**STRATEGIC PLANS FOR HANDLING WATER QUALITY ISSUES IN NIGERIA: A CASE STUDY OF LAGOS STATE**

**BY**

**MAKANJUOLA OMOBOLANLE**

**MATRIC NO: 15/ENG03/022**

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING.**

**COLLEGE OF ENGINEERING**

**AFE BABALOLA UNIVERSITY, ADO-EKITI.**

**EKITI STATE, NIGERIA.**

**MARCH,2020.**

ABSTRACT

The challenges faced in water supply in most cities and developing countries are increasing population size, poor operational efficiency of existing waterworks, leakages, low reticulation coverage and poor cost-recovery. Our study revealed variation in the public water-supply-demand gap estimates under low, middle and high population growth rate scenarios. Under a largely urbanized evolution of the LGAs, Lagos State faces an imminent critical water shortage if pragmatic steps are not taken to bridge the public water supply-demand gap. Pragmatic solutions recommended include strategic planning and implementation of new waterworks, improved operational efficiency of existing waterworks, improved reticulation and appropriate cost-recovery.

**INTRODUCTION**

Water is a chemical compound with the formula H2O. Water covers 71% of the earth’s surface, and is vital for all known forms of life on earth. Water is distributed around the planets in oceans, seas, lakes, and ground and in the air as vapor and clouds. Water is vital both as a solvent to man has many of his body’s solute dissolve in it and as an essential part of many metabolic process within the body.

As man requires water for their metabolism, so do bacteria cells require water for their survival, growth and reproduction. Water being a polar compound that is able to dissolve cellular compounds and provide a suitable environment for various metabolic reaction of a cell. It also provides resistance to sudden temperature change in the environment. It is a chemical reactant required for many hydrolytic reactions carried out by a cell.

The cross contamination of waste water from the soak pit to the water source as being one of the major mode of contaminating our drinking water and thus not making them safe for consumption. This lack of proper construction of this soak pit to the water source with about a distance of 30m and a proper land slope had enhanced several water borne disease.

Waterborne disease is caused by pathogenic microorganisms that most commonly are transmitted in contaminated fresh water. Infection commonly result during bathing, washing, drinking, in preparation of food, and or consumption of food thus infected. Various forms of waterborne diseases are probably the most prominent examples, and affect mainly children in developing countries; according to world health organization, such diseases account for 4.1% of the total DALY global burden disease, and cause about 1.8 million human deaths annually. The World Health Organization estimates 88% of that burden is attributed to unsafe water supply, sanitation, and hygiene. (WHO 2004)

Escherichia coli (E-coli) are bacteria that constitute about 0.1% of gut flora. (Eck burg et al., 2005) and fecal oral transmission is the major route through which pathogenic strains of bacterium causing disease. Cells are able to survive outside the body or limited amount of time, which makes them indicator organisms to test environmental samples foe fecal contamination in water and some food substances.

Several diseases and infections are caused by the consumption of water, which may be classified into; protozoa infection such as Amoebiasis caused by the consumption of sewage non treated water and likewise presence of flies in water and its microbial agent is Entamoeba histolytic, parasitic infection such as schistosomiasis caused by the consumption of fresh water contaminated with certain types of snails that carry schistome, viral infections such as SARS which is caused by consumption of water that is improperly treated having the presence of corona virus in it and likewise the bacterial infections such as cholera caused by consumption of water contaminated with the bacterium Vibrocholerae. (Dziuban Et al, 2006)

As drinking of purified water has its good effect so does it possess bad effect on human health due to the fact that purified water lacks minerals and ions such as calcium that plays key role in biological functions such as in nervous system homeostasis, and are normally found in potable water. They lack naturally-occurring minerals in distilled water has raised some concern.

In Nigeria, Water is widely regarded as the most essential of natural resources, yet freshwater systems are directly threatened by human activities and stand to be further affected by anthropogenic climate change. Water systems are affected by intensive agricultural activities; urban development, industrialization and unplanned engineering infrastructures. Unplanned agricultural practices arising from lack of adequate extension workers and largely unmechanised procedures leave farmers with the option of bush burning as the only site clearing method. This practice results in deforestation which translate into land degradation and mass wasting events leading to soil water deficits and sediment loading of surface water. Irrigation practices often affect the wetland hydrology of downstream areas thereby impacting negatively on aquatic ecosystem. It has become common practice in most Nigerian cities to always resort to surface water bodies as a viable receptacle of solid and industrial wastes. The quantity and quality of Nigeria’s water resources are affected by the coupling of the human factors and climate change. The spatial distribution of rainfall, climate pattern and hydrogeological units from the coastal areas to the Sahel regions of Nigeria provide a framework for the identification of the threats in terms of quantity and quality. Considering the importance of water to a developing nation like Nigeria, and in line with the MDGs number 7, the issues to be addressed are; the ever increasing water demand due to urban population increase vis-à-vis the impairment of the available water resources from both manmade and natural causes. Identification of these threats and their pathways are key to the formulation of mitigation or adaptation.

