AFRIKA FOCUS — Volume 28, Nr. 2, 2015 — pp. 146-155

Sustainable groundwater management in Lagos, Nigeria: the regulatory framework[1]

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This doctoral research focuses on groundwater degradation in Lagos, Nigeria. Groundwater is a fundamental natural resource in Lagos that is presently troubled by pollution emanating from solid waste and wastewater. The city generates 10,000 metric tons of waste and 350 million gallons of wastewater daily, all of which are improperly managed and are heavily polluting its groundwater. This direct environmental pollution is aggravated by indirect problems of over-urbanization, and legal and institutional shortcomings. Over-urbanization in Lagos has resulted into a monumental population of 21 million people in the tiny city, which generates the enormous quantities of solid waste and wastewater. The population places a tremendous burden on the city's water resources, forcing residents to revert to groundwater which is suffering the plight of pollution, and hence the concern of this research. The pollution problem is worsened by civic apathy to environmental matters, and unresolved by a nascent water sector whose evolving governance structures do not adequately address the multi-dimensional pollution problem. In the final analysis, the absence of holistic and comprehensive groundwater legislation that addresses all these problems challenges the sustainability of this vital resource. The research study contributes to knowledge by attempting to provide broad and holistic recommendations for law reform which address the pollution, management of the effects of over-urbanization and overpopulation on groundwater, and the strengthening of institutions to achieve a sustainable groundwater resource.

Key words: groundwater, solid waste, wastewater, urbanization, pollution

Research Questions

1. What are the direct environmental problems, and the indirect social, and institutional threats that contribute to groundwater degradation in Lagos?
2. How can law resolve the current fragmented and cursory frameworks and formulate a comprehensive one that addresses the direct and indirect problems that confront groundwater, thus safeguarding groundwater sustainability in Lagos?

1 This is the report of PhD research carried out at Ghent University, under the supervision of Jamie Benidickson.

Statement of the Research Problem and Context of the Study

Although the primary concern of this study is the pollution of groundwater, the problem occurs within a complex socio-legal framework that is summed into three categories: environmental, social, and institutional problems. Environmental problems occur as direct pollution of groundwater by solid waste and wastewater emissions. The twin sources of this pollution are respectively, the open waste dumps that leach into groundwater (open dumps are the official method of solid waste disposal), and untreated wastewater from industrial processes and (to a smaller degree) from domestic sources. Underlying this environmental problem, urbanization into Lagos which has resulted into a massive and burgeoning population, represents the social problem that is at the root of the pollution. The large population generates enormous quantities of solid waste and wastewater that place tremendous pressure on the state's water and waste management resources, and this is worsened by public apathy to environmental protection. A nascent water sector, whose governance structures are still evolving in spite of the city's age and relative sophistication, is an institutional problem that needs to be addressed. In the final analysis, the regulatory framework proves to be fragmented and rudimentary, and encounters the thorny problem of non-compliance. Each of these specific categories is discussed further below.

The Environmental Problem: Municipal Solid Waste and Wastewater

To a significant degree, the problem of groundwater contamination in Lagos arises from a waste management problem. Lagos residents generate 10,000 metric tons of diverse solid wastes daily (Olubori, 2013). The waste management agency collects the bulk of solid waste and disposes them in open dumpsites without treatment. The unhealthy open dumps constitute a serious health hazard owing to the diverse mix of the untreated wastes in them, especially electronic waste, which is perhaps the most hazardous. Electronic waste is termed the most rapidly growing waste problem in the world because of its toxic mix of chemical substances like lead, printing wiring boards, and cathode ray tubes that are potentially dangerous to humans who are in contact them (Puckett et al, 2002). It presents a more serious dimension to the waste problem for a city that is still sadly lacking a safe handling of basic municipal waste (Nnorom & Osibanjo, 2008). The used electronic equipment is disposed along with municipal waste in open dumps without further treatment, and its potential to leach toxic elements into the surrounding groundwater constitutes a real threat to human health especially when the dumpsite is close to drinking water wells[2]. This practice of improper electronic waste disposal prompted researchers to describe it as the "worst global example of waste mismanagement" (Nnorom & Osibanjo, 2008). Collectively, the diverse wastes in open dumps create a potential for harmful leachates to percolate into groundwater.

