



The effect of industrial chemicals on biodiversity and human health: A case study of DDT in Kanungu district, Uganda

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By

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Uganda's background information

- **Total area:** 241,500km². Out of this, 15.3% is open water, 3.0% permanent wetlands and 9.4% seasonal wetlands.
- **Location:** Astride the Equator in the Eastern Region of Africa.
- **Climate:** Tropical Climate. The country experiences only two dry seasons (December-February and June-August).
- **Neighbouring countries:** Kenya (East), Tanzania and Rwanda (South), Democratic Republic of Congo (West) and Sudan (North).
- **Form of Government:** Republic and got her independence on 9th October 1962. It is governed under a multi-party system with NRM as a ruling party.
- **Languages:** English is the official language. Kiswahili is spoken by few people. Local languages include;- Luganda, Runyankole, Rukiga, Rutooro, Lusoga, Luo and others.
- **Ethnic Groups:** Bagada, Karamajomgo, Basoga, Iteso, Langi, Banyankole, Bakiga, Banyoro, Batoro, Bagisu, Acholi, Lugubara, Non-Africans (Europeans, Asians, Indians, Arabs) and others.
- **Religion:** Uganda is a Christian country. (Roman Catholics, Protestants, Muslims and Indigenous beliefs.

Background information cont...

- **Economy:** GDP growth rate is estimated at 5.7% per annum. Agriculture occupies 82% but the industry sector is growing at the highest rate.
- **Population:** Currently, Uganda's population is estimated at 27 Million people with the growth rate at 3.4%. Of the total population, 85% live in rural areas. Urbanization is estimated at 14.4%. Life expectancy is estimated at 50-78 years for men and 52-73 years for women. Fertility rate is estimated at 6.9%. Adult literacy rates are estimated at 45% among women and 70% among men. Population below poverty line is estimated at 13.58 Million people. The population is projected to be 36.4 Million in the year 2018. About 47% of the total population is still under the age of 15 years and there are more women than men.
- **Urban and rural Population:** settlement patterns and distribution in both urban and rural areas are normally influenced by;- history, infrastructure, landforms, productivity of the land, climate, vegetation, water supply, presence of disease agents, land tenure systems and economic activities among others. 85% live in rural areas while 15% in urban areas. Kampala is the most urbanized district because of its status as a capital city.

An overview of chemical production, use and management in Uganda

- Chemicals in Uganda are mostly used in the agriculture sector, health sector, energy and mining sector, water supply and sanitation sector, academic and research sectors and most importantly, the industry sector. Data and information on chemical production, import, export and use in Uganda is not comprehensive and is lacking in a number of aspects.
- Chemicals in Uganda have been seen in the form of petrochemicals, fertilisers, pesticides, industrial chemicals, synthetic organic cosmetics, pharmaceuticals, solvents, and natural-synthetic (rubber etc) among others.
- Overtime in Uganda, an extensive array of chemical substances, which never existed in the environment, and for which the environment can not provide natural conditions to cause their degradation or break down, now predominates in the name of development.

Uganda and Industrial chemicals

- Industrial chemicals have become common in many economical activities and are increasingly used in almost all the sectors of Ugandan societies.
- The production of chemicals in Uganda is still minimal, and account for less than 2% of the total amount available within the country.
- Most chemicals used in Uganda are imported. The major suppliers of chemicals to Uganda include Israel, Kenya, China, South Africa, India and Arab-Gulf Countries among others.
- Distribution of industries in all parts of the country is being encouraged by the government.
- Uganda does not export chemicals but it is only used as a transit country to transport large quantities of chemicals through to neighbouring countries such as Sudan, Congo and Rwanda. However, there is also a likelihood that re-exporting some chemicals illegally.

Uganda and Pesticides

- Pesticides are chemicals used for destruction of an organism that is detrimental to man or any of his interest.
- Most of the pesticides used in Uganda have been classified as; - insecticides that kill insects, acaricides that kill mites, molluscides that kill snails (molluscs), nematicides that kill nematodes (round worms), fungicides that kill fungi, rodenticides that kill rats (rodents), herbicides that kill herbaceous plants (weeds, and arboricides that kill shrubs and trees.
- The common pesticides that have been used in Uganda include;- organophosphates (Bromophos, DDVP (*Dichloro dimethyl vinyl phosphate*), Diazinon, Dursban, Dimethoate, Malathion, Parathion), organochlorines (Aldrin, BHC, DDT, Dieldrin, Lindane, Thiodan, Toxaphene), Carbamates (Dithane M45, Dithane M22, Furadan), Pyrethrins/pyrethroids (Ambush CY (*Permethrin*), Ripcord (*Cypermethrin*), Decamethrin), Phenoxy Acetic Acid (2-4-D, (*Dichlorophenoxy acetic acid*), 2-4-5-T, (*Trichlorophenoxy acetic acid*), MCPA (*Monochlorophenoxy acetic acid*), Inorganic Metals (Shell copper (*copper oxide*), Lead arsenate Arsenic trioxide, Phenylmercuric Acetate) and Bipyritydyls (Grammoxone (*Paraquat*), Weedol, Diquat).

