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Water Pollution Due to Agricultural Pesticides

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ABSTRACT

The term "pesticide" is a composite term that includes all chemicals that are used to kill or control pests. Pesticides are used to protect crops against insects, weeds, fungi, and other pests. They also play a significant role in food production. They protect or increase yields, and the number of times per year a crop can be grown on the same land. In agriculture, this includes herbicides (weeds), insecticides (insects), fungicides (fungi), nematocides (nematodes), and rodenticides (vertebrate poisons).

Pesticides are potentially toxic to humans and can have both acute and chronic health effects, depending on the quantity and the ways in which a person is exposed. Some of the older, cheaper pesticides can remain in the soil and water for years. They have been banned in developed countries for agricultural use but are still used in many developing countries. There are more than 1,000 pesticides used around the world to ensure food is not damaged or destroyed by pests. Each pesticide has different properties and toxicological effects (and the toxicological effects of multiple pesticides can be greater than the sum of their parts).

KEYWORDS: *pesticides, herbicides, insecticides, rodenticides, toxic, food, effects, water, agriculture*

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INTRODUCTION

FACTORS AFFECTING PESTICIDE POLLUTION OF WATER

Drainage: Farmland is often well drained and natural drainage is often enhanced by land drains. Water from excessive rainfall and irrigation cannot always be held within the soil structure. Therefore, pesticides and residues (also nitrates and phosphates) can be quickly transported to contaminate ground water and freshwater supplies over a large geographical area.

The pesticide: Individual pesticides have unique properties, and many variable factors (including those below) determine the specific risk in terms of water pollution.[1]

- active ingredient(s) in the pesticide formulation
- contaminants that exist as impurities in the active ingredient(s)
- additives that are mixed with the active ingredient(s) (wetting agents, diluents or solvents, extenders, adhesives, buffers, preservatives, and emulsifiers)
- degradate that is formed during chemical, microbial, or photochemical degradation of the active ingredient

Pesticide half-life: The more stable the pesticide, the longer it takes to break down. This can be measured in terms of its half-life, the longer it takes to break down, the higher its persistence. The half-life is unique to individual products but variable depending on specific environmental and application factors.An active substance is any chemical, plant extract, pheromone, or microorganism (including viruses), that has action against 'pests' or on plants, or parts of plants or plant products.

Mobility in soil: All pesticides have unique mobility properties, both vertically and horizontally through the soil structure. Residual herbicides applied directly to the soil are designed to bond to the soil structure.[2]

Solubility in water: Many pesticides are soluble in water out of necessity so that they can be applied with water and be absorbed by the target. The higher the solubility of the pesticide, the higher the risk of leaching. Residual herbicides are generally of lower solubility to aid soil binding but their persistency in the soil can cause other problems.

Microbial activity: Pesticides in the soil are primarily broken down by microbial activity. The greater the microbial activity, the faster the degradation. Loss of pesticide residues can also occur by evaporation and photodecomposition.

Soil temperature: Soil microbial activity and pesticide breakdown is largely linked to soil temperature.