2 The country as a whole still lacks a significant form of e-waste recycling in spite of regulations that aim at preventing and minimizing pollution from the electronics sector in particular. The Regulations specify the 5Rs in treating electrical waste: Reduce, Repair, Re-use, Recycle, and Recover: National Environmental (Electrical/Electronic Sector) Regulations, Official Gazette (2011), Ss. 2-3.

The second dimension of the environmental problem is industrial and domestic wastewater. Residents generate an estimated 350 million gallons of wastewater daily from both sources within the Lagos metropolis[3]. Lagos city is the locus of manufacturing and of financial services for Nigeria, and has a massive scale of economic activity that is unequalled by any other city. As a result of its large-scale commercial activity, particularly manufacturing, industries in Lagos generate vast quantities of industrial wastewater. Industrial wastewater is very concerning because of its high concentration of toxic compounds employed within manufacturing and other industrial processes, and also because industry operators discharge these effluents into the environment with minimal treatment[4]. Untreated wastewater discharged into the environment constitutes a threat to human and ecological health. (Oteri, 2013).

Apart from industrial wastewater, municipal wastewater from domestic sources is another problem for groundwater. Wastewater from bathrooms and kitchens is collected individually in each building through an on-site sanitation system that employs the use of septic tanks (UN, 2008). This system creates a distributed or diffused method of sewage ejection that is hazardous because of the non-uniformity in design of these structures, and the usual non-inclusion of a primary treatment device in them. Consequently, the wastewater is released untreated into the soil, constituting a real threat in that the pathogens in it will migrate into groundwater. The septic tanks are also sometimes wrongly situated too close to wells which abstract groundwater for drinking, with pollution occurring as a result. Although there are some rules governing the locations of septic tanks in terms of minimum location specifications from wells and other potable water supplies, there does not appear to be much compliance[5]. Lagos is a substantially built environment whose preliminary urban planning did not take into account centralized wastewater collection and treatment. The diffuse ejection method is ridden with the problem of leaching of very harmful contaminants into surrounding groundwater, quite apart from the frequent need for dislodging septic tanks (Olanrewaju, 1990). Although wastewater discharge is primarily a problem of surface water bodies, the connection of both streams of water in the hydrological cycle makes it a problem for groundwater as well. Due to this connection, groundwater pollution is imminent, as the toxic components of the effluent discharges eventually reach groundwater and contaminate it (Egboka et al, 1989). Improperly managed wastewater has rightly been described as a major challenge to development and a cause of poverty because it generates healthcare costs and lost labor productivity (UNEP, 2010).

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3 Lagos State Wastewater Management Office, "Institutional, Regulatory and Legal Framework of Lagos State Wastewater Management Office" (2012). Paper presented to the Lagos State Government in August 2012.

4 *Ibid*. The Lagos State Environmental Protection Agency (LASEPA) is responsible for regulating wastewater from industries and has Standards for the effluents from industrial activities but laments low industry compliance: Lagos State Government, Final Report on Effluent Limitations Standards and Guidelines (1999).

5 See for instance: National Environmental (Sanitation and Wastes Control) Regulations, Federal Republic of Nigeria Official Gazette, (2009) No. 60, Vol. 95, S. 10 and Schedule IV. The problem of non-compliance is due in part to the rules being fairly recent compared to many of the non-compliant structures which have pre-existed the laws by several years.

Social Problems: Urbanization and Apathy/Non-compliance

The groundwater quality problem discussed so far is occurring within a context of over-urbanization in Lagos. Urbanization, the large and increasing influx of people into an urban area, is a natural process in development, and a major contributor to economic development in that it encourages product specialization by leveraging on the population mass (scale economies), and the concentration of similar industries - localization economies (Henderson, 2002).

