PLANNING FOR THE MITIGATION OF HYDROLOGIC DROUGHTS IN NIGERIA

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ABSTRACT

Nigeria's water resources require proper management to cope with increaseing demand for both in-basin and withdrawal uses in normal hydrological periods. In periods of drought, however, the inability of supplies to satisfy demands can have serious disruptive effects on both the economy and the environment. Hardships caused by droughts require a balance between demand for and supply of the nation's water resources.

This paper examines alternative measures, structural as well as non-structural, to ensure sustainable water use in Nigeria. Particular attention is given to long-term measures that reduce the growth rate of water demands, increase the efficiency of existing water uses, enchance water supply systems, and increase user awareness of water value.

KEYWORDS

Water Resources Development and Management, Hydrological Drought, Water Supply, Water Demand, Drought Impacts, Adjustment and Response Measures.

1. INTRODUCTION

Droughts constrain water resources development and utilization, especially in areas where moisture deficits exceed surpluses, as shown in Fig. 1(a). The margin between surplus and deficit is often small, even in normal hydrological conditions. Droughts further reduce that margin, resulting in low economic output and increased user conflicts. Fig .1 (b) shows the drought pattern in Nigeria.

In the face of growing water demands in industry, agriculture and municipalities, coupled with rising economic and environmental costs associated with traditional methods of exploitation, a new approach is needed in water resources management. Failure to respond appropriately to this need could jeopardize the sustainability of water use. The principle of sustainable water resources development is hinged on long-term planning and management. These call for an integrated multisectoral approach, and close cooperation among all parties involved. A balance between demand and supply must be reached during a drought, as in normal hydrological conditions, for sustainability. As Fig . 2 suggests, with rational measures based on careful planning, drought impacts can be minimized.

This paper disscusses some of the measures to prevent or reduce the impact of hydrological droughts in Nigeria, with emphasis on long-term measures. A hydrological drought, for this purpose, is defined as a sustained period of below normal streamflows, lake or groundwater levels, resulting in insufficient water to meet established needs.

2. DROUGHT IMPACTS

2.1 BIOPHYSICAL IMPACTS

Low water levels and flows lead to reduced water quality. This is reflected in increased water temperature, decreased dissolved oxygen content, greater weed and algae growth and higher concentrations of contaminants, such as nutrients and dissolved salts. Municipal and industrial pollutants, as well as agricultural non-point source pollution, increase the problems caused by low flows. Consequently, reduced water quality limits the ability to maintain aquatic and wild life.

2.2 SOCIO-ECONOMIC IMPACTS

Water supplies are often inadequate to meet established needs during a hydrologic drought. This can have far-reaching effects on the national economy.

The degree of impact will depend on the physical extent, duration and severity of the drought, as well as on societal factors. In addition to the direct impacts on society, e.g., limited domestic and municipal water supplies, there are indirect impacts resulting from reduced economic output in agricultural and hydropower sectors. Outdoor recreation is also adversely affected as low water levels and flows result to poor water quality and reduced aesthetics in water bodies. The associated reduced population of fish limits opportunities for fishing and related socio-economic activities.

3. PREVENTION AND MITIGATION OF DROUGHT IMPACTS

To minimize adverse effects of drought upon the economy and the environment, long-term integrated planning is required. This will involve activities fundamental to the development of effective response measures, whether they are the traditional supply oriented measures or demand management measures, such as data collection, impact assessment, and research. An effective communication system will be necessary to link all parties involved, if drought impacts are to be prevented or mitigated and water used efficiently.

3.1 DATA COLLECTION AND MONITORING

Data on various aspects of water resources, their uses, as well as on factors affecting their bio-physical characteristics will be needed. Providing reliable, timely, accessible and user specific information will require effective and efficient data collection and monitoring programs. A variety of techniques for data collection, such as surface-based instruments, remote sensing, on-site inspection and personal communication, are needed. Information on current conditions and long-term trends are the bases for timely decisions by managers to protect the environment, conserve available resources, and warn against possible socio-economic disruption due to an impending drought.

3.2 DROUGHT IMPACT ASSESSMENT

Impact assessment is used to gain an understanding of the linkages between sub-normal rainfall, water quality and use, and the effects that droughts have on the environment and economy. Thus, improved long and short-term response measures can be developed to prevent or mitigate adverse impacts.

Two ways of drought impact assessment are as follows:

(1) Monitoring impacts of on-going droughts in real time;

(2) Evaluating past, present and future droughts.

The first approach is needed for drought detection and warning. The second approach is for documenting drought-related impacts. Empirical documentation of impacts of past and on-going droughts, and computer simulation of future droughts, are some of the techniques employed.