**LITERATURE REVIEW**

**Water and Its Importance to Man Kind**

Water is the common name applied to the liquid form (state) of the hydrogen and oxygen compound H2O. Pure water is an odorless, tasteless, clear liquid. Water is one of nature's most important gifts to mankind. Essential to life, a person's survival depends on drinking water. Water is one of the most essential elements to good health -- it is necessary for the digestion and absorption of food; helps maintain proper muscle tone; supplies oxygen and nutrients to the cells; rids the body of wastes; and serves as a natural air conditioning system. Health officials emphasize the importance of drinking at least eight glasses of clean water each and every day to maintain good health.

Since water contains no calories and can serve as an appetite suppressant and helps the body metabolize stored fat, it is possibly being one of the most significant factors in losing weight. Drinking enough water is the best treatment for fluid retention; the overweight person needs more water than the thin one; water helps to maintain proper muscle tone; water can help relieve constipation; drinking water is essential to weight loss.

Water is a key component in determining the quality of our lives. Today, people are concerned about the quality of the water they drink. Although water covers more than 70% of the Earth, only 1% of the Earth's water is available as a source of drinking. Yet, our society continues to contaminate this precious resource. Water is known as a natural solvent. Before it reaches the consumer's tap, it comes into contact with many different substances, including organic and inorganic matter, chemicals, and other contaminants. Many public water systems treat water with chlorine to destroy disease-producing contaminants that may be present in the water. Although disinfection is an important step in the treatment of potable water, the taste and odor of chlorine is objectionable. And, the disinfectants that are used to prevent disease can create byproducts which may pose significant health risks. Today, drinking water treatment at the point-of-use is no longer a luxury, it is a necessity! Consumers are taking matters into their own hands and are now determining the quality of the water they and their families will drink by installing a drinking water system that will give them clean, refreshing, and healthier water.

**2.1 SOURCES OF WATER**

There are many ways in which we can collect water. The main sources are discussed below:

**2.1.1 Surface Water**: This is water which falls to the ground as rain or hail. The water is collected from a special area called a catchment. The catchment feeds water into a holding area via rivers, streams and creeks. The water is then stored in a natural or artificial (manmade) barrier called a dam or reservoir.  
**2.1.2 Rivers or Lakes**: Town or community water supplies are sometimes drawn directly from nearby rivers or lakes.

**2.1.3 Spring**: These are found where underground water flows out of the ground naturally without the use of bores, wells or pumps. It often occurs towards the bottom of a hill or on sloping ground.

**2.1.4 Rock Catchment Areas and Rock Holes**: Sometimes large rocky outcrops contain low areas in which water is trapped. These low areas make good natural dams. Often a wall can be built to increase the amount of trapped water.

**2.1.5 Excavated Dams**: Excavated dams are made by scooping out soil to make a large shallow hole. These dams are sometimes placed at the bottom of a slope to aid water collection. However, this can only be done in areas where the soil will not allow the water to drain away very easily through the ground.e.g. (clay soils). Soils which do not allow water to drain away are called impervious. If a community wants a dam in an area where the soil is not impervious this can still be done by digging the hole and lining it with clay or an impervious liner, such as concrete or heavy plastic. Excavated dams are often used by farmers to supply water to stock.

**2.1.6 Rainwater Tanks**: The rainwater which falls on the roofs of houses is often collected using roof guttering leading through a pipe to a storage tan

**2.1.7 Bores and Wells**: These are holes drilled into the ground deep enough to find a permanent (long-lasting) body of water. A pipe runs down the hole into the water and a pump is used to get the water up to ground level. The water is then pumped to the community.

**2.1.8 Artesian Bores**: Sometimes when a bore is sunk into a low lying area the water gushes out of the hole under its own pressure. This water is under pressure because it is part of an underground body of water much of which is at a higher level than the bore opening. This kind of bore is called an artesian bore. Water of this kind would require special treatment to make it potable