Urbanization in Lagos is therefore not *ipso facto* an anomaly. However the problem has occurred because of absolute and unrestrained increments and an overall explosive population growth rate that totally outstrips infrastructure in a pattern that scholars find to be typical of Third World demographic processes generally (Kasarda & Crenshaw, 1991). It is in sharp contrast to the pattern of urban development in First World cities which were progressive, and which allowed for the concurrent design and development of a full range of complementary social institutions, particularly of commensurate waste and wastewater management infrastructure that have guaranteed an overall good quality of urban life (Kasarda & Crenshaw 1991; Henderson, 2002).

The high growth rate in Lagos is also enhanced by national social factors which encourage childbearing. Cultural and religious factors have contributed to Nigeria's large population of 170 million people. Everyone is expected to marry and to procreate, because marriage is perceived as a very respectable and required social institution, and a woman's status is enhanced by childbearing. Within marriage, premium has traditionally been placed on male children, and this has often resulted in repeated births in an effort to secure one. The two main religions, Christianity and Islam, although differing in fundamental ideologies, both promote childbearing as gifts from God (Kokole, 1994; Onwuka, 2006; Iwejingi, 2011). The city's growth rate exceeds the government's ability to plan for and manage important infrastructural facilities notably for appropriate solid waste treatment, safe wastewater disposal, and adequate water supply.

According to the United Nations, Lagos is the fastest growing megacity in the world with the potential to become a world city and to compete with long-established cities in Europe and North America which have traditionally laid exclusive claim to that status[6]. Its exponential growth rate has led to an "over-urbanized" city, a phenomenon that causes public services to be over-burdened, and that tends to outstrip overall economic development, amongst other related problems (Kasarda & Crenshaw, 1991). Scholars do acknowledge that the most significant consequence of overly large populations is the dire impact on environmental resources (Ehrlich & Ehrlich, 1997). This observation is true of Lagos where urbanization has occurred at such a fast rate that water, wastewater, and solid waste management infrastructure have not kept pace with it.

Apathy and non-compliance with environmental laws represents the other dimension of social problems that affect groundwater quality. The apathetic attitude of industrial operators especially to environmental security, which has implied non-compliance

6 UN Habitat, State of the World's Cities 2006/7 Urbanization.
Online: http://www.unhabitat.org/documents/media_centre/sowcr2006/SOWCR%202.pdf

with environmental regulations on effluent discharges and treatment to specified standards, is a particularly distressing problem[7].

Institutional Problems Affecting Groundwater Management

A Meagre Regulatory Framework

The existing rudimentary and fragmented regulatory framework does not offer enough protection for the groundwater resource. No single law is dedicated to groundwater in Lagos. Rather, as this thesis documents in Chapter 6, a combination of federal and state laws provides at best a cursory and fragmented framework to which problem of vagueness, legal pluralism, gaps in legislation, and non-compliance attend. The regulatory attempts are superficial, spread out over several enactments, and are not complied with. Thus dangerous wastewater disposal practices and wrongful solid waste handling have continued virtually unheeded and unaddressed by law, even as the pollution of groundwater escalates. Limited regulation has also encouraged a culture of indiscriminate exploitation of groundwater that, combined with careless waste habits, has put the groundwater resource at a very serious risk from the perspectives of quality and sustainable supply.

A Nascent Water Sector

An inadequately structured water sector characterizes the institutional framework in Lagos. Lagos has never had a governing Ministry of Water Resources, but rather the Lagos State Water Regulatory Commission was created only in 2012. It oversees the water sector which comprises the Lagos Water Corporation and the Lagos Wastewater Management Office. The Commission aims at achieving sustainable water supply and wastewater management services, but is still streamlining its functions amidst pre-existing structures and overlapping responsibilities between the water sector operators. Functional overlaps are occurring, whilst responsibilities still need to be clarified, streamlined and monitored for effectiveness[8]. It appears that the ultimate impact of the Regulatory Commission on water quality and water supply may not be discernible for some time, and in the meantime groundwater has not received the attention and protection that it requires.

