EFFECT OFCORRUGATED ROOFING IRON SHEET ON RAINWATER QUALITY: CASE STUDY OF AKWANGA L.G.A

BY

LUCAS HENRY
MATRIC No. 2004/18384EA

BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

FEBRUARY, 2010

DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University or Institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

17/02/2010

Lucas Henry
2004/18384EA

Date

CERTIFICATION

This project entilted "Effect of Corrugated Roofing Iron Sheet on Rainwater Quality: Case Study of Akwanga L.G.A" by Lucas Henry, meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

Mrs. Jiya. J. Musa
Supervisor

16-02-10
Date

Engr. Dr. A.A. Balami
H.O.D, Agricultural and Bioresources Engineering

17/02/10
Date

Engr. Prof. G.O. Chukwuma
External Examiner

10-02-10
Date

DEDICATION

This project is dedicated to Almighty God and my family who throughout these years have nurtured me in the way of truth.

ACKNOWLEDGEMENTS

My profound gratitude goes to Almighty God, the creator of the heavens and the earth for his protection, guidance, wisdom, intelligence and blessings He has bestowed upon me unto this day and I pray that He continues to bless me with his kindness and mercy in the many years to come.

My gratitude also goes to my supervisor, Engr. Jiya. J. Musa who through his valuable pieces of professional advice and kind interactions during lectures piloted me through this ambitious effort and made it a total success.

I would also like to acknowledge and appreciate the efforts and knowledge imparted to me by my HOD, Engr. Dr. A .A .Balami and my level adviser Engr. Sadeeq including all the Lecturers of Agricultural and Bioresources Engineering Department, Federal University of Technology, Minna, for their relentless effort to make my set to be the turning point of the Department. May God Almighty grant you long lives and be with you all. May God Almighty bless and assist you in performing all tasks you wish to carry out. Amen.

I would also love to give thanks to Engr. Adeoye of the Department of Agricultural and Bioresources Engineering, Federal University of Technology, Minna, who through his countless efforts and moral support helped me to complete this project. May Almighty Allah grant you long life and bless you with wealth as well as raise you in ranks. My gratitude also goes to Mr. Paul Sheku, CHAN Plateau; Sen. J. k. umaru, CEO Jogness Akwanga, Mallam. Haruna Shaibu, Automobile Minna, Mr. Kehinde and Mallam Zegi of the Agricultural and Bioresources Engineering Laboratory, Federal University of Technology, Minna who through their efforts aided me in speeding up this work.

I would also like to express my appreciations to my family Late (Mr) Lucas. D. Adamu and Mrs Esther Lucas Adamu, Asp Maxwell, Arc Donatus, Dennis, Jonathan, Samson, Daniel, who through their supports and advice have made me what I am today. May God Almighty bless and grant you your utmost desires.

My gratitude also goes to Sen. J.K. umaru who through his love and moral advice supported my upbringing, may the Almighty Lord bless and grant you wisdom and long life.

Finally, my thanks go to my friends Elizabeth, Obadiah, Dr Tsene, Dr Joseph, Kyuni, Jimmai, Dayo ,Mico, Sunday, Dave, Engr John Eneche , Dauda, Odion, Barr Maji, Per Natal, Barr Bawa, Mama Darling, Chijioke, Stephen , layo, Bune breaker Glane,Hope, Nuhu, Leonard, Spintex, Jerry, Jude, Mallex, Uche, Ogo, Dullas, Kelly, D1, Teddy, Kigbu, Segun Engr Chijioke Imran, khalid Adekunle, Ezekiel, Whisper Njuko Garbiel Arc kenndy and others who through the ultimate concern, efforts and care made this study a huge success. May God Almighty bless and see you all through each and every endeavour of yours. Amen.

ABSTRACT

In this work, a comprehensive survey was carried out to cover one governates in Akwanga, where rainwater collection for domestic use is practiced on regular basis. Two samples of harvested rainwater from various storage tanks were collected and analyzed for different quality parameters (pH, Colour, turbidity, total dissolved solids, suspended solids, suspended solids, iron content, sulphate, total alkalinity, hardness, temperature, nitrogen and electrical conductivity). The results of the analysis were compared with valid quality guidelines to evaluate its suitability for domestic purpose.

TABLE OF CONTENTS

CHAPTER ONE

1.0 Introduction

Water is essential for life; it covers 71% of the earth surface and makes up to 65% of the human body. Water is a necessity for life. A good deal of the water that we use everyday comes from lakes and reservoirs. Rainwater can be collected from most forms of roof, tiled roofs or corrugated mild steel e.t.c. The liquid which descend from the clouds in rain, and which forms rivers, lakes, sea e.t.c. pure ordinary water consist of hydrogen (11.1888%) by weight and oxygen (88.812%). It has a slightly blue colour and is very slightly compressible at its maximum temperature of 39.2°F or 4°C, there are referred standard for the specific gravities of solid and liquid its specific heat is the basis for the basis for the calorie and the B.T.U units of heat, it freezes at 32°F or 0°C. (Webster's Dictionary).

Roof runoff in industrial areas can be significant source of pollutants to storm water. Early studies of roof runoff have shown that galvanized metal roofs are source of zinc at concentrations two to twenty times greater than other urban source areas, and often produce runoff that exceeds acute toxicity for aquatic life. Materials, paints, and coatings associated with roofing are also suspected of being significant sources of copper and lead. Potential sources identified for copper and nickel in roof deposition includes copper chloride etchers, ammonia etchers, and acid plating bath exhaust vents. Water contamination containing toxic substances are generated by a wide variety of chemical processes, as well as by a number of other common household and agricultural applications. In this context, corrugated roofing sheets and their chemical are toxic recalcilant compounds, which may accumulate in the environment. The inadequate management of these effluents can have harmful consequences on human health.

1.1 Runoff

Runoff is the portion of the precipitation that makes its way towards stream, channel or ocean as surface or surface runoff. When rain falls onto the earth surface, it moves according to gravity a portion the precipitation seeps into the ground to replenish earth's ground water, most of its flows down hill as runoff (Perlman 2005). Runoff is extremely important not only does it service rivers and streams, but also changes the landscape by action of erosion (Perlman 2005). Water erosion is the removal of soil from earth's surface by running water. Runoff occur only when rate of precipitation exceed the rate at which water infiltrates into the soil after infiltration rate is satisfied, water begins to fill depression small and large, once the depression is filled, over land flow of water beings (Schwab 1981).

When water evaporates in the air above a coal burning energy plant, the water droplets pick up polluting particles. Polluted water droplets then fall to earth as rain or snow, thus polluting everything the drops touch whether it is the surface of lakes, front yard or homes. Runoff is the middle step of the hydrologic process in which rain and snow melt, picking up pollution in the form of fertilizers and pesticides.