* 1. **PROPERTIES OF WATER**

**2.2.1 Physical Properties**

* Water appears in nature in all three common states of matter (solid, liquid, and gas)
* Water is a liquid at [standard temperature and pressure](http://en.wikipedia.org/wiki/Standard_conditions). It is tasteless and odorless. The intrinsic [color of water](http://en.wikipedia.org/wiki/Colour_of_water) and ice is a very slight blue hue, although both appear colorless in small quantities. Water vapor is essentially invisible as a gas. (Braun 1993)
* Water is [transparent](http://en.wikipedia.org/wiki/Transparency_%28optics%29) in the visible [electromagnetic spectrum](http://en.wikipedia.org/wiki/Electromagnetic_spectrum). Thus [aquatic plants](http://en.wikipedia.org/wiki/Aquatic_plant) can live in water because [sunlight](http://en.wikipedia.org/wiki/Sunlight) can reach them. Infrared light is strongly [absorbed](http://en.wikipedia.org/wiki/Absorption_%28electromagnetic_radiation%29) by the hydrogen-oxygen or OH bonds.
* Since the water molecule is not linear and the oxygen atom has a higher [electro negativity](http://en.wikipedia.org/wiki/Electronegativity) than hydrogen atoms, it carries a slight negative charge, whereas the hydrogen atoms are slightly positive. As a result, water is a [polar molecule](http://en.wikipedia.org/wiki/Polar_molecule) with an [electrical dipole moment](http://en.wikipedia.org/wiki/Electrical_dipole_moment).
* Water also can form an unusually large number of intermolecular [hydrogen bonds](http://en.wikipedia.org/wiki/Hydrogen_bonds) (four) for a molecule of its size. These factors lead to strong attractive forces between molecules of water, giving rise to water's high [surface tension](http://en.wikipedia.org/wiki/Surface_tension) (Campbell, 2006) and capillary forces
* Water is a good polar [solvent](http://en.wikipedia.org/wiki/Solvent) and is often referred to as the universal [solvent](http://en.wikipedia.org/wiki/Solvent). Substances that dissolve in water, e.g., [salts](http://en.wikipedia.org/wiki/Salt_%28chemistry%29), [sugars](http://en.wikipedia.org/wiki/Sugar), [acids](http://en.wikipedia.org/wiki/Acid), [alkalis](http://en.wikipedia.org/wiki/Alkali), and some [gases](http://en.wikipedia.org/wiki/Gas) – especially oxygen, [carbon dioxide](http://en.wikipedia.org/wiki/Carbon_dioxide) ([carbonation](http://en.wikipedia.org/wiki/Carbonation)) are known as [hydrophilic](http://en.wikipedia.org/wiki/Hydrophilic) (water-loving) substances, while those that are [immiscible](http://en.wikipedia.org/wiki/Miscibility) with water (e.g., [fats and oils](http://en.wikipedia.org/wiki/Lipids)), are known as [hydrophobic](http://en.wikipedia.org/wiki/Hydrophobic) (water-fearing) substances.
* Most of the major components in cells ([proteins](http://en.wikipedia.org/wiki/Protein), [DNA](http://en.wikipedia.org/wiki/DNA) and [polysaccharides](http://en.wikipedia.org/wiki/Polysaccharide)) are also dissolved in water.
* Pure water has a low [electrical conductivity](http://en.wikipedia.org/wiki/Electrical_conductivity), but this increases with the [dissolution](http://en.wikipedia.org/wiki/Dissolution_%28chemistry%29) of a small amount of ionic material such as [sodium chloride](http://en.wikipedia.org/wiki/Sodium_chloride).
* The [boiling point](http://en.wikipedia.org/wiki/Boiling_point) of water (and all other liquids) is dependent on the [barometric pressure](http://en.wikipedia.org/wiki/Barometric_pressure). For example, on the top of [Mt. Everest](http://en.wikipedia.org/wiki/Mt._Everest) water boils at 68 °C (154 °F), compared to 100 °C (212 °F) at [sea level](http://en.wikipedia.org/wiki/Sea_level). Conversely, water deep in the ocean near geothermal vents can reach temperatures of hundreds of degrees and remain liquid.
* At 4181.3 J/(kg·K), water has a high [specific heat capacity](http://en.wikipedia.org/wiki/Specific_heat_capacity), as well as a high [heat of vaporization](http://en.wikipedia.org/wiki/Heat_of_vaporization) (40.65 kJ·mol−1), both of which are a result of the extensive [hydrogen bonding](http://en.wikipedia.org/wiki/Hydrogen_bonding) between its molecules. These two unusual properties allow water to moderate Earth's [climate](http://en.wikipedia.org/wiki/Climate) by buffering large fluctuations in temperature.
* The maximum [density](http://en.wikipedia.org/wiki/Density) of water occurs at 3.98 °C (39.16 °F), (Kotz 2005). It has the anomalous property of becoming less dense, not more, when it is cooled to its solid form, ice. During freezing, the 'open structure' of ice is gradually broken and molecules enter cavities in ice-like structure of low temperature water. There are two competing effects: 1) Increasing volume of normal liquid and 2) Decrease overall volume of the liquid. Between 0 and 3.98 °C, the second effect will cancel off the first effect so the net effect is shrinkage of volume with increasing temperature.
* The [density](http://en.wikipedia.org/wiki/Density) of liquid water is 1,000 kg/m3 (62.43 lb/cu ft) at 4 °C. Ice has a density of 917 kg/m3 (57.25 lb/cu ft).
  + 1. **Chemical Properties**
* Water is [miscible](http://en.wikipedia.org/wiki/Miscible) with many liquids, such as [ethanol](http://en.wikipedia.org/wiki/Ethanol), in all proportions, forming a single [homogeneous](http://en.wikipedia.org/wiki/Homogeneous_%28chemistry%29) liquid. On the other hand, water and most [oils](http://en.wikipedia.org/wiki/Oil) are immiscible, usually forming layers according to increasing density from the top. As a gas, water vapor is completely [miscible](http://en.wikipedia.org/wiki/Miscible) with air.
* Water can be [split by electrolysis](http://en.wikipedia.org/wiki/Electrolysis_of_water) into hydrogen and oxygen.
* As an oxide of hydrogen, water is formed when hydrogen or hydrogen-containing compounds [burn](http://en.wikipedia.org/wiki/Combustion) or [react](http://en.wikipedia.org/wiki/Chemical_reaction) with oxygen or oxygen-containing compounds. Water is not a [fuel](http://en.wikipedia.org/wiki/Fuel), it is an end-product of the combustion of hydrogen. (Ball, 2007)
* [Elements](http://en.wikipedia.org/wiki/Chemical_element) which are more [electropositive](http://en.wikipedia.org/wiki/Electropositivity) than hydrogen such as [lithium](http://en.wikipedia.org/wiki/Lithium), [sodium](http://en.wikipedia.org/wiki/Sodium), [calcium](http://en.wikipedia.org/wiki/Calcium), [potassium](http://en.wikipedia.org/wiki/Potassium) and [caesium](http://en.wikipedia.org/wiki/Caesium) displace hydrogen from water, forming [hydroxides](http://en.wikipedia.org/wiki/Hydroxide). Being a flammable gas, the hydrogen given off is dangerous and the reaction of water with the more electropositive of these elements may be violently explosive.

