

# GROUNDWATER PROTECTION AS VIABLE OPTION FOR SUSTAINABLE WATER SUPPLY IN NIGERIA

H. O. NWANKWOALA AND G. J. UDOM

(Received 18 March, 2008. Revision Accepted 29 September, 2008)

## ABSTRACT

The threat of contamination of groundwater due to indiscriminate refuse disposal, bad management of sewage and septic tanks, industrial effluent discharges, leakage of underground fuel pipes and storage tanks and non-point pollution sources in major urban and semi-urban locations across the country are real. The argument to start planning for groundwater protection before there is serious contamination is clear and powerful. Such preventive action is the essence of groundwater protection. The logic of preventing groundwater contamination is clear but our problem or concern is in remediation of groundwater contamination. Although there are many well documented examples of groundwater remediation and good sources of information on how to clean up contaminated aquifers, the need to protect our groundwater supplies cannot be over emphasized. The age long aphorism " *prevention is better than cure*" applies here. This is because, once polluted, groundwater supplies are difficult and expensive to purify and the aquifer requires a long time to "heal" naturally. It then constitutes a health hazard to the consumers. This paper therefore addresses the question of how we can protect groundwater from becoming polluted. The paper not only concentrates on the problems of protecting groundwater from toxic chemicals but also discusses ways of protecting groundwater from conventional pollutants.

**KEYWORDS:** Groundwater protection, contamination, pollution, sustainable water supply, Nigeria.

## INTRODUCTION

The overwhelming number of activities concerning groundwater has been involved with remediating contamination rather than protecting groundwater from becoming contaminated. This results from the necessity to protect the public from the potential health threat of existing contamination. Many contaminants that reach our potable water are harmful at even trace concentrations. Small quantities of these toxic chemicals can contaminate many thousands of gallons of groundwater. Once in groundwater, they may be protected from the unusual environmental degradation processes. Their movement in the aquifer may be difficult to predict. Remediation efforts are usually extremely expensive. Because of these factors, it is now time to look beyond immediate crises and develop programs that will prevent future groundwater contamination.

On a national scale, the extent of groundwater contamination is thought to be small. Indeed, the pollution of our national water resources seems to be a gradual process that tends to render the resources irredeemable. And the rate of pollution tends to be on the increase owing to increases in the emerging industries and lack of effective monitoring of these industries and commercial establishments in keeping with the national environmental protection acts or legislations (FEPA, 1991).

A country where solid wastes are dumped in burrow pits and most times in abandoned shallow wells with no regard to groundwater contamination, surely must inherit serious water resources management problems.

The true extent of contamination is unknown in Nigeria because no comprehensive national database or

monitoring system exists. Groundwater contamination is of national concern because it is often found where the concentrations of human population are dependent on groundwater sources for their drinking water.

There are many sources from which toxic chemicals may reach groundwater. These sources are widely dispersed. Industrial solvents are found in our urban industrial centres, but are also widely distributed because of the decentralization of our industrial base and also because of disposal practices. Pesticides and herbicides are problems in many agricultural areas. The problems also extend to suburban areas because of manufacture, storage, and transportation accidents. Leaking storage tanks are problems everywhere. Hazardous waste disposal sites, abandoned dumpsites, and the disposal of small quantities of toxic wastes by commercial establishments and private households all have the potential of causing serious groundwater contamination.

## Groundwater Resource Protection and Water Policy Imperatives

Unlike most environmental problems, Nigeria has not passed comprehensive legislations to protect groundwater. Perhaps the possible reason for this *laissez faire* attitude over groundwater protection is the belief that Nigeria is blessed with an abundance of groundwater, which is ubiquitous in every geological setting, ranging from crystalline rock terrains to regions that are underlain by sedimentary rocks and in most cases, groundwater may be used without prior treatment. Given these scenarios groundwater resource supply should not constitute a problem. This is of course, not the case.

Groundwater source protection is extremely important because when the resource is no longer available at source either in terms of quantity and/or quality, there is scarcely any substitute for the overwhelming population which depends on groundwater.

There is a dire need for a policy. This is imperative because as pollution increases, the amount of useable water decreases and whatever remains is endangered.

A detailed study of the decree for water resources management (Decree 101 of 1993) by several workers (Akpoborie, 1999; Nwaogazie, personal communication) showed it drew heavily on the Riparian law concept without detailed distinction of groundwater concepts and their significance, thus resulting in a great bias to mainly surface water development and management. It is this bias of Decree 101 of 1993 towards surface water that underscores the built-in neglect of groundwater resource development in Nigeria. This has created a lacuna in the control and practice of groundwater resources development

Offodile (2000) lamented seriously on the inability of the government to "deliberately and intensively integrate regional groundwater exploration and exploitation programs in the overall National Water Resources Development Programmes. Groundwater is exploited rather haphazardly and indiscriminately by government, private institutions and individuals without any control, management or organization" even in open breach of Decree 101 (of 1993). It is in this context that Nwaogazie (2006) concluded that "*the Nigerian people are in desperate need for industrial waste disposal acts to protect the resources for the future*". He further stated that without the strict implementation of such acts, our national water resources will be grossly polluted in the shortest possible time and thus water for all will become a dream. Akpoborie (1997) articulated the modalities for the establishment of a consistent and goal oriented national policy on water quality in order to give added fillip to work being undertaken by academia.