1.1.1 Source of Water

Rain is the main sources of water, and it is classified under two categories based on its location. These two categories are surface water and ground water. Both having varying characteristics, the most important of these characteristics are accessibility, quality and quantity. Water from these sources flow from over the surface to form lakes, ponds reservoirs, rivers, canals, creeks, and are termed as surface water. Surface water is easily contaminated with bacteria and organic substance harmful to health. Surface water is the term used to describe the flow of water from rain, or the other source over land and is a major component of water cycle. Surface water is the water that exists in streams, rivers or lakes. Runoff that occurs on surface before reaching a channel is called non point source, refers to contamination that as its name suggests, does not originate from a single discrete source.

Non point source pollution is often accumulative effect of small amounts of contaminants gathered from a large area. While point source pollution refers to contaminants that enter a waterway through a discrete "point source" examples of this category includes a wastewater treated plants effluent from factory. A land area which produces runoff due to common point is called watershed. When runoff flows along the ground, it picks up soil contaminants in particular.herbicide and insecticide that become discharge or non point source pollution. Watershed is absorbed into soil by infiltration, stored as ground water and slowly discharge into stream through seeps on springs (wikipedia 2007). As watershed is urbanized, much of the vegetation is replaced by impervious surface, thus reducing the area where infiltration to ground water occurs. Thus, the more the storm water runoff occurs, the runoff that must be collected by expensive drainage system which curbs, storm servers and ditches to carry storm water runoff to streams. Or simply in a developed watershed, much more water arrives into a stream, much more quickly resulting man increased like hood of more frequent and server flooding (perlman 2005).

Surface water pollution comes from various source of rainwater, treated and untreated effluent from industries and towns, water percolating through the ground. The ever increasing use of nitrogenous fertilizers, whether chemical or natural is quantities exceeding those at which the can be fixed or retained in soil, has an effect on this nitrogen is carried away with rainwater and percolating water. In addition to increasing imperviousness removal of vegetation and soil grading the surface and constructing drainage networks increase runoff volume and shorten runoff time into streams from rainfall and snow melts. As a result the peak discharge, volume and frequency of floods increase in nearby streams (perlman 2005). A composition of roof runoff revealed that organic carbon and NH4+ are the nutrients that can occur at higher concentrations. Analysis of roof runoff showed strong fluctuation in the concentration of component during rain events. These fluctuations prevented to observe a steady interaction of dissolved compounds with the aquifer matrix during infiltration.

1.2 Statement of Problems

The need to determine the effect of rainwater runoff on corrugated roofing zinc on the surrounding surface water from the need to reduce the rate at which rainwater is been polluted from runoff on corrugated zinc and agricultural land.

1.3 Aim

The aim of this study is to analyze the effect of rainwater runoff on corrugated roofing zinc surrounding surface water, the causes of the runoff and its contribution to economy.

1.4 Objective

i) To determine the effect of rainwater runoff on corrugated roofing zinc

ii) To determine the physical and chemical qualities of the rooftop runoff

1.5 Scope of Analysis

The study is concentrated only on the effect of rainwater runoff on corrugated roofing zinc surrounding surface water of Akwanga area of Nasarawa state, it is important that some analysis be carried out on various samples of rainwater. These samples are as follows.

i) Rainwater sample from the corrugated roofing zinc.

ii) Direct rainwater

Analysis will be carried out on these two samples to find out the physical, chemical, BOD, metallic and non metallic constituents of the water samples.

1.6 Justification of the Study

The study has enormous significance to many communities in these sense those asses the effect of rainwater runoff on corrugated roofing, agricultural quality of their land and estimate the loss resulting from surface water runoff, consequently this project will gathered information on water pollution and soil degradation in Akwanga due to water erosion and runoff.

CHAPTER TWO

2.0 Literature Review

Several researches have been carried on rainwater runoff, but majority has been concentrating on the effect on surface water and agricultural farmland. Surface water pollution is still a problem in Nigeria despite decades of effort, partly due to industrial and sewage pipe discharges into lakes, rivers and streams. Roofs are made of a variety of material and most, with the exception of those made with grass/reed which is potential toxic materials to catchments of surfaces water. The following are the different types of roofing materials, metal sheets, ceramic and clay tiles, rock slate and Ferro concrete, asbestos cement, gravel, polyester, tar felt. Roof runoff is considered a potential source of pollution for two primary reasons (Zanetal *et al.*2007). First compounds contained in roofing material (the material used for the roof cover, the guttering, the down pipes and paints, sealants and cleaners) may be leaching into runoff (physical washing off or erosion), and air bone pollutants and organic substances, such as leaves, dead insects, and bird wastes, are added to roofs by interception and deposition(Zunckel *et al.*.2007). During storms, rainwater not only adds a variety of chemicals and contaminants to the roof watershed, the acidic nature of rainwater react with compounds retained in or by the roof and cause many elements in the roof runoff to leach out. Roofs can be source of water pollution. However, results of roof runoff studies have been variable. The variation reflects difference in roofing materials, industrial treatments, care and maintenance, age climatic conditions, orientations and slope of roofs and air quality of the region, the deposition of various pollutants from atmosphere into roof surface during a dry period greatly influences the runoff water quality from catchments systems (Teemusk et al.200

7) The amount of the pollutants deposited on the roof surfaces increases with the age of the roofing material, the increase in the length of the dry period between rainfalls events and ambient temperature, as evidenced by the increase in pollutant concentration in the water samples collected. Rain falling on the landscape may flow quickly over soil or rock surface as runoff into streams channels. (Mc. Broom *et al* 2004).

2.1 Sources of Water

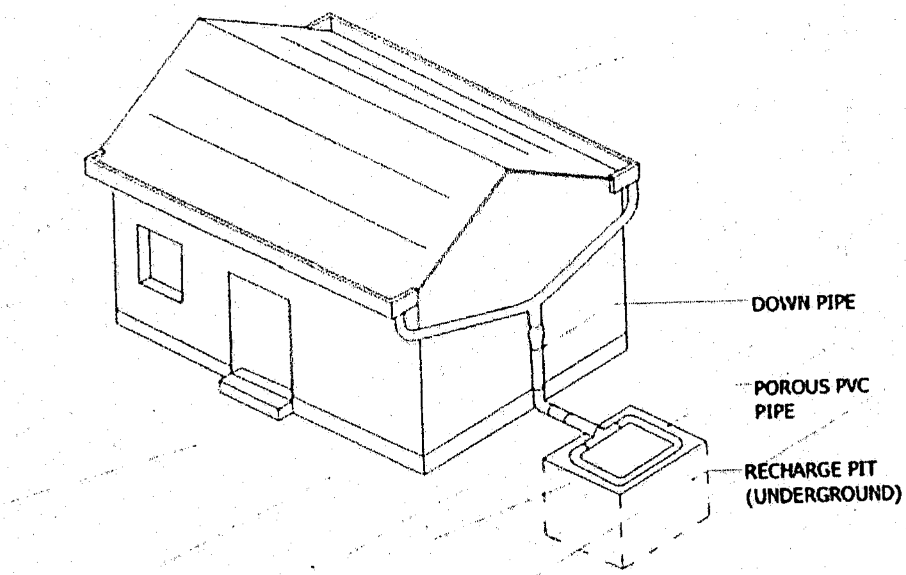
The ultimate source of all natural portable water on the earth is rain, which is rarely used as direct source except on island in salt water, such as Bermuda, where the rain is collected and led into cistern to serve as the only available water supply. When rainfalls, it runoff into streams, in the case of heavy rains, or soaks into the ground, percolating through porous strata until it reaches an impervious stratum, upon which it collects, forming groundwater. Groundwater is the source of wells and of the springs that feed streams, rivers, and lakes. In its course, groundwater dissolve soluble mineral matter, and often the surface waters of rivers, and lakes are polluted by the influx of sewage or industrial waste. (Wikipedeia 2008).

