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Causes, Categories and Control of Water Pollution

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Abstract— *The study aims at systematic literature review on sources of water pollution, causes of water pollution, categories of water pollution and its mitigating control measures. Twenty eight (28) related articles were employed for the study. The scholar's contributions were viewed under water pollution contextual definitions, sources of water pollution consider, classification and categories of water pollution were assessed, causes of water pollution scholarly contributions were evaluated and mitigating control measures as stated by scholars were also highlighted in this studies. Additionally, twenty eight (28) journals employed for the studies uncover the statistical distributions as; control of water pollution is more popular among the scholars who constitute 36%, categories of water pollution with 25%, causes of water pollution as contributed by scholars 21%, sources of water pollution are least popular among the scholars with 18%. This shows water pollution experts globally are more concerned with its control measures rather than sources, causes and categories of water pollution. Furthermore, the articles employed for the study uncover that, articles that dwells on global perspective are more than those whose work are solely on Asian countries, Europe/US as well as African continents. This depicts that water pollution experts are distributed across the globe. The study recommends human behavior approach and techniques in controlling water pollution especially in developing world should be implemented. Solid waste from households, industries and agricultural products should be properly controlled through proper campaign with the aid of public lecture, billboards to convey messages, visual broadcasting and audio broadcasting and with the aid and support of pamphlets. Sewage from both households & industries should be properly monitored by government by enacting policies for the industrialists to treat effluents before discharging in to water bodies. This could be achieved through organizing environmentally friendly conference, workshops, seminars and it should be organize periodically so as to create avenue for sharing new ideas and methodologies interchanged by the experts.*

Keywords— *Causes, categories, control, sources, pollutants.*

I. INTRODUCTION

Water is the most important aspect of natural resources, and is essential to the existence of all living species including human, food production, and economic growth. Water is the important and necessary element that makes up about 75% of our planet and the crust of Earth the Earth (Arif, Muhammad, Somia, Asifa, Kainat et al., 2020). It is one of the essential natural resources required for the reproduction of all forms of surface organisms. Water is a vital ingredient that we will find in all three states as liquid, solid, and gaseous or modes of matter. However the main concern is that the various kinds of natural and anthropogenic practises conducted by humans influence this natural supply. These change water by introducing harmful chemicals, organic and inorganic products which damage this natural source of water very seriously, directly or indirectly (Abdulrazzak, Bierk & Abdulrazzaq, 2020). As a consequence, by touching these substances, which may contain toxins, the resources of wetlands and human beings living in this environment are negatively affected. Polluted water per year causes 4 million diarrhea diseases and 2.2 million deaths (Jabeen, Huang & Aamir, 2015). Within present situation, where demand for freshwater is rising, there is growing lack of uncontaminated and disease-free water sources. (Santana, Olivares, Silva, Valesco, Luzardo, de jesus, 2020). Water pollution is the introduction of substances and materials that are toxic to living creatures when they pass their absorption threshold levels of the polluted water (Singh, 2015). It comprises, along with the radiological compounds, the heat, organic, inorganic, and biological compounds. The consequent water pollution poses a significant threat to Earth's well-being along with its population.

The key causes of water pollution are domestic, industries and agricultural practices. Globally, 80% of industrial waste and garbage is dumped into water sources and industry is responsible for annual disposal into water bodies of millions of tonnes of heavy metals, solvents, hazardous sludge and other waste (WWAP, 2017). Agriculture, which contributes for 70 percent of worldwide water abstractions, plays a significant role in water pollution (Javier, Sara & Hugh 2017). Farms spill vast amounts of agrochemicals into water sources, organic matter, medicine metabolites, sediments, and freshwater runoff. The resulting water contamination poses identified threats for marine habitats, human health and economic practices (UNEP, 2016). There are several cities around the world currently experiencing a severe water crisis, and approximately 40 percent of the world's food production is cultivated under irrigation, and a wide range of industrial processes rely on water (Joshua & Nazrul Islam, 2015). The climate, economic growth, and technologies are all strongly affected by regional and seasonal water supply, and surface and groundwater quality. Water quality is influenced by human activity and is decreasing as urbanization, population growth, industrial development, climate change and other influences increase (Santana, Olivares, Silva, Luzardo, Valesco, de jesus, 2020).

