KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI.

COLLEGE OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

CENG 291 ENGINEERING IN SOCIETY

UNDERGROUND WATER POLLUTION BY PESTICIDES IN NKYESA, ASHANTI REGION.

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DECLARATION:

I hereby declare that the project work with title" underground water pollution by pesticides in Nkyesa" submitted to the Chemical Engineering department of Kwame Nkrumah of University of science and technology(KNUST) is a record of an original work done by Oppong Daniel Kyei under the guidance of Dr. Emmanuella Kwao-Boateng, a lecturer in the Chemical Engineering department, college of engineering, and this is in partial fulfillment of a course "engineering in society".

OPPONG DANIEL KYEI

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Throughout the project, I have relied on the assistance and expertise of many friends in the field and academic community who contributed immensely through discussions and interviews.

I would also want to thank the following individuals for their notable contribution; Justice Kyei Nkrumah, Hannah Kyei Nkrumah, course coordinator for the chemical engineering department who went far beyond call of duty in helping me refine and cite most works.

I appreciate the guidance and assistance of all who have probed me to meet requirements and expectations of the course.

ABSTRACT:

Groundwater connects or serve as a source of water to wells.

Pesticide contamination of groundwater is a national topic because of the potential risk to health of mankind.

Human activities sometimes employ the use of pesticides, usually in agriculture. Even though pesticides have lots of benefits, they are poison.

Nkyesa in the Ashanti Region has about 90% farmers and these farmers do apply pesticides in their farming activities which pose great threat to their livelihood.

Underground water forms part of the hydrological cycle, hence any pollution of that matter affects the entire cycle.

Nkyesa depends on boreholes and the River Pra as source of water. These boreholes have their system filled by the water from beneath.

This study sought to address the problem facing the village, by use of questionnaires, google forms and interviews to solicit enough information from the general public, farmers in the village and some personnel working on water treatments.

The study's analysis and recommendation was solely based on the environmental protection agency's code of conduct, Ghana poverty reduction strategies, opinions from respondents and personal conclusions.

It is therefore observed that the best method for curbing the issue in Nkyesa is the natural pest control methods rather than chemicals.

The government of Ghana, therefore has to enforce laws that ban some pesticides that harm humans.

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ABBREVIATIONS:

WHO- World Health Organization
GPRS- Ghana Poverty Reduction Strategy
COD- Chemical Oxygen Demand
BOD- Biological Oxygen Demand
TDS- Total Dissolved Solids
TSS- Total Suspended Solids
DO- Dissolved Oxygen
Resp- respondents
WRC- Water Resources Commission
EPA- Environmental Protection Agency
CEPS- Customs Exercise and Preventive Service

CHAPTER ONE

1.0 INTRODUCTION

Underground water may seem abstract when the hydrological cycle is considered. Nevertheless, there is a consistent exchange of underground water and surface waters.
This fact therefore draws our attention to the pollution on underground water.
Notwithstanding the advantages and benefits from the usage of pesticides, they, however threaten our underground water source with severe contamination.

Racheal Carson's 1962 publication 'The Silent Spring' dealt with the impact human activities have on the environment. Her work exposed the indiscriminate use of pesticides thereby causing rejuvenises era of environmental concern and advocacy.
This contamination is mostly observed in areas with quite a large amount of rainfall since these areas are usually 'hit' with surface runoffs.
No matter the source (Point and Non-point sources) of contaminants(pesticides), when these problems are addressed will free the Globe exposure to toxins.

1.1COURSE BACKGROUND

Engineering in Society is a course aimed at developing problem solving ability of first year engineering students of Kwame Nkrumah University of Science and Technology. The course code is CENG 291.

CENG 291 is to help students identify problems in their society and design possible engineering solutions from field of specialization and if possible solve the problem.

1.2 BACKGROUND OF STUDY

Technology is subject to engineering. Advancement in engineering results in improved technology.

Engineering employs the concept of advanced mathematics, physics, chemistry, biology, geology, computing and networking to solve complex problems and implement solutions in an economical way.

Chemical engineering in particular is the study of transformation of raw materials into desired products.it involves how fast, favorable conditions, given amounts, properties of raw materials, flow rates of process streams-describing how they are related, defined, calculated and, in some cases, measured.

1.3 SIGNIFANCE OF STUDY

The aim of the study is to make natives of Nkyesa have a prior knowledge on the use of pesticides to farms.

Okoh Agyeman Emmanuel,2010 addressed "the advanced waste water treatment technologies, to protect public health and meet water quality criteria, for aquatic environment and for water recycling and reuse". His work dealt with treatment of industrial waste water.

WHO, July 2008 identified what pesticides are, and the risks they may pose, where and when children are exposed, and diseases that may be related to children's exposure to pesticides.

This study seeks to combine the topics of both Authors and similar writers with respect to underground water quality index in Nkyesa in the Ashanti Region. It is also part and parcel for the award of marks in two (2) credit hour-semester course, engineering in society (CENG 291).

1.4 AIMS AND OBJECTIVES

(i) To assess perception of general public on the use of pesticides,

(ii) To find out specific methods best for the application of pesticides on farms,

(iii) To find out the extent to which the underground water is polluted.

(iv) To solicit the opinions of farmers on the importance of pesticides in Nkyesa, Ashanti Region.

