of rain in savanna, the Mediterranean, and the monsoon subtropics. The periodic (seasonal) reduction of rain is called normal seasonal drought, and a dry period within a dry or wet season is called abnormal drought.

The term ***drought*** is differently defined because the phenomenon is studied from different points of view. Different terms are used in different fields of study, e.g. meteorological drought, soil drought, or agricultural drought. Depending on seasons, droughts are classified as spring, summer, or autumn. By intensity, droughts are moderate, severe, or extreme.

Drought is often defined as a temporary situation when the water demand of a hydrological system (which may be an ecosystem or an anthropogenic system) exceeds the income of water from any sources. Precipitation is a major source in most ecosystems. Hence, many droughts directly depend on the failure of precipitation. These droughts are also called meteorological droughts. They occur, as a rule, because of lack, insufficiency, or inadequate distribution of precipitation. The approach in the context of meteorological drought is objective, but the assessment of drought is relative.

A prolonged lack of precipitation may have varied consequences for many water use systems. Resulting from this approach, drought actually disappears as a specific natural phenomenon. Therefore, in many other definitions of the term ***drought***, researchers seek to precisely define the effect of water shortage on a water use system.

The second approach defines drought as an atmospheric phenomenon as well as soil,

agricultural, and hydrologic phenomena. For example, agricultural and hydrological droughts appear when the water shortage significantly affects the agricultural or hydrologic activity. This approach is indefinite too. The point when moisture loss in the root-inhabiting layer becomes dangerous as a result of lack of precipitation, is variable and indefinable. The financial value of crop damage resulting from lack of precipitation depends on both the local situation and the agricultural practice.

Bearing in mind the above points, drought can be defined as an extended period when evapotranspiration exceeds precipitation, causing the depletion of soil moisture and consequently reduction of ecosystem productivity. In general, drought means the temporary reduction of environmental moisture status (EMS) relative to the mean state.

It should be noted that there are other specific definitions of drought, e.g. a period of increased fire hazard to forests or pastures.

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Biographical Sketch

Alexander Nikolaevich Zolotokrylin was born on July 12, 1938. He is a leading scientist of the Climatology Laboratory at the Institute of Geography (IG), Russian Academy of Sciences (RAS).

His main objective is observation and study of spatial and temporal variability of energy cycle components and surface characteristics over inhomogeneous surfaces in different vegetation zones at a sub-grid scale for global climate models, diagnosis of inter-annual changes of atmospheric circulation and climate, forecasting impacts of climate change on selected components of the environment, and climate aspects of desertification.

He graduated in 1967 (MS, Geography-Climatology) in the Department of Geography, Moscow State University, and in 1975 obtained his doctorate (Ph.D.) in geography (climatology, meteorology, agrometeorology). His thesis was entitled Energy Balance of Forests.

Dr. Zolotokrylin has authored more than 90 research papers and sections of collective monographs in the field of climate and environment.

Other Positions: 1986–1996 – Head of Geosystem Climatology laboratory IG RAS; 1988–1994 – member of National Program on Hydrological and Atmospheric Processes for the project Global Energy and Water Cycle Experiment (GEWEX) of the World Climate Research Programme. 1988–1991 – responsible for the climatological part of international experiments KUREX-88 and KUREX-91 under GEWEX. Since 1994 he has been a member of the Russian National Committee on GEWEX Asian Monsoon Experiment – Siberia (GAME – Siberia). Since 1988 he has been a full member of the Russian Geographical Society.