If water contains organic, inorganic components together with the existence of bacteria, fungi, viruses, algae, protozoa and other organisms, it is not fit for drink. When certain species are found in the higher concentration, the water becomes toxic. That renders the water unfit to drink. The

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degree of contamination depends mostly on substances concentration. Some substances although at low concentration can cause pollution. Poisons, contaminants, chemicals and some pathogens are included. The contamination of water is not natural and is primarily man-made (UNEP, 2016). Very commonly, waste is discharged into the receiving water sources by failing to do its direct or indirect treatment with too little care for its self - purification ability. Threats to the diluting capacities of lagoons and waterways in big cities include the dumping of raw sewage, refuse, as well as oil spills. In itself, the natural purification of contaminated waters is never easy, whereas heavily polluted water can travel long distances in days before a sufficient degree of purification is reached (Joshua & Nazrul Islam, 2015). Water contamination is a global problem, and has risen in both industrialized and emerging countries, affecting economic development as well as millions of people's physical and environmental health. Global water shortage is exacerbated not only by the resource's physical shortage but also by the increasing water pollution in many countries, decreasing the quantity of clean water to use (Javier, Sara & Hugh 2017).

II. Literature

A. Sources of Water Pollution

Point Source Pollution: Point source pollution is the discharge from a drain, outfall or ditch into surface waters at a given site. In addition, it is a measurable, unique, and restricted discharge of toxins into a body of surface or underground water. Examples include surface water discharges from feedlots, agricultural production plants and agrochemical manufacturing plants, and chemical spill pollution from groundwater (Wato & Amare, 2020).

The term "point source" means any perceptible, confined and distinct conveyance comprising, but not limited to, any drain, canal, conduit, duct, tube, distinct fissure, container, rolling stock, concentrated animal feeding activity, or vessel or other floating vessels from which pollutants are or may be discharged (Wato & Amare, 2020). This concept does not include discharges of agricultural storm water and the drainage of irrigated land returns (Shanda and Sharon, 2016).

Non-Point Source Pollution: Non-point source pollution, often referred to as "diffuse" source emissions, occurs from a large range of human activities that the toxins do not have a clear entry point to access watercourses (Wato & Amare, 2020).

Non-point source pollution is extremely difficult than point sources to detect, monitor and regulate. Non-point sources' key features are that they react to hydrological conditions, are not readily assessed or specifically monitored (and thus difficult to regulate), and rely on land and associated management activities (Davey, Bailey, Bewes, Mubaiwa, Hall et al., 2020).

Point source regulator within those countries that have successful control systems is done by supervised effluent treatment, normally under a discharge permit scheme. By contrast, regulation of non-point sources, particularly in agriculture, has been through education, promotion of effective management practices, and land use modification (Wato & Amare, 2020).

B. Causes of Water Pollution

Domestic water pollution

It is those wastes which the households generate. In many of these homes of developing countries, a septic tank discharges only bathroom and toilet waste, and all other domestic liquids are drained directly into drainage ditches where they exist and find their way in to water bodies (Galadima, Garba, Leke, Almustapha & Adam, 2011). Some domestic wastes are from leakage of sewage or septic tanks which end up in natural waters. Such comes not only from human waste but also from fertilisers commonly used in lawns and gardens in households (Qadri, Bhat, Mehmood & Dar 2020). Many residents today spill their waste into ponds, lakes, waterways, and oceans, making the water sources the last resting spot for containers, bottles, chemicals, and other household items.