(v) To solicit suggestions from stakeholders, respondents on how best to curb this menace in Nkyesa, Ashanti Region.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 UNDERGROUND WATER

It is natural to think that water is something that flows or evaporate. We see it coming down in the form of Rain, and also flowing as rivers, but hardly do we notice that most freshwater is not easily observed because it lies deep in underground aquifers.

"the part of precipitation that seeps into the ground as a result of gravity and fills the pores between soil particles and rocks is known as Underground water" (environmental chemistry, optional module-1). About 50 percent freshwater on earth is stored beneath the ground. Different areas with different rate of seepage. The following factors determine the rate of seepage; Porosity, permeability, amount of rainfall, topography of land.

Water continues to seep into the ground until it reaches a zone called the saturated zone. In Ghana during the dry season, the water table is lower as compared to the rainy season. Groundwater does not stay in the ground forever; it flows as streams through their discharge points. Groundwater serves as a source of water to wells, springs, lakes normally during drought. In the figure below, about 59% of Ghanaians depend on Natural sources and wells for water, which concludes that most Ghanaians by far rely on sources which have their recharge points at the discharging points of underground water.

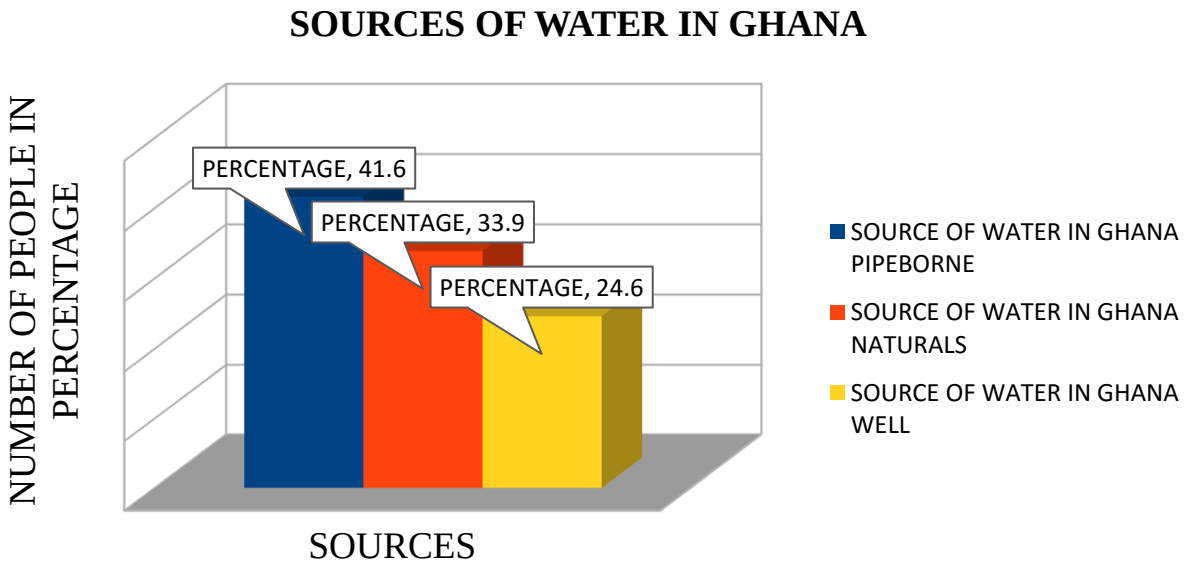

Figure 1: shows number of Ghanaians, in percentage and their dependence on the respective sources of water.
Source: Ghana Poverty Reduction Strategy(GPRS), February, 2003 p.19

This shows great dependence of some Ghanaians on underground water. In the Urban and Rural setting, they continue to distinguish the actual citizens of Ghana that solely depend on groundwater. Figure below goes on to elaborate the importance of underground water to the rural Areas.

