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# The Toxicity of Synthetic Pesticides in the Niger Delta Region: A Review

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### Abstract

The Niger Delta region of Nigeria with a vast and resourceful ecosystem which has welcomed diverse agricultural practices and crude oil exploration. On the other hand, being a wetland it has also become a breeding ground for major pests of agricultural and public health interest. One major problem is the proliferation of mosquitoes which have obliged the intense usage of pesticides. Typically, pesticides are agents meant to control targeted organisms (pests) that have caused adverse effects to man and his environment. Due to the excessive and inappropriate usage of pesticide they drift and get linked to contaminable environmental media such as water, air and soil. Human exposure can occur from inhaled spray drift, accidental ingestion, runoffs and in a broad sense through food chains. Pesticides find their way into different ecosystems causing adverse effects to non-target organisms, most of these non-target organism lacks metabolites to degrade these toxic pesticides residue in their cells and tissues; hence accumulate them and transfer them to other organisms via food chain which could cause acute and chronic effect. In addition, industrial and municipal effluents have a more toxic synergistic effect with pesticides. Toxic effects of pesticides can be controlled by; adhering to safety instructions from manufacturers of pesticides, thorough washing of agricultural produce, use of gloves and mask by the applicant and other safety measures. In addition, toxicological research and advocacy should be more active in the Niger Delta Region as well as proper and active regulation of pesticides usage to comply with minimal residual limits of pesticides and anthropogenic agents.

## 1. Introduction

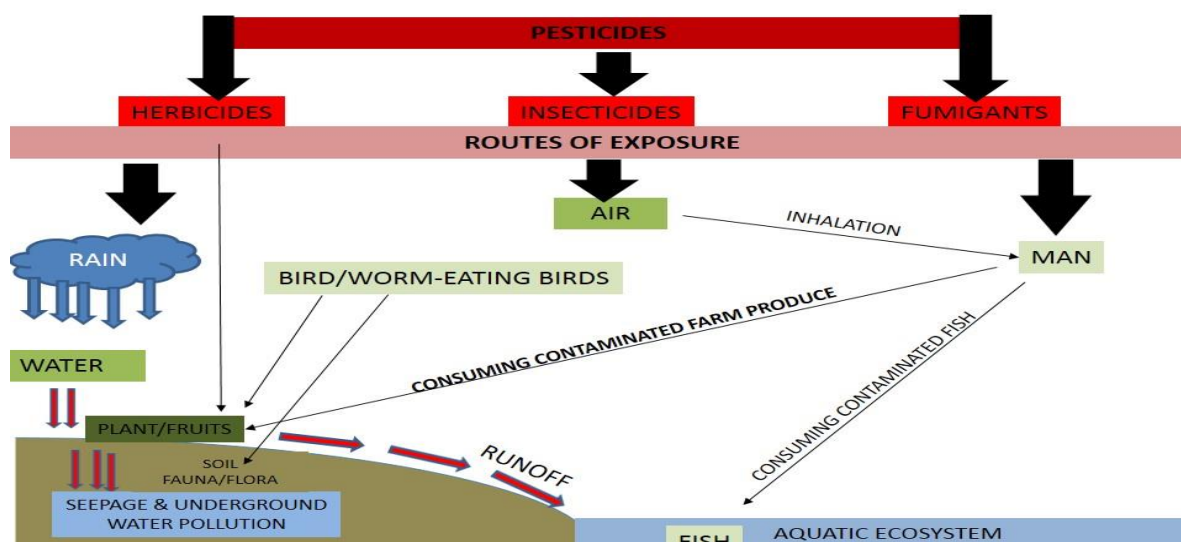
The Niger Delta Region of Nigeria is a triangular Delta which is basically made up of three States, having Bayelsa State as central, with Rivers State to the East and Delta State to the West. This Region is characterized by abundant rainfall, abrupt flooding and more wetland as opposed to dryland having flood plains of over 70,000 sq km (Ohimain, 2004). Consequent upon this fact, its populace has embraced diverse agricultural practices that oblige use of pesticides. In addition, the waterlogged nature of the terrain has obliged breeding ground for many pests of which mosquitoes ranked highest.