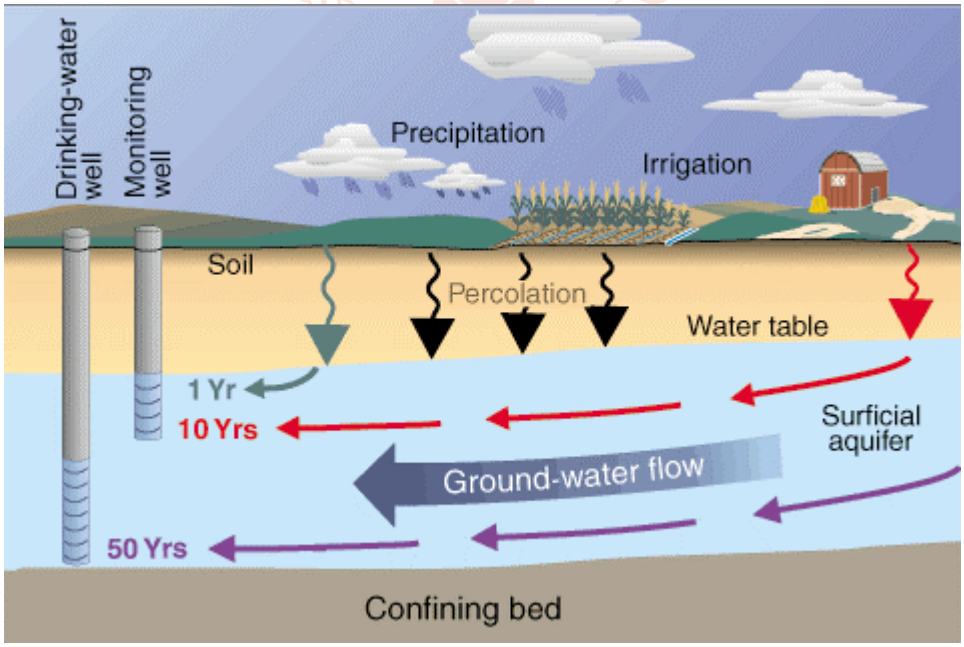
Application rate: The more pesticide that is applied, the longer significant concentrations remain.

Irrigation Management: Irrigation increases the chance that pesticides will migrate to ground water and surface water. Irrigating saturated soils or irrigating at a rate that exceeds the infiltration rate of soil promotes runoff that can carry pesticides with it. Irrigation that promotes the frequent downward movement of water beyond the root zone of plants also promotes the leaching of substances including pesticides to ground water. This is of particular concern in areas where frequent irrigation is necessary because of coarse-textured soils. Proper irrigation management is critical to minimize the risk of pesticides infiltrating ground water.[3]

Another factor affecting pesticide pollution of water is rainfall, as high levels of rainfall increase the risk of pesticides contaminating water. Movement into bodies of water occurs when runoff, after rainfall, moves through areas that have been sprayed with pesticides. It can also occur within the soil structure by displacement of pesticides from absorption sites near water and through treated soil that has moved into the water through soil erosion.

The Cornell University Cooperative Extension states "cleanup of groundwater contaminated by pesticides is usually impossible. The slow movement of groundwater means that it may take decades for the contaminated water to flow beyond the affected wells. Determining which wells will be affected and for how long is a difficult problem."

They also observed the problem with private wells and state that "most family farms rely on their own wells and private wells are rarely tested or treated and in many instances are located close to fields on which pesticides have been applied. While not all wells can become contaminated, it is important to know why some become contaminated (leached) and why others do not."[4]



Leaching of pesticides depends in part on the amount applied per acre per year; where, when and how it is applied; the solubility of the compound: how strongly it is held by the soil; and how quickly it breaks down in the root zone. After a pesticide is applied to a field, it meets a variety of fates. Some may be lost to the

atmosphere through volatilization, carried away to surface waters by runoff, or broken down in the sunlight by photolysis. Pesticides in soil may be taken up by plants, degraded into other chemical forms, or leached downward, possibly to groundwater. The remainder is retained in the soil and continues to be available for plant uptake, degradation or leaching.

How much pesticide meets each of these fates depends on many factors including:

- the properties of the pesticide
- the properties of the soil
- the site conditions including climate
- management practices

Many pesticides bind strongly to soil and are, therefore, immobile. For those that are mobile in soil, their leaching to ground water can be thought of as a race in time between their degradation into nontoxic by-products and their transport to ground water. If the pesticide is not readily degraded and moved freely with water percolating downward through the soil, the likelihood of it reaching ground water is relatively high. If, however, the pesticide degrades quickly or is tightly bound to soil particles, then it is more likely to be retained in the upper soil layers until it is degraded to nontoxic by-products. [5]