**2.3 USES 0F WATER**

Water is a vital tool to life several thins would have been possible without the existence of water. Some of its uses are discussed below:

**2.3.1 Agricultural**: It is estimated that 69% of worldwide water use is for irrigation, with 15-35% of irrigation withdrawals being unsustainable. It takes around 2,000 - 3,000 liters of water to produce enough food to satisfy one person's daily dietary need. ([UN 2007](http://www.fao.org/nr/water/docs/escarcity.pdf))

**2.3.2 Environmental**: Explicit environment water use is also a very small but growing percentage of total water use. Environmental water may include water stored in impoundments and released for environmental purposes (held environmental water), but more often is water retained in waterways through regulatory limits of abstraction.(UN 2007) Environmental water usage includes watering of natural or artificial wetlands, artificial lakes intended to create wildlife habitat, [fish ladders](https://en.wikipedia.org/wiki/Fish_ladder), and water releases from reservoirs timed to help fish spawn, or to restore more natural flow regime (Molden, 2007) Like recreational usage, environmental usage is non-consumptive but may reduce the availability of water for other users at specific times and places.

**2.3.3 For Drinking**: The human [body](http://en.wikipedia.org/wiki/Body) contains from 55% to 78% water, depending on body size.(Jeffrey, 2009).To function properly, the body requires between one and seven liters of water per [day](http://en.wikipedia.org/wiki/Day) to avoid [dehydration](http://en.wikipedia.org/wiki/Dehydration); the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is not clear how much water intake is needed by healthy people, though most specialists agree that approximately 2 liters (6 to 7 glasses) of water daily is the minimum to maintain proper hydration.

**2.3.4 Washing**: The propensity of water to form [solutions](http://en.wikipedia.org/wiki/Solvation) and [emulsions](http://en.wikipedia.org/wiki/Emulsion) is useful in various [washing](http://en.wikipedia.org/wiki/Washing) processes. Many industrial processes relies on reactions using chemicals dissolved in water, suspension of solids in water [slurries](http://en.wikipedia.org/wiki/Slurry) or using water to dissolve and extract substances. Washing is also an important component of several aspects of personal [body hygiene](http://en.wikipedia.org/wiki/Body_hygiene).

**2.3.5 Transportation**: The use of water for transportation of materials through rivers and canals as well as the international shipping lanes is an important part of the world economy.

**2.3.6 Chemical uses**: Water is widely used in chemical reactions as a [solvent](http://en.wikipedia.org/wiki/Solvent) or [reactant](http://en.wikipedia.org/wiki/Reactant) and less commonly as a [solute](http://en.wikipedia.org/wiki/Solution) or [catalyst](http://en.wikipedia.org/wiki/Catalyst). In inorganic reactions, water is a common solvent, dissolving many ionic compounds. In organic reactions, it is not usually used as a reaction solvent, because it does not dissolve the reactants well and is [amphoteric](http://en.wikipedia.org/wiki/Amphoteric) (acidic and basic) and [nucleophilic](http://en.wikipedia.org/wiki/Nucleophilic).

**2.3.7 Fire extinction**: Water has a high heat of vaporization and is relatively inert, which makes it a good [fire extinguishing](http://en.wikipedia.org/wiki/Fire_fighting#Use_of_water) fluid. The evaporation of water carries heat away from the fire. It is dangerous to use water on fires involving oils and organic solvents, because many organic materials float on water and the water tends to spread the burning liquid. Use of water in firefighting should also take into account the hazards of a [steam explosion](http://en.wikipedia.org/wiki/Steam_explosion), which may occur when water is used on very hot fires in confined spaces, and of a hydrogen explosion, when substances which react with water, such as certain metals or hot carbon such as [coal](http://en.wikipedia.org/wiki/Coal), [charcoal](http://en.wikipedia.org/wiki/Charcoal), [coke](http://en.wikipedia.org/wiki/Coke_%28fuel%29) graphite, decompose the water, producing [water gas](http://en.wikipedia.org/wiki/Water_gas).

**2.3.8 Water industry:** The [water industry](http://en.wikipedia.org/wiki/Water_industry) provides drinking water and [wastewater](http://en.wikipedia.org/wiki/Wastewater) services (including [sewage treatment](http://en.wikipedia.org/wiki/Sewage_treatment)) to [households](http://en.wikipedia.org/wiki/Household) and [industry](http://en.wikipedia.org/wiki/Industry). [Water supply](http://en.wikipedia.org/wiki/Water_supply) facilities include wells cisterns for [rainwater harvesting](http://en.wikipedia.org/wiki/Rainwater_harvesting), [water supply network](http://en.wikipedia.org/wiki/Water_supply_network), [water purification](http://en.wikipedia.org/wiki/Water_purification) facilities, [water tanks](http://en.wikipedia.org/wiki/Water_tank), [water towers](http://en.wikipedia.org/wiki/Water_tower), [water pipes](http://en.wikipedia.org/wiki/Water_pipe) including old [aqueducts](http://en.wikipedia.org/wiki/Aqueduct_%28watercourse%29). [Atmospheric water generators](http://en.wikipedia.org/wiki/Atmospheric_water_generator) are in development.