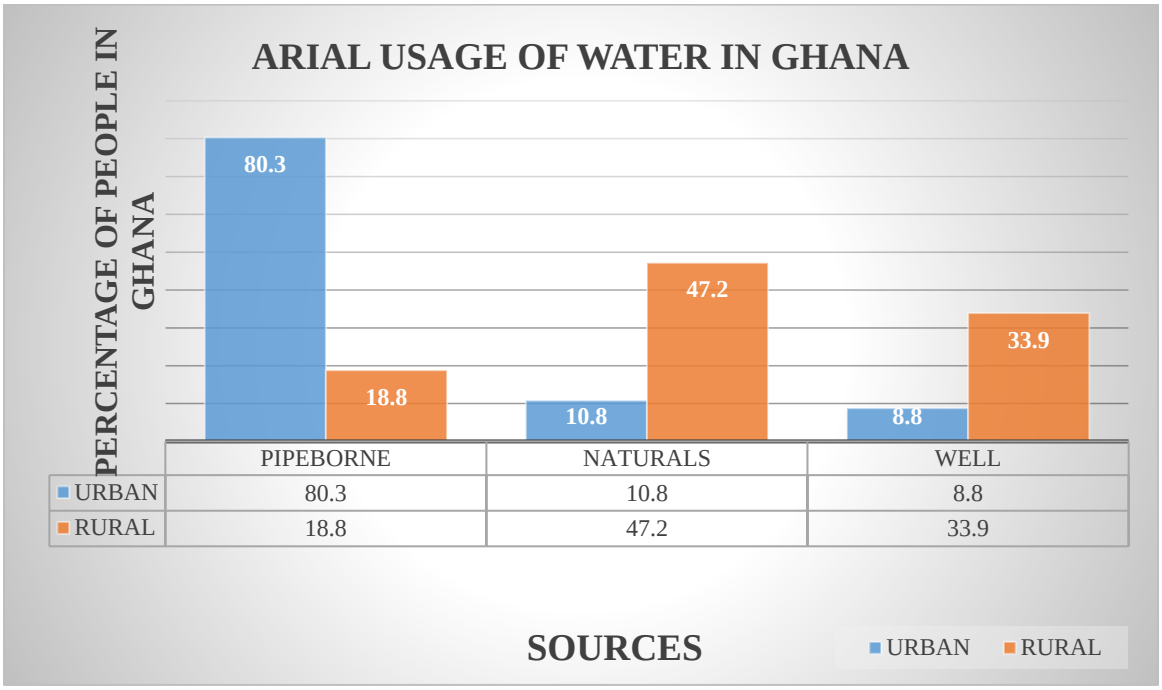

Figure 2: Urban and Rural usage of water in Ghana.
Source: Ghana poverty reduction strategy(GPRS), February, 2003 p.19

According to figure 2 above, rural areas have the highest percentage (80%) of Ghanaians that depend on other sources other than from portable sources which makes the rural areas more exposed to pesticide pollution of water.

2.2 PESTICIDES

Pesticides are example of chemicals that provide society with wide range of benefits particularly in agricultural and industrial productivity.

However, pesticides cause potential health problems and are toxin to the body. First use of pesticides was in 1940 and about 25% of the world production are used in the developing countries. (*WHO, July 2008*)

2.2.1 USE OF PESTICIDE

Pesticides are toxic (biocides). Pesticides are used in the homes to kill mosquitoes, cockroaches, rodents. Sometimes in lawns and to destroy weeds. In agriculture, pesticides are frequently used and renders farmer and surrounding environment high risk menace.

Pentachlorophenol, PCP, a pesticide is used as wood preservative in play structures. For Health purposes, pesticides are used on lice or scabies, fleas or ticks on Pets (WHO, 2003)

2.2.2 WHAT MAKES PESTICIDES HARMFUL

Pesticides can be further grouped into four (4); Organochlorines, Organophosphates, Carbamates, Synthetic pyrethroids. These organic pesticides consist of compounds containing mainly Carbon and hydrogen, chlorine, Sulphur, nitrogen, tin, phosphorus, even in their natural states are harmful. Some have pungent smell; some are acidic oxides when combined with oxygen which accumulate as toxins.

Most pest have become resistant to synthetic pesticides, hence instead of killing insects, rodents and the like they turn to harm humans since they are non-biodegradable.

2.3 POLLUTION

Pollution is simply defined as contamination of the fresh source of a resource. Typical aspects of pollution are Air pollution, water pollution, land degradation/destruction. Some natural components of the earth are at level of moderation, hence excessive amounts of them renders it polluted.
The table below show some natural groundwater components, their origin and effects in excess.

Table 1. Some natural groundwater components which in excess cause inconvenience, pollution.

COMPONENT	ORIGIN	EFFECTS
Boron	Some minerals and volcanic Activity, fine marine sediments	Detrimental to plants at around 1 mg/L
Arsenic	Sediments and rocks	Affects health by 10µL
Manganese	occurs in rocks mainly as manganese and manganeferrous oxides	Black stains and precipitates
Fluoride	From rocks and in some instances acidic volcanoes	Affects bones and teeth
Iron	acidic and reducing environments	Produce stains, encrustations and precipitates. Water becomes yellowish
Cadmium	occurs as accessory element in zinc ore (sphalerite, ZnS) (largest industrial source), CdS, $CdCO_3$ (rare)	Acidic, water becomes acidic.
Potassium and Aluminum	Potassium feldspars ($KAlSi_3O_8$), albitic feldspars ($NaAlSi_3O_8$) and plagioclase ($CaAl_2Si_2O_8$).	Chest tightness, vomiting and nausea

2.4 UNDERGROUND WATER POLLUTION

"The importance of water in all facets of life cannot be over emphasized. It is vital for consumption and health. It is a fundamental resource for human development, especially residential area location. The development of any city has practically taken place near some source of water supply (Rangwala et al., 2007)
When does underground water become polluted?

