

## Development and Management of Groundwater for Appropriate Water Supply in Nigeria: Problems and Actualisation Strategies.

<sup>\*1</sup>Jijingi, H. E., <sup>2</sup>Simeon, P. O. and <sup>3</sup>Emerson, K. U  
<sup>1,2,3</sup>Department of Soil Science and Land Resources Management,  
Federal University Wukari, P.M.B 1020, Wukari Taraba State - Nigeria  
Corresponding Author: Jijingi, H. E

**ABSTRACT:** *There is need to give necessary attention to the development and management of groundwater, which is a sector of water resources development, that has been relegated to the background. This need is as a result of the enormous groundwater potentials and the obvious role it can play in the supply of potable water. The failure as a matter of policy to integrate regional groundwater exploration and exploitation programs gives cause for concern. In Nigeria, groundwater resources are too often developed by public authorities and private users without sufficient control, organization and management. This brings to fore the issue of borehole failures, dams collapse, brine-salt water intrusions and insufficient water delivery to millions of Nigerians. Against this backdrop, this review paper examines groundwater development and management in Nigeria with the aim of identifying the problems and possible solutions or workable actualisation strategies.*

**Keywords:** *Development, Management, Groundwater, Water supply, Problems and Solutions.*

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### I. INTRODUCTION

Groundwater, an important component of the hydrologic cycle, serves as a major source of water supply in most part of the world [1]; [2]; [3]. In most cases, groundwater is safer and more reliable for use than surface water, thus constituting a vital source for domestic and agricultural usage. The occurrence, extent and usability of groundwater are determined by geologic, hydrologic and human factors. Thus, the protection and management of the groundwater resources in an area must be carried out to ensure sustainability.

Groundwater development and management is a combination of efforts geared towards sustainable groundwater supply. [4] presented an expert flow chart system for groundwater development and management which included aquifer characteristics consideration and the collection of technical, economic and social data.

Nigeria has been richly endowed with groundwater resources. Groundwater occurs practically everywhere in the country despite the varied climatic and other environmental conditions. [5] opined that, Nigeria has about 224 trillion litres/year of surface water and 50 million litres/year of groundwater for the population of about 128 million to cater for the domestic water consumption need of 6 billion litres/year. This shows that the groundwater is still untapped. Each geographic zone of Nigeria is characterised by its peculiar hydrogeological characteristics and groundwater potentials which need to be explored and exploited. While the far northern parts of the country fall under the typically harsh sahelian climatic zone with comparatively high relief under laid by essentially impermeable rocky formations, the southern areas are marked generally by high humidity with much higher rainfall, low lands and plains under laid by much more permeable sedimentary formations [6].

Groundwater is the water beneath the earth surface that can be collected with wells, tunnels, drainage galleries and water that flows naturally to the earth surface via seeps or springs. It is the water that is pumped by wells and flows out through springs [7]. According to [6], the availability of groundwater in any given area depends on the hydrogeological characteristics of the under laying formation in the area. Based on this, Nigeria has been sub-divided into eleven (11) groundwater provinces [8].

The importance of groundwater exploration and exploitation to water supply cannot be over-emphasized and its advantage over surface water lies, however, in its availability in practically every part of the country even though in varying quantities [9]. In the sahelian region of the north for example, surface water is

either not available or only seasonal. The cost of development of groundwater is cheaper than that of surface water and the quality of the water is reasonably good requiring minimal treatment [10] and in most areas readily potable. Hence, groundwater is relevant in the supply of water to the rural and semi-urban areas of the country and in some cases even the urban town where surface water is unavailable.

Despite the potential of groundwater and the critical role it plays in the water-supply security of Nigeria, its development and management appear not to be attracting the attention it deserves [11]. Its development and management is under private rather than municipal initiative [6]. Groundwater is exploited rather haphazardly and indiscriminately by government, private institutions and individuals without any control, Organisation and management. This ugly scenario is consequent upon the failure to deliberately and intensively, integrates regional groundwater exploration and exploitation programs in the overall National Water Resources Development Program [9]. The need to give commensurate attention to groundwater development headed and operated by relevant professionals has been very necessary. This need has arisen as a result of enormous groundwater development potential and obvious neglect of this sector of water Resources Development. As a result of the foregoing, this review paper aimed at identifying the challenges and problems militating against it and offering some guidelines leading to the proper planning, development and execution of groundwater schemes in Nigeria.