2.1.1 Source of Water Pollutants

Water pollutant result from many human activities, such as pollutants from industrial sources may pour out from the outfall pipes of factories or may leak from pipelines where the water has leached through mineral-rich rocks or has been contaminated by the chemicals used in processing the ores. Cities and other residential communities contribute mostly sewage, with traces of household chemicals mixed in sometimes industries discharge pollutants into city sewers, increasing the variety of pollutants in municipal areas. (Mc Broom *et al*,2004).

2.2 Rainwater Harvesting

Rainwater harvesting is still the source of portable water for most rural communities where there are no water supply networks (MWI, 2009). Even in some areas where portable is supplied by networks, harvested rainwater is still a significant supplemental resource for domestic uses, especially during summer. Current roof top rainwater harvesting is being practiced for drinking water, domestic uses, and watering livestock and for garden irrigation (MWI, 2009). Due to the importance of collected rainwater especially in the arid areas, rainwater harvesting and its quality are the focal points of several ongoing researches. The study indicated that the measured inorganic compounds in the rainwater harvested from-yard catchments systems generally matched the WHO standards for drinking water while the concentration of some inorganic compounds of the rainwater collected from land and road surfaces appeared to be higher than the guideline values for drinking water (Zhu *et al*, 2004). A similar study by Yaziz, *et al,* 1989 concluded that there were significant variations in the concentrations of pollutants of water samples collected from tiles roofs and galvanized irons roofs. Jiries et al. (2002) the highest concentrations of all constituents were detected during low rainfall and long dry periods of atmospheric deposition preceding rainfall events. However, high levels of both lead and copper were recorded which might be attributed to traffic pollution. An investigation of rainwater quality found that there is a correlation between water qualities and quantify sources of contamination in harvested water. Roofs made of reinforced cement concrete (RCC), or roof tiles are the most common roof types in Nigeria. Roofs are contaminated as a result of ambient air pollution and the emitted smokes from fire places and chimneys.



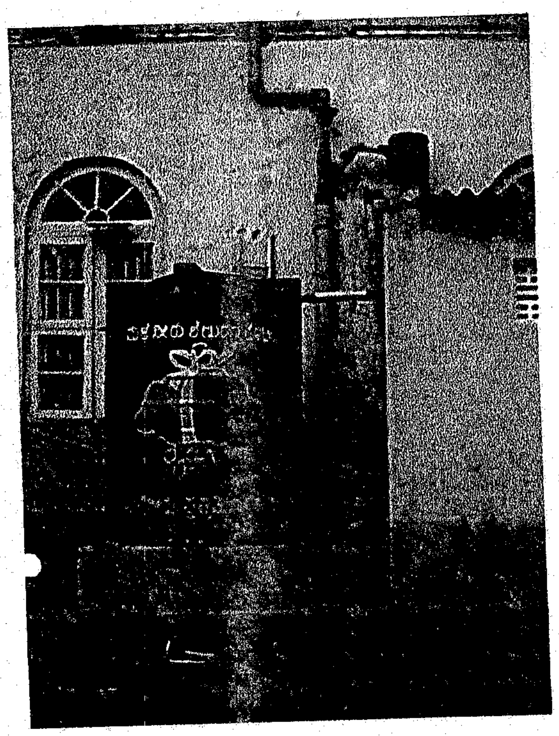


Fig 2.0 Rainwater Harvesting

2.2.1 What is Roof Water Harvesting?

'Rainwater harvesting' is a widely used term covering all those techniques whereby rain is intercepted and used 'close' to where it first reaches the earth. The term has been applied to arrangement to cause rainfall to percolate the ground rather than runoff its surface, to forms of flood control, to the construction of small reservoirs to capture runoff from roofs and other impermeable surface. Thus, roof water harvesting is a subset of rainwater harvesting albeit an important one. (Thomas, et al 2004)

2.2.2 Basic Roof Water Harvesting System

Rain falls onto roofs and then become runoff. The runoff is extremely variable for the typically 90% of each year that it is not raining, runoff flow is zero. However if the runoff is channeled into a tank or jar, water can be drawn from such whenever it is needed, hours, days or even months after the last rainfall. Moreover as jar are generally located immediately next to the building whose roof the rain fell on, roof water harvesting is used to supply water to that very building. The essential elements of a roof harvesting system are a suitable roof, water store and a means of leading runoff flow from the first to the second. In addition, some RWH systems have other components to make them easier to manage or to improve the quality of the water. (Thomas, et al 2004)

2.2.3.Roofs

To be 'suitable' the roof should be made of some has material that does not adsorb the rain or pollute the runoff. Thus, tiles, metal sheets and most plastics are suitable, while grass and palm leaf roofs are generally not suitable. (Martinson, et al 2007). The larger the roof, the bigger the run-off flow. The rainwater reaching a roof in a year can be estimated as annual rainfall times the roof's plan area. But in the tropics only about 85% of this water runoff the roof. The remaining 15% is typically lost to evaporation and splashing. If the rain falls mainly as light drizzle, as in some temperature countries even more than 15% will be lost in this way through way through slow evaporation.

2.2.4 Water store

A Rain Water Harvesting (RWH) system with a large water store will perform better than one with a small store. A small store such as 500 litre jar will often over flow in the wet season (because of the quantity of rainfall) 'wasting' up to 70% of the annual runoff. It will also dry before the end of the season. However, a small store is cheaper than a larger one and gives cheaper water. The designer of a system can choose the combination of cost and performance that best suit the user's needs and fund available.

2.2.5 Guttering

The arrangement for leading water from the roofs to water store is usually called 'guttering' or 'gutters and down pipes'. The gutters are open channels carrying water side ways under the edge of the roof to a point just above the water shore; the down pipes are tubes leading water down from gutters to the entrance of the water shore. However guttering is the most popular method because it helps keep runoff water clean.