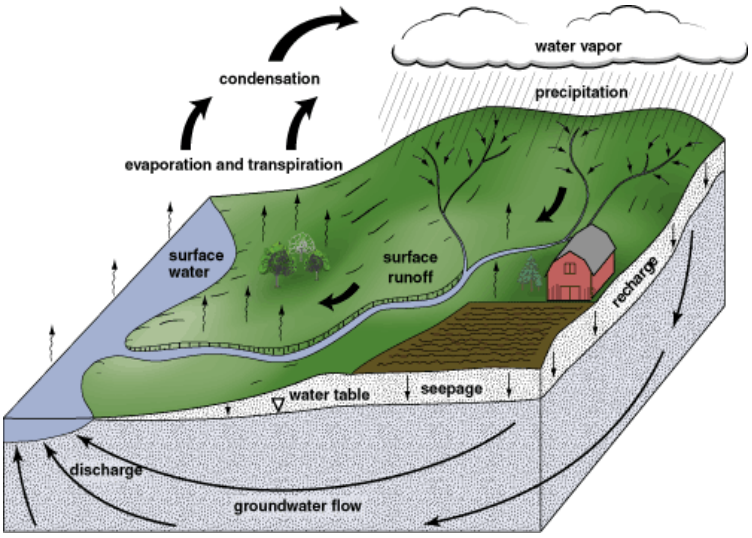

Figure3: Sources of Groundwater Pollution in rural areas.
Source: http://www.isgs.uiuc.edu/sections/hydro/hydrocycle.shtml

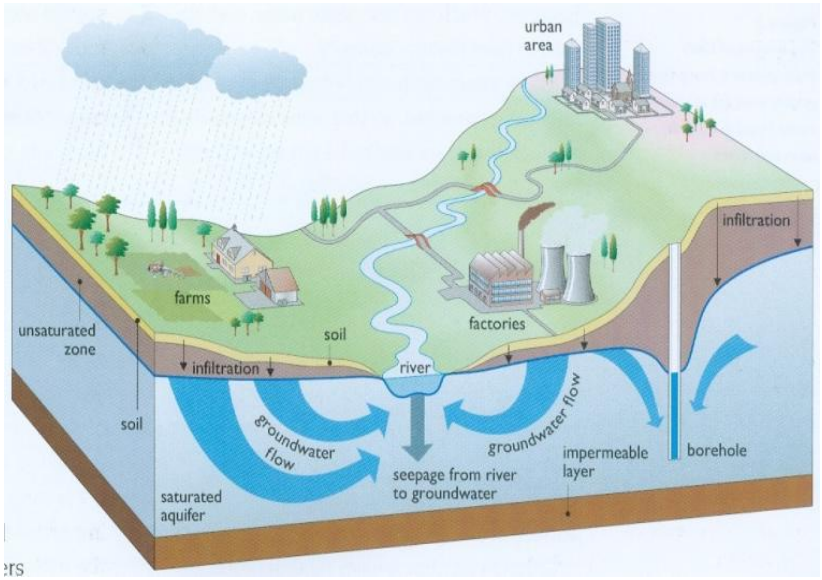

figure 4: sources of groundwater pollution in Urban Areas.

Notwithstanding the idea that groundwater is free from contaminants as a whole, scientists and engineers are discovering cases of pollution in aquifers are able to retain contaminants larger than rivers and other sources. The table below show the accepted Ghana EPA Values for groundwater source.

Table 3: shows accepted EPA Ghana values for underground water.

PROPERTY	**MEAN EPA GHANA RANGE**
Ph	6-9
Turbidity	75 NTU
Conductivity(µs/cm)	750µs/cm
Temperature(ºC)	30
Colour (TCU)	100

BOD(mg/l)	50 or less
COD(mg/l)	250 or less
TDS(mg/l)	1000 or less
TSS(mg/l)	50 or less
DO(mg/l)	1 or less
NH_3-N(mg/l)	1.0
Sulphate(mg/l)	250
Cadmium(mg/l)	0.02 or less
Copper(mg/l)	1
Lead(mg/l)	1 or less
Coliforms(mg/l)	400

There is a wide range of pesticides designed to kill pests, right from; insecticides, herbicides, fungicides, rodenticides, fumigants, algaecides, miticides, acaricides(ticks).
These pesticides are made from pyrethroids, organochlorines, manganese compounds, and other Carbamates and synthetic pyrethroids which are toxins to Human health. They seep into the ground affecting the groundwater and changing the experimented and accepted values of the EPA making it polluted.

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 METHODOLOGY

This work researched into and gave possible solutions to problem of pollution of underground water and the Pra River in Nkyesa, Ashanti Region. Survey was taken from personnel with certain qualities relevant to the study, inhabitants of Nkyesa and the General Public on their perception of the use of pesticides

3.2 POPULATION

Population for this study was the general public, inhabitants of Nkyesa and personnel in the field of study.

3.3 STUDY SAMPLE

The study sample was thirteen (13) farmers or inhabitants of Nkyesa, general public and one (1) personnel. We chose this sample because the topic at hand needed key stakeholders who have certain qualities relevant to the study. Also the opinions of the general public were needed to draw solutions that are community-friendly and nationwide accepted.

3.4 DATA COLLECTION INSTRUMENT

Questionnaires and google forms were used to undertake study by collating information. This was done to obtain as much information as possible from respondents. Questionnaires were tested, thus, to friends and course mates before they were administered to respondents to check if various questions are accurate enough for the work.

3.5 LIMITATION OF METHODOLOGY

this study used questionnaires but the village on study had few literate farmers, therefore a sample of the population were taken which involved literate famers, enough information might not be accrued since a few farmers were interviewed.