The fact that Nigeria has been abundantly endowed with groundwater resources notwithstanding, the development and management of the resource for water supply appears not /to be receiving the attention it deserves. The failure, as a matter of policy, to integrate the regional groundwater exploration and exploitation programs into an overall National Water Resources Development has been responsible for indiscriminate development of the resources by both individuals, private organizations and government. The resource is often developed by public utility agencies and private users without any control and organisation plan. The consequences of this include dams collapse, brine-salt water intrusions, borehole failures and insufficient water delivery to millions of Nigeria. The need to develop and manage groundwater resource, therefore, becomes imperative [12]. The relegation of the development of the groundwater of Nigeria necessitated this discussion. The paper identifies the challenges hindering the development and management of this important sector of national socio-economic development and offers remedies that can lead to the proper exploration and exploitation of the abundant groundwater resources.

The specific objectives of this paper are the following:

1. Review of the development and management of groundwater for water supply in Nigeria;
2. Identification of the problems militating against the development and management of groundwater for water supply;
3. Presentation of the discovered remedies to the challenges and problems making groundwater development and management difficult in Nigeria.

## II. MATERIAL AND STUDY AREA

This work is an original scholarly inquiry based on review of related literatures which have been incorporated into the introduction. It is thus, a secondary data work and the result and discussion is descriptive. The study area, Nigeria lies within Longitude  $4^0$  and  $14^0$  East of the Greenwich Meridian and Latitude  $3^0$  and  $15^0$  North of the Equator. The country is well drained and so there are great sources of water

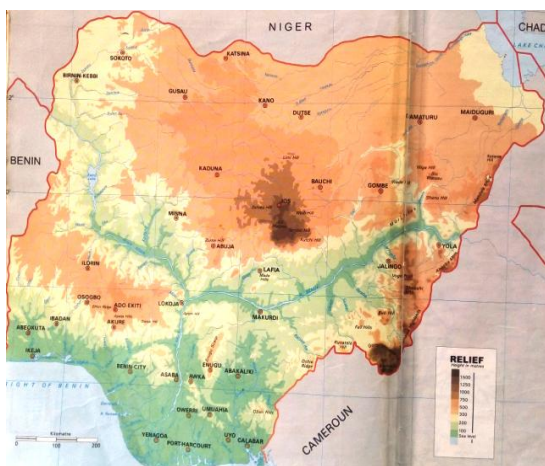


Fig. 1: Map of Nigeria showing its Physical Feature Fig. 2: Surface drainage Rivers

Source: [13]

### III. RESULT AND DISCUSSION

A critical review of groundwater development and management for water supply in Nigeria has revealed that this sector of water Resources Development is militated against by several problems which are interwoven. These problems are identified as problems associated with hydrogeological exploration for groundwater resources, evaluation and strategic planning, abstraction and use regulation, source assessment protection, groundwater resources monitoring and impact mitigation as well as groundwater resources administration, among others.

#### 3.1 Challenges/Problems of Developing and Managing Groundwater Resources in Nigeria

##### 3.1.1 Hydrogeological Exploration

The availability of groundwater for development of any state or community in the country depends on the hydrogeological characteristics of the under laying groundwater province in the area. It is therefore necessary to study, identify and evaluate the water of the hydrogeological province in any area and develop an exploitation strategy that best suits the province. The Federal Ministry of Water Resources, in 1979, carried out a pre-drilling hydrogeological investigation of the whole country. This study culminated in the preparation of a “ Provisional National Master plan for the development of Groundwater Resources. The implementation of this master plan has gone into limbo, since more quantitative information on aquifer characteristics and recharge rates, groundwater regimes and abstraction rates are generally incomplete. Besides this, in 2002, a hydrogeological mapping program of the country was embarked upon and it has also been abandoned. The abandonment of these exploratory studies has set the whole program for Ground Water Resources Development back [14].

##### 3.1.2 Data Management

The first step to the development and management of groundwater resources is to understand it through appropriate systems on a regular basis and incorporating the monitoring data in planning the use of the resource. Existing data, vital for efficient planning and implementation of groundwater development in Nigeria, are not readily accessible and not in user-friendly format. The lesson learnt from successful and unsuccessful projects are not being collected through post-case evaluation and used for new projects planning and design. As a result, there remains much blind well drilling culminating in high failure rates, escalating costs and ineffective use of available funds.

##### 3.1.3 Evaluation and Strategic Planning

A fruitful groundwater exploitation strategy cannot be possible without proper planning backed by a suitable exploration program. Lack of systematic assessment of the resources of key aquifers has raised concern in Nigeria. Groundwater resources needed to be planned and evaluated for maximum basin level efficiency. Groundwater is exploited rather haphazardly and indiscriminately, by both public utilities agencies and private users without any form of evaluation planning, control, management and/or organization. The consequences of this are cases of boreholes failure, dams collapse and insufficient water delivery just to mention a few.

##### 3.1.4 Abstraction and Use Regulations.

It has been observed that groundwater exploitation is carried out anarchically, which is far from optimum use by each of the beneficiaries especially in areas which are drought prone and water stressed. This is so for the reason that there is no systematic monitoring or regulation of groundwater draft and use in Nigeria.