**2.3.9 Industrial Applications:** Water is used in [power generation](http://en.wikipedia.org/wiki/Power_generation). [Hydroelectricity](http://en.wikipedia.org/wiki/Hydroelectricity) is electricity obtained from [hydropower](http://en.wikipedia.org/wiki/Hydropower). Hydroelectric power comes from water driving a water turbine connected to a generator. Hydroelectricity is a low-cost, non-polluting, renewable energy source. The energy is supplied by the motion of water. Typically a [dam](http://en.wikipedia.org/wiki/Dam) is constructed on a river, creating an artificial lake behind it. Water flowing out of the lake is forced through turbines that turn generators. Water is also used in many industrial processes and machines, such as the [steam turbine](http://en.wikipedia.org/wiki/Steam_turbine) and [heat exchanger](http://en.wikipedia.org/wiki/Heat_exchanger), in addition to its use as a chemical [solvent](http://en.wikipedia.org/wiki/Solvent).

**2.3.10 Food processing:** Water plays many critical roles within the field of [food science](http://en.wikipedia.org/wiki/Food_science). It is important for a food scientist to understand the roles that water plays within food processing to ensure the success of their products. (Food and Nutrition Board 1945)

Water activity can be described as a ratio of the vapor pressure of water in a solution to the vapor pressure of pure water. Solutes in water lower water activity. This is important to know because most bacterial growth ceases at low levels of water activity. (DeMan, 1999). Not only does microbial growth affect the safety of food but also the preservation and shelf life of food.

Water hardness is also a critical factor in food processing. It can dramatically affect the quality of a product as well as playing a role in sanitation. (Vaclavik, 2007). The hardness of water affects its pH balance which plays a critical role in food processing. For example, hard water prevents successful production of clear beverages.

**2.4 WATER QUALITY**

Water quality refers to the chemical, physical and biological characteristics of [water](http://en.wikipedia.org/wiki/Water). (Diersing, 2009). It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purposes (Johnson, 1997). It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of [ecosystems](http://en.wikipedia.org/wiki/Ecosystems), safety of human contact and [drinking water](http://en.wikipedia.org/wiki/Drinking_water).

**2.4.1 Standards**

In the setting of standards, agencies make political and technical/scientific decisions about how the water will be used. (EPA 2006).In the case of natural [water bodies](http://en.wikipedia.org/wiki/Body_of_water), they also make some reasonable estimate of pristine conditions. Different uses raise different concerns and therefore different standards are considered. Natural water bodies will vary in response to environmental conditions. [Environmental scientists](http://en.wikipedia.org/wiki/Environmental_science) work to understand how these systems function, which in turn helps to identify the sources and fates of contaminants. [Environmental lawyers](http://en.wikipedia.org/wiki/Environmental_lawyers) and policymakers work to define legislation with the intention that water is maintained at an appropriate quality for its identified use.

The vast majority of [surface water](http://en.wikipedia.org/wiki/Surface_water) on the planet is neither [potable](http://en.wikipedia.org/wiki/Potable) nor [toxic](http://en.wikipedia.org/wiki/Toxicity). This remains true even if [seawater](http://en.wikipedia.org/wiki/Seawater) in the oceans (which is too salty to drink) is not counted. Another general perception of water quality is that of a simple property that tells whether water is [polluted](http://en.wikipedia.org/wiki/Pollution) or not. In fact, water quality is a complex subject, in part because water is a complex medium intrinsically tied to the [ecology](http://en.wikipedia.org/wiki/Ecology) of the Earth. Industri0al and commercial activities (e.g. [manufacturing](http://en.wikipedia.org/wiki/Manufacturing), [mining](http://en.wikipedia.org/wiki/Mining), [construction](http://en.wikipedia.org/wiki/Construction), [transport](http://en.wikipedia.org/wiki/Transport)) are a major cause of [water pollution](http://en.wikipedia.org/wiki/Water_pollution) as are [runoff](http://en.wikipedia.org/wiki/Surface_runoff) from [agricultural](http://en.wikipedia.org/wiki/Farm) areas, [urban runoff](http://en.wikipedia.org/wiki/Urban_runoff) and discharge of treated and untreated [sewage](http://en.wikipedia.org/wiki/Sewage).

**2.4.2 Categories**

The parameters for water quality are determined by the intended use. Work in the area of water quality tends to be focused on water that is treated for human consumption, industrial use, or in the environment.

* **Human Consumption**

Contaminants that may be in untreated water include [microorganisms](http://en.wikipedia.org/wiki/Microorganism) such as viruses, protozoa and bacteria; inorganic contaminants such as [salts](http://en.wikipedia.org/wiki/Salt_%28chemistry%29) and [metals](http://en.wikipedia.org/wiki/Metals); [organic chemical](http://en.wikipedia.org/wiki/Organic_chemistry) contaminants from industrial processes and [petroleum](http://en.wikipedia.org/wiki/Petroleum) use; [pesticides](http://en.wikipedia.org/wiki/Pesticides) and [herbicides](http://en.wikipedia.org/wiki/Herbicides); and [radioactive](http://en.wikipedia.org/wiki/Radioactive) contaminants. Water quality depends on the local geology and ecosystem, as well as human uses such as sewage dispersion, industrial pollution and overuse (which may lower the level of the water).

