

**The Development and Management of Ground Water for
Water Supply in Nigeria.**

Presented at the 2nd Fellow's Workshop of NMGS on Monday 6th March 2000.

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1. Introduction.

The importance of ground water in Water Resources development appears not to be attracting the attention it deserves in Nigeria, despite the fact that a substantial part of Nigeria's Water Supply comes from underground. The amount of Run-off water or infiltration resulting from rainfall is controlled by climatological and hydrogeological factors which include evapotranspiration, topography vegetation cover, land use, soil moisture content, depth to water table intensity, duration and distribution of rainfall etc.

While the northern parts of the country fall under the, typically harsh Sahelian Climatic zone, with predominantly high relief underlain by essentially impermeable rocky formations, the southern areas are marked generally, by high humidity with much higher rainfall, low lands and plains underlain by much more permeable sedimentary formations. Each zone is characterised by its peculiar hydrogeological characteristic and ground water potentials, which need to be explored and exploited.

The advantage of ground water over surface water lies however, in its availability in practically every part of the country, though, in varying quantities. In the Sahelian region of the north, surface water is either not available, or is only seasonal. The cost of development of ground water is cheaper than that of surface water and the quality of the water reasonably good requiring only minimal treatment, and in most areas readily potable. Hence it is relevant in the supply of water to the rural and semi urban areas of the country, and in some cases even the Urban towns, where surface water is not available.

The failure, to deliberately and intensively, integrate regional ground water exploration and exploitation programs in the overall National Water Resources Development program gives cause for great concern. Ground Water is exploited rather haphazardly and indiscriminately, by government, private institutions, and individuals without any control, management or organisation. This paper tries to review the situation and offer some guidelines leading to the proper planning development and execution of ground water schemes in Nigeria.

2

The unit of water resources management is the River basin or the river catchment, which according article 5 of the African Vision provides a basin of regional cooperation and development. In each basin the various parameters of the hydrologic cycle can be quantified and analysed in the context of a water budget. In this budget, Input = Output. Input implies rainfall and all forms of water flow into the catchment and output means all components of discharge (evaporation and losses to other catchment). The catchment is subjected to several physiographic factors which include land use, area of the basin, shape, slope and drainage density etc.

In the same manner the unit of ground water resources management is the reservoir. In this ground water system, a similar but modified water budget is maintained. (Input = Output). Input now implies all forms of recharge into the reservoir or aquifer as infiltration from rainfall, influent river systems, artificial recharge and other forms of recharge, while “Output” indicates discharge from the reservoir, through all forms of abstraction including boreholes wells, springs etc. In ground water basins or reservoirs the attention shifts from a more open system, the river basin or catchment, to a closed up system of the underground reservoir or basin. The geometry structure and disposition of the Nigerian ground water reservoirs, as described *inter alia* (Offodile 1988), determines the ground water potential of any particular area. Hence ground water can occur as

simple horizontal aquifers or in the form of basins, which could be symmetrical, asymmetrical or concentric. Such reservoirs could occur wholly within a or cut across a river basin.

Hence, it is found that some ground water areas overlap one or more of the Nigerian River Basin Authorities Areas as the case may be. (table 1). Even In some situations the recharge areas occur outside the River basin areas making an orderly coordination, development and management of the ground water basin rather difficult. This necessitates inter catchment cooperation and collaboration of the contiguous. River Basins Authorities in ground water resources management.

2. Ground Water Development and the River Basins. Conjunctive Use of Surface and Underground Water.

In Water Resources Management, conjunctive uses of surface and subsurface water resources are generally recommended as part of an Integrated Water Resources Development Programme. This necessitates the separate determination of available ground and surface water resources in any one situation. Where both sources of water are

available, a careful balance can be maintained in the abstraction from either source, in order to sustain long term supply, depending on several factors, most important of which is available funds and water demand. For the big demands like in Urban cities and towns, big irrigation and industrial projects the exploitation from surface sources, viz dams and open water bodies, may be preferred. However, in semi urban, rural communities and institutional water needs, ground water, where available, is recommended because of its obvious advantages. These advantages include the need to save available surface water, in arid and semi arid areas of the country, and the lower development and maintenance costs. Hence for rural and semi rural and even some urban water supply schemes boreholes are usually much more easily accessible. Ground Water occurs practically every where in the country rainfall. In Nigeria, it supplies potable water to over 90% of the population, in situ, through boreholes, hand dug-wells and springs. Ground water, because of these advantages, provides the immediate panacea for the provision of potable water to the majority of Nigerians despite the varied climatic environments. A fruitfull exploitation strategy cannot be possible without proper planning backed by a suitable exploration program.