Some of the institutions and agencies managing chemicals in Uganda

- Ministry of Agriculture, Animal and Fisheries.
- Ministry of Tourism, Trade and Industry
- Agrochemicals Control Board (ACCB)
- National agricultural Research Institute (NARO)
- Ministry of Health (MOH)
- The National Drug Authority (NDA)
- The National Medical Stores (NMS)
- Uganda Virus research Institute (UVRI)
- Ministry of Water and Environment
- The National Environment Management Authority (NEMA)
- Ministry of Internal Affairs
- Ministry of Energy and Mineral Resources
- Non- Governmental Environmental Organizations (NGOs)
- Others e.g. Ministry of Works, Transport and Communication e.t.c

Some of the laws governing the management of chemicals in Uganda

- **Laws/Legislations:** The 1995 Ugandan Constitution, the National Environment Act Cap 153, the Public Health Act 269, the Control of Agricultural Chemicals, Statute 8/1989, the National Drug Statute 1993, the National Environment Statute 1995, the Uganda National Bureau of Standards Act, the Plant Protection Act. Cap. 244 of 1964, the Protection of Animals (anaesthetics) Acts 1954/64, the National Medical Stores Act 2000, the Factories Act 2000, the Employment Decree of 1975 and the East African Community Customs Management Act 2004 among others.
- **Regulations:** The Chemicals Regulations (Registration and Control) 1998, the Guidelines for Inspection issued by; Agrochemicals Board, Uganda National Bureau of Standards (UNBS) and the National Drug Authority (NDA), the Modalities for safe disposal of chemicals Regulations, the National Environment (Waste Management) Regulations 1999, the Environment Impact Assessment Regulations 1998, the National Environment Standards for the discharge of Effluents onto Land or Water Regulations 1999, the Regulations on Ozone Depleting Substances, the National Environment (Minimum Standards for the Management of Soil Quality) 2001, the National Environment (Waste Management) Regulations 2001, the National Environment (Conduct and Certification of Environmental Practitioners) Regulations 2003, the Guidelines for solid waste management in Uganda 2004 and the Environmental Audit Guidelines for Uganda 2006 among others.

Uganda and International chemical Conventions/Agreements

- Uganda is a signatory to several international Conventions and Agreements related to the management of chemicals. These include the following among others; -
 - (I) The Stockholm Convention on Persistent Organic Pollutants (POPs),
 - (ii) The Vienna Convention on the Protection of the Ozone Layer,
 - (iii) The Montreal Protocol on substances that deplete the Ozone Layer,
 - (iv) The Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction.
- The Kyoto Protocol e.t.c.
- However, the National implementation of the Principles of the Agreements can not be said to be excellent.

DDT as a pesticide

- Dichlorodiphenyltrichloroethane (DDT) is an organochlorine insecticide. It is a highly hydrophobic colourless crystalline solid substance (in its pure form) with a weak chemical odour and tasteless. It has good solubility in most organic solvents and animal fats, such as Benzene, chloroform, petroleum solvents, ethanol but it is practically insoluble in water.
- DDT was first synthesized, for no purpose, in 1874 by a German chemist Othmar Zeidler. It remained in the shelves of the laboratory until over 60 years later (in 1939) when Dr. Paul Herman Muller discovered its chemical insecticidal potential. Muller found that DDT quickly killed flies, aphids, mosquitoes, walking sticks and Colorado potato beetles. Muller and the Geigy Corporation patented DDT in Switzerland (1940), England (1942) and U.S. (1943). Peak usage of DDT in the world occurred in 1962, when 80 million kilograms of DDT were used and 82 million kilograms produced.
- The first large-scale use of DDT occurred in 1943 when 500 gallons of DDT were produced by Merck & Company and delivered to Italy to help squelch a rapidly spreading epidemic of louse-borne typhus.