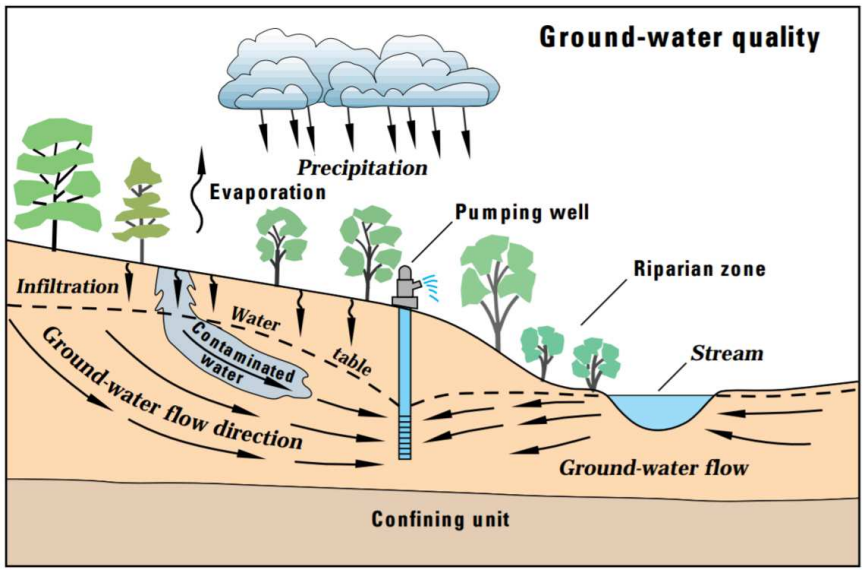
In the U.S., about 10% of the country's population (approximately 13 million people) rely on water from private wells but the private wells are not regulated under the Safe Drinking Water Act (SDWA). The SDWA does not provide recommended criteria or standards for individual wells, but it does provide information about technologies that may be used to treat or remove any contaminants. It also educates well owners on ground water and provides them with information that is useful to them in protecting their health.

Discussion

The health effects of pesticides depend on the type of pesticide. Some, such as the organophosphates and carbamates, affect the nervous system. Others may irritate the skin or eyes. Some pesticides may be carcinogens (cancer causing). Others may affect the hormone or endocrine system in the body. Pesticide mixtures may be derived from common sources (such as point sources) or from multiple nonpoint sources, and may include several different types of pesticide compounds with different mechanisms of toxicity.The World Health Organization (WHO) states, "The toxicity of a pesticide depends on its function and other factors. For example, insecticides tend to be more toxic to humans than herbicides."[6]

In many cases, the European Union (EU) regulates pesticides more tightly than Canada or the U.S. For example, in 2003, there was a ban on atrazine in Europe due to health and safety concerns and its pollution of water sources. Despite the ban in Europe, it is still widely used in the U.S. and Canada today. In 2016, a petition arose from common concern because it had been banned by the EU. The following year, during the spring of 2017, Canada decided to allow the continued use of atrazine.

While there have been reports and some research conducted on the effects of atrazine, the most concerning factor is that, the research was done with such low doses of the herbicide. Atrazine has been known to alter the genetic characteristics of frogs and even low doses of atrazine can cause frogs to develop female organs. These feminized males can reproduce with male frogs.