The google forms online were also not patronized as expected, afew respondents took time off to help take the survey.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 DESCRIPTION OF COMMUNITY

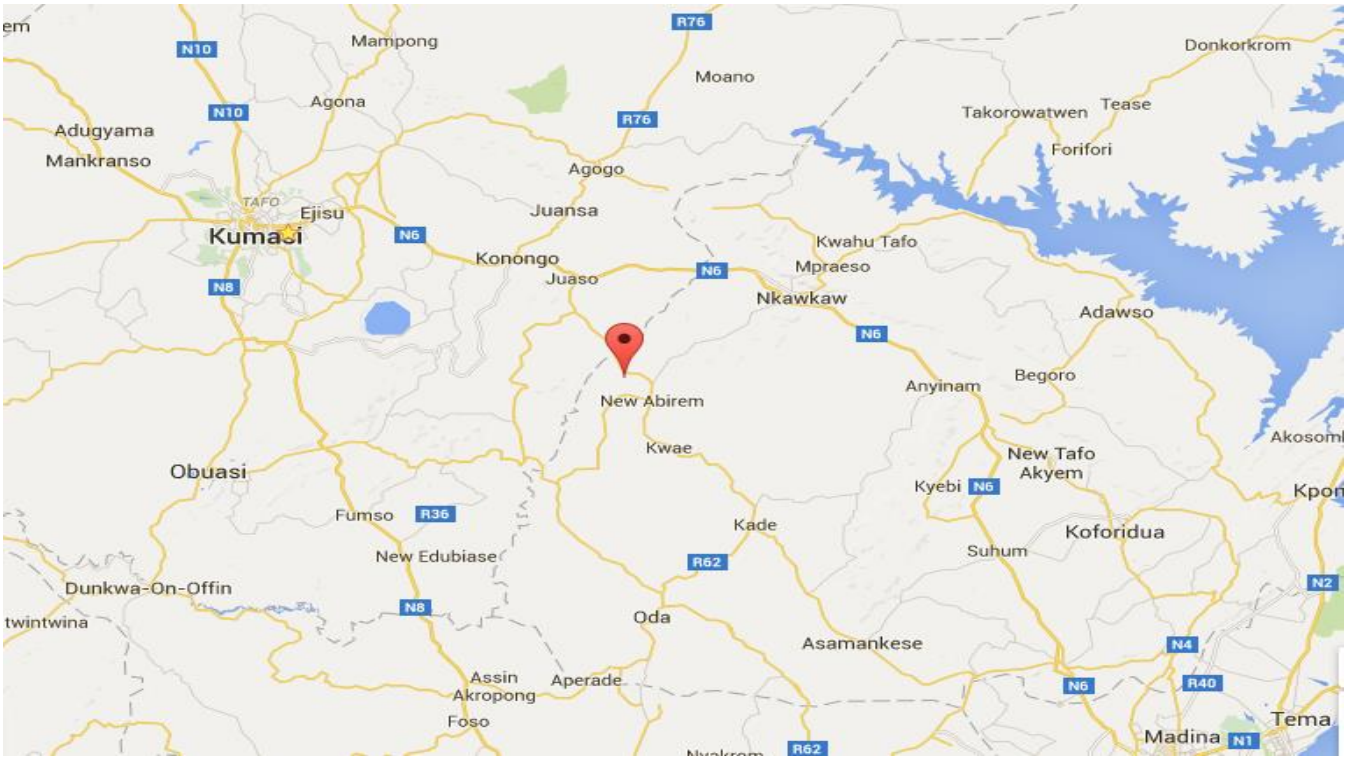

Figure **5:** Map of Nkyesa and neighboring villages

4.1.1 LOCATION

Nkyesa is found in the Asante Akim South District which is located at the Eastern part of the region with its eastern boarder forming part of the regional boundary dividing the Ashanti and Eastern Regions.

The District also shares common boundaries on the North and North-West with Asante Akim North Municipal and Kwahu South District on the West. On the South-West lies Bekwai Municipal and on the South-East is Birim North District in the Eastern Region. **Juaso**, is the Capital. The District was established by Legislative Instrument (L.I) 1409.

4.1.2 POPULATION

The Ashanti Akim South district has a population as according to the 2010 Population and Housing Census at 117,245 with 57,951 males and 59,294 females. The population of Nkyesa not exact but has about 2000 people. (PHC, 2010).

4.1.3 GEOLOGY & GEOGRAPHY

Asante Akim south district has two main landforms. Nkyesa also falls within its jurisdiction. The two main landforms are Birrimian (middle pre-Cambrian) and Dahomeyan with underlying tarkwaian rocks. These rocks can be used as building material in construction activities. There are large deposits of mineral in this district. Examples are Banka and its affirmed by the presence of illegal miners and quarry sites. With silty clay loams: soils developed under lower and upper Birrimian rocks.

4.1.4 AGRICULTURE AND INDUSTRIAL

It falls within the moist semi deciduous forest region. Similar trees to come across in the village are Wawa, Onyina, Mahogany. The district is known as the "gateway to Ashanti" meaning that is it exposed to the investors and travelers who use the road. It provides food for natives of the village and even outsiders. Nkyesa produces wide variety of crops and vegetables which most travelers buy as they use the Accra-Kumasi road and in turn adds up to the nations' revenue.

4.1.5 CLIMATE

Nkyesa in the Ashanti Akim South district in then Ashanti region has temperature in conformity with the amount of rainfall and by so doing supports Agriculture making food available throughout the year.it has a maximum temperature of about 30ºC and 26ºC minimum temperature. It used to experience 1500mm-1700mm of mean annual rainfall but currently has a mean annual rainfall reduced to 1020mm-1132mm. this pattern favour crops like citrus, cocoa, Oil Palm, Cassava, Plantain.