2.2.6 General Character of Roof Water Harvesting

The general characteristic of harvested roof water may be broken down into convenience, quantity and quality.

. The most striking characteristics of Domestic Rain Water Harvesting (DRWH) is that it delivers 'water without walking' in this sense, it offers users much greater convenience than do point water-source like wells from which water has to be fetched, or even than public stand pipes. This convenience is moreover available at every house on which rainfalls, whether on a mountain top or an island in salt water, the supply is not constrained by geology, Hydrology or terrain.

2.2.7The Quantity

The quantity of water obtainable from a typical house roof depends on nature and type of roofing of the house. At high demand levels, such as 50litres per person per day, DRWH will very rarely be able to meet all the household's water demands. Annual output depends on the rainfall, the roof size and the complexity of the harvesting system.

2.2.8The Quality

The quality of harvested rainwater varies with the seasons, the roof type and the complexity of the DRWH system. Elaborate RWH systems exist in rich a country that gives the highest quality of water. Crude and informal RWH system may be found in poor countries giving water that is green with algae and risky to drink. Between these extremes, a good typical country DRWH practice gives water that is as safe as that obtainable from protected point such as wells and often superior to them in taste.

2.3 Water Quality

Quality of water drawn from RWH system is very important. Rainwater itself is of excellent quality, only surpassed by distilled water it has little contamination, even in urban or industrial areas, so it is clear, soft and tastes good. Contaminant can however be introduced into the system after the water has fallen onto a surface. The runoff from thatch roofs is by contrast quite seriously contaminated with the impurities of the grasses used on roofs. Where thatch water is harvested, it is commonly then improved by processes such as alum-accelerated sedimentation, boiling, SODIS (Solar water disinfection) or other disinfection

2.3.1 Path Contamination

When considering the water quality of a roof water system, it is useful to observe the complex path of a contaminant and order it follows to enter a human being. Roof Water Harvesting (RWH) generally represents a hostile environment for microbiological contaminants and presents a number of barriers to chemical and physical contaminants. Material washed in from the roof can come from several sources. (JEW, 2007)

i) By far the largest contribution will come from material that has accumulated on the roof or is blown onto the roof during a storm. Accumulated material may have blown onto the roof by the wind, stirred up by passing vehicles, dropped from over hanging trees or deposited by an animal (or person) with access to the roof.

ii) If the roof is made of decayed materials, the roof itself can contribute to the dirt load. This is particularly true of low-quality roof material such as thatch or tar sheets, though asbestos sheeting and galvanized iron (Particularly if it is rusty) can also add material to coming water.

iii) Passage of water along unclean gutters may add further debris.

2.3.2 Microbiological Contamination

A large number of studies measure indicator bacteria, such as total or themo-tolerant coliforms, in rainwater system. Most have shown indicator bacteria in rainwater tanks in some quantity have large variation both from system to system and over time, with readings changing several orders of magnitude within a few days.

2.3.4 Bacteria Quality of Roof Water

As the bacteria contaminating harvested rainwater are generally of animal rather than human origin, indicators of human faecal contamination are not ideal surrogates for health risk in RWH systems; however it is unlikely that separate indicators just for RWH will ever be used. (JEW, 2OO7)

The large variation in roof water quality overtime has implications for monitoring water from RWH systems.

. It is impossible to determine the typical bacteriological quality of the system from a single reading.

. The wide variation makes normal averaging (The use of arithmetic mean) in appropriate, as it will be dominated by high readings that only exist for a very short length of time.

2.3.5 Chemical and Physical Contaminants.

Since rainwater is the result of natural distillation process, the chemical quality of rainwater is good. It contains very little in the way of dissolved minerals and suspended solids. In the case of microbiological contamination the risk of chemical contamination comes after the rain has hit the roof.

2.3.6 Acidity

When the rains fall through the atmosphere it is usually saturated with oxygen and with carbon dioxide. The first is beneficial and improves tastes, the second makes rainwater slightly acid with a pH6 in rural areas. Pollution in urban areas can lower the pH to 4-5, but roof run-off that is more acid than this is rare. The pH of rainwater tends to change with storage in cement-based tanks as clean, acidic rainwater reacts with the cement and absorbs calcium, making the water more alkaline in the range of pH8-9.

2.3.7Temperature

Standard toxicity test are carried out at constant fixed temperature. However, in natural waters the daily temperature can fluctuate within in a 5°C range and on a seasonal basis within the range 0-30°C or even higher. These changes will affect the rate of reaction and possibly the sensitivity of pollution, as well as the toxic state of some chemical in the water.

2.3.8Dissolved Oxygen

Normally, natural waters are saturated with DO in equilibrium with air, the concentration at these saturation value decreases as the temperature of the water rises. However, the DO content of the water can be reduced by other natural factors perhaps the most common of these respirations of aquatic plants. This comes as a surprise to many people who think of plants as suppler of oxygen of the water. Plants do this, however, only during the day light hours when producing carbohydrate from carbon dioxide and water by the process known as photosynthesis and thereby releasing oxygen at a faster rate that required for respiration.

2.3.9 Heavy Metals and Urban Pollutants.

Particularly in urban areas, pollutants such as heavy metals and sulphates can enter the water and these materials are found in several studies in urban roof run-off. These materials are found in the rainwater itself, in deposits on the roof and sometimes leached out of the roof itself (Particularly Zinc and Lead). While it is often not practical to filter these minerals, it has been found that these pollutants decrease over the length of rainstorm.

2.3.10 Zinc

Pure zinc is a crystalline metal, insoluble in hot and cold water and soluble in alcohol, acids and alkalis'. It is extremely brittle at ordinary temperatures but becomes malleable between 120° and 150°C (248° and 302°F) and may be rolled into sheets between heated rollers. Zinc is affected by dry air, in most air it is oxidized and becomes coated with a carbonate film that protects it from further corrosion zinc melts at about 420°C (788°F), boils at about 907°C (about 1665 °F), and has a specific gravity of 714 the atomic weight of zinc is 65.39. (Zinc. Microsoft student 2008 Encarta).

2.3.11 Uses of Zinc

The metal is used principally as a protective coating, or galvanizer, for iron and steel, as an ingredient of various alloys, especially brass, as plates for dry electric cells, and for die castings. It is also used as filler in rubber and is employed in medicine as an antiseptic ointment. Zinc chloride is used as a wood preservative and as a soldering fluid

2.3.12 Lead

Although lead has a high profile in human toxicology, it is of much lesser importance for aquatic life. This mainly due to a low solubility which limits its occurrence at significant concentration in all but very soft waters. Diffuse inputs of lead into surface waters arising from its widespread use in petrol and batteries may increase the concentration in sediments but this does not appear to be significant for aquatic life.