The [United States Environmental Protection Agency](http://en.wikipedia.org/wiki/United_States_Environmental_Protection_Agency) (EPA) limits the amounts of certain contaminants in [tap water](http://en.wikipedia.org/wiki/Tap_water) provided by US public water systems. The [Safe Drinking Water Act](http://en.wikipedia.org/wiki/Safe_Drinking_Water_Act) authorizes EPA to issue two types of standards: primary standards regulate substances that potentially affect human health, and secondary standards prescribe aesthetic qualities, those that affect taste, odor, or appearance. The U.S. [Food and Drug Administration](http://en.wikipedia.org/wiki/Food_and_Drug_Administration) (FDA) regulations establish limits for contaminants in [bottled water](http://en.wikipedia.org/wiki/Bottled_water) that must provide the same protection for public health. Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of these contaminants does not necessarily indicate that the water poses a health risk.

In [urbanized](http://en.wikipedia.org/wiki/Urbanization) areas around the world, [water purification](http://en.wikipedia.org/wiki/Water_purification) technology is used in municipal water systems to remove contaminants from the source water (surface water or [groundwater](http://en.wikipedia.org/wiki/Groundwater)) before it is distributed to homes, businesses, schools and other users. Water drawn directly from a stream, lake, or [aquifer](http://en.wikipedia.org/wiki/Aquifer) and that has no treatment00 will be of uncertain quality.

* **Industrial and Domestic Use**

Dissolved minerals may affect suitability of water for a range of industrial and domestic purposes. The most familiar of these is probably the presence of ions of [calcium](http://en.wikipedia.org/wiki/Calcium) and [magnesium](http://en.wikipedia.org/wiki/Magnesium) which interfere with the cleaning action of [soap](http://en.wikipedia.org/wiki/Soap), and can form hard [sulfate](http://en.wikipedia.org/wiki/Sulfate) and soft [carbonate](http://en.wikipedia.org/wiki/Carbonate) deposits in water heaters or [boilers](http://en.wikipedia.org/wiki/Boiler).(Babbitt, 1949) Hard water may be softened to remove these ions. The softening process often substitutes [sodium](http://en.wikipedia.org/wiki/Sodium) cat ions (Linsley, 1972) .Hard water may be preferable to soft water for human consumption, since health problems have been associated with excess sodium and with calcium and magnesium deficiencies. Softening decreases nutrition and may increase cleaning effectiveness.

* **Environmental Water Quality**

Environmental water quality, also called ambient water quality, relates to water bodies such as lakes, rivers, and oceans. These includes water is used for non-drinking purposes such as irrigation, swimming, fishing, boating, and industrial use

Most current environmental laws focus on the designation of particular uses of a water body. In some countries these designations allow for some [water contamination](http://en.wikipedia.org/wiki/Water_contamination) as long as the particular type of contamination is not harmful to the designated uses. The environmental scientists focus on achieving goals for maintaining healthy ecosystems and may concentrate on the protection of populations of [endangered species](http://en.wikipedia.org/wiki/Endangered_species) and protecting human health.

**2.5 DRINKING WATER, QUALITY AND STANDARDS**

Drinking water also known as portable water is water safe enough to be consumed by humans or used with low risk of immediate or long term harm. In most developed countries, the water supplied to households, commerce and industry meets drinking water standards, even though only a very small proportion is actually consumed or used in food preparation. Typical uses (for other than portable purposes) include toilet flushing, washing and landscape irrigation.

Over a large part of the world, humans have inadequate access to portable water and use sources contaminated with diseases vectors, pathogens or unacceptable levels of toxins or suspended solids. Drinking or using such water in food preparation leads widespread of acute and chronic illnesses and is a major cause of death and misery in many countries. Reduction of water borne diseases is a major public health goal in developing countries.

**2.5.1 Drinking water quality standards**

It describes the quality [parameters](http://en.wikipedia.org/wiki/Parameter#Environmental_science) set for [drinking water](http://en.wikipedia.org/wiki/Drinking_water). Despite the truism that every human on this planet needs drinking water to survive and that water can contain many [harmful constituents](http://en.wikipedia.org/wiki/Water_pollution), there are no universally recognized and accepted international standards for drinking water.[[1]](http://en.wikipedia.org/wiki/Drinking_water_quality_standards#cite_note-Water_quality_in_international_river_basins-1) Even where standards do exist, and are applied, the permitted concentration of individual constituents may vary by as much as ten times from one set of standards to another.

* + 1. **Range of standards**

Although drinking water standards are frequently referred to as if they are simple lists of parametric values, standards documents also specify the sampling location, sampling methods, sampling frequency, analytical methods and laboratory accreditation. In addition, a number of standards documents also require calculation to determine whether a level exceeds the standard, such as taking an average. Some standards give complex, detailed requirements for the statistical treatment of results, temporal and seasonal variations, summation of related parameters, and mathematical treatment of apparently aberrant results. (ISO, 2011)

* + 1. **Parametric Values**

A parametric value in this context is most commonly the concentration of a substance, e.g. 30 mg/l of Iron. It also be a count such as 500 [E. coli](http://en.wikipedia.org/wiki/E._coli) per liter or a [statistical](http://en.wikipedia.org/wiki/Statistics) value such as the average concentration of copper is 2 mg/l. Many countries not only specify parametric values that may have health impacts but also specify parametric values for a range of constituents that by themselves are unlikely to have any impact on health. These include color, [turbidity](http://en.wikipedia.org/wiki/Turbidity), [pH](http://en.wikipedia.org/wiki/PH) and the [organoleptic](http://en.wikipedia.org/wiki/Organoleptic) (aesthetic) parameters (taste and odor).