The Lagos Water Corporation, although charged with responsibility for water supply meets only 30% of the city's water needs, hampered by a diversity of operational difficulties that range from financial limitations to power outages that constantly disrupt water pumping and transportation processes[9]. In the present state of an inadequate managerial framework, the groundwater pollution problem is escalating and threatening the

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7 Personal discussions with Lagos State Government officials confirmed the pervasive attitude and are discussed in more detail within the thesis, in Chapter 5.

8 The Lagos State Water Sector Law (2004) establishes the Commission with regulatory functions similar to those of the Water Corporation. An example is the responsibility for public sewers for wastewater that the Water Sector Law places on the Water Corporation, whereas the Lagos Wastewater Management Agency now has that exclusive responsibility (S.95, Water Sector Law). Personal discussions with the head of the Commission in 2013 confirmed the presence of these functional overlaps.

9 Lagos Water Corporation, *Water Supply Plan 2010-2020* (April 2012).

sustainability of an invaluable resource which is needed for life and economic development in the city. Over the years, empirical studies conducted by scientists on the state of groundwater in the city have consistently affirmed proliferate and escalating degradation of groundwater that is caused by the migration of diverse pollutants into groundwater from solid waste and wastewater (Sangodoyin & Agbawhe 1992; Ikem et al, 2002; Longe & Balogun, 2007; Asubiojo, 2012; Eruola *et al.*, 2013).

Methodology

This study combines a number of methods to enhance the legal research and to achieve its objective. It employs the historical methodology, a comparative legal approach, insights from sociological and scientific studies, analysis of field work undertaken, and analysis of information in official documentation obtained from Lagos state departments.

The **historical method** is the process of extracting general facts through attention to chronology and to the evolution of the subject of study. In this thesis, it enables a review of the contributions of groundwater to human life in Chapter 3, which underscores its importance and the rationale for the present study. The method is also employed to appraise the evolution of sustainable development in Chapter 2, and leads to the extraction of pertinent principles for water management as a benchmark on which development in Lagos is evaluated. These historical reviews provide the conceptual basis for the study.

Still employing the historical methodology, the study also examines the origin of environmental legislation in Nigeria in Chapter 6. The method facilitates the tracking of its evolution up until the emerging efforts to regulate groundwater. Primary sources of law including federal and Lagos laws as well as regulations made under the laws are examined.

Following the historical legal review in Chapter 6, the study employs the **comparative approach** in the same chapter to examine and compare pertinent aspects of the European Union's legal framework for groundwater and (due to their intersection), solid waste and wastewater management in Lagos. The comparison is being made in order to aid the proposed recommendations for law reform. The process ascertains similarities and differences in legal provisions between the two systems, and recommendations are being offered based on analysis and aggregation of the perceived best management solutions offered by the European Union.

A review of **sociological and scientific studies** provides important insights for the research. The sociological theories on urbanization in Chapter 4 explain it as a demographic phenomenon which is the context in which the groundwater pollution problem is occurring in Lagos. They provide understanding of the migration to Lagos which accounts for the generation of massive quantities of waste and wastewater that pollute its groundwater. The theories also explain the reasons for the lackluster attitude of industrialists to compliance with environmental standards for wastewater.

The **empirical studies** discussed in Chapter 5 provide insights into the causes, sources, and extents of groundwater pollution from municipal solid waste and waste-

water, as well as the implications for human health. The references to scientific studies provide a real account of the groundwater pollution occurring in Lagos over a ten-year period, from 2002 until 2012.

Field work carried out in Lagos over a period of ten weeks between 2012 and 2013 is reported in Chapter 5. It includes a series of interview sessions held with officials of Departments within Lagos State which are responsible for water, solid waste and wastewater management, as well as scientists.