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The River Basin Development Authority.

The River Basin Development Authorities(RBDA) were set up in 1976.

The eleven RBDAS are as shown in Fig.1 and as follows:

A	Sokoto River Basin Authority	G	Anambra River Basin Authority
B	Hadejia Jamare River Basin Authority	H	Niger River Basin
C	Lake Chad Basin	I	Ogun Oshun River Basin
D	Upper Benue River Basin	J	Benin Basin
E	Lower Benue River Basin	K	Niger Delta Basin
F	Cross River Basin		

Despite the acceptance the River Basin concept as discribed above, the Nigerian RBDAS areas appear to cut across finite boundaries due to political considerations.

The Water Resources decree sets up a National River Basin Development Coordinating Committee to “ensure integrated development of each basin and even development of the different basins”.

The River Basin Authorites were expected to carry out the following functions:-

- i) Undertake comprehensive development of ground water resources for multipurpose use.
- ii) Undertake Water Shed Management Schemes for flood and erosion control.
- iii) Construct and maintain dams, dykes, wells or boreholes, irrigation and drainage systems.

- iv) Provide water from reservoirs, wells and boreholes for urban and rural water supply schemes.
- v) Resettle persons affected by the works and schemes specified in (iii) and (iv) above.

Ground Water Areas.

In the implementation of the above functions of the RBDA it would appear that item (i) above which sort to “Undertake comprehensive development of ground water resources for multipurpose use”, attracts least attention in the overall water resources development programme

Nigeria has been subs-divided into eleven ground water provinces as shown in Fig.2. (Fed. Atlas 1978) numbered as follows:-

1. Coastal Alluvium Mangrove and Fresh Water Swamps.
2. River Course Alluvium.
3. Coastal Sedimentary Lowlands.
- 4a. Chad Basin (Confined Aquifers)
- 4b. Chad Basin (Unconfirmed Aquifer)

5. Keri-keri Sandstone
- 6a. Sokoto Basin (Tertiary)
- 6b. Sokoto Basin (Cretaceous)
- 7 Nupe Sandstone of the Niger Basin.
- 8 Anambra Basin.
- 9 Cross River Basin.
- 10 Benue Basin
- 11 Crystalline Area. (Basement Complex)

The availability of ground water for the development of any State or Community in the country depends on the hydrogeological characteristics of the underlying ground water province in the area. It is therefore necessary to study, identify and evaluate the water resources of the hydrogeological province in any area and develop an exploitation strategy that best suits the province. For example while the Coastal Alluvium is restricted to the Coastal States like, Cross River, Akwa-Ibom Rivers, Bayelsa, Delta, Edo, Ondo, Ogun and Lagos States, the River Course Alluvium traverses the whole country following the various rivers systems draining the country.

While the Coastal Sedimentary areas underlie the southeast States of Imo, Anambra Abia, Enugu, parts of Delta, while the Crystalline Area or Basement, occupies most of the Sahelian northern States Like, Kano, Bauchi, Kwara, Oyo, Niger, Kaduna Plateau, Adamawa, Taraba etc., the Basement Complex hydrogeological Province, occupies nearly half and most of the Central area of the Country. It is therefore apparent that despite the obvious poor hydrogeological properties of the Crystalline or Basement Complex province, the area cannot be ignored in the Water Resources Development of the Country. Similarly, despite, the apparent good ground water prospects of the Sedimentary regions, problems like, Saline intrusion in the Coastal areas, depth of occurrence and the predominance of impermeable shales and clays in the sedimentary sequence present obstacles in the ground water development of those areas of the country.

Table 1: River Basins and the Corresponding Ground Water Areas.