Pests are organisms that cause damage or adverse effects to other organisms, insect pests are the most frequent pest because they make up three-quarter of all species on the earth (Jankielsohn, 2018). Pest is opportunistic in nature; they tend to reproduce and migrate quickly into their target areas. They are capable of taking an entire biotic community due to their rapid succession and adaptive features, thus causing adverse effects. It was in order to mitigate the menace the pest poses in the environment that pesticides were fabricated.

Pesticides are substances that are manufactured for the direct or indirect control, prevention, mitigation, attraction, repellence or elimination of any pest or even the alteration of the growth, development or characteristics thereof (Asogwa and Dongo 2009; Ojo 2016). The name "pesticides" was believed to be derived from the French word "peste" and Latin word "caedere"

which means pest or plague and kill respectively (Akunyili and Ivbijaro, 2006). Thus, pesticides are vitally important to increasing or protecting the quality and quantity of food, commodities, building materials, clothing and ornaments in improving animal health and in combating diseases transmitted to man. Asogwa and Dongo (2009) reported that in Nigeria, an estimated 125,000 - 130,000 metric tons of pesticides are applied every year.

On the contrary, pesticides contain a wide variety of harmful chemicals that can find their way into the natural environment (Figure 1), where they can cause a great deal of harm, particularly to aquatic ecosystems (De Lorenzo *et al.*, 2001; Ohimain *et al.*, 2013). Pesticides are counterproductive when its use is abused as it poses a threat to human reproductive health, especially children (OCFP, 2012). In addition, there is a linkage between pesticide exposure and birth weight, this association depends on the type of pesticide, with some having lesser, chronic or acute effects (OCFP, 2012). For instance, atrazine has the ability to disrupt the endocrine system, and poses adverse effects at a very minimal concentration (Vandenberg, 2012). The exposure to pesticides, especially organophosphate or carbamate insecticides may oblige respiratory symptoms and different forms of obstructive and restrictive lung diseases (OCFP, 2012).



**Figure 1** Chart showing different routes of pesticide exposures

The adverse effects of pesticides in the environment cannot be overemphasized as it enters the major routes of exposure like water, air and soil. Exposure occurs directly or indirectly through ingestion, inhalation of spray mist, surface runoffs and through energy exchange in the food chain (Figure 1). These adverse effects might be chronic or acute to the affected organism or entire ecosystem. Depending on the concentration, level of exposure, persistence, age and species affected, these toxic pesticides can bio-accumulate, biomagnify and even become carcinogenic in some cases. This review has become necessary to educate farmers and the entire populace on the use of pesticides as it concerns the health of Niger Delta ecosystem.

## 2. Review of Literature

### 2.1 Categories of pesticides

According to **Akashe et al. (2018)**, Pesticides can be classified based on several criteria they include the targeted pest, toxicity, chemical composure, mode of action, mode of entry, how or when they work, type of formulations and sources of origination.

#### 2.1.1 Organophosphate Pesticides

These are pesticides that affect the nervous system by disrupting the acetylcholine enzyme which is a neurotransmitter. Most organophosphates are insecticides that are highly toxic to insects like bees, wildlife animals and even humans (**United State Environmental Protection Agency, 2012**). In the year 2001 environmental protection agency place Restrictions were placed on the uses of organosulphate to minimize exposures to farmers. It was rated as the most hazardous pesticides inducing chronic symptoms like, aphasia, headache, reduced memory retention, insomnia, anorexia, anoxia depression. Examples of organophosphate pesticides are chlorpyrifos, dieldrin, heptachlor amongst others.

#### 2.1.2 Carbamate Pesticides

These pesticides are disruptors of the nervous system; they affect the enzyme that regulates the neurotransmitter called acetylcholine. The effects of this enzyme are usually reversible. There are several subgroups within the carbamates.

#### 2.1.3 Organochlorine Insecticides

These were one of the first generation of pesticides which were very common, but many of them obsolete due to their relative wide range of toxicity to other non-targeted species, as well as their direct adverse health effects and environmental persistency (e.g., DDT and chlordane).