4.2 NATURE AND CHARACTERISTICS OF PROBLEM

Nkyesa in the Ashanti Akim south district in the Ashanti region is not quite a well-known village in the district but has been struck with issues of contamination of their wells and natural water source which is the Pra River. This river is contaminated by activities of illegal miners, pesticides in farming, chemicals in fishing.

Previously, river Pra used to be their main water source, nevertheless they still use its water as supplement to boreholes put up by the government through the District chief executive(DCE).

Figure6: River Pra with its Colour changed due to illegal mining.

Figure7: Wells.

Throwing more light on that, Mr. George Addo, assemblyman for Osaabo electoral area told the Ashanti Regional Minister, hon. Sampson Kwaku Boafo on his visit to affected communities along the Pra River in the Ashanti Akim South district that because of the water borne diseases in communities whose only source was the Pra River, teachers refused postings to those affected areas.

The affected areas are Osaabo, Okoree-krom, Yaw Addokrom, Tetteh Yawkrom, Oko Yawkrom, Nyakoma, ***Nkyesa.*** Mr. Addo appealed to the government to extend its helping hand to put up Pipe-borne water in the village.

4.3 DESCRIPTION OF CHEMICAL ENGINEERING ASPECT OF THE PROBLEM

Essumang et al.,2009 did work on pesticide residues in water and fish and observed that most Lagoons and River bodies in Ghana have abnormal concentrations of some Organochlorines and Organophosphorus'. These chemicals are normally what termed as pesticides because their vast effects on insects, rodents, ticks and to higher extent humans.

"The presence of pesticides in water (particularly bio-refractory organics that is aromatic chlorinated hydrocarbons) impacts objectionable and Offensive taste, odour and colours to fish and aquatic plants even when they are present in low concentrations. (Essumang et al.,2009).

These pesticides include;

(a) Organochlorines

I. Propiconazol
II. 2,4-Dichlorodiphenyldichloroethylene(2,4'-DDE)
III. 4,4'-dicholorodiphenyltrichloroethane(4,4-DDT)
IV. p,p'-dichlorodiphenyltrichloroethane(p,p'-DDT)

These organochlorines accumulate and turn toxic in the body tissues since they are resistant to microbial degradation, therefore the organochlorines are the most dangerous to work with.

(b) Organophosphorus

I. Chlorpyrifos
II. Dichloros(a) (I')

III. Fenitrothion(i)
IV. Diazinon(a) (i)

These organophosphorus do not accumulate in tissues since they are readily deactivated and degraded by microorganisms. In conclusion, organophosphorus pesticides be preferred over organochlorous pesticides, since they are less harmful.

By far, consumption of fish and other nutrition from rivers pose great threat of health risk to animals and humans who rely on the water. Hence there is a need for education to preserve water bodies.

(c) Carbamates

Carbamates are derivatives of Carbamic acid(H_2NCOOH), they are formed when an alkyl group replaces one of the hydrogen bonded to the nitrogen. Just like organophosphates, carbamates have shorter lifespan in the environment.

Carbamates react with water and form simple, nontoxic products and are preferred to Organochlorines (Asiedu,2013)

(d) Synthetic Pyrethroids

These are manmade pesticides which have their structure built up like that of natural pyrethrins in chrysanthemums. They are commonly used in society due to it less toxicity to the environment. Pyrethroids are stable to sunlight and very effective if even used in small concentrations to fight pesticides.

4.4 SOLVING BASED ON POSSIBLE SOLUTIONS

Most of the pesticides used in the village have been banned, examples are DDT, Aldrin, Dieldrin, Heptachlor, lindane (Gamma HCH), Thiodane (Endosulfan).

The problem can be addressed in a lot of ways, we first address the manufacturer, the transportation, storage, handling and method of application.

I Manufacturer

Before any pesticide is used, first it must be;

I. Recommended by the World Health Organization Pesticide Evaluation Scheme (WHOPES).

II. Approved to be less harmful to the human and ecological health impact.

III. Approved by Ghana standards board authority.

IV. Labelled with the method of application.

4.4.1 ANALYSIS FROM QUESTIONNAIRES AND GOOGLE FORMS

The figure below shows the distribution of available sources of drinking water in Nkyesa, out of the 13 people interviewed 2 people depended on the natural source,8 depended on naturals and wells, 2 were on boreholes and 1 person on boreholes and wells. Therefore, about 85% of the respondents depended on natural and wells making the greater percentage of the respondents more exposed to pesticides pollution of the river with about 15% on boreholes which were situated far from the river and farms.