2.3.13 Suspended Sediment

The largest component of roof water pollution will be in the form of particles washed from the roof such sediment are suspended are the water and is measured by assessing turbidity, a measure of how cloudy the water is usually, suspended material is non-toxic (unless there are significant industrial pollutants in the area) but it can carry micro-organism and organic material and presents an aesthetics problem. Rain water tends to produce water with a low turbidity, as most suspended matter settles in the still tank. The incoming stream of suspended matter is also higher in the first flush and can be significantly reduced by first flush devices.

2.4 Agricultual Pratice

As stated earlier, the largest percentage of land in Akwanga of Nasarawa state is for residential and agricultural purpose. With the rate of rapid increase of population the little land used for agricultural, need to provide large quantity of crops to take care of the rising population, increased the pollution of water. Hence the use of modern technology is in agricultural practice. These involve clearing land tillage by means of heavy mechanical application of fertilizer, pesticide, and insecticide and herbicide e.t.c. are harmful, all to increase output production and economy. The fertilizer and all other agro-chemical contain poisonous chemicals. After the application, the percolate into our river through runoff via of drainage, the use of chemical trapping fish is another source of surface water pollution. The fears that the use of fertilizer nitrogen on farms contribute considerably to nitrate pollution of groundwater. Investigations reveal that nitrate is accumulating in the shallow ground waters of some irrigated areas with intensive agriculture fertilizers are indispensable for increasing food production but their excessive use has occasioned much concern as a possible environmental threat. The entire environment has been applied directly to the environment to increase one resource, but in doing so, they adversely affect another pollutant which affect the environment are dispersed either by air or water. Pesticide as air pollutant do not occur naturally in the atmosphere through improved agricultural practices i.e spray application, volatilization, entrainment like dust, evaporation from water manufacturing and formulating and disposal processes, this group of pollutants have been introduced into the environment by their use in large amounts. Pesticide are regarded as air pollutants because they can remain in suspended in air for long periods, become sorbed and possibly accumulate on air bone particles and undergo photochemical alterations to even more toxic components. There is several ways by which pesticides find their way into bodies of water. The may fall on to the surface of water when forest or agricultural land are sprayed from the air. Residues may reach water as surface runoff from treated soil and pesticides may be discharged into river from factory or sewage.

2.5 Runoff

Runoff is that portion of precipitation that finds its way into streams, channel lakes and ocean as surface and sub-surface flow. Rain falling on the landscape may flow quickly over soil or rock surface as runoff into streams channels. Alternatively, some water may flow more slowly down slope towards stream within the soil. Some may percolate downward through pores in soil and fractures in rock to reach the top of the saturated zone (water table). Below the saturated zone, it flows much more slowly as groundwater (Wikipedia 2007). Runoff occurs after precipitation has satisfied the water demand of infiltration,, surface detention, channels detention and interception by foliage. Interception by dense cover of forest or shrub common amount to 25% of the annual precipitation (Schwab 1981). As long as the rate at which rainfall reaching the soil surface is less than the infiltration capacity, all the water is absorbed into the soil. As the rain continues plant surface become saturated, the interception-loss rate declines, and infiltration capacity is reduced factor affecting runoff are rainfall factors of duration intensity and a real distribution influence the rate and volume of runoff. Total runoff for a storm is related to the duration for a given intensity. Since infiltration capacity is usually high at the beginning of a storm and decrease with time, a storm of very short duration may not produce runoff. Roof runoff in industrial areas can be a significant source of pollutants to storm water. Early studies of roof runoff have shown that galvanized metal roofs are sources of zinc pollution at concentration two to twenty times greater than other urban sources areas and produce runoff that exceed acute toxicity for aquatic life materials, paints and coatings associated with roofing are also suspected of being significant source of copper and lead.

2.6.0 Factor Affecting Runoff

The factor affecting runoff may be divided into those associated with the precipitation and watershed. The geological and soil material determined to a large extent that the rate of infiltration of water. Thus on runoff vegetation cover cropping pattern also influence infiltration and runoff. Vegetation retards over flow and increased surface detention to reduce peak runoff rate (Wikipedia 2000)

2.6.1 Rainfall Duration

A storm of shorter duration may not produced runoff, where as a storm with the same intensity but longer duration will results into runoff. Long duration storm will produce much more runoff than storm of shorter storm. Duration is measured in precipitation per day

2.6.2 Rainfall Intensity

Rain intensity influences the volume of water harvested for domestic and agricultural purpose. An intense storm exceeds greater infiltration is capacity by a greater margin than does a gentle rain. Thus the total volume of runoff is great for the intense storm even though total precipitation for the two is the same. The intense storm actually may decrease the infiltration because of it destructive action on the soil structure at the surface (Schwab et al 1992). Rate and volume of runoff from a given watershed are influences by the distribution of rainfall intensity over the watershed. However, an intense storm on one portion of the watershed may result in greater runoff than a moderator storm over the entire watershed (Dandeker 1982) may be expected to occur.

2.6.3 Watershed

Watershed factors affecting runoff are size, shape, orientation, topography, geology and nature, and extent of vegetative cover over the surface. Both runoff volume and rate increase as watershed size increases. However both volume and rate per unit of watershed area decrease, as the runoff area increase. Watershed may determine the season at which high runoff may be expected to occur (Schwab et al 2005).

i) First the increased amount of water flowing into streams during storm causes. Larger flood and runoff, and they build to pick faster because of rapid flow of water covers smooth surface.

ii) Most precipitation has a chance to percolate downward to ground water, so the supply of groundwater to well is reduced many steps have been taken to reduce these impact, pavement can be constructed so that water can pass through the recharge groundwater and storm runoff can be noted to artificial basin that allow water soak (Lawrence 1994

2.6.4 Rainfall Distribution Over Catchment

A large area extent of the rainfall over the catchment produces large runoff. Heavy rainfall in the lower reaches of the catchment causes a rapid increase in the runoff. On the other hand, for the heavy rainfall in the upper reaches of the catchment, there is a slow increase in runoff.

2.6.5 Infiltration Rate

Infiltration is the downward entry of water into the soil. The rate at which water is penetrating the surface of the soil at any given instant is called the infiltration rate usually measured in centimeters per hour. The amount of moisture already in the soil greatly influences the rate of movement of water varies with which factors, such as the soil structure and texture, initial moisture content of irrigation water. Knowledge of infiltration rates under field conditions is important in designing a farm irrigation system and determining the time required to irrigate a given plot of land to the required depth, also further reduces due to alkalinity, salinity and poor soil structure rain falling on the areas where un fractured bedrock is expose has little opportunity of infiltrate and instead will runoff surface (Wikipedia 2007).