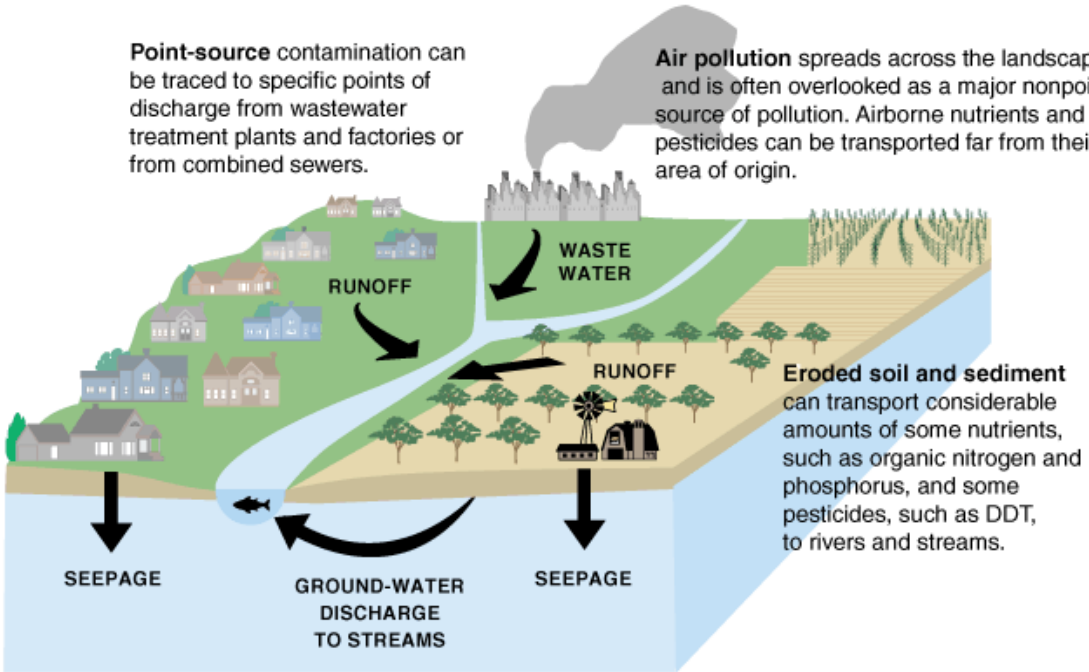


A study in the May 2004 Journal of Environmental Health Perspectives found pre-natal exposure to harmful chemicals poses an array of other dangers as well. The investigators tested several common lawn and garden chemicals—including ground water contaminants 2,4-dichlorophenoxyacetic acid (2,4-D), atrazine, and dicamba—for their ability to harm mouse embryos during a period corresponding to the first five to seven days after human conception. These three chemicals, along with nine other common compounds, caused increased cell death among the embryos.[7]

In Canada, the pest management regulatory agency is responsible for the regulation of pesticides in Canada. The Government of Canada's website states, "Pesticides are stringently regulated in Canada to ensure they pose minimal risk to human health and the environment." Under authority of the Pest Control Products Act, Health Canada:

- registers pesticides after stringent, science-based evaluation that ensures any risks are acceptable
- re-evaluates the pesticides currently on the market on a 15 year cycle to ensure the products meet current scientific standards
- promotes sustainable pest management

They also state, "Beyond Canada, they also work with international organizations like the U.S. EPA, the North American Free Trade Agreement Technical Working Group and the Organization for Economic Co-operation and Development." The U.S. Environmental Protection Agency (U.S. EPA) conducts ecological risk assessments to determine whether changes to the use or proposed use of a pesticide are necessary. Before allowing pesticide products to be sold on the market, they ensure that the pesticide will not pose any unreasonable risks to plants, wildlife, or the environment.



The EPA has drinking water regulations for more than 90 contaminants. They follow the SDWA and it must follow a process to identify and list unregulated contaminants.

SDWA requires the EPA to consider three criteria when making a determination to regulate:

The contaminant may have an adverse effect on human health.

The contaminant is known to occur or there is a high chance that the contaminant will occur in public water systems often enough and at levels of public health concern.

Control of the contaminant presents a meaningful opportunity for health risk reductions for people served by public water systems.[8]

The European Commission website states they "evaluate every active substance for safety before it reaches the market in a product. Substances must be proven safe for people's health, including their residues in food and effects on animal health and the environment. The European Commission and Member States take risk management decisions on regulatory issues, including approval of active substance and setting of legal limits for pesticide residues in food and feed (maximum residue levels, or MRLs)."