* + 1. **Water Quality Standards as Set by Union Health Ministry**

The union health ministry is a health ministry founded by the Soviet Union in the year 1923. On November 15 1991, this union was dissolved and this section of the union was superseded by the ministry of health of Russian Federation in 1922 with their headquarters in Moscow, RSFSR (Russian Soviet Federative Socialist Republic) and Soviet Union.

**2.5.5 Water quality of rivers in Nigeria**

High TSS found in rivers in Nigeria has tendency of reducing the light penetration into the river leading to a reduced photosynthesis with consequent effects on both phytoplankton and zooplankton populations of the aquatic environment. A study by Ajibade (2004) has shown high TSS values in Asa River (Kwara state) while Osibanjo et al. (2011) has also reported similar findings for Rivers Ona and Alaro in Ibadan. Harrod and Theurer (2002) in a similar study reported that high TSS concentration could cause a reduced development and survival of salmonid eggs and larvae. Clogging of TSS on fish gills could also result into stress, reduced growth, suppressed-immune system leading to increased susceptibility to www.intechopen.com

Surface Water Quality Monitoring in Nigeria: Situational Analysis and Future Management Strategy 307 disease and osmotic dysfunction and death (Bilotta and Brazier, 2008). Elevated values of TSS are capable of shielding harmful organisms in drinking water (Taiwo et al., 2011). TSS could also act as a vector of nutrients such as phosphorus (Heathwaite, 1994), and toxic compounds such as pesticides and herbicides from the land surface to the water body (Kronvang et al., 2003) leading to proliferation of phytoplankton in rivers. In surface water, TSS could cause drift in invertebrate population (Bilotta and Brazier, 2008). Another notable water quality characteristic of rivers in Nigeria is high turbidity. Turbidity values reported for most rivers in Nigeria were far greater than 5.0 NTU limit given by WHO (2008) (Table 2). Ajibade (2004), Adefemi et al. (2007) and Wakawa et al. (2008) have also reported elevated turbidity values in rivers in Nigeria. This could be linked to run-off effects as well as domestic and industrial discharges on the rivers. Low BOD and COD values have been reported in New Calabar River and Kubanni River in Kaduna. However, a high BOD and COD values have been observed for Challawa River in Kano State with mean concentrations ranging between 10 to 30 mg L-1 and 170 to 260 mg L-1 respectively (Wakawa et al., 2008). Very low DO values (2.67-3.30 mg L-1) were also observed in Challawa River. Pollution of the rivers was directly linked with the industrial effluent discharges. Osibanjo et al. (2011) also reported high COD values for the water samples from Rivers Ona and Alaro. The authors attributed these to leachate from dumpsites, agricultural and urban runoffs.

**3.0 METHODOLOGY**

**3.1. Study area**

Lagos State is one of the fastest growing and emerging urban coastal cities in Sub-saharan Africa (Sojobi, Balogun, & Salami, 2016). As the commercial capital and economic hub of Nigeria and West Africa, it has ve ports and generates between $32–$52 million internally generated revenue (IGR) monthly (Filani, 2012) and contributes about 60% of Nigeria’s non-oil revenue (Adelekan, 2010). As a burgeoning coastal city located in Southwest Nigeria, it is bounded by the Atlantic Ocean in the South, Benin in the West, Ogun State in the North and East as depicted in Figure 1. Its climate is characterized by two major climate/vegetation namely freshwater swamp and wet lowland tropical rainforest climates and two minor climate/vegetation namely dry lowland rainforest and southern guinea savannah.

The study area is the coastal plain sand (CPS) geomorphological unit of Lagos State with some alluvium deposits shown in Figure 3 and it lies approximately between Latitudes 6° 30′N and 6° 40′N and Longitudes 3° 00′E and 4°00′E. The study area occupies approximately 73.63 km area of land which covers distinct geographical settlements as shown in Figure 4. The region is drained by dendritic drainage system comprising some rivers such as Rivers Abesan, Berre, Ibu, Ore and Owo to mention a few which ow into the Lagos Lagoon which ultimately discharges into the Atlantic Ocean (Oyegoke & Sojobi, 2012).

In terms of population size, Lagos State is estimated to have population size ranging from 24.5 million in 2015 to 29 million in 2025 (Lagos Water Corporation, 2011; United Nations Human Settlements Programme (UN-Habitat), 2008), even though this estimate has been questioned by Potts (2012) based on the population estimate released by Africapolis Team (2008). The population growth rate was estimated to range between 2.35 and 8% (Africapolis Team, 2008; Oyegoke, Adeyemi, & Sojobi, 2012; Potts, 2012; United Nations Centre for Human Settlements, 1996; World Bank, 2012).