##### 3.1.5 Sources, Assessment and Protection

The environmental aspects of water resources development include the sustenance of the ecosystems, desertification, pollution, coastal erosion and sea water. Intrusion has attracted little or no attention, until very recently and even so, with conflicting and overlapping as well as over-sight considerations from various ministries and departments like the Ministry of Agriculture, Ministry of Health, Ministry Solid Minerals Development, Ministry of Water Resources and more recently Ministry of Environment.

Soil erosion and/or compaction are leading to reduced rates of infiltrations with increasing flash runoff, and thus, there is loss of environmentally and socially-critical spring flows and base flows to smaller rivers, and of discharge to vegetation in topographic lows. There is need to halt such processes, conserve soil cover and find ways of enhancing groundwater recharge through land management and small scale engineering measures.

It is also important to realise that there is a substantial number of aquatic ecosystems and terrestrial ecosystems in Nigeria which depend upon or utilize groundwater. This aspect of groundwater service provision and its potential constraint on other uses is only just beginning to be appreciated. In many parts of Nigeria, much uncertainty remains over the level of groundwater dependence of these aquatic and terrestrial ecosystems. The

ecosystems susceptibility to degradation due to groundwater resource development and water table decline has also not been ascertained. The occurrence and value of groundwater dependent on ecosystems needs to be better characterised and the impact of groundwater in use for water supply needs to be monitored to be able to arrive at balanced approaches to their conservation.

### 3.1.6 Resources Monitoring and Impact Mitigation

Often, due to lack of standard monitoring procedures, available data cannot be compared and are inadequate to plan regional action for the sustainable development and use of groundwater resources. Clearly, for beneficial use of groundwater, it is necessary to evaluate and map all potential damaging impacts. This is of particular importance because the impacts may be subtle and widely spread in space and delayed in time.

### 3.1.7 Administration

The water resources Decree (Decree 101) of 1993 recognised the following institutions in Nigeria for Water Resources Management:

- i. Ministry of Water Resources, representing the Federal Government
- ii. National Water Council (Consultative)
- iii. River Basin Co-ordinating Committee
- iv. River Basin Development Authority

#### v. State Water Board

Although, the decree (Decree 101 of 1993) has vested the right of water resources administration on the above mentioned institutions, groundwater development appear to have been submerged in the overall crowded schedule of these institutions. In the execution of their responsibilities, the River Basin Development Authorities have relegated or even ignored the important program of developing groundwater resources. Hence, for maximum development and exploitation of the country's groundwater resources, there is a need for a separate and much needed groundwater development department in each of the River Basin Development Authorities.

A lot of efforts and resources have been wasted over the years on ill-planned, un-coordinated and unaccomplished groundwater development programs. The Ministry of Water Resources appear to have given up somewhere along the line and surrendered its responsibility as far as ground water development is concerned. This has resulted in the indiscriminate ground water exploitation through the drilling of boreholes by individuals, private and government organizations without any control whatsoever.

An orderly co-ordination, development and management of the groundwater basin by the River Basin Co-ordinating Committee has been thwarted, hence, it is found that some groundwater areas overlap one or more of the Nigerian River Basin Authorities Jurisdiction.

### 3.1.8 Lapses in the Legislation (Decree 101) on Water Resources Development and Management

A review of the legislation (Decree 101 of 1993) on water resources development and management [15] revealed that there are lapses in the decree as it affects groundwater development and management. The whole responsibility for the provision, control of water for whatever purposes and the preparation of master plans is placed on a "Secretary" who appears more powerful than the Minister of Water Resources. In spite of the existence of legal water institutions at both States and Federal levels, the law fails to address structural lapses in the water supply industry as represented by the recognised organizations. There are areas of possible conflicts between the "Secretary" and Minister and there is completely alienation of the "Public Authorities having responsibility for public water supply" because they were not even mentioned in the decree.

Furthermore, the whole thrust of the decree appears to be on surface water with casual references to groundwater. The schedule mentions the major surface water sources in Nigeria. In each river basin, it identified, rather vaguely, the inclusive groundwater basin, as shown in table 1 below. The decree recognises groundwater development just for the prime purpose of issuing licences for the drilling of boreholes.

**Table 1:** Major Surface Water Sources and the Groundwater Basin as Outlined in the Water Resources Decree 101 of 1993

Major Surface Water Sources	Groundwater Basins
"The River Niger from the Boarder Basin"	"The Sokoto sedimentary Basin"
"The River Niger from the outlet of the Kainji Reservoirs"	"The Upper Niger"
"Benue River"	"Sedimentary (Niger) Hydrogeological Area"
"River Niger from the Confluence there and of the Benue River".	Benue Sedimentary
"All water courses rising or situated in Federal	Chad sedimentary Basin

Republic of Nigeria directly or indirectly influent to lake chad”	
“All water course directly or indirectly influent to the lagoon...”	“ Ogun/Osun sedimentary Hydrogeological Area”
“ The Cross River .... Indirectly influent to the lake chad”	Cross River Hydrogeological Area.