Many of today's washing materials come from the petrochemical industry and are synthetic detergents. Many detergents and washing powders contain phosphates, which among some other items are used to smooth the skin. This and other additives in the washing powders affect the wellbeing of all life forms in the environment. The water polluted from untreated or inadequately treated waste washing into rivers, reservoirs, dams and so on induces severe infectious diseases such as typhoid, cholera, dysentery and other skin diseases (Paranjape 2013)

Industrial water pollution

Plant pollution acts as the primary reservoirs of all water pollutants (Arif, Muhammad, Somia, Asifa, Kainat, et al., 2020). Over 70 per cent of industrial waste is discharged untreated into rivers in many developing countries, polluting the already available water supply (Qadri, Bhat, Mehmood & Dar, 2020). Manufacturing industries such as fertiliser, oil refining and steel and so on add many of the most toxic substances, including a variety of highly sensitive and toxic organic chemicals and heavy metals. Certain industries have less possible effects but are still considered extremely problematic as far as pollution is concerned. These are textile, leather, paint, plastics, pharmaceutical, paper and pulp industries (Qadri, Bhat, Mehmood & Dar 2020) are included in these industries. Chemical waste from industries can only be treated through the use of special waste treatment plants, as sewage treatment plants cannot treat them.

Agricultural water pollution

Agricultural waste has now overtaken pollution from homes and factories in most high-income countries and many developing economies as the main driver in destroying inland and coastal waters (e.g. eutrophication); Agricultural nitrate is the most frequent chemical contaminant found in freshwater aquifers worldwide. 38% of water sources in the European Union are under substantial threat from agricultural pollution. Agriculture is the primary cause of pollution in rivers and streams in the United States of America, the second largest cause in wetlands and the third major cause in lakes. Irrigation is responsible for a huge proportion of surface-water pollution and is almost entirely responsible for nitrogen groundwater pollution in China. The massive amounts of untreated urban and industrial wastewater are significant issues in low-income countries and developing economies. However, agricultural pollution, compounded by increased drainage of sediments and salinization of groundwater, has become quite a concern. (Javier, Sara & Hugh, 2017).

Agricultural stresses on water quality stem from crop and livestock programs, both of which have increased and escalated to satisfy the rising demand for food due to population growth and dietary changes. In the past few decades, the region built for irrigation has almost doubled from 139 million hectares (Mha) in 1961 to 320 million hectares (Mha) in 2012, and the overall amount of livestock has almost tripled from 7.3 billion in 1970 to 24.2 billion in 2011 (FAO, 2016). Worldwide crop production growth was achieved largely by the extensive use of inputs like pesticides and chemical fertilizers (Wato & Amare, 2020). The pattern has been exacerbated by the expansion of agricultural land, where irrigation plays a strategic role in improving production and rural livelihoods, thereby shifting agricultural pollution to water bodies. The livestock sector from almost all countries grows and intensifies more rapidly than crop production. The related pollution, including manure, has significant repercussions for the safety of water (FAO, 2016). A new class of agricultural pollutants has arisen in the last 20 years as a result of veterinary medicines (antibiotics, vaccines, and growth promoters [hormones]), which travel from farms to habitats and drinking-water supplies through water. A further big problem is zoonotic waterborne infections (WHO, 2012).

C. Categories of Water Pollution

Sediments

Sediments consist of small particles of mainly inorganic content such as mud and silt washed into a stream by agriculture and development of land. They can also emerge from excavation and mining operations where these practises occur. It is the existence in the flowing water of solid particulate matter that makes many rivers look brown in colour, particularly in the rainy season (Khatoon, Khan, Rehman, & Pathak, 2013). The particles are called suspended solids when being held in liquid water (suspended). They are called sediments as they sink downwards.

Organic matter includes anything that comes from living organisms, that is to say both plants and animals. Rather than biological, inorganic matter has a geological basis that indicates it emerges from rocks and other non-living materials. Significant amounts of inorganic matter in the form of suspended solids can limit the penetration of light into the water, which can impact plant growth (Frey, Gottschall, Wilkes, Gregoire, Topp et al., 2015). Sediments can also suffocate river bed creatures. River water can indeed have organic matter, such as waste from humans and animals, which can exhaust (reduce) the oxygen in water if the river flows sluggish. This can contribute to anaerobic environments, which can create uncomfortable symptoms and odors (Singh, 2015).

