International Journal of Education and Science Research Review
E-ISSN 2348-6457
Volume-10, Issue-1 Jan-Feb-2023 P-ISSN 2349-1817
www.ijesrr.org Email- editor@ijesrr.org

IMPACT OF WASTEWATER DISCHARGE ON AQUATIC FAUNA

Mukesh Kumar Prajapat

Assistant Professor (Zoology)

S. B. D. Government College, Sardarshahar

ABSTRACT

When chemical compounds are discharged into aquatic environments including rivers, lakes, and oceans, the phrase "biotic integrity" refers to the possibility that these chemical compounds could cause changes to the structure and function of biotic communities. These changes might be caused by the discharge of chemical compounds. The findings of the study indicate that aquatic organisms are the most susceptible to the negative effects of pollution, which may result in the development of severe illnesses, behavioural problems, and even the extinction or migration of some species. Not only can these influences alter the functioning of communities and ecosystems, but they also result in the disappearance of valuable artefacts that may potentially have a beneficial effect on public health and efforts to ensure the long-term sustainability of the environment. The protection of natural ecosystems and habitats in the places where they were originally found is very necessary in order to maintain biological diversity. In the hope of bringing attention to the ways in which these pollutants may harm aquatic ecosystems and, by extension, how they degrade water resources both quantitatively and qualitatively, with a focus on the biodiversity that they threaten, the purpose of this study was to synthesise the research that has already been conducted on urban liquid effluents. Within this chapter, the work is broken down into four basic sections. An analysis of the physicochemical characteristics of urban runoff is presented in the first section of the study. The second part provides an in-depth analysis of the several approaches that are used to clean up urban waterways. The regulatory considerations that are naturally involved with urban effluents are listed in Section 3, which may be found here. The fourth section will focus on investigating the ways in which urban effluents have an impact on aquatic biodiversity. The "complete ecotoxicological approach" is used in order to highlight the short-term and long-term consequences that certain toxins in urban rivers have on aquatic life and food webs.

Keywords: *Wastewater, Discharge, Aquatic fauna*

INTRODUCTION

The actions of humans that deplete natural resources result in the production of a number of byproducts, including solid waste, liquid discharges (wastewater), and gaseous effluents. They are responsible for the introduction of pollutants into the environment, which has the potential to disrupt the delicate balance of life that exists inside ecosystems. In many cases, the physicochemical aggressions that surface waters are subjected to as a consequence of pollution in liquid discharges are responsible for the reduction in aquatic biodiversity that occurs in these waters. In point of fact, the continual release of chemical compounds into aquatic environments has the potential to modify the composition and behaviour of the biotic community, which results in a potential compromise of the integrity of the biotic community. As a result of the bioavailability of these contaminants, pollutants found in effluents have a broad variety of adverse effects on the biodiversity of aquatic ecosystems.

Metallic substances, organic compounds (especially organohalogenated chemicals), detergents (sometimes referred to as "surfactants"), pesticides, polycyclic aromatic hydrocarbons (PAHs) and polycyclic aromatic hydrocarbons (PCBs), nitrates and phosphates, and pharmaceutical residues are the most prevalent types of chemical pollutants. Studies conducted by scientists have shown evidence that these pollutants have an impact on bodies of water. They have the potential to create long-term disturbances to the aquatic ecosystems that they occupy, which is especially troublesome for primary producers who are susceptible to organic and metallic pollution.

The findings of the study indicate that aquatic organisms are the most susceptible to the negative effects of pollution, which may result in the development of severe illnesses, behavioural problems, and even the extinction or migration of some species. Not only do these consequences alter the functioning of societies and ecosystems, but they also result in the disappearance of valuable artefacts that have the potential to have a beneficial effect on public health and the long-term viability of the environment (United Nations, 1992).