#### 2.1.4 Parathyroid Pesticides

These categories of pesticides were developed as a synthetic variety of the naturally occurring pesticide pyrethrin, which is derived from chrysanthemums, and a very good example is Lambda-cyhalothrin (**He et al., 2008**). These pesticides have been reformed in order to improve their adaptability to the environment. Most pyrethroid pesticides are lethal to the nervous system and can cause paralysis (**Bradbury and Coats 1989; Shafer and Meyer 2004**). Pyrethroids are multipurpose pesticides and can be used for the control of insect pests in agriculture pests, domestic pests and even pests of public health significance (**He et al., 2008**).

#### 2.1.5 Biopesticides

Biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered biopesticides. In a broad sense, microbial pesticides does not pose significant environmental threat, it was evaluated in literature about a decade ago that there were about 195 bioactive biopesticides ingredients and 780 products in available in the market as well (**United State Environmental Protection Agency, 2012**). Examples of biopesticides includes; microbial pesticides, biochemical pesticides, Plant-Incorporated-Protectants (PIPs) amongst others.

## 3. Critical Review

In Nigeria, there has been a steady rise in the use of pesticides over the past decades since its inception when used to control cocoa pests (**Asogwa and Dongo, 2009**). Pest control in the Niger Delta Region has become a mainstay as there are varieties of pest in the Region, especially insect pests, of which mosquitoes that carry the plasmodium parasites ranks the highest. In addition, the waterlogged nature of the terrain and

abundant rainfall has provided a good breeding ground for mosquitoes amongst other pests which have continuously obliged the use of pesticides. While in developing countries, about 3million farmers experience pesticide toxicity of which about 18,000 die (Miller, 2004). The threat pesticides pose to various ecosystems in the Region cannot be overemphasized. For instance, these pesticides abruptly alter the optimal physicochemical condition of their natural habitat (Radhaiah, 1987). These changes might oblige rapid migration or death of keystone species which may have adverse effects on the food chain (Figure 1).

Pesticides, thought meant for the targeted organisms (pest), may occasionally drift to non-targeted organisms or an entire ecosystem where they bioaccumulate prior to their biomagnification along different trophic levels (Figure 1). This happens as a result of improper application of the pesticides or refusal of the applicant to adhere to the manufacturer's instruction as well as some safety procedures. Pesticides become exposed through media subject to pollution such as water, air and soil.

Most of these pesticides hardly degrade and are transported via this medium directly or indirectly especially through the food chain, to suffice this as well, it is consequent to the fact that most organisms lack metabolites to degrade the pesticides in their tissues. As documented in literature, detectable concentrations of pesticides were found in urine and blood stream of samples of some farmers exposed to pesticides (Gilden *et al.*, 2010; Huen *et al.*, 2012). The toxicity of these pesticides has the ability to dislodge various ecosystems in a very significant manner. For instance, Khan and Law (2005) reported that the persistent nature of some pesticides in the environment bioaccumulates in tissues of organisms with a rise in concentration as it moves along the food web.

Furthermore, pesticides have the ability to disrupt the enzymes and hormones of terrestrial and aquatic organisms especially fish, and amphibians, it remains one of the key suspect causes of species depletion worldwide as studies revealed that about 46% amongst species of fish are threatened (Khan and Law, 2005). Once the fish is exposed to intolerant doses of the pesticides they exhibit behavioral and clinical symptoms affecting the kidney, brain, lungs and gills, especially their endocrine system (Kim 1998; Khan and Law, 2005). In terrestrial ecosystems the soil fauna and flora are also dislodge by high doses of pesticides (Roger *et al.*, 1994), and in some cases persistent pesticides may lead to underground water pollution (Srivastava *et al.*, 2018).

There are diverse species of amphibians in the Niger Delta region of Nigeria that play keystone roles in the ecosystem, which are exposed to drifted pesticides carried along the coast of the region. Amphibians are highly susceptible to pesticides due to their semipermeable skin coupled with the fact their breeding ecosystem (water) is amongst basic mediums subject to pesticide pollution (Bishop, 1992). Pesticides can affect the reproductive effort of amphibians as well as the growth rate of its juvenile, thereby reducing their population (Carey and Bryant, 1995); and may also cause hind limb deformity in several amphibians as studies had revealed such around agricultural areas (Ouellet *et al.*, 1997). It was reported that about 32% of amphibians are threatened due to the usage and release of anthropogenic substances of which includes pesticides (Khan and Law 2005).