It is to be noted that the science of hydrogeology was born and evolved from the necessity to search for and procure water for various uses. It is worth-emphasizing as Linsky (2003) argues, "*Good science cannot be left out of policy making*".

It is absolutely important that the groundwater resource be handled and protected in a sustainable manner so as to align the Nigerian nation with the UN-driven Millennium Development Goal (MDG). To achieve this objective and to avoid future crises, policy makers need to update groundwater policies and take steps to:

- \* Understand the situation – recognizing the importance of groundwater and the value of protecting it and understanding the trends and drivers behind groundwater use;
- \* Use resource analysis – to identify hot-spots of unsustainable groundwater use and prioritize these for action;
- \* Actively manage groundwater-even in the early stages of the groundwater socio-ecology, shifting from 'resource- development' to 'resources – management' policies.

Policy makers must as a matter of urgency, rise to the challenge of finding ways to manage groundwater and

sustain same. It is, after all, the most 'democratic' source of water available for improving livelihoods and household food security, and reducing poverty in the country. Amendment of Decree 101 or outright separate policy on groundwater protection should be considered without delay to ensure a regulated and well-controlled groundwater development and management programme in Nigeria.

### **Groundwater Protection Techniques**

In this section, specific techniques that are thought to be useful for groundwater protection are discussed:

#### **The reduction, recycling, and treatment of waste products**

Reduction of the volume of waste products, including recycling, and treatment of waste products to make them less damaging to the environment are approaches that facilitate the protection of groundwater from contamination.

#### **Ambient Groundwater Standards**

Ambient groundwater standards for contaminant concentrations in groundwater can be an important component of groundwater protection efforts. Their basic role is to provide benchmarks on groundwater quality that are available to identify when potential problems exist that require intervention. A monitoring system that collects and analyses data on groundwater quality to ensure that standards are met is also required. When standards are exceeded, intervention is required. Intervention may be taken an action to remediate contamination or it may be new controls or adjustment of existing controls on sources of contamination. In fact, there is need for the establishment of numerical groundwater standards. Standards based on scientific risk assessments, analogous to the uniform national standards for contaminants in surface water, would be an important contribution to groundwater protection.

#### **Effective Enforcement Provisions for Groundwater Protection Regulations**

These are needed to ensure compliance with groundwater protection requirements. Enforcement provisions may range from administrative orders to civil and criminal penalties. Enforcement provisions at the federal, state, and local government levels must be available to force violators to comply with groundwater protection regulations.

#### **Control of groundwater withdrawals**

Control of groundwater withdrawals is necessary in order to manage groundwater resources to avoid contamination. Issues of groundwater quantity and quality are integrally related and must be managed in a coordinated fashion. Management to ensure that optimum yield (maximum stable basin yield) is not exceeded can prevent many groundwater problems including contamination. Some form of a groundwater withdrawal permit system will provide control if and when it is needed. This is important, especially for the coastal towns where the use of large capacity pumps cause salt water up-conning through excessive withdrawal from a well.

### **An Inventory of Potential Sources of Groundwater Contamination**

This is needed for groundwater protection planning, especially at the local level. The inventory may be accomplished at the aquifer, regional, municipal, or the wellhead level. All potential sources of contaminants in the study area should be inventoried. The potential sources should include sites where potential pollutants are produced, stored, used, transported, and disposed of. The toxic chemicals which are of great concern in groundwater should receive the most attention because even small quantities can contaminate large volumes of groundwater for long periods of time. Potential sources of conventional pollutants should also be included in the inventory. The inventory should identify the potential sources, the potential pollutants at each source, and estimates of volumes. Planning to mitigate the anticipated problems should then be directed to the targets indicated in the inventory.

### **Effective Controls on all Potential Sources of Groundwater Contamination**

These are needed to prevent contamination. These controls take many forms. The controls may be granting licence or permit for the construction of facilities or the discharge of potential pollutants. The license or permit may be required of new or existing facilities that are source(s) of potential groundwater contaminants. The license or permit is usually conditional upon compliance with design specifications, performance standards for the operation of the facility, and discharge limits established to protect groundwater.

The license or permit requires application, inspection, and renewal that allow the regulating unit to assess compliance. Permits may be required for all activities that have a potential adverse impact on groundwater. Activities that require permits may range from constructing new wells or septic systems to constructing waste disposal facilities.