Nutrients

Through growing crops, nitrogen water leakage happens when fertilizers are added at a rate higher than those set by soil particles or removed from the soil profile (e.g. by plant absorption or by washing them off the soil surface before plants can pick them up). Nutrients may seep into groundwater, or flow into waterways through surface runoff. Phosphate is not as soluble as ammonia and nitrate and appears to be adsorb on soil particles and join extensive surface degradation into water sources (Kuwayama, Olmstead, Wietelman, Zheng., 2020). Feedlots are often situated on the banks of watercourses in livestock processing, so that animal waste (e.g. faeces, rich of nutrients) can be discharged directly into such water courses. Manure is mainly collected for use as organic fertilizer and can result in diffuse water pollution if used unnecessarily (Kuwayama, Olmstead, Wietelman, Zheng., 2020). In certain instances, too, manure is not kept in enclosed areas and can be washed into watercourses by surface runoff after major rainfall events. High nutrient loads, along with other stressors, can lead to eutrophication of wetlands, rivers, dams and coastal waters, resulting in algae blooms that threaten other aquatic plants and animals (Javier, Sara & Hugh 2017).

Biological pollutants

Bacteria: The fresh water contains several different species of bacteria. They aren't just pollutants, but many are in no way toxic and play a vital part in the normal degradation of organic matter and nutrient availability. Some bacteria are parasites, and often cause waterborne infections. The existence of faecal coliform bacteria in drinking water, and especially E.coli, may represent a potential presence of harmful organisms that cause disease (Dwivedi, 2017).

Viruses: Viral infection may result from untreated effluent dumped into a river, or from a contaminated person's open defecation, that may be washed into a river or stream by rainwater. Any enteric viruses are Chlorination immune. Polio, hepatitis A and rotavirus are popular water borne viruses. The existence of some enteric virus may be taken as an indicator of the potential presence of other dangerous viruses in water bodies (Dwivedi, 2017).

Protozoa: There are some protozoa which can be released from infected individuals into water sources. Criptosporidium and Giardia for example. A home sand filter is ideal to extract protozoa from potable water. The Protozoa would be covered by the sand and gravel layers.

Helminthes: Helminthes or parasitic worms may also pollute water and cause human illness. Infection happens by absorption of helminthes eggs and may occur in food. Helminthes eggs, for example, can be found in cattle meat grazing on facially polluted land. Guinea worm (dracunculiasis) is spread through drinking water, including copepods infected with worm larvae.

Chemical Pollutants

Heavy Metals: Mercury, zinc, arsenic, cadmium and copper are environmental pollutants present in lakes, rivers, and soil. Such heavy metals can affect aquatic and human organisms. Farmers using river water contaminated by municipal waste for fruit and vegetable irrigation can see their crops affected by the buildup of such chemicals (Renu, Singh, Upadhaya & Dohore 2017).

Pesticides: Fungicides, herbicides, and insecticides are all forms of pesticides. Many thousand different forms are in use and almost all of them are potential sources of polluting water.

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For instance, for the prevention of disease vectors such as mosquitoes, DDT, malathion, parathion, delthametrine and others were sprayed into the environment for long periods of time (FAO, 2016).

They may pollute water resources with carcinogens and other hazardous chemicals that can affect humans if incorrectly selected and handled. Pesticides can also affect ecosystems by killing weeds and insects, mostly with food chain having negative impacts (Schreinemachers and Tipraqsa, 2012). Although substantial use of older broad-spectrum pesticides continues in industrialized nations, the pattern is towards the use of new generation pesticides which are much more selective and far less harmful to humans and the environment and offer low quantities per unit area to be efficient.

Oil Spillage: Oil spill onto the water bodies by disaster or leaks from oil tankers transporting petrol, diesel and their equivalents seriously pollutes water. Offshore oil drilling also contributes to contamination of the oil in water. The lingering oil spills across the water surface creating a thin film of emulsion from water-in - oil (Singh & Gupta 2017).

Acid Rain: Water pollution which changes the surrounding pH level of a plant, for example due to acid rain, may damage or destroy the plant. Ambient Sulphur dioxide and nitrogen dioxide released by natural and man-made activities such as volcanism and fossil fuel combustion combine with ambient chemicals, such as hydrogen and oxygen, to produce sulphuric and nitric acids in the air. These acids in the form of rain or snow come back to earth by precipitation (Singh & Gupta 2017). When acid rain hits the field, it runs into rivers that bring the acidic compounds into bodies of water. Acid rain collected in marine ecosystems reduces water pH levels and influences the marine biota.