	RIVER BASINS DEV. AUTHORITY WITH IDENTIFICATION AS PER FIG.		GROUND WATER BASINS WITH IDENTIFICATION AS PER FIG.
A	Sokoto River Basin Authority		Sokoto Basin (Tertiary) Sokoto Basin (Cretaceous)
B	Hadejia – Jamare River Basin		Chad Basin (Unconfined) Part of Basement Complex Part of KeriKeri Basin.
C	Lake Chad Basin		Chad Basin (Unconfined) Chad Basin (confined).
D	Upper Benue River Basin		Part of KeriKeri Basin Part of Benue Basin
E	Cross River Basin		Coastal Sedimentary Cross River Basin
F	Anambra Imo River Basin		Part of River Course Alluvium Anambra Basin.
G	Niger River Basin		Part of River Course Alluvium Nupe Sandstone. Part of Basement.
H	Ogun Oshun River Basin		Costal Sedimentary
I	Benin River Basin		Coastal Sedimentary
J	Niger Delta.		Coastal Alluvium Mangrove Coastal Sedimentary

From the above table it is clear that various ground water basins are shared by two or more River Basin Development Authorities.

3. Decree 101 (Water Resources) and Ground Water Development.

Decree 101 and Other Water Acts.

Decree 101 (Water Resources) and Ground Water Development.

The need for a Water Resources Policy as articulated in Water Resources Decree 101 has long been identified. This resulted in the promulgation of the decree in 1993 by the Federal Military Government of the country. Unfortunately the policy as outlined in the decree does not appear to have addressed the development of ground water resources very seriously.

The history of Water Resources Development in Nigeria evolved from the early years of the 20th Century when there was no formal water management programme. In the Colonial days the Minerals Act of 1946 provided the only legal instrument which only sort to protect the public water supply from the activities in the Mining Industry. While public water supply was essentially developed and managed by the then Public Works Department, the Geological Survey of Nigeria from its inception in 1917 undertook the exploration and development of ground water resources. The activities of the Geological Survey of Nigeria culminated in the setting up of the Water Well drilling section department and the design of the, now, widely used concrete lined well sinking technique in 1938. The engineering and the concrete wall sinking programme was developed and taken over by the Public Works Department in 1947. The Geological Survey of Nigeria initiated and carried out the regional surveys of some Nigeria's very important ground water basins viz: Sokoto, KerriKerri, Chad and Anambra basin. However, with establishment of the Federal Ministry of Agriculture and Water Resources in 19... the ground water section of the Geological Survey was merged with the new Ministry.

The environmental aspects of water resources development which include sustenance of the ecosystems, (desertification) and biodiversity, pollution, coastal erosion and sea water intrusion attracted little or no attention until very recently, with conflicting and overlapping and oversight considerations from various Ministries and Departments like the Ministries of Agriculture, Health, Solid Minerals Development, Water Resources, and more recently Environment.

Reviewing Decree 101 as it affects Ground Water Development.

The decree recognizes the following institutions in Nigeria's Water Resources Management:

1. Ministry of Water Sources Representing the Federal Government.
2. National Water Council (Consultative)
3. River Basin Coordinating Committee
4. River Basin Development Authority
5. State Water Boards.

The Nigerian Water Resources Decree 101 vests "the right to use and control all surface and groundwater and of all water in any water course affecting more than one State" in the Federal Government. Akpoborie (1998) took a swipe at this decree, more from a political angle, viz the rights of communities and States under the decree. While the decree outlines the "dos" and "don'ts" required by the Federal Government, it places the

whole responsibility for the provision, control of water for whatever purpose and the preparation of master plans, on a “Secretary” who appears more powerful, or at par, with the Minister of Water Resources. Despite the existence of legal Water Institutions, both in the States and at the Federal level, the law fails to address the Organisational Structural Lapses in the Water Industry as represented by these organisations. This creates possible areas of conflict between the “Secretary” and the Minister and completely alienates the so-called “Public authorities having responsibility for Public Water Supply” which were not even mentioned in the Decree.

Furthermore, the whole thrust of the decree appears to be on Surface Water with only casual references to ground Water. The schedule mentions the major surface Water Sources in Nigeria. In each river basin it identifies rather vaguely the inclusive Ground Water Basins, as follows: (Table III)

Table 3: Major Surface Water sources and the Ground Water Basin as outlined in the Water Resource Decree 101 of 1993.

1.	“The River Niger from the Boarder..... Basin”	“The Sokoto Sedimentary Basin”
2.	“The River Niger from the Outlet of the Kainji Reservoir”	“The Upper Niger Sedimentary (Niger) Hydrogeological Area. Benue Sedimentary Basin.
3.	“Benue River	Benue Sedimentary Basin.
4.	“River Niger from the Confluence thereof and of the Benue River”	-
5.	“All Water Course directly or indirectly influent to the Lagoon.....”	“Ogun/Oshun Sedimentary Hydrogeological Area”
6.	“All Water Courses rising or situated in Federal Republic of Nigeria directly or Indirectly influent to the Lake Chad”.	Chad Sedimentary Basin.