3.3 RESEARCH AND DEVELOPMENT

Drought problems involve a complex integration of environmental and economic factors. They require an interdisciplinary research approach, and a long-term commitment of resources. However, research into drought problems is necessary for improved understanding of causes and consequences, as a prerequisite to anticipating and preventing drought impacts.

Areas for drought research can be classified as follows:

(1) The determination of the economic and social value of water for future uses.

(2) The determination of mechanisms for conflict resolution among water uses, in order to bridge the gap between water demand and supply in drought periods.

(3) The development of tools which aid in drought impact prevention. For example, the application of remote sensing techniques to provide early warning information in real time needs. Also, long range weather forecasting needs to be developed.

(4) Improvement of models designed to predict drought and their impacts. Such models, where they exist and do not need to be developed, require refinements both in terms of data and assumptions on which they are based.

(5) Development of technology for increasing water use efficiency, for municipal, industrial and agricultural purposes.

3.4 ADJUSTMENT AND RESPONSE MEASURES

Preparation for a drought is best done when no drought exists. A well thought out response plan can be developed, which becomes the basis for quick and effective action when drought conditions reach predetermined stages.

Traditionally, the strategy has been to enhance water supplies through the construction of dams, diversions, pipelines, wells and similar water resources development projects. However, rising economic and environmental costs associated with the traditional approach, together with increasing competitive demand for the limited resources, necessitate a new approach to water management. A greater use of demand management adjustment and response measures is hereby advocated, in contrast to the traditional supply management adjustment and response measures. Tables 1 and 2 show details of the two approaches.

Public education and information programs, water audits and licensing are applicable in both approaches, Public information and education programs can alter user attitudes and consumption patterns in both the long and short term. Programs must, however, be responsive to the needs of the public, as information needs change in the course of a drought and between droughts. Also, different types of users will require different information. The coordination of drought planning and response, both during and between droughts, requires effective communication among all the parties involved.

4. CONCLUSION

Periodic droughts are a natural feature especially of the semi-arid weather regions of Nigeria, as shown by the parts of the country marked I and II in Fig .3. Though droughts may not be exactly predictable, their probability of occurrence can be determined. With rational action based on careful planning, as suggested in Fig .2, drought impacts can be minimized.

Long-term planning is essential to minimize the adverse environmental and economic impacts of drought. Planning needs to be carried on through both the wet and dry weather cycles. Crisis management is usually ineffective during a drought, and can actually increase societal vulnerability. Achieving and maintaining a sustainable level of water use requires a balance between supply and demand oriented measures. Limiting water use to conform to existing supplies is the objective of demand management. The interdisciplinary nature of drought impact prevention and mitigation requires an integrated approach, and an effective communication system.