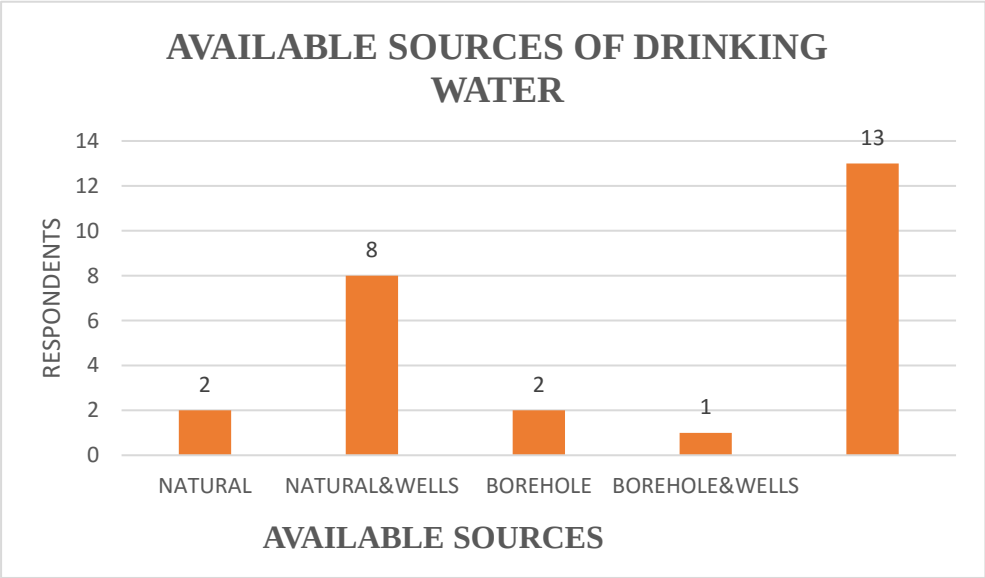

Figure 8: Available sources of drinking water in Nkyesa.

Water quality index provides the qualities that help to determine the purity of water. from the figure below 92% of respondents lamented on the fact that their source is not Pure with the remaining percentage (8%), content with the quality of water. This is shown below in figure .

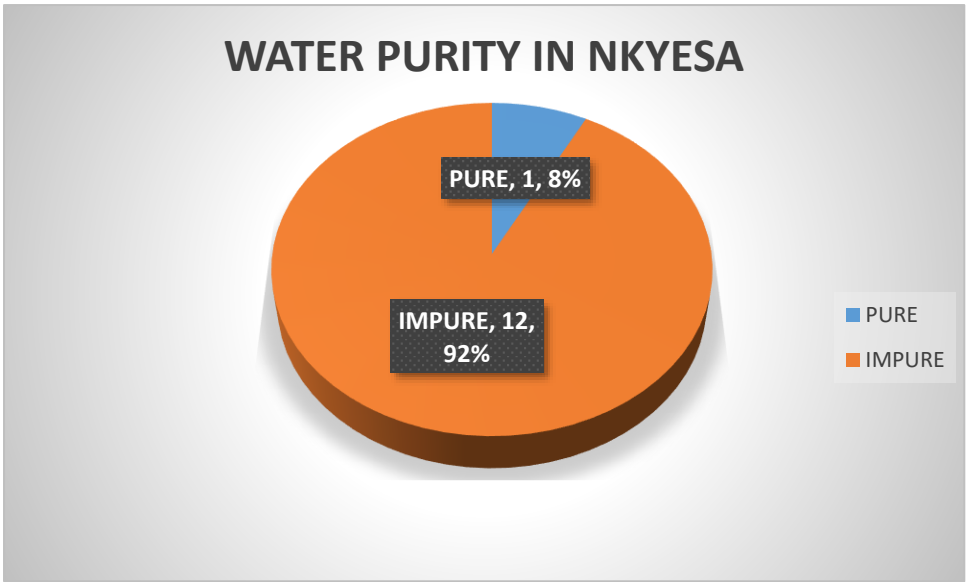

Figure 9: water purity distribution in Nkyesa

Table3: taste and smell of water sources in Nkyesa

SMELL	**NUMBER OF RESPONDENTS**
Foul smell	8
No smell	5

TASTE	NUMBER OF RESPONDENTS
Taste	9
No taste	4

Almost all water bodies in Nkyesa have taste and smell, this is confirmed by the greater number of respondents which are nine (9) and eight (8) respectively in both taste and smell. The greater number of respondents had no idea of the method to apply pesticides, banned pesticides whatsoever**.** Most of the farmers had skin irritations, and some to the extent of dying through the exposure to pesticides.

4.4.1.1 GENERAL PUBLIC

- Share some examples of pesticides you know? **Answers**:

No idea, Rodomil, Akate, sidalco, none, NPK

- What makes pesticides harmful? **Answers**:

It contains chemicals harmful to human health, when used in excess, Toxic chemical substances, the chemical content in the pesticide is poisonous, the chemicals used, the toxic active chemicals they possess, their dangerous chemical composition, the chemicals used in manufacturing it.

- What methods, do you think are best for application of pesticides? **Answers**:

1st respondent answered saying Spraying,2nd Spraying, no idea, using them as traps for rodents, Natural pesticides, spraying. Generally, all respondents have good sense on the pesticides usage which fell in line with the responses from the farmers.

- Do you agree to the fact that; sources of water should be far from farms? **Answers**:

thirty-three percent (33%) disagreed to the question, forty-four (44%) agreed and strongly agreed that sources of water be far from sources and remaining percentage (22%) had no response. Therefore, the conclusion is that there need to be more education to the general public, to enlighten the citizens on the use of pesticides and its impact on the environment, the right methods.