7. The Cross River.....”
Lake Chad

“Indirectly influent to the

Cross River Hydrogeological Area.

Despite the few ground water basins mentioned above, there are at least eleven other ground water areas or basins criss-crossing the, or occurring within the, river basins. (Fed. Atlas 1988). Most of the ground water basins described above are known to transgress some of if not all the river basins mentioned above.

Setting up of Regional and Localised Ground Water Development Programmes.

The bias in this decree, in favour of surface water, underscores the in built neglect of ground water Resources development. The decree recognises ground water development just for the sole purpose of issuing licences for the drilling of boreholes. Furthermore, the implementation of the decree setting up the River Basin Authorities appears, in practice, to concentrate more on Surface Water Development only, viz: direct river abstraction schemes, and their associated irrigation projects. Even then there is little to show for the enormous financial resources pumped into the projects. Hanidu (1990) regrets their ability to put only 70,000 hectares of land under irrigation.

While it is recognised in this paper that Water Resources Management generally, should be under a River Basin Authority, the need to give commensurate attention to Ground Water development, headed and run by relevant professionals has been very necessary. This need has arisen as a result of the enormous ground water potential and the obvious neglect of this sector of Water Resources development. The Geological Survey of Nigeria had played the role before the merger of its Water Section with the newly Fed. Ministry of Water Resources in 19... Such department will be charged with identifying, evaluating, surveying the extent, geometry and potential of the various ground water basins.

The more prolific basins like the Sokoto, Chad, Anambra, and Benin basins should be developed and exploited as well fields for supply to nearby big cities, and rural and semi rural towns and villages. The Anambra basin, for example, holds enormous quantities of water, enough to meet the water needs of the capitals of Enugu and Anambra States of Nigeria and the neighbouring towns and villages and also sustain huge irrigation projects. It is on record that about ten of such artesian boreholes in different locations in the basin have been, are free flowing wastefully, at the rates of 10 – 20 lits/sec.. The most recent addition was drilled under a Petroleum Task Fund (PTF) contract on the Enugu – Onitsha Road and has been flowing to waste, unattended to. The Sokoto, Kerrikerri and Chad basins Benin and Coastal Basin aquifers hold great potential for Water Supply to the areas within and outside the basins.

The shallow aquifers of the River course alluvium have generated a lot of interest, of recent. They are now being heavily exploited under the Federal Government/World Bank sponsored Fadama development program. The shallow aquifers, not exceeding 10m – 20m in total depth, are exploited by means of “tube wells” and “Wash Bores” Drilling, a simple affordable drilling technique that are very much in use by dry season farmers. This has provided, not just the irrigation water for dry season farming in most riverine areas of the country, but also clean potable water for the rural people. The shallow aquifers also sustain the riparian wetlands associated with the major rivers in the country.

The Basement Complex or Crystalline Rock ground water areas covers nearly 50% of the country and underlies areas subjected to harsh climatic environment of the Sahel belt, in which surface water supply is limited. Despite the low ground water yield from this geological formation it is a very important water source for those areas. It has been proved that, with good regional study, areas of relatively higher yields due to the

secondary permeability induced by fractures and deep weathering, can be identified for the siting of one or more boreholes depending on the need of the area. While in a sedimentary area one may need to drill, one, '100m borehole' to obtain yield of 5 to 10 lits/sec, three much cheaper shallow boreholes in a good Basement Crystalline rock area, of depths 20 to 50m can yield 2 lits/sec each, jointly approaching nearly the same yield as a 100m borehole. Most of the rural and semi rural settlements in the Sahel region situate on the Basement area and holding nearly half the population of Nigeria. Hence despite its precarious hydrogeological situation, the Basement Complex ground water area is still very important and therefore needs attention. All that is required is a systematic study and the identification or mapping of favourable areas, for the location of such shallow and cheap boreholes. The task of mapping, and developing the country's ground water basins is an onerous one and needs an effective ground water management policy.

It is, therefore, being suggested that the Decree 101 on Water Resources be reviewed immediately in line with the suggestions made above, including addressing the fears of other interest groups, like the Water Boards, private people and the communities. It is obvious that, so soon after the decree was released, it does not appear to be meeting its objective. Hence there should be no hesitation in transforming it appropriately into a more useful legal document for the Water Industry.