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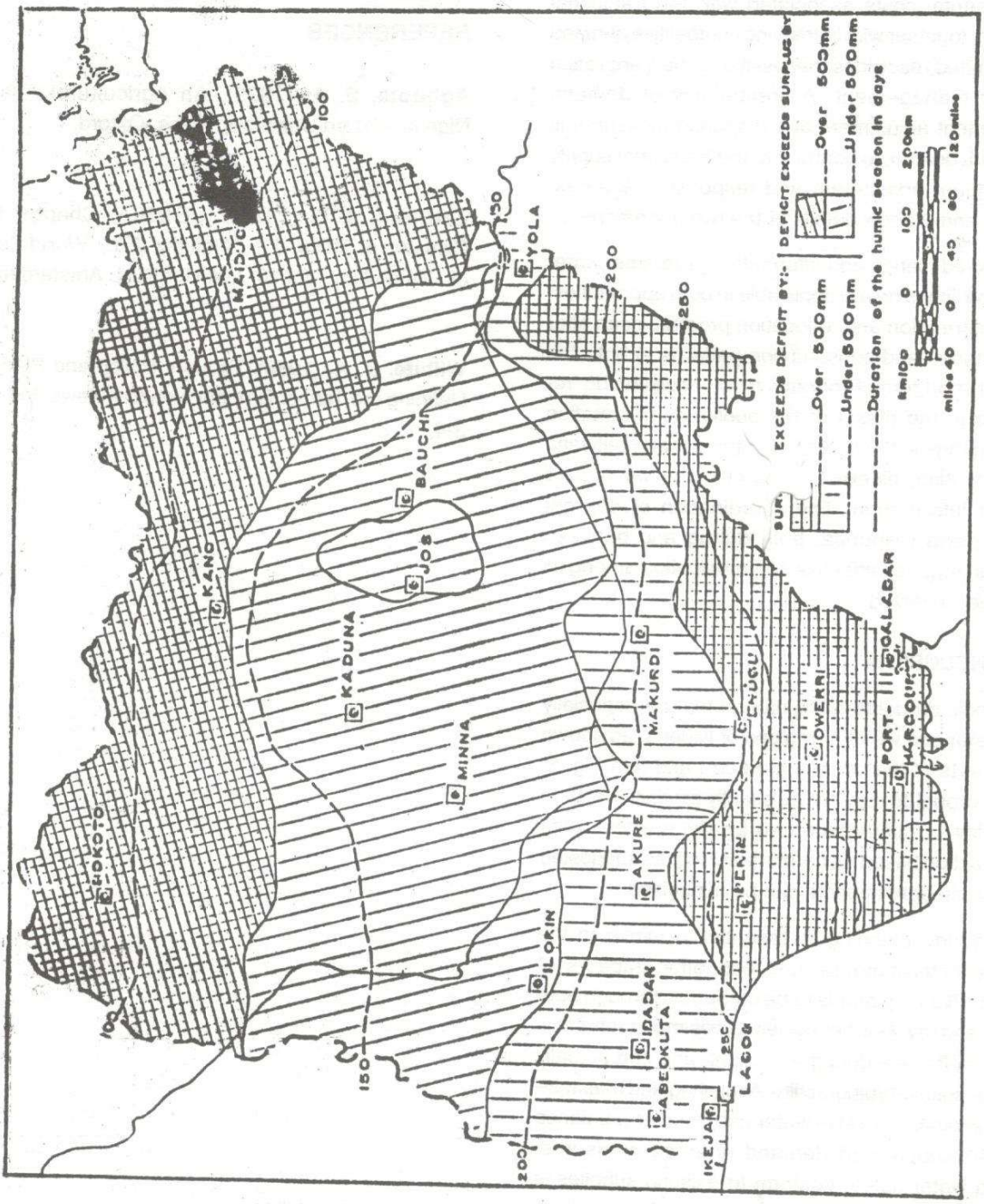


Fig.1(a) Nigeria: Moisture balance (after Agboola, 1979)