2.7 Water and Public Health

Water is essential for life; it covers 71% of the earth surface and makes up to 65% of human body. Water is a necessity for life. A good deal of the water that we use everyday comes from lakes and reservoirs. Water and sanitation are so married together that each of this entity cannot do without the need of the other. To enhance safe and portable water for human consumption, it must be protected physically, chemically and biologically. Physical properties of water appears to be colourless, odourless and tastless, turbidity, temperature, suspended, dissolved and total solids. However, water from certain source that is not sanitary satisfied may contain brownish or reddish colour, this is due to organize matter that are dissolved into it odour may also be sense due to excessive organic and inorganic matters. Algae these are called single called plants can be a great nuisance to surface water because the production rapidly. Turbidity of water also signifies the presence of suspended particles or colloidal impurities, the turbidity in surface water indicates inadequate protection of the surface water from the source and possible bacteria contamination. Turbidity is usually caused by clay, silt soil particles and other impurities. Chemical properties of water are quantified in terms of the organic constituents that may be present in water. Biological properties are microorganisms are commonly present in surface water. The most common microorganisms in water are bacterial, algae, fungi and protozoa.

CHAPTER THREE

3.0 METHODOLOGY

To obtain a true indication of the nature of water, it is necessary to ensure that the sample is an actually representative of the source. Having satisfied this requirement the appropriate analysis must be carried out using standard procedure so that results obtained by physical and chemical analysis can be directly compared.

3.0.1 Collection of samples

Samples collected include the following i) direct rainwater, ii) rainwater from a corrugated rooftop.

A 1 litre plastic container was used to collect the samples. At each sample collection point the sampling bottle was again rinsed properly with distilled water and subsequently, rinsed properly with a good quality of the sample

3.0.2 Samples analysis

The sample analysis was carried out in Niger state water laboratory and the apparatus used includes the following:

1. Evaporating dish
2. Drying oven
3. pH meter model
4. Measuring cylinder
5. Pipettes
6. Test tube
7. Wash bottles
8. Volumetric flask

9. Filter papers

10. Beakers

11. Funnels

12. Reflux apparatus

13. Conductivity meter model

14. Burettes

15. Hot plate

The following were the apparatus used for nitrates

1. Sodium arsenids
2. Bromide sulphate
3. Sulphamid acid
4. Antimony metal
5. Chlorotopic acid
6. Acitivated decolorize charcoal

For the analysis of dissolved suspended solid and total solids, the following were the apparatus used:

1. Platinum dishes (100mls)
2. Filter papers

And for the hardness test the following apparatus were used:

1. EDTA
2. Ammonia buffer solution
3. Monoxide
4. Solo chrome black

While for alkalinity the following were the apparatus used:

1. Methyl orange indicator solution
2. Barium chloride
3. Phenolphthalein
4. Sodium disulphate solution
5. Sulphuric acid

3.0.3 Electrical Conductivity

Electrical conductivity (Ec), also called specific conductance is a measure of the ability of water to convey an electrical current and it is related to the concentration of ionized substances in water. Conductivity can be used as approximate measure of the total concentration of inorganic substance in water. Irons that have major influence on the conductivity of ware are H^{+},Na^{2+},Mg^{2+},Ca^{2+},SO_4^{2}- and HCO^{3}- test are as follows:

1. Samples
2. Bunches funnel
3. Glass fibre filter paper
4. Hot water bath
5. Conductivity meter

3.0.3.1 PROCEDURE

The conductivity meter with its electrode immerged in distilled water was switched on and left for 10 minutes to standardize. The electrode was reused two times with the sample. The pointer and the selected knob were adjusted to the appropriate range and readings on the scale were taking.

The sample were heated through evaporated dish of appropriate in oven at 180°C for 1hr. cooled in desiccators and weighed. Then the accurate volume of well mixed sample was measures through glass fibre filter paper under slight suction. The transfer filtrated was pre-weighed through evaporating dish and evaporate to dryness in a hot water bath for the diction of conductivity.

3.0.4 Determintation of Total Dissolved Solids (Tds)

The weight of empty evaporating dish and heated to dryness in the hot plate. The concentration was dried in an oven for 1hr. the dish was cooled in a desiccators and constant weighed. The cycle of drying was repeated until accountant weight was obtained and recorded.

3.0.5 Determination of Temperature

The temperature of the samples was noted by inserting a thermometer with each sample and their result were noted.

3.0.6 Determination of Suspended Solids (Mg/C)

The filter was washed in filter holder under suction with successive small volumes of laboratory water. The filter paper was removed and placed in the Aluminum dish and oven at 105°C for 1hr cool in desiccators and weighed. The procedure was repeated until the drift is less than 0.5mg. This filter were placed and dumped with laboratory water and the accurate volume of well-mixed water sample (100-500ml) and filter under slight suction then the filter was removed and dried in the oven at 105°C for 1hr and recorded.

3.0.7 Determination of Colour

The colour of the sample, were observed by filling one clean test tube with distilled water and another with sample and comparison was made between the two solution and the colour was noted.

3.0.8 Determination of pH

The pH meter was used according to the manufacture instructors and specifications. The electrode was rinsed and left in distilled water for two minutes to remove possibility or the presence of other agents. The pH meter was standardized using the buffer solution of 4,7 and 9.2. The electrode was rinsed several times with the samples.

The pH of the samples and their pH value was noted.

3.0.9 Determination of Iron

The samples were shaking thorough sample bottle and pipette of 50.0ml (aq) into conical flask. Then the 2ml of concentrated HCL was added to 1ml hydroxylamine solution and some glass beads. The sample was boiled until the volume reduced to about 20ml and the result was recorded.

3.1.0 Determination of nitrate

10ml of distilled water and the samples were measured in two different tubes to each sample 0.5ml bromine was added followed by the addition of 20ml of concentrated H_2SO_4.

The colour of the distilled water appears to be lighter which was overcome by titrating with $AlNO_3$ until the same colour match was obtained and the result was noted.

3.2.0 Determination of Hardness

The ethylene dioxide tetra acetic acid (EDTA) solution, the pipette for 20ml aliquots of the primary standard $CaCo_3$ (0.04m) solution into 250ml conical flasks. Titrate each with the 0.004m of EDTA solution in the following manner. The 15ml is added to the EDTA solution in the following manner. The 15ml is added to the EDTA solution from the burette then; 10ml of the buffer solution is added to 5 drops of the ferrochrome black indicator solution and recorded.

3.3.0 Determination of Alkalinity

100ml of each sample was transferred to a flask and drops of phenolphthalein indicator were added the resultant pink colour solution was tritrated with 0.1m Hcl SO_4^{2-} until the colour change to colourless.