### **Inventory of Aquifers, their Characteristics and Classification**

Inventory of aquifers and their characteristics is an important activity for the protection of groundwater. In order to effectively protect our groundwater resources, it is essential to know about them. We need to know their boundaries, their hydrogeologic characteristics, and their chemical characteristics. Knowledge of aquifer recharge areas and hydrological connection to other aquifers are essential information if we are to develop and implement programs designed to protect and sustain groundwater quality. Details of the investigations needed may vary tremendously. In areas where there is no contamination and known sources of potential contamination, the inventory of aquifers and their characteristics may consist of no more than collecting existing knowledge about the aquifer. In areas where many people depend on groundwater for their drinking water supplies and where many potential sources of contamination exist, extensive hydrogeological investigations may be appropriate (Page, 1989; Nwankwozia and Odigi, 2008). Also, a classification of aquifer is necessary to determine which aquifer should receive the highest attention in developing aquifer protection plans. When constrained by limited resources, the aquifers that are

most important and most threatened should receive the most immediate attention.

### **Land use Controls**

Land use controls are among the most important techniques for protecting groundwater. Controlling the uses of the land that overlies an aquifer can be an effective way of controlling what substances might reach and contaminate the aquifer. Land use controls are most effective if they are site-specific and are used to restrict activities on aquifer recharge areas or other sensitive land. A wide variety of techniques are available for controlling the uses of land. The most useful of these land use planning tools for groundwater protection include: Zoning, siting, development and construction regulations, conservation easements, and transfer of development rights programs, among others.

### **CONCLUSIONS**

It is possible to protect our groundwater resources from conventional and toxic contaminants. Mechanisms to accomplish groundwater protection exist. No single mechanism or technique can be entirely effective, but combination of the options discussed above can be coordinated in a comprehensive groundwater protection plan that will greatly enhance the probability that groundwater resources will remain free of serious contamination.

Protecting groundwater is not an easy task. Even with broad political support to use all of the techniques available, there are many uncertainties that may hinder with success. This is obvious as our knowledge of aquifer characteristics hidden below the surface of the earth is limited. Aquifers are rarely composed of homogenous material, and it is not very possible to know all of the locations and the extent of the non-homogenous material that can affect the quality and movement of groundwater. Heterogeneities in aquifers produce many uncertainties that affect our ability to understand groundwater systems and our ability to plan for groundwater protection.

There are substantial gaps in our knowledge of what contaminants are present in our groundwater, how to predict their movement, how long they will remain, how they will affect human health, the contribution of contaminants in drinking water relative to other health risks, and the effectiveness of our efforts to develop and implement a groundwater protection plan. The entire process of planning for groundwater protection may be, on the whole, much more important than the set of groundwater protection techniques that have been used at any given time and place. Because of the uncertainties involved, it is important that groundwater protection plans be continually reassessed. The process of collecting information needed to get the groundwater protection process started should be continued to keep inventories of potential contaminant sources current and to evaluate if each protection option and/or technique is having its intended effect. It is the process of studying, developing, implementing, and monitoring groundwater protection plans that may lead to the understanding that will finally enable us protect our groundwater.

## REFERENCES

- Akpoborie, I. A., 1997. A framework for developing a groundwater quality management policy for Nigeria. Paper presented at the 10<sup>th</sup> Annual Conference of the Nigeria Association of Hydrogeologists, Enugu, Nov. 22-25.
- Akpoborie, I.A., 1999. Implications of Decree 101 for water resources development and management in Nigeria. *Water Resources Journal*, Nigeria Assoc. Hydrogeol. 10: 19 – 25.
- FEPA, 1991. Guidelines and Standards for Environmental Pollution Control in Nigeria, Federal Environmental Protection Agency, The Presidency, Lagos.
- Linsky, R. B., 2003. Is there a Paradox in Translating Science and Technology into the Decision – Making Process? *Water Resources Update*, Issue 123: 49-554.
- Nwankwoala, H. O. and Odigi, M. I., 2008. Hydrogeological Problems caused by Mining, Quarrying and Petroleum Exploration in Nigeria (In Press)
- Nwaogazie, I. L., 2006. Water supply for all: who cares. University of Port Harcourt Inaugural Lecture Series No. 52.
- Offodile, M. E., 2000. The development and management of groundwater for water supply in Nigeria. Paper Presented at the 2<sup>nd</sup> Fellows workshop of the Nigeria Mining and Geosciences Society 6<sup>th</sup> May, 2000.
- Page, G. W., 1989. Groundwater Protection, *Water Resource Systems*, Encyclopedia Article, *Encyclopedia of Physical Science and Technology*, 1989 Yearbook. pp 312 – 316.