Source: [6]

Despite the few groundwater basins mentioned above, there are several other groundwater areas or basins occurring within the river basins. Most of the groundwater basins described above are known to transgress some if not all the river basins mentioned above. This clearly shows that the decree (Decree 101) is bias in favour of surface water. This neglect has set groundwater resources development backwards.

### 3.2 Prospect of Groundwater Development and Management for Water Supply in Nigeria

No meaningful headway can be recorded in groundwater development and management for water supply in Nigeria unless the under development, neglect and the existing problems in the groundwater industry are redressed. These problems can be redressed by applying or employing a round table approach which will involve all the stakeholders in groundwater industry.

Below are the considered remedies to the problems militating against groundwater development and management for water supply in Nigeria:-

- i. It is necessary to resume the hydrogeological mapping program of the country which has been abandoned with the view to resuming the regional groundwater exploration of the various groundwater provinces or basins.
- ii. There is also need for proper management of groundwater data since problems of boreholes failures, dams collapse and insufficient water delivery to millions of Nigerians are associated with such data e.g hydrogeological base maps, for efficient planning and implementation of groundwater development.
- iii. The problem of planning can be arrested by studying, identifying and evaluating the water resources of the hydrogeological province in any area and developing an exploitation strategy that best suits the province.
- iv. It is also of importance to put in place an effective system for regulating the withdrawals to sustainable levels and such a system may include:
  - a. Registering users through a permit or license system;
  - b. Creating appropriate laws and regulatory mechanisms;
  - c. A system of pricing that aligns the incentives for groundwater use with the goal of promoting conjunctive use; and
  - d. Promoting “ precision” irrigation and water saving crop production technologies and approaches.

This regulatory system will strive to eschew the current free-for-all groundwater appropriation and use, and in the process promoting a more responsible management of this precious resource that is easy to deplete or ruined through depletion.

- v. Another aspect of managing groundwater is augmenting groundwater recharge. This could be accomplished through:-
  - a. Reducing the velocity of runoff around recharge area so as to provide ample time for recharge, thus, enhancing ground water reservoir or storage;
  - b. Finding waters of enhancing groundwater storage through land management and small-scale engineering measures. Soil erosion and/or soil compaction widely lead to reduced rate of infiltration and thus, the loss of environmentally and socially-critical spring flows and base flows to smaller rivers and of discharge to vegetation in topographic lows. Such processes should be halted and soil cover conserved.
- vi. It is also essential to protect recharge areas from environmental pollution and extensive civil engineering works or projects. If pavement is constructed over this area, less water will enter the aquifer. The more the water that enters the aquifer the more desirable.
- vii. Another action that can lead to unprecedented exploitation and development of groundwater is to modify, improve, update and implement the 1978 Provisional National Master Plan for the Development of Groundwater Resources.
- viii. A special developmental program for the Basement Complex hydrogeological areas and shallow aquifers of the riverine areas for the maximum exploitation of their potential should be put in place.
- ix. Amendment of Water Resources Decree (Decree 101 of 1993). It is obvious that, so soon after the decree was released, it does not appear to be meeting its objectives. Hence, there should be no hesitation in transforming it appropriately into a more useful legal document for the water industry. The decree should be amended to define clearly the roles of the various authorities of water management recognised by the decree. Amendment of the decree should also provide for a strong groundwater development department in

the River Basin Development Authorities across the nation. The department should be responsible for implementing all aspects of the decree that relate to groundwater development.

#### IV. CONCLUSION

Nigeria has very high groundwater potentials. Groundwater occurs practically everywhere in Nigeria though in varying quantities. It is the cheapest means of providing the much needed potable water. Despite its enormous potential and importance in supplying potable water its development and management has been faced with score of problems. The groundwater is being developed indiscriminately without any form of control and management or organisation. Therefore, these problems must be addressed for maximum development and exploitation of the resource.

The authors of this paper have highlighted necessary ingredient for the proper planning, development and execution of groundwater schemes in Nigeria. The government is to assume a responsible role to harness and apply the available information on groundwater occurrence and quality to better guide the major investments in water supply provisions from groundwater. Sub chapter 3.2, the prospect of groundwater development and management for water supply in Nigeria dwelt extensively on what is needed to be done to get going on the right path of growth and development and it is the wish of the authors that the provisions therein are adopted for actions for the purpose of achieving an unprecedented development and management of groundwater for water supply for the social and economic growth and development of Nigeria.

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