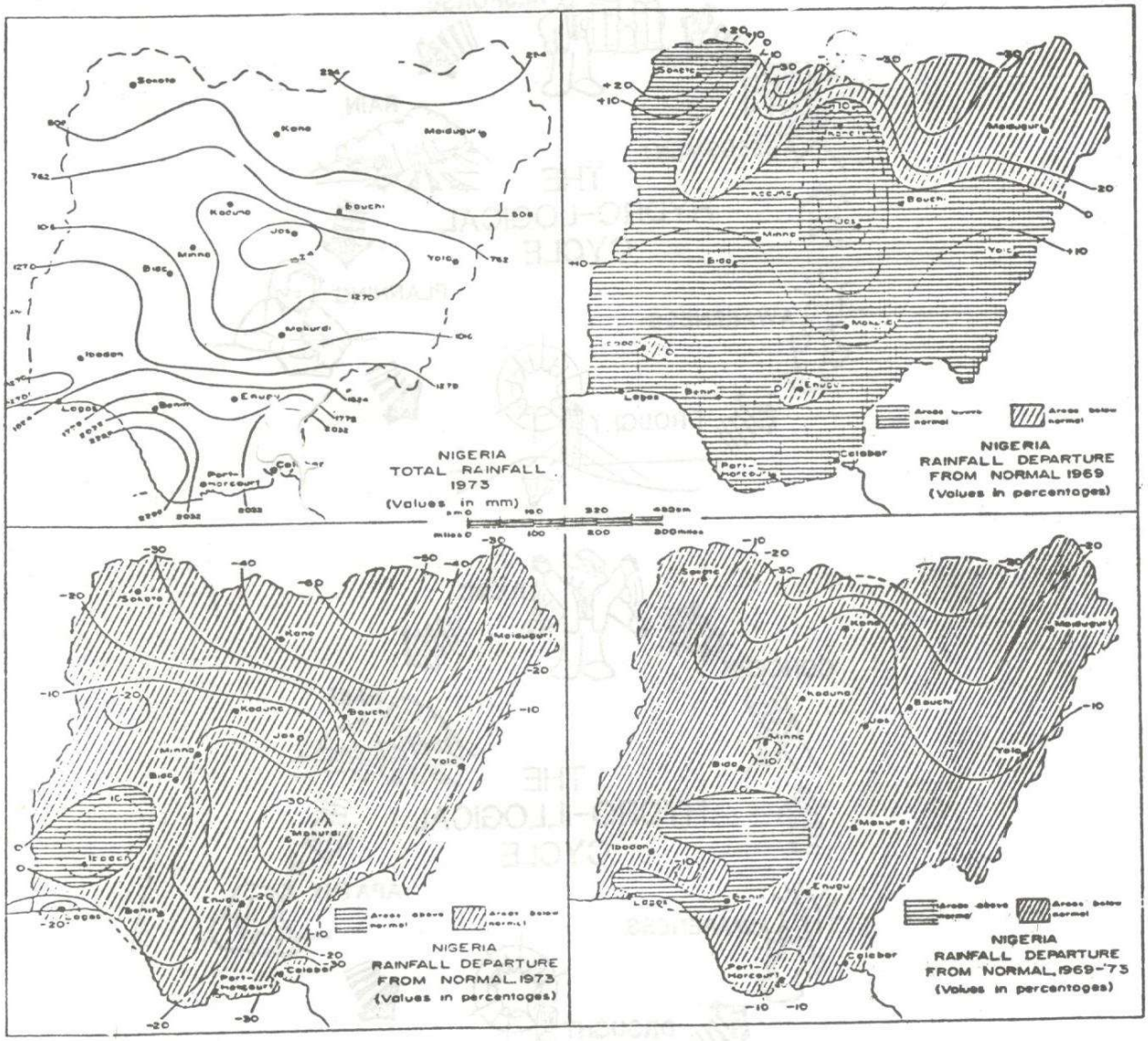


Fig.1(b) Nigeria: Pattern of Drought (after Agboola, 1979)

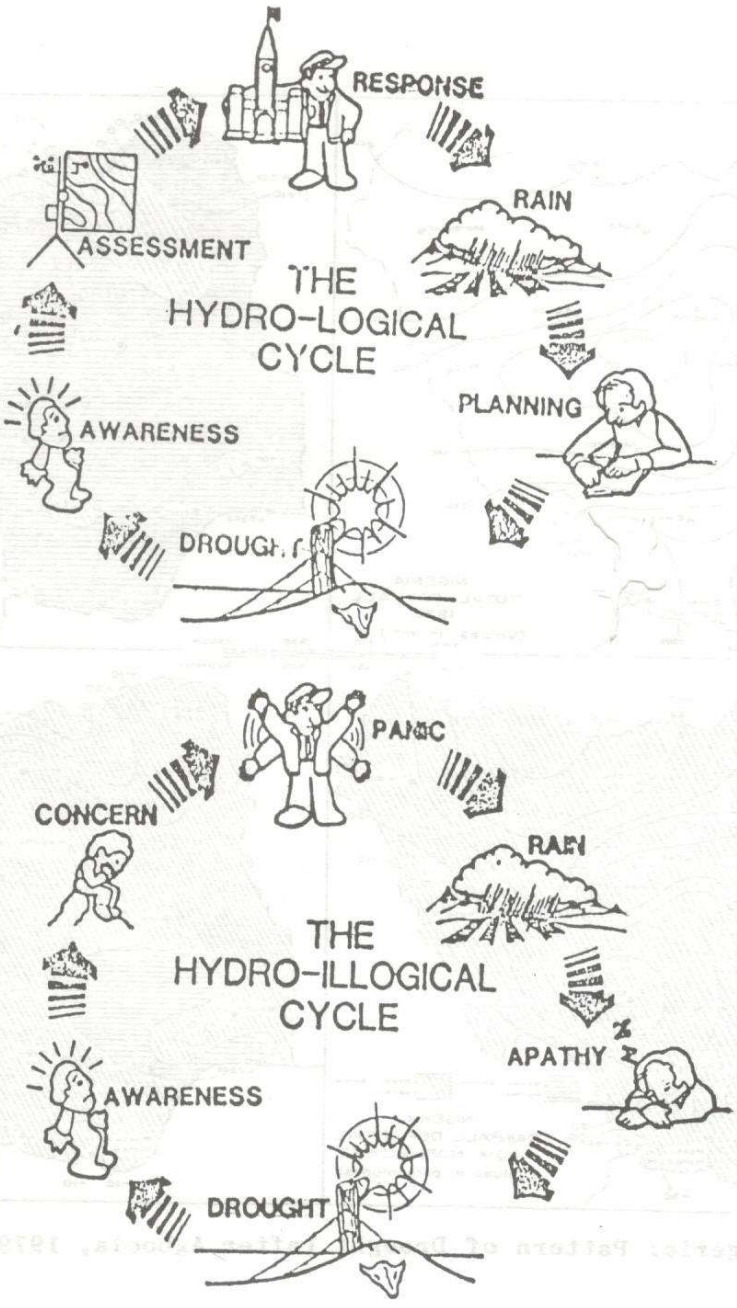


Fig.2 Alternative Responses to Drought (after Wilhite, 1989)