When and where was DDT used in Uganda?

- In 1959-1960, DDT indoor residual spraying (IRS) was applied at 2g/m² in homesteads and kraals in Kihihi sub county of Kanungu District just adjacent to Queen Elizabeth National Park as recommended by the World Health Organization (WHO).

Why was DDT used in Uganda?

- In May 1955, the Eighth World Health Assembly adopted a Global Malaria Eradication Campaign based on the widespread use of DDT against mosquitoes and anti-malarial drugs to treat malaria and to eliminate the parasite in humans. . DDT was thus used in Uganda to kill mosquitoes. However, it is alleged that DDT was also used in the agricultural sector.

Why was there a study on DDT?

- People especially the environmentalists raised eyebrows on the likely negative impact of the chemical to human health and the environment generally.
- Because of the resurgence of the malaria epidemic in Uganda. Malaria in Uganda has had a negative impact on human social welfare and economic development.
- In 2006, the World Health Organization (WHO) gave a clean bill for indoor residual spraying of DDT in the fight against malaria. On hearing that, Uganda was one of the first countries to relax their bans on DDT use for indoor residual spraying (IRS) in malaria control.
- However, the permission triggered a hot debate the country over whereby two groups emerged with one supporting the move by WHO whereas the other group vehemently opposing the idea on the grounds that DDT is dangerous to human health and the environment.
- The study of DDT was therefore aimed at resolving the controversy by probing the persistence of DDT in the environment and looking for markers of diseases allegedly associated with DDT.

What were the objectives of this study?

The major aim of the study was to find out whether DDT negatively affects human health and environment. This was however guided by the following specific objectives;-

- To prove whether DDT persists in the environment
- To examine and establish the bio-chemical markers of diseases associated with DDT.
- To quantify the residues of DDT in human body fluids and environmental specimens.

When was the study conducted?

- The debate to re-introduce DDT for Malaria control in Uganda intensified in 2004. However, this study was conducted between 2005- 2006.

Where was the study conducted?

- The study was conducted in Kihhi Sub County (Kanungu district) and Nyarusiza sub county (Kisoro district) in the extreme end of South Western Uganda approximately 510 km from Kampala city. The study was conducted in an area (Kihhi) where DDT was sprayed and in another area (Nyarusiza) where DDT was not sprayed.

How was the study designed?

- The study team consisted of 9 people. The study was designed by five lead researchers with one among them acting as a core researcher.
- There were also 4 assistant researchers who purposively collected the samples from the two study areas.
- Two Assistant researchers (one from MUK and one from PROBICOU) collected samples (plasma, urine, beans, bananas and soil) from Kihihi sub county while the other two also collected samples (plasma, urine, beans, bananas and soil) from Nyarusiza sub county.
- Besides collecting these types of samples, fish samples were also collected. Five fish species were collected and these were only collected from Kihihi sub county.
- The study also involved reviewing the literature of the related studies.
- After collecting the samples, they were handed over to the lead researchers for verification, testing, analysis, comparison and interpretation.

How many people were involved in the study?

- The number of people differed depending on the sample to be tested. For example, on plasma samples, 150 people were randomly selected from Kihihi while 169 were selected from Nyarusiza. On urine samples, 45 people were selected from Kihihi while 44 people were selected from Nyarusiza.
- The study also established and probed the fecundity of men from the two study areas. On this, 42 men were used by purposively selecting 21 men from each of the two study areas.

What were the results of the study?

Interpretation of Results by tables

Table 1: DDT/DDE levels in Samples from Kihihi and Nyarusiza

| Area | Kihihi | | <i>Nyarusiza</i> | |
|----------------|-----------|-------------|------------------|--------------------|
| | n | DDT/DDE ppb | n | <i>DDT/DDE ppb</i> |
| Plasma | 150 | 52.4 | 169 | 9.7 |
| Urine | 45 | 11.7 | 44 | 6.9 |
| Beans | 22 | 11.1 | 15 | 7.3 |
| Soil | 34 | 7.3 | 35 | 1.1 |
| <i>Bananas</i> | <i>15</i> | <i>0</i> | <i>13</i> | <i>0</i> |

Table 2: Fecundity of sampled men from (A) Kihihi (21) and (B) Nyarusiza (21)

| Sample | A | B |
|-------------------------------|-----|-----|
| Mean number of wives | 1.3 | 1.2 |
| Mean number of children | 9 | 8 |
| Mean number of grand children | 14 | 9 |