D. Control of Water Pollution

The best way to control water pollution is to adopt an appropriate waste treatment and disposal methods. Decisions on the form and degree of treatment and the disposal and utilization of properly treated waste must be focused on taking into account all the functional considerations of each drainage basin to avoid further pollution or damage to the environment.

Sewage treatment

Centralized sewerage treatment systems usually treat domestic waste in urban areas of industrialized countries. In those countries, urban households recognize sanitation as a service and people are happy to spend for it as long as there are reasonable and effective providers (Adesogan, 2013). Well designed and operated systems (i.e., secondary treatment) can remove treat sewage with more 90 percent efficiency (Singh, 2015). Few plants have supplemental nitrogen and pathogens control devices. Wastewater treatment plants also accept wastewater from industrial customers, in addition to wastewater from domestic and commercial sources. Wastewater should be treated prior to disposal to avoid surface and groundwater pollution and to minimize the transmission of contagious diseases induced by sewage-related pathogenic species (Han, Currell & Cao, 2016).The technologies for solid waste disposal and resource regeneration which can be implemented include aerobic composting, sanitary landfill and incineration.

Aerobic composting: Is a microbiological mechanism that decomposes organic household waste into an organic soil conditioner and fertilizer. The method uses particular temperature, humidity, carbon and nitrogen ratio and ventilation, along with the introduction of fungi, fungi, actinomycete (microbes) and/or other microorganisms which are commonly spread in nature, to decompose organic domestic waste into healthy humus (used as fertilizer) (Wato & Amare, 2020). The decomposed product is dark brown and smells like a soil; it is a very strong soil conditioner for soil reaction.

Sanitary landfill: In this method, domestic waste are disposed by burying them. It involves special measures to prevent rainwater from entering, and the base of the landfill is sealed to avoid the percolation of contaminants from the waste into the environment and to protect local water sources from pollution. Emissions of methane from the waste are collected and used as fuel in industrial processes (Wato & Amare, 2020).

Incineration: It is commonly used worldwide in high-temperature furnaces for burning waste. If properly conducted this method can be efficient; if not, it will create a range of poisonous gases and by-products during the combustion phase.

Industrial waste treatment

A few industrial systems produce ordinary domestic sewage which can be treated by municipal equipment. Specialized treatment systems are required for industries that produce wastewater with high levels of conventional pollutants (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or other non-conventional pollutants such as ammonia (Bhatnagar, Kaczala & Hogland., 2014). Some of these systems can have pre-treatment installed facilities for removing toxic components, and then sending partially treated wastewater to the municipal system.

Industries producing vast amounts of wastewater usually run their own full treatment facilities on site. Few industries, by a method called pollution prevention, have been active in redesigning their production processes to mitigate or remove pollutants.

Agricultural waste treatment

Washed off fields with sand (sediments) is the main cause of agricultural pollution in the United States. Farm workers can use erosion controls to lower runoff flows and keep soil on the fields. Popular strategies comprise of contour ploughing, crop rotation, and riparian installation (Singh, 2015).

Contour Ploughing: Connecting Through ridges, furrows, and roughness created by tillage, planting, and other agricultural activities to adjust velocity and/or course of runoff from direct downstream water flow to across the hillslope. Contour ploughing diminish the distribution of pollutants present in solution runoff-Environmental Risk (Water Quality Depletion –too much nutrients in surface and ground water; pesticides transferred to surface and ground water; excessive pathogens and chemicals from waste, bio-solids or compost applications). (US-NRCS 2015).

Crop Rotation: Attempting to change crops grown in a field, usually in the series prepared. Rotations of the crops include

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rice, legumes and small grains. Rotations of small grains and legumes can greatly minimise soil erosion. In addition, legumes will save nutrient costs because they absorb the nitrogen that is lost from soil by corn and other grains. Rotations eliminate pesticide usage by disrupting the chain between weeds, insects and viruses, naturally. The purpose of crop rotation is to lower the risk for leaching nitrate to groundwater by replacing crops that supply nitrogen such as alfalfa, clover and soybeans with nitrogen-using crops like corn and wheat (US-NRCS 2015).