EU pesticide laws are the strictest in the world. The European Commission only approves an active substance after a rigorous and lengthy 3-year science-based assessment to ensure its use is safe. A complete dossier of studies must be submitted addressing the comprehensive data requirements which are set at the EU level by specific regulations. The dossier is then conducted jointly by EU member states and the European Food Safety Authority (EFSA).

There are many things that can be done to reduce the risk of pesticide contamination. The Government of Canada has assessed the use of pesticides and written the Indicator of the Risk of Water Contamination by Pesticides and it "evaluates the relative risk of water contamination by pesticides across agricultural areas in Canada. The indicator can be used to assess pesticide inputs to cropland and the amount of pesticide transported to surface and ground water from 1981 to 2011."

Some of the strategies suggested are:

- reducing risk of pesticide transport to surface or ground water
- decreasing amount of pesticide used
- reducing the persistence or mobility of the active ingredients

It is critical that pesticides are only applied during suitable weather conditions with the recommended application techniques. Local spray advisories are helpful with this. BMPs (Best Management Practices) that reduce runoff or soil erosion or increase soil organic matter content, help reduce pesticide [7]transport as well. BMPs include:

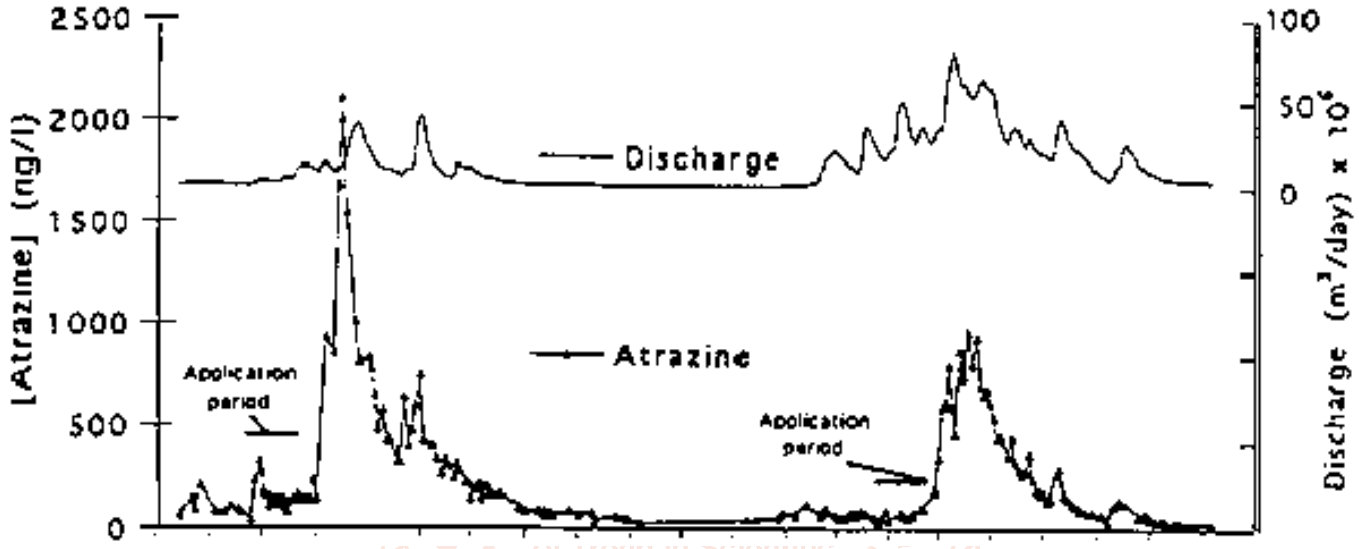
- riparian buffers
- crop rotation
- contour farming
- strip cropping

- reduced tillage or zero tillage systems (herbicide use usually increases with reduced tillage which may off set the pesticide-related benefits of the reduction in runoff associated with this practice)