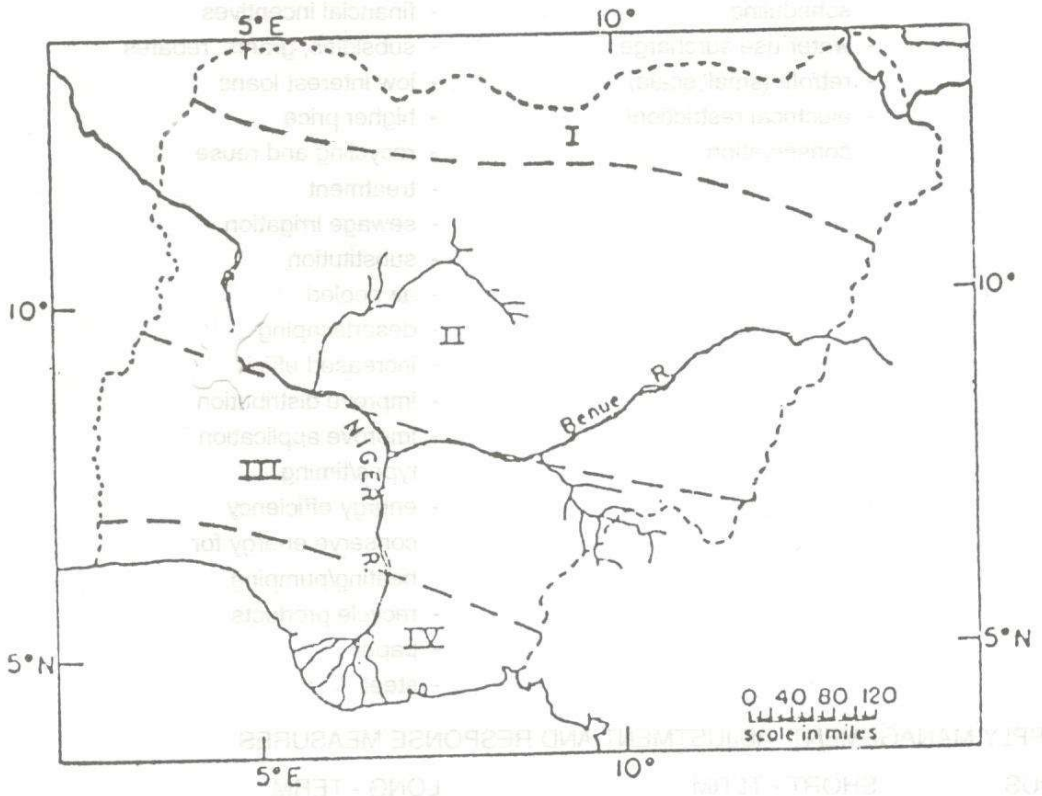


Fig.3 The Weather Regions of Nigeria (after Griffiths, 1972

Table 1: DEMAND MANAGEMENT ADJUSTMENT AND RESPONSE MEASURES

CONTINOUS	SHORT-TERM	LONG-TERM
- Education - Public Info - Technical Info (demonstrations) water audits (data collection) licensing, allocation	- Mandatory and Voluntary restrictions - Rationing - Time of use - Pressure reduction - Reuse - grey water irrigation - scheduling - water use surcharge - retrofit (small scale) - electrical restriction/ conservation	- User Pay - Rate Adjustment Plus metering - Regulation - Building and plumbing codes - Outdoor codes - fines for over use - financial incentives - subsidies, grants, rebates - low interest loans - higher price - recycling and reuse - treatment - sewage irrigation - substitution - air cooled - desertscaping - increased efficic - improve distribution - improve application types/timing - energy efficiency - conserve energy for heating/pumping - recycle products - paper - steel

Table 2: SUPPLY MANAGEMENT ADJUSTMENT AND RESPONSE MEASURES

CONTINUOUS	SHORT - TERM	LONG - TERM
- education - public info - technical info - technology - transfer - water audit - (data collection) - licensing - allocation	- emergency supply - pumping - hauling - reuse - use sewage for fire control - precipitation - snow management - collect rain water - ground water use - mix surface/ground water - freeze treatment - change reservoir operation - reduce releases - reduce evapotranspiration - remove hydrophytic vegetation along waterways	- project construction/reconstruction - dams - pipelines - diversions - dugouts - wells - vegetation management - forest management - wetland retention - ground water management - aquifer construction - conjuctive use - recharge - water quality improvement - desalination - sewage reuse