Riparian Installation: A region mainly of trees and/or shrubs situated next to and up-gradient from watercourses or water sources. Minimize surface runoff waste sediment, organic material, nutrients and pollutants and reduce excess phosphorus and other pollutants in the drainage of shallow groundwater.

Farmers can use Integrated Pest Management (IPM) techniques to mitigate the impacts of pesticides to keep control of pests, reduce dependence on chemical pesticides and preserve water quality.

Integrated Pest Management (IPM)

IPM is a pest management technique that involves a series of complementary strategies which combine to minimise pests, costs and chemical pesticide use. Farmers who practise IPM go through four stages (USEPA, 2017):

Action thresholds: Prior to taking any action to control pests, Integrated Pest Management sets mainly a threshold for action, a level where pest communities or environmental factors suggest that action should be taken to control pests. Detecting a solitary pest doesn't mean it's control is needed. Critical for guiding future pest control judgments is the level where pests will be an economic problem.

Monitoring and identifying pests: Control is not needed on all insects, weeds or other living species. A lot of organisms are harmless and others are also helpful. IPM systems work to detect and reliably classify pests, but in accordance with intervention criteria effective decisions can be taken for their management. This surveillance and detection ensures that pesticides are only used as appropriate, and that only the correct pesticide is used.

Prevention: preventative measures such as rotating between different crops, choosing pest-resistant varieties and planting pest-free rootstock. With these, the method can be beneficial to the farmers as it is cost-efficient and have little to no risk to humans or the environment.

Control: If the criteria for tracking, detecting and taking action suggest that pest management is needed and prevention measures are no longer efficient or appropriate, IPM systems determine the correct management approach for both efficacy and risk (USEPA 2017). Efficient, less dangerous pest controls, including highly concentrated chemicals, such as pheromones to interrupt pest breeding, or mechanical control, such as trapping or weeding, are preferred first according to surveys. If more surveillance, detection, and response criteria suggest that less aggressive measures are not effective so alternate methods of pest control such as selective pesticide spraying will be employed.

III. METHODOLOGY

The study employed twenty eight (28) academic scholarly journals. The journals are mostly developed country based. Systematic literature techniques aided the study of the sampled journals and areas that suit the topic of the study were intensively identified and consider as part of the study. Results, arguments, perceptions of the sample journals were added to the study. In addition, this study gives emphasis to the scholarly contributions with emphasis to (a) sources of pollution (b) causes of pollution (c) categories of pollution and (d) control and mitigating measures.

IV. SCHOLARS MAJOR CONTRIBUTIONS

The study conducted categorized the scholar's contributory work in to;

A. *Articles that Dwells on Global Perspectives.*

They are general in their approaches; it could be applicable in accordance with their finding situations. They discussed sources of water pollution, its categories, its causes as well as its control. The scholarly work cover the work of Abdulrazzak, Bierk & Abdulrazzaq (2020)., Arif, Muhammad, Somia, Asifa, Kainat et al.,(2020)., Bhatnagar, Kaczala, Hogland (2014)., Dwivedi, (2017)., FAO, (2016)., Frey, Gottschall, Wilkes, Grégoire, Topp et al., (2015)., Javier, Sara & Hugh. (2017)., Joshua & Nazrul Islam. (2015)., Qadri, Bhat, Mehmood & Dar. (2020).,Renu, Singh, Upadhyaya & Dohare. (2017)., Singh & Gupta. (2017)., Santana, Olivares, Silva, Luzardo, Valesco et al., (2020)., Schreinemachers & Tipraqsa, (2012).,Wato & Amare. (2020). and WHO. (2012).The scholars immensely contributed to the trajectory of generalized water pollution.

B. *Scholars Whose Work Covers Solely Asia*

The scholars also greatly added value to water pollution, its causes, its classification as well as its mitigation techniques. These scholars are Han, Currell & Cao. (2016)., Jabeen, Huang & Aamir. (2015)., Khatoon, Khan, Rehman, & Pathak. (2013). and Paranjape. (2013).