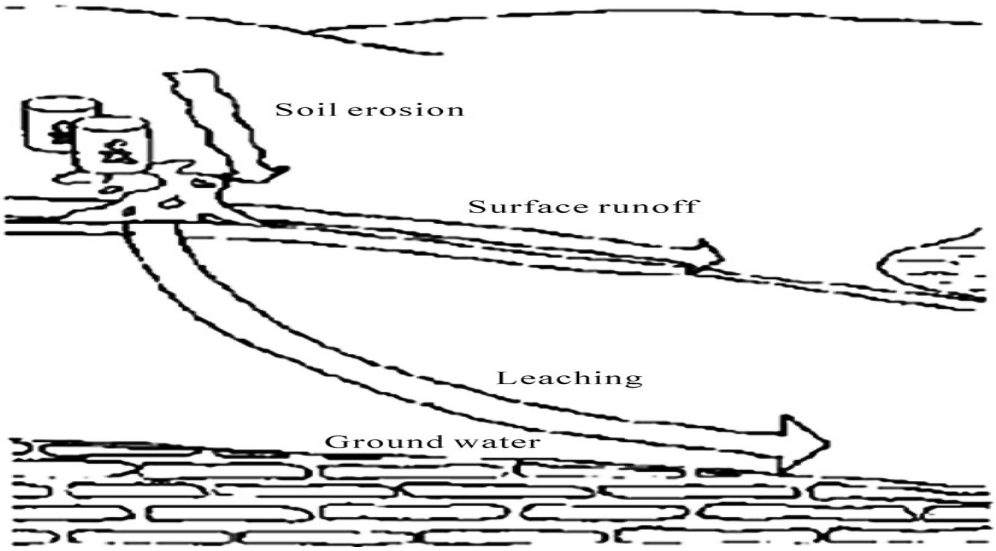
Results

Proper pesticide storage is vital. Locking pesticides inside a fire resistant, spill proof storage system is the best way to prevent accidental spills. It is also very cheap compared to the consequences that can be very expensive to clean up such as accidents, spills, or fires.

There are many ways in which pesticide contamination can be prevented such as selecting the appropriate pesticides, proper pesticide mixing, and loading procedures. Preparation of seedbeds and planting allows crops to emerge quickly, potentially reducing early season disease and insect damage that reduces the amount of pesticides needed. It is also important to dispose of pesticide containers properly and these containers should be triple rinsed. Contaminated containers exposed to rain can leak pesticides into the environment.



Pesticides and herbicides contain toxic materials that pose both environmental and human health risks. Humans, animals, aquatic organisms, and plants can be severely threatened by these chemicals. However, with an aggressive march toward the protection of source waters from pesticide and chemical mixtures, as well as improving technology to treat polluted water, there is hope that the flow of pesticides into humans via drinking water can be brought to a tiny trickle for future generations. The Safe Drinking Water Foundation has educational programs that can supplement the information found in this fact sheet. Operation Water Drop looks at the chemical contaminants that are found in water; it is designed for a science class. Operation Water Flow looks at how water is used, where it comes from, and how much it costs; it has lessons that are designed for social studies, math, biology, chemistry, and science classes. Operation Water Spirit presents a First Nations perspective of water and the surrounding issues; it is designed for Native Studies or social studies classes. Operation Water Health looks at common health issues surrounding drinking water in Canada and around the world and is designed for a health, science, and social studies collaboration. Operation Water Pollution focuses on how water pollution occurs and how it is cleaned up and has been designed for a science and social studies collaboration. Operation Water Biology teaches students about biological water treatment and has them build a model biological water treatment system; it is designed for grade nine to twelve science classes. Operation Community Water Footprint has students ask their local water treatment plant operator a list of questions in order to gather the information necessary to calculate the amount of raw water that is required to treat and deliver one litre of drinking water to someone's home, it is designed for science, social studies, and math classes. [8]



Pesticides are chemicals that contain oxygen, sulfur, chlorine, nitrogen, phosphorus, and bromine as well as heavy metals such as copper, arsenic, sulfates, lead, and mercury – they are simply chemicals. They are used in the agriculture sector to control and/or eliminate pests. Pests such as insects, diseases, rodents and weeds can be harmful to crops if they are left uncontrolled and/or eliminated. And would otherwise damage them if they were allowed to thrive in agricultural land areas. As a result, pesticides are used to control and/or eliminate pests from agricultural land areas, thereby improving crop productivity and yields.