Table 3: DDT/DDE in Kihihi Fish Samples

| Type of fish | DDT/DDE ppb |
|-------------------------|-------------|
| Clarius (Male) | 0.00 |
| Tilapia (Ngege) | 0.12 |
| Harprochomis (Njunguli) | 3.94 |
| Protopterus (Mamba) | 4.92 |
| Bagrus (Semutundu) | 22.98 |

**Table 4: DDT/DDE in food stuffs in Toronto,
Canada (1996)**

| Food code | Name of food | DDT/DDE ppb |
|-----------|--------------------------|-------------|
| G16 | Raw potatoes | 0.49 |
| G18 | Boiled unpeeled potatoes | 0.54 |
| G08 | Celery | 0.64 |
| G04 | Broccoli | 2.30 |

Table 5: Maximum DDT found in Meat fat around the World

| Country | Year | DDT ppb |
|---------------------|------|---------|
| Egypt | 1989 | 4100 |
| China | 1990 | 4100 |
| Former Soviet Union | 1991 | 2000 |
| India | 1993 | 7000 |
| Spain | 1994 | 9100 |

Discussion of results

- The study results confirm persistence of DDT in man and his environment in Kihihi and Nyarusiza in small harmless quantities (table 1, 3, 4, and 5).
- Clinical and laboratory examinations yielded no cancer, no neurological defects, no hormonal imbalances or abnormal levels of disease biochemical-markers (table 1)
- Harmless traces of DDT in ppb were found: 50 in blood, 12 in urine and 7 in soil (table 1)
- DDT persists in the different fish species but that, it does not harm them (table 3).
- DDT resulting from IRS does not cause cancer, teratogenicity, mutagenicity, neurological defects or infertility in man (table 2).
- Despite DDT residues in environment, its associated bad effects on food, flora and fauna were not reported or detected (table 4).
- DDT is found in trace levels almost all over the world (table 5).
- Queen Elizabeth National Park which drains Kihihi boasts of 100 mammal species, a remarkable 606 bird species and claims the highest biodiversity rating of any game reserve in the world.
- In comparison to their findings, DDT in blood drawn from European Ministers of Health and Environment were reported to the tune of 3300 ppb which is 66 fold of that found in Kihihi and Nyarusiza people.

Conclusion by lead and core researchers

- From the study, all the lead and core researchers concluded that DDT as used in IRS protocol is safe, inexpensive and effective against mosquitoes/malaria and should be used for malaria control in Uganda.

Emerging issues from the study results

However, the pronouncements of the study results culminated into some serious questions with some people questioning their authenticity and accuracy. The issues queried about the study results include;-

- That the researchers tested for the DDT/DDE using the same method and yet these are different.
- That the samples were collected from people who were not sick. It did not cover people who were in the hospitals and sick beds to see whether they had the alleged DDT diseases.

Emerging issues cont.....

- The study showed that some DDT traces were found in the plasma blood samples but that they were harmless. People criticizing the results argue that the study did not determine how harmless those traces were and to which degree.
- People are inquisitive to know how DDT which was sprayed in Kihihi went into Nyarusiza where it was not sprayed.
- The study did not investigate to know how many have died ever since the spray of DDT in Kihihi and to determine whether they died of DDT related sicknesses.
- The study did not explain why the DDT residues in some fish species were much higher than in other fish species. They also argue that the study did not establish whether the presence of DDT in the Kihihi fish has any effect on their population.
- The study population is queried to be small compared to the number of people in Kihihi and Nyarusiza. This therefore does not guarantee the researchers to conclude that DDT is harmless.
- That there are alternatives to DDT in the control of malaria and that therefore DDT should not be looked at as a safe blanket

Emerging issues cont.....

- That mosquitoes too have a right to co-exist with people.
- That, different studies have been carried out and the negative effects of DDT and both human health, biodiversity and the environment generally have been cited and observed.

Conclusion

- In my personal opinion, the study incorporates all the three aspects of population, health and environment. However, there are a lot of gaps in the study. It is therefore not right for one to conclude that DDT has no harm to human health and the environment. Some studies have also noted that DDT as a single tool can not eradicate malaria. An integrated approach therefore needs to be applied.
- Science is rapidly proving beyond any doubt that, if we are to preserve our own personal health, we must protect the natural systems that make all life on this planet possible... and that means, protecting the health of ecosystems and individual species around the globe.

Some of the References

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Thanks for listening to me

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