- Do you think that moving from pesticides usage to natural pest control methods will help in anyway? Please explain choice of answer? **Answers**:

1st resp: Yes.it will reduce pollution

2nd resp: No it won't help.
3rd resp: Using natural means won't have a positive effect on the crops. The pest will get used to the natural way and change it course. But the pesticides will eliminate them for a longer period
4th resp: The choice has to be subject to the environmental conditions. Plantations may not benefit fully from NPC. The choice of NPC has to be selected to fill the role of pesticides effectively. If this is achieved then yes, because a toxic element has been eliminated.
5th resp: Yes, because it is safe and less costly.
6th resp: Yes.
7th resp: Yes.
8th resp: Yes, it will since they do not contain processed chemicals.

- Name some diseases, you think come from pesticide use? **Answers:**

Food poisoning, Respiratory infection (can't specify the disease) and pollution of water bodies in a way to cause a disease I have no name for, Cancer of the throat, Severe stomach ache.

- Suggest how the diseases can be controlled? **Answers**:

Avoid use of harmful pesticides, there should be an alternative for the pesticides or the usage should be minimal, eating organic food, boiling water from streams near farms.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

"The importance of water in all facets of life cannot be over emphasized. It is vital for consumption and health. It is a fundamental resource for human development, especially residential area location. The development of any city has practically taken place near some source of water supply (Rangwala et al., 2007)

Some banned pesticides appear still to be used by Ghanaian farmers. Most farmers apply close to harvest, sometime go beyond the dose. Presence of pesticides in the water have rendered the resource useless in the village.

It was observed that the best solution to curb this issue in Nkyesa is natural pest control methods. Nevertheless, pesticides like Carbamates and organophosphates are preferred to organochlorines since Organophosphates and Carbamates have shorter lifespan in the environment, with Carbamates in particular less toxic and very effective.

5.2 CONCLUSION

Ghana is fairly endowed with water resource; it is not used to its full potential but rather depleted. A country that is endowed with such resource should experience continual flow of pure refined water for its citizens.

Before the water resources commission act in 1996, custody of water was to some families, stools and communities, aftermath the act, it still did not provide a judicial mechanism that settles disputes between the customary rights and statutory rights(Sarpong,2003). Consumption of fish from these rivers is most likely to pose some health risk to animals and humans who might obtain nutrition from them.

Hence there is a need for rigorous education to preserve water bodies. The results have shown that inhabitants of Nkyesa are contaminated with many pesticides, the commonest is DDT, which is a banned pesticide. Avoiding pesticides pollution of underground water is very easy. There need to be public education on ways to reduce pesticide usage at recharge areas of underground water, inhabitants of Nkyesa must reside to Natural pest control methods. There are issues that Government officials and policy makers have to deal with in the years to come on water and sustainable development.

5.3 RECOMMENDATION

- Analysis of individual boreholes to determine any localized area of poor quality water.
- Farmer education on safe pesticides used to reduce
- Siting hand-dug wells for at least 100ft(30m) away from agricultural field (Harris, Hoffman, &Mazae,1996; WHO,2004)
- Dealers who wish to engage in pesticides business (business, manufacture, distribute, sell, or use) must be formally licensed by the EPA in accordance with the WRC Act.
- Appointment of pesticides officers to inspect any land, or reported to be exposed to pesticides.
- The CEPS Ghana must prevent importation into Ghana of any pesticide, where the importation is contrary to this Act.
- Finally, product may be labelled in the local Languages and English to avoid misuse and overuse.

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APPENDIX(ES)

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF ENGINEERING
DATA GATHERING INSTRUMENT
TOPIC:
UNDERGROUND WATER POLLUTION BY PESTICIDES IN NKYESA

Dear sir/madam,

This study is an academic exercise which is part of the requirements of engineering in society course. This study aims at exploring the pollution of underground water by pesticides. I will be very grateful if you can share your thoughts on the subject by responding to the questions.

1. Gender 1-Male
   2-female

2. Occupation…….....

3. Which of the following sources of water drinking water are available in the village?
   1-borehole
   2-natural
   3-wells

4. What is your main source of water? Single response

   1-borehole 2-natural 3-well

5. How long does it take to fetch water and return home?
   ……
   ……
   ……

6. Is your water source as pure as you want it?
   1-yes
   2-No

7. Generally, how does your water smell?
   1-no smell
   2- foul smell

8. Generally, does the water have taste?
   1-yes

2-no(tasteless)

If yes, specify the taste (how does it taste)

……
……
…….....

9. What is the distance between any nearby farm and source of water?

……
……
……

10. Are you struck by pests on your crops?
    1-yes
    2-No

11. How do you fight the pests?

……
……
……

12. Do you personally apply pesticides on your crops?
    1-yes
    2-No

13. How often, do you use the pesticides?

……
……
……

14. Can you give us the name(s) of your pesticides?

……
……
……

15. Have you by any means thought that the application of pesticides has negative effects on your health and source of water?

……
……
……

16. If the extension officers come to caution you to stop using pesticides, would you?
    1-yes
    2-No

17. What methods do you use to apply pesticides?

……..……
……...……
…….

18. Name any outbreak of diseases, you think come from the use of pesticides?

……
……
……

19. Suggest how the diseases and the water source can be corrected?

……
……
……

20. Any additional information?

……
……
……

GALLERY


TOPUM
BENCO


Actara


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Garden Insecticide


ATRAZINE