In spite of the fact that the use of pesticides helps to improve crop productivity and yields, it is imperative to note when pesticides are used indiscriminately; they come with negative consequences – in the sense that they can cause environmental pollution.

Water pollution is one form of pollution that is caused by the improper use of pesticides. It simply means the presence of unsuitable substances in waters, which changes its properties, thereby making it contaminated and unsuitable for use. This can occur when pesticides are used on land areas that are used to grow crops and are flushed away by wind and rainfall into water bodies. As a result, they alter the state of such water bodies by changing to its physical, chemical or biological conditions, thereby making it toxic, contaminated and unsuitable for use.

When pesticides contaminate waters, such waters become harmful to living organisms that consume or come in contact with them.

Water pollution is very bad for the environment. It creates negative impacts. And a few of them are described below.

Groundwater contamination: Pesticides, when sprayed on crop plants, are able to flow below the surface of the ground, reaching water-bearing aquifers, thereby contaminating groundwater, making it unsuitable for both human and agricultural uses.

Conclusions

Marine Life: Pesticides being chemicals are harmful to live. When pesticides get into water bodies, water animals are not spare as it can kill animals such as fish.

Food Chain Disruption: When pesticides come in contacts with water bodies, they can interfere with the food chain and cause disease in hidden ways. For example, if chemicals from pesticides such as lead or copper get into water bodies, fishes sometimes take them up. And when humans eat such fishes (with contaminated waters), they can damage multiple systems in the human body. Kidney damage is one disease that can be caused by the consumption of contaminated water.[8]

Costs: There are also financial impacts associated with water pollution. When fresh water has been contaminated, they are deemed to be unsafe to drink, thus requiring treatment. Contaminated waters will be unsafe and not suitable for drinking if left untreated. Treating contaminated waters can be expensive. Considering the global economic downturn, spending money on treating contaminated waters that should not have occurred in the first place is economically unsustainable.

Having mentioned that the indiscriminate use of pesticides can cause water pollution issues, it is noteworthy to acknowledge that there are a lot of ways that can be used to address these issues. Sustainable management and application of pesticides can be used to address these issues. Also, there are many organic pesticides that can be used in place of harmful synthetic pesticides.7,8]

References

[1] Center for Integrated Pest Management. (n.d.). Pesticide Environmental Stewardship. Retrieved from pesticidestewardship.org.

[2] European Commission. (n.d). Plants. Retrieved from https://ec.europa.eu/food/plant/pesticides/approval_active_substances_en

[3] European Commission. (n.d.). Pesticides Explained. Retrieved from http://ec.europa.eu/assets/sante/food/plants/pesticides/lop/index.html

[4] Gardner, R. (n.d.). How to Prevent Water Contamination. Retrieved from https://pesticidestewardship.org/water/prevent-contamination/

[5] Statistics Canada. (2015, Nov. 27). Farm Environmental Management Survey. Retrieved from https://www150.statcan.gc.ca/n1/pub/21-023-x/2013001/part-partie1-eng.htm

[6] United States Environmental Protection Agency. (2017, Aug. 31). Overview of Risk Assessment in the Pesticide Program. Retrieved from https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/overview-risk-assessment-pesticide-program

[7] United States Environmental Protection Agency. (2018, Jun. 6). Private Drinking Water Wells. Retrieved from https://www.epa.gov/privatewells

[8] World Health Organization. (2018, Feb. 19). Pesticide Residues in Food. Retrieved from http://www.who.int/news-room/fact-sheets/detail/pesticide-residues-in-food