4. Conclusion and Recommendations.

The development of Nigeria's ground water resources is still very poor. A lot of effort and money has been wasted over the years on ill planned, uncoordinated and unfulfilled ground water development programs. The Ministry of Water Resources appears to have given up somewhere along the line, and surrendered it's responsibilities, as far as Ground Water Development is concerned. This has resulted in the haphazard indiscriminate ground water exploitation through the drilling of boreholes by individuals, private and government organisations without any control whatsoever, even in open breach of the Decree 101. The Federal Ministry of Water Resources in 1979, carried out a pre-drilling

hydrogeological Investigation of the whole country. This study led to the preparation of a “Provisional National Master Plan for the Development of Ground Water Resources” in Nigeria (Basil and Associates 1979). The implementation of this Master Plan appears to have gone into limbo. In 2002, a hydrogeological mapping programme of the country was embarked upon and appears to have also been abandoned. The abandonment, of the pre-drilling hydrogeological investigations, and the hydrogeological mapping programme has set the whole program for Ground Water Resources Development backwards.

But it is not too late. It is still possible to start afresh and put things aright. It is necessary to review the Provisional National Master Plan for full implementation and resume the hydrogeological mapping programme with the aim of resuming the regional ground water exploration of the various ground water provinces or basins. To beef up the plan the following strategies are recommended;

1. Amendment of the Water Resources Decree to define clearly the roles of the various authorities in the Industry viz:-
 - i) The Minister of Water Resources
 - ii) The National Water Council.
 - iii) National River Basin Dev. Coordinating Committee, (or Board as recommended above).
 - iv) The River Basin Authority
 - v) The Water Boards.

1. In order to redress the under development, neglect and the existing chaos in the Ground Water Industry, amend the Decree to provide for a strong Ground Water Development departments in the River basins. The departments should be responsible for implementing all aspects of the Decree 101 that relate to Ground Water Development.

3. Identify Nigeria's most important Ground Water basins for immediate Study and development.
4. Modify, Improve, update and implement the 1978 Provisional National Master Plan for the Development of Ground Water Resources.
5. Encourage the establishment of Water well fields for group or collective water schemes for Urban, rural and semi rural cities.
6. Stop all wasteful ground Water Discharges particularly from artesian basins, to avoid wastes and depletion of the Storage.
7. Protect Recharge areas of Nigeria's most important aquifers from environmental pollution and extensive civil engineering structures and buildings that can deplete surface water replenishment of the aquifers.
8. Prepare a special developmental program for the Basement Complex hydrogeological areas and the shallow aquifers of the River Course Alluvium of the riverine areas, for the maximum exploitation of their potentials.
9. Introduce a management program to minimise Saline intrusion in the Coastal aquifers.

Ground Water, even though less in available quantity than surface water, is readily the main source of water to the majority of Nigerians. It is the fastest and cheapest means of providing the much needed potable water supply. However, its importance appears to have been submerged in the overall crowded schedule of the River Basin Development Authorities. In the execution of their responsibilities the RBDAS have relegated or even ignored the important program of developing Ground Water Resources. Hence, for maximum development and exploitation of the country's Ground Water Resources is a need for a separate and well equipped Ground Water Development Department in each of the River Basin Development Authorities cannot be over emphasized

References.

Akpoborie, P. Anthony: Implications of Decree 101 (1993) for Water Resources Development and Management in Nigeria (Paper Presented at the 19... NAH Conference at Abuja.

Ayoade J. O., and Oyebande B.L:
Water Resources, in A Geography of Nigerian Development.
Edited by Oguntoyinbo J. Areola O.O and Filani M. 1978 pg.71.

Basil & Associates Ltd, in Assoc. with Frank E. Basil, Inc.

Provisional Master Plan for Ground Water Resources Dev. Basil & Associates.

Hanidn. J. E. 1990: National Growth, Water Demand and Supply Stragies in Nigeria in the 1990s Water Resources Journal of NAH Vol.2 No.1

Offodile M. E. 1988: Water Resources Management Nigerian Ground Water Systems. Water Resources: Journal of NAH. PP. 63 – 74 Vol.1 No. 1.

Offodile M. E. Problems of Water Resources Management in Nigeria.

Offodile M. E. An Approach to Ground Water Study & Dev. In Nigeria 1992

Published by Mecon Services Ltd.

Twort A. C.: Hoather R.C. and Law F.M. 1974 Water Supply. Fed Atlas of Nigeria (1988).