The major exposure route of humans to pesticides in the Region has been obliged in the course of controlling mosquito pests in the waterlogged terrain. In addition, malaria happens to be the most prevalent tropical and sub-tropical parasitic disease affecting the world population, with schistosomiasis ranking second (WHO, 2002; WHO, 2010). Chronic and acute doses of pesticides are encountered as the applicant of the pesticides. It

has been reported in Bayelsa State Nigeria, which happens to be one of the Niger Delta States, that pesticides carried by runoff have been a threat to catfish farming, especially in earthen ponds (Ohimain *et al.*, 2013).

Furthermore, excessive oil exploration activities in the Niger Delta Region have obliged emissions of hydrocarbon effluents which have impaired the health of various ecosystems. On a more serious note, these pesticides may pose a more adverse synergistic effect with hydrocarbons. For instance, the synergistic toxicity of pesticide and Methyl-tert-butyl ether (MTBE) was investigated against *Vibrio fischeri*, with adverse effects within 5 minutes compared to 30 minutes when only pesticide was used (Hernando *et al.*, 2003). Pesticide can contaminate underground water (Srivastava *et al.*, 2018); as well as hydrocarbons (Werner *et al.*, 2001).

It is documented by the World Health Organization that at least 4 million persons are exposed to pesticide annually out of which at least 1 million are hospitalized and can result in about over 300,000 fatalities (Raven *et al.*, 2011). The established routes of exposure of pesticides to humans are through the skin, eyes, mouth and via inhalation, with higher cases of exposure in farmers from developing nations (Roger *et al.*, 1994; Ojo, 2016; Srivastava *et al.*, 2018). Toxic synthetic pesticides that affect non-targeted and beneficial species include organochlorine pesticide like DDT, organo-phosphates pesticide like parathion, as well as pyrethroids, and cabamate (Miller and Spoolman, 2016). Pesticides affect the skin as well as vital organs and systems in humans like; the nervous system, respiratory system, reproductive system, gastrointestinal tract etc. Chronic effects in pesticides have been reported as carcinogen, teratogen, mutagen and endocrine disruptors. Acute cases of human exposure to pesticides includes insomnia, anorexia, sweating, dizziness, nervousness, irritation of the vital organ, dizziness, headache, diarrhea, fatigue, restlessness, nausea, vomiting, lacrimation, excessive salivation, respiratory depression, seizures, loss of consciousness, reduced visual ability, allergy, abdominal cramps, and rapid pulse or even death (Hashimi *et al.*, 2020).

The use of pesticides in the Niger Delta Region is inevitable, nevertheless it must be utilized in such a way that all exposure routes to non-targeted organisms must be minimized to a tolerable limit. Media subject to pollution such as air, soil and water must be watched with keen interest and the applicant of the pesticides must adhere to the instructions of the manufacturer and use safety gadgets such as gasmask, gloves and wash hands thoroughly to avoid direct exposure. In addition, regulatory agencies in the Niger Delta must be active to monitor the residual and exposure limits of pesticides in the environment.

## 5. Conclusion

The Niger Delta is a wetland and the waterlogged nature of the terrain has obliged the breeding of mosquito pests and the consistent use of pesticides as well as the introduction of anthropogenic agents from municipal and industrial sources. These agents combine with pesticides in the ecosystem to abruptly increase their toxicity in a synergic reaction. Consequent upon this the ambient quality of the ecosystem becomes significantly impaired as a result of direct or indirect exposure; measures must be put in place through active research and advocacy in the region to reduce the toxic effect of pesticides as well as check the municipal and industrial release of toxic effluents in the region. In addition, those applying pesticides must adhere to safety measures by using the appropriate protective devices and adhere to manufacturers guide.

## Conflict of Interest

The authors report no conflicts of interest. The authors are responsible for the content of the paper.

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