3.4.0 Determination of Zinc

Atomic absorption spectrophotometry is the most widely used method for the determination of zinc. The detection limit of the direct air acetylene flame method is 50µg/litre (4).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Water Samples and Analyses

The result of the water samples analyses are shown in table 4.1

Table 4.1 Physiochemical Analysis of Water Samples

S/NO	Parameters/units	Sample '1' Rainwater from a corrugated zinc	Sample '2' Direct rainwater
1	Electrical conductivity (us/m)	180	120
2	Total dissolved solids (mg/L)	90	70
3	Temperature in the lab. (°C)	25.0	25.0
4	Suspended solids (mg/L)	0	3.0
5	Turbidity (FTU)	2.3	7.2
6	Colour	4.2	10
7	PH	7.0	6.8
8	Iron content (mg/l)	0.19	0.23
9	Sulphate	0.7	32
10	Nitrate as Nitrogen (mg/L)	6.4	5.6
11	Nitrate (mg/L)	28.6	24.6
12	Total hardness (mg/L)	58	42
13	Hardness (ca) as $caco_3$	23.2	16.8
14	Hardness (mg) as $caco_3$	34.8	25.2
15	Total Alkalinity(mg/L)	49.2	60
16	Zinc	3.0	2.0

Electrical Conductivity (us/m).

Electrical Conductivity (EC), also called specific conductance, is a measure of ability of water sample to convey an electric current and it is related to the concentration of ionized substance in water. The result of EC Were 180, and 120, for samples of 'A' corrugated rainwater, 'B' direct rainwater respectively. These values when compared to the standard were below the 1000uS/cm World Health Organization (WHO) limits NAFDAC, SON. It therefore poses no salinity problem and there is no restriction on the use of the water consumption. Conductivity can be used as an approximate measure of the total concentration of inorganic substances in water. Conductivity is often used to express the mineral content of water sample. It is an important measurement in waters destined for various uses; irrigation, drinking, food industry and industrial boilers. Conductivity is also used to monitor the operation of desalination plants. (Metcalf and Eddy 2004)

Total Dissolved Solids (mg/L)

Total Dissolved Solids of the samples were 90, and 70, for samples A, and B, respectively compared to the guideline was below the 500mg/L WHO limits NAFDAC and SON. Hence the water does not pose any threat. Total Dissolved Solid is generally satisfactory for domestic use and many industrial purposes.

Temperature in lab (°C)

The temperature of water is an important parameter because of its effect on chemical reactions and reaction rates, and aquatic life. Temperatures were 25.0, and 25.0, respectively, which is lower than the WHO limits, NAFDAC and SON. Therefore the water temperature will not cause harm to aquatic life and other beneficial uses. Optimal temperatures for bacterial activity are in range from 25 to 35°C. Aerobic digestion and nitrification stops when the temperature raises to 50°C. Metcalf and Eddy (2004).

pH

The pH is a measure of the acidity or alkalinity of the water. The pH obtained was 7.0, and 6.8 respectively; In general, water with pH <7 is considered acidic and with a pH> is considered basic. The normal pH range value of WHO and NAFDAC is 7.0-8.5, and it is recommended for drinking and other domestic uses and also for agricultural purposes.

Suspended Solids (mg/L)

Suspended solids were 0.0 and 0.3 respectively, and for the all samples analysis which is lower than 25mg/L of world health organization (WHO) limits and NAFDAC, the lower the values of these analyses of suspended solids of stream runoff is due to screening process that taken place through the soil particle which is compatible for domestic purposes.

Turbidity

Turbidity is the degree to which water looses its transparency due to the presence of suspended particulates. Turbidity values obtained were 2.3, and 7.2 respectively; from the result obtained in sample 'B' has turbidity above WHO and NAFDAC recommendation which poses threats of absorbing heat from the sunlight, making turbid waters becomes wormer, and so reducing the concentration of oxygen in the water

Zinc (mg/l)

Zinc is used in the production of corrosion-resistant alloys and brass, and for galvanizing steel and iron products. Zinc values obtained were 2.0 and 3.0 respectively; from the result obtained zinc values are compared lower to the WHO and NAFDAC guidelines standard. Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complex.

Colour (pt.Co).

Colours were 4.2, and 10, for all three samples analyses and they are lower than world health organization standard which is 15. Therefore by this WHO and NAFDAC standard it clear that the stream runoff is good for domestic activities

Iron Content

Iron content obtained was 0.19, and 0.23, and respectively; these values when compared to the guidelines were below 0.3mg/l WHO limits and NAFDAC. Water for domestic and industrial use is generally required to contain less than 0.2-0.3mg/l. Despite being the second most abundant element on earth's crust iron is present in relatively small amount in natural waters. High concentration of iron is not known to have any adverse health effects; however they may lead to other problem.

Sulphate

Sulphate (SO_4^{2-}) is a major ion occurring in water, the main natural source of sulphate in surface and ground water is the processes of chemical weathering and dissolution of sulphur-containing minerals, predominantly gypsum ($CaSO_4.2H_20$). Other natural sources are the oxidation of sulfides and elemental sulfur, and the decomposition of animal and plant residues. Sulphate values obtained were 0.7, and 32, respectively; it was observed that the values obtained were very low compared to guideline of WHO 200mg/l limits and NAFDAC.

Nitrates

The presence of nitrate ions in unpolluted surface is due mainly to processes in the water body itself, such as nitrification. The nitrate content of drinking water is rising at an alarming rate in both developed and developing countries owing largely to lack of proper sewage treatment, and excessive fertilizer application. The WHO and NAFDAC drinking water guideline is 50mg/l no adverse effects have been observed with water concentration <20-30mg/l, expect for mathaemoglobinemia in infants. Nitrate in drinking water is a major health concern because of its toxicity, especially to young children.

Nitrogen compounds are of interest to environmental engineers because they are both essential nutrients, beneficial to living organisms, and pollutants. With potentially harmful consequences. Nitrogen pollution can exist in seven different oxidation states: NH_3 (-lll), N_2 (0), N_20 (l), NO (ll), N_2O_3,(lll), NO_2 (lV) and N_2O_5 (v), and its environmental chemistry is consequently quite complex. Nitrogen pollution can have potentially harmful effects in surface and ground waters, and these are causing considerable current concern. Nitrate of Nitrogen values obtained were 6.4, and 5.6, respectively and nitrate are as follows 28.6 and 24.6 respectively; these values when compared to the guideline were below the 50mg/l WHO limits.

Total Hardness (Ca) and hardness (Mg)

The hardness of water is characterized by its ability to form lather with soap. Total hardness is defined as the sum of Ca and Mg concentrations expressed as calcium carbonate in mg/l or ppm. Hardness (Ca) is due to magnesium in the water only. Total hardness of (Ca and Mg) values obtained was 23.2 and 16.8 respectively, and 34.8 and

25.2 respectively. The values obtained from the total hardness do not exceed WHO limit therefore it is good for consumption, no guide by WHO to compare the calcium and magnesium hardness.