Presentation of Chapters

Chapter 2 introduces the concept of sustainable development as the standard on which development in Lagos is evaluated. It outlines the general agreements at important international meetings, and pertinent principles relating to water resources management for analysis across the thesis.

This is followed in Chapter 3 by a discussion of the relevant literature on groundwater, and an examination of its global contributions as a basis for appreciating its overall importance. This precedes a discussion of its specific importance and contribution to life and industrial growth in Lagos.

Chapter 4 is an overview of urbanization, the social context in which pollution of groundwater is occurring in Lagos. The chapter reviews theories that explain the motivations for migration into Lagos, which accounts for the overly large population in the megacity, and which is also enhanced by a national high rate of population growth. It also discusses the probable environmental consequences of an over-urbanized city, as a prelude to the next chapter's discussion of actual pollution that has occurred.

In Chapter 5, the core of the research, the problems of solid waste and wastewater pollution of groundwater that emanate from the large, urbanized population are discussed. This is immediately followed by the results of the field work which are presented separately for solid waste and wastewater. The chapter concludes with a consideration of the implications of polluted groundwater on human health.

Chapter 6 contains the discussion of the legal and institutional framework for groundwater. It incorporates an appraisal of the limitations of the current legal and institutional system following a historical review of the evolution of environmental legislation in Nigeria. The legal frameworks for groundwater, waste, and wastewater are reviewed and recommendations made to improve them in the overall interest of groundwater security. The legal frameworks are also compared to that of the European Union, and best management practices are extracted for application in Lagos. Recommendations are also made to tackle the perceived problems within environmental governance institutions in an effort to secure groundwater.

Chapter 7 concludes the thesis with a discussion and summarization of each segment of the overall problems confronting groundwater, and of probable solutions. This is followed by recommendations in each category of the problems for incorporation in a legal framework that is expected to contribute to groundwater security in Lagos. The chapter presents all the recommendations in tables.

Conclusions and Recommendations

In answering the first research question, this thesis identifies the direct environmental threats as leachate from improperly managed solid waste, and wastewater generated from domestic and industrial activities that, in combination, are polluting groundwater. The indirect problems are over-urbanization that has led to overpopulation, and industrial apathy.

To resolve the direct problems, this study recommends alternative methods for managing solid waste, preferably engineered dumpsites with leachate collection and control. It also recommends a waste management policy that prioritizes waste minimization, and that emphasizes recycling and reuse. In the process of transitioning to better waste management, the useful role of scavengers may be properly harnessed. In the case of industrial wastewater, industrialists are urged to explore phytoremediation to rehabilitate their wastewater, as well as explore wastewater re-use generally. In terms of domestic sewage, it recommends that a moratorium be given to residents to acquire standard septic tanks which function as primary treatment, whilst the efforts to have decentralized treatment plants continue. The study also finds that the current pressure on groundwater, which has contributed to its degradation, is caused by inadequate water supplies. It thus urges that the pressure can be reduced by optimizing existing water, and exploring the use of alternative, existing sources of water.

In order to tackle the indirect problems, this thesis proffers a number of measures to address industrial apathy, and these include: education about the 'water fit' concept that is expected to significantly reduce wastewater treatment costs; the employment of community pressure based on environmental reputation to be brought to bear on industrialists in order to change their apathetic environmental behavior; and incentives and other measures to encourage good environmental behaviour.

To answer the second research question, this thesis recommends a single law to be written to manage groundwater. The law should build upon existing provisions of the Federal NESREA Regulations, and go much further by incorporating safe wastewater and solid waste management practices that intersect with groundwater. It should also adopt best practices identified within the European Union's legal framework. It proposed the strengthening of institutions through cooperation, and the elimination of functional overlaps.

All the recommended measures are urged for incorporation into law and policy in Lagos in order to accomplish a safe, secure and sustainable groundwater resource.

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