Furthermore, there have been concerted calls to improve the public urban water supply in Lagos State (Jideonwo, 2014; Longe, Kehinde, & Olajide, 2015; Olajuyigbe, Rotowa, & Adewumi, 2012; Omole, Ndambuki, Badejo, Oyewo, & Soyemi, 2016; Olukanni et al., 2014; Oyegoke et al., 2012). According to Sample, Awopetu, and Harou (2013), residents in Lagos State utilize differentt multiple sources to meet their water demands. The author revealed that high-income households get 95% of their water from boreholes, while medium-income households source 38% of their water from wells and 54% from public/commercial boreholes and vendors while low-income households obtain 59% of their water from wells and 36% from boreholes. The author also stated that the type of water sourced depends on price, quality and proximity.

Therefore, water supply data was obtained from Lagos Water Corporation covering all the existing waterworks spanning ten years from 2004–2013. The locations of each waterworks is shown in Figure 6. Trends in the public water supply were studied. In addition, to ascertain existence of inequality in water supply distribution across the various LGAs, the State was divided into three income classification.

**CONCLUSION**

While the WHO/UNICEF Joint Monitoring Programme (JMP) has classified protected dug wells as improved water sources, in this study they were frequently found to be as contaminated as unimproved water sources. Water from protected dug wells was consistently of poor quality across the countries and within regions. Water tested from rainwater catchment systems, boreholes, and protected springs also contained non-negligible levels of contamination. This illustrates that source type is not an adequate substitute for water quality.

Regulated water monitoring provides an important contribution for evaluating progress toward universal access to safe water. It is therefore necessary to increase monitoring and risk management, particularly of non-piped improved water sources such as dug wells, as these are the sources most commonly used by Africans while posing potential microbial risks to health.

**RECOMMENDATION**

* Scientists should become role models in Africa, communicating with the non-scientific public about the role of science in society, raising the profile of science and attracting into the scientific domain the brightest and best of the next generation
* Every country must have a national water strategy and develop the policies to deliver it. The strategy must first deliver the correct quantity of water (linked to catchment protection) and must then also address the essential elements of water for food, health, drinking and sanitation.
* It is essential that all relevant national and international institutions necessary for delivery of the strategy and policies are established.
* The economic impact of water and sanitation services must be communicated, with particular emphasis on their contribution to GDP, in order to drive change.
* The true value of water must be communicated to ensure the buy-in and support from society

**REFERENCES**

Calamari, D. and Naeve, H. (Eds.) (1994). Review of pollution in the African aquatic environment. CIFA Technical Paper No. 25, FAO, Rome, 118 pp.

Lloyd, B. and Helmer, R. (1992). Surveillance of drinking water quality in rural areas. Longman Scientific and Technical, New York: Wiley, pp34-56.

Ajibade, L.T. (2004). Assessment of water quality near River Asa, Ilorin, Nigeria. The Environmentalist, Vol. 24, No 1, pp. 11-18. DOI:10.1023/B:ENVR.0000046342. 65791.07

Osibanjo, O., Daso, A. P. and Gbadebo, A.M. (2011). The impact of industries on surface water quality of River Ona and River Alaro in Oluyole Industrial Estate, Ibadan, Nigeria. African Journal of Biotechnology, Vol. 10, No. 4, (January 2011), pp. 696-702. ISSN 1684–5315.

Bilotta, G. S and Brazier, R. E. (2008). Review: Understanding the influence of suspended solids on water quality and aquatic biota. Water Research, Vol. 42, pp. 2849 – 2861. Doi:10.1016/j.watres.2008.03.018.

Taiwo, A. M. (2011). Composting as a sustainable waste management technique in developing countries. Journal of Environmental Science and Technology, Vol. 4, No. 2, pp. 93-102. doi=jest.2011.93.10

Heathwaite, L. (1994). Eutrophication. Geography Review, Vol. 7, No. 4, pp. 31–37.

Kronvang, B., Laubel, A., Larsen, S. E., Friberg, N. (2003). Pesticides and heavy metals in Danish streambed sediment. Hydrobiologia, Vol. 494, No. (1–3), pp. 93–101. ISSN:1573-5117.

Bilotta, G. S and Brazier, R. E. (2008). Review: Understanding the influence of suspended solids on water quality and aquatic biota. Water Research, Vol. 42, pp. 2849 – 2861. Doi:10.1016/j.watres.2008.03.018.

WHO. (2008). Guidelines for drinking water quality. 3rd Ed. Health criteria and supporting information, Geneva

Adefemi, O. S., Asaolu, S. S. and Olaofe, O. (2007). Assessment of the physico-chemical status of water samples from major dams in Ekiti State, Nigeria. Pakistan Journal of Nutrition, Vol. 6, No. 6, pp. 657-659. ISSN 1680-5194.

Wakawa, R. J ., Uzairu, A., Kagbu, J. A. and Balarabe, M. L. (2008). Impact assessment of effluent discharge on physico-chemical parameters and some heavy metal concentrations in surface water of River Challawa Kano, Nigeria. African Journal of Pure and Applied Chemistry, Vol. 2, No 9, (October 2008), pp. 100-106. ISSN 1996 – 084

Osibanjo, O., Daso, A. P. and Gbadebo, A.M. (2011). The impact of industries on surface water quality of River Ona and River Alaro in Oluyole Industrial Estate, Ibadan, Nigeria. African Journal of Biotechnology, Vol. 10, No. 4, (January 2011), pp. 696-702. ISSN 1684–5315.