Total Alkalinity

Total alkalinity is the total concentration of bases in water expressed as parts per million (ppm) or milligrams per litre (mg/l) of calcium carbonate ($CaCO_3$). Total alkalinity values obtained are as follows 49.2 and 60 respectively. Water with high total alkalinity is not always hard, since the carbonates can be brought into the water in the form of sodium or potassium carbonate. An important environmental aspect of alkalinity in natural water is the capacity to neutralize acidity originating from atmospheric decomposition. Although alkalinity has a little public health significance, highly alkaline waters are unpalatable and are not used for domestic water supply. But all the results obtained proved no harm since it is below WHO limits and NAFDAC.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Rainwater harvesting is an attractive option for increasing available water resources, especially in the drought and arid regions. The research results showed that there variations in the water quality according to the location.

The quality of harvested water is found to be strongly affected by catchment area. Harvested water from rooftops has better quality than the water harvested from the surrounding areas. Finally, public awareness has an important role in collecting rain water management. Education, Training, and Financial supports are needed to encourage people to consider importance and role in collecting rain water management.

5.2. Recommendation

In order to have better quality harvested water, it is recommended that;

1) Rooftops and catchment areas must be cleaned before the rainy season
2) Water samples should be collected and analyzed on regular basis from the storage tanks before using in water for drinking purposes.
3) Adding some disinfecting agents such as chlorine might help in reducing the risk of biological contamination.

REFERNCE

A.M. Michael. and T. P. Ojha.: Principle of Agricultural Engineering Volume Two.2003, 623-631

Chang.M.c Broom.M.W and Beasley. R; Roofing as a source of non-point water pollution. 2004, 73, 307-315

Gnecco. I, Berretta C., Lanza L.G. and LaBarbera P; storm water pollution in the urban environment of Genoa, Italy Ress. 2005, 77, 60-73.

He W., Odnevall Walinder .I., and legraf. C. A laboratory study of copper and zinc runoff first flush and steady state conditions. Corr 2001, 43, 127-146

Mansor Ahmmed, M. meera, 2006. Water quality of rooftops rainwater harvesting systems.

Meera, V., rooftop rainwater harvesting systems: a review, Journal of water supply : research and N.4, pp. 257-268. [11] MWI, (Jordan Ministry of Water and Irrigation), (2009), Water strategy in Jordan, found at: http://www.mwi.gov.jo/m

Pio C.A., Salgueiro M.L., Nunes T.V., (1991), Seasonal and air-mass trajectory effects on rainwater quality at the effects of short-term events, Ecological Engineering, Vol.30, N. 3-2, Pages 271-277.

Thomas.T.H and Martinson. D. B. : Rainwater Harvesting. 2007, 15-18,38-45

Vazquez A.; Costoya M.; Pena R.M.; Garca S.; Herrero C(2003), A rainwater quality monitoring network: a preliminary study of the composition of rainwater in Galicia,Chemosphere, Vol. 51, N

WAJ, (Water Authority of Jordan), (2006), wastewater treatment in Jordan, annual report.

WHO (World Health Organization.) 2004, Health guidelines for the use of water for domestic purpose

Yaziz, M.I , Gunting H., Sapari, N., and Ghazali. A.W.,(1989), Variations in rainwater quality from roof catchments, Water Research, Vol.23, N. pages 761-765.

Zhu Kun, Zhang Linus, William Hart, Mancang LiChen Hui., (2004), Quality issues in harvested rainwater arid and semi-arid Loess Plateau of northern China, Journal of Arid Environments, Vol. 57, N. 4, Pages 487-505. [19] Zunckel, M., Saizar, C., Zarauz, J., (2003), Rainwater composition in northeast Uruguay, Atmospheric Environment, Vol

APPENDICES

PROCEDURE

The conductivity meter with its electrode immerged in distilled water was switched on and left for 10 minutes to standardize. The electrode was reused two times with the sample. The pointer and the selected knob were adjusted to the appropriate range and readings on the scale were taking.

The sample were heated through evaporated dish of appropriate in oven at 180°C for 1hr. cooled in desiccators and weighed. Then the accurate volume of well mixed sample was measures through glass fibre filter paper under slight suction. The transfer filtrated was pre-weighed through evaporating dish and evaporate to dryness in a hot water bath for the diction of conductivity.

Determintation of Total Dissolved Solids (Tds)

The weight of empty evaporating dish and heated to dryness in the hot plate. The concentration was dried in an oven for 1hr. the dish was cooled in a desiccators and constant weighed. The cycle of drying was repeated until accountant weight was obtained and recorded.

Determination of Temperature

The temperature of the samples was noted by inserting a thermometer with each sample and their result were noted.

Determination of Suspended Solids (Mg/C)

The filter was washed in filter holder under suction with successive small volumes of laboratory water. The filter paper was removed and placed in the Aluminum dish and oven at 105°C for 1hr cool in desiccators and weighed. The procedure was repeated until the drift is less than 0.5mg. This filter were placed and dumped with laboratory water and the accurate volume of well-mixed water sample (100-500ml) and filter under slight suction then the filter was removed and dried in the oven at 105°C for 1hr and recorded.

Determination of Colour

The colour of the sample, were observed by filling one clean test tube with distilled water and another with sample and comparison was made between the two solution and the colour was noted.

Determination of pH

The pH meter was used according to the manufacture instructors and specifications. The electrode was rinsed and left in distilled water for two minutes to remove possibility or the presence of other agents. The pH meter was standardized using the buffer solution of 4,7 and 9.2. The electrode was rinsed several times with the samples.

The pH of the samples and their pH value was noted.

Determination of Iron

The samples were shaking thorough sample bottle and pipette of 50.0ml (aq) into conical flask. Then the 2ml of concentrated HCL was added to 1ml hydroxylamine solution and some glass beads. The sample was boiled until the volume reduced to about 20ml and the result was recorded.

Determination of nitrate

10ml of distilled water and the samples were measured in two different tubes to each sample 0.5ml bromine was added followed by the addition of 20ml of concentrated H_2SO_4.

The colour of the distilled water appears to be lighter which was overcome by titrating with $AlNO_3$ until the same colour match was obtained and the result was noted.

Determination of Hardness

The ethylene dioxide tetra acetic acid (EDTA) solution, the pipette for 20ml aliquots of the primary standard $CaCo_3$ (0.04m) solution into 250ml conical flasks. Titrate each with the 0.004m of EDTA solution in the following manner. The 15ml is added to the EDTA solution in the following manner. The 15ml is added to the EDTA solution from the burette then; 10ml of the buffer solution is added to 5 drops of the ferrochrome black indicator solution and recorded.

Determination of Alkalinity

100ml of each sample was transferred to a flask and drops of phenolphthalein indicator were added the resultant pink colour solution was tritrated with 0.1m Hcl SO_4^{2-} until the colour change to colourless.

Determination of Zinc

Atomic absorption spectrophometry is the most widely used method for the determination of zinc. The detection limit of the direct air acetylene flame method is 50µg/litre (4).