C. *African Scholars Contributions*

African scholars also participated in contributing to the water pollution monitoring, treatment and water scarcity control. The scholars include Adesogan, 2013)., Galadima, Garba, Leke, Almustapha & Adam. (2011)., Singh, (2015). and UNEP, (2016), though when observed critically from the samples of journals employed for this study, African scholars contribution is immensely.

D. *European and United States of America Scholars*

European/US scholars from both European and United State of America (USA) also contributed within the context of this papers theme, categories, causes and control of water pollution. The scholars Davey, Bailey, Bewes, Mubaiwa, Hall et al. (2020)., Kuwayama, Olmstead, Wietelman & Zheng. (2020)., Shanda & Sharon, (2016)., USEPA, (2017) and US-NRCS, (2015).

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V. Recommendations

The research titled "causes, categories and control of water pollution" focused on sources, causes, categories and control of water pollution and based on the mathematical result, control mitigating measures are found to be most popular among the scholars across the globe. This study strongly recommends human behavior approach and techniques in controlling water pollution especially in the developing world i.e Africa as a whole and Nigeria specific.

The human behavior approach should cover public orientations and campaigns with regards to essentiality of water resources and its application in the human physiology. In developing countries, particularly African continents, in most urban centers solid waste disposal in water ways should be effectively controlled. In addition, discharge of sewer (sludge) should also be controlled.

Solid wastes are from households, industries and agricultural products. Campaigns on proper solid waste disposal and consequences of otherwise should be taken to community by government and local authority as becoming aware of a risk is the first step to avoiding it. This campaigns can be through public lecture (with experts invited to speak on the subject), by the use of Billboards to convey the message, Visual broadcasting (through TV stations), Audio broadcasting (through radio stations) and by using pamphlets.

Sewage is mostly from households and industries. Government should come up with policies tailored at combating water pollution from industries. For example, industries that use rivers should have their water inlet pipes downwards of their effluent outlet pipes, so they are the first to suffer as they create pollution themselves. This will make it less economical for them to act in an environmentally friendly manner. Conferences, workshops and seminars should be organize periodically to discuss and share knowledge on new ideas, methods, process and emerging technologies for treatment of sewage and sewage discharge in other to control water pollution.

VI. Conclusion

The study statistically considers four major parameters of water pollution viz;

A. *Sources of water pollution*
B. *Causes of water pollution*
C. *Categories of water pollution and*
D. *Control of water pollution.*

From fig. 1. Control of water pollution is more popular among the scholars. It receives 36% of the total scholarly articles employed for this study. Categories of water pollution are the second dominant that receives 25% of scholarly contributions on water pollution. Additionally, causes of water is second to the least or its third when observe carefully from the figure. It records 21%. It is therefore the third in popularity that receives scholarly contributions across the globe. Sources of water pollution as reveal by literature study, it covers 18%. Looking at that we can rank the water pollution parameters employed for this study as follows; Control of water pollution, Categories of water Pollution, Causes of water pollution and Sources of water pollution.

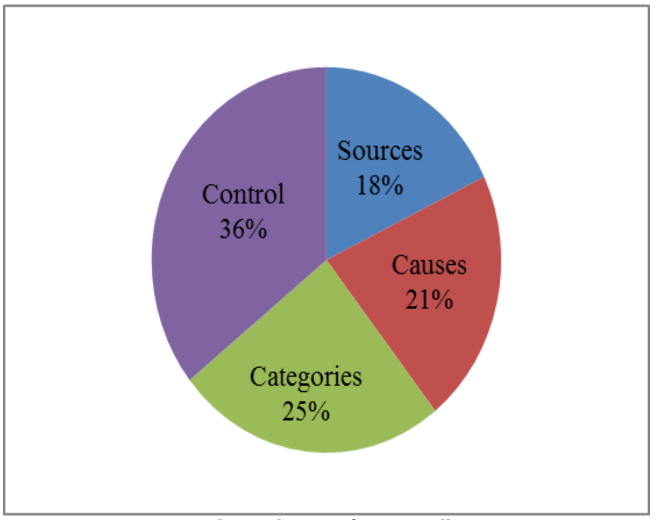

Figure 1: Statistical Distribution of Water Pollution Parameters

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