The protection of natural ecosystems and habitats in the places where they were originally found is very necessary in order to maintain biological diversity. Concern is further exacerbated by the fact that the development of technology that is capable of successfully regulating the toxins that are found in urban wastewater has lagged behind the progress that has been made in the scientific community. In the hope of bringing attention to the ways in which these pollutants may harm aquatic ecosystems and, by extension, how they degrade water resources both quantitatively and qualitatively, with a focus on the biodiversity that they threaten, the purpose of this study was to synthesise the research that has already been conducted on urban liquid effluents.

Within this chapter, the work is broken down into four basic sections. This section begins with the presentation of our physicochemical classification of urban waters. In this first section, the principal pollutants that are present in urban water matrices, which are wastewater and rainfall, are discussed. Following this, a synthesis of data on these two components is suggested. The second part provides an in-depth analysis of the several approaches that are used to clean up urban waterways. It describes the process by which some chemicals spread across the natural environment, which is beyond the jurisdiction of wastewater treatment facilities, while also underlining the threat that these compounds pose to creatures that live in ecosystems. The regulatory concerns that are intrinsic to urban effluents are discussed in the third section of this study, which is intended to assist in comprehending the significance of this research. The fourth section will focus on investigating the ways in which urban effluents have an impact on aquatic biodiversity. The "complete ecotoxicological approach" is used in order to highlight the short-term and long-term consequences that certain toxins in urban rivers have on aquatic life and food webs.

Grey water and black water

The water that is considered grey is devoid of any substances that may be found in a toilet. Therefore, the term refers to effluent that originates from any home or commercial source, which may include, but is not limited to, sinks, washing machines, kitchens, and bathrooms. In contrast to black water, which is regarded to be typical wastewater and contains things like urine, faeces, toilet paper, and other such materials, grey water, which accounts for about three quarters of domestic drainage, has a lower ratio of organic matter to other substances. In accordance with Eriksson and his colleagues, it occurred in the year 2002.

It is possible to find both organic chemicals and minerals in the wastewater of metropolitan areas. Metals (copper, zinc, lead, and cadmium), suspended particles, dissolved solids, nitrous and ammoniacal compounds, and phosphate compounds are some of the substances that may be used in order to evaluate the amounts of these pollutants that are present in the matrices (Tardat-Henry, 1984; Grey and Becker, 2002).

There is a broad range of home objects that contain metals and may be flushed down the drain (Lester, 1987). Some examples of these things are paints, cosmetics, cleaning supplies, and pharmaceuticals. According to Grommaire-Mertz (1998), the bulk of the metals that are found in wastewater from households originate from water that is used for washing anything, mainly textiles. Table 1 is an overview of the concentrations of numerous pollutants that are found in urban waterways, including both conventional and non-conventional contaminants.

Table 1: Pollutant concentrations in urban wastewater

Parameters	Symbol	Concentrations
Total suspended matter	TSM	100 to 500 mg/L
Chemical oxygen demand	COD	250 to 1000 mg/L
Biochemical oxygen demand	BOD_5	100 to 400 mg/L
Cadmium	Cd	1 to 10 µg/L
Copper	Cu	83 to 100 µg/L
Lead	Pb	5 to 78 µg/L
Zinc	Zn	100 to 570 µg/L

Rainwater

The precipitation of liquid water from the atmosphere is what is meant to be understood as rainfall. Meteorological water and water that runs off of urban surfaces (roads, rooftops) are both included in this category. According to Valiron (1990), there are two distinct forms of water that may be derived from rainfall: runoff water and infiltration irrigation water. There are a variety of organic dusts and microorganisms that may be found in rainwater, as well as dissolved gases from the atmosphere (N2, O2, and most importantly CO2), as well as tiny amounts of the various chemical combinations that can be found in the atmosphere (H2SO4, NaCl near coastal locations, Ca salts and Mg, PO4, etc.). Rainwater also includes dissolved gases from the environment. This is in addition to the fact that they are laden with various pollutants.

It has been noted in the scientific literature that rainfall contains significant amounts of a number of heavy metals, including cadmium, lead, and zinc, among others. The values that were measured for heavy metals that were found in runoff water are summarised in Table 2, which may be seen here.

Table 2: Heavy metal pollution in runoff water: sources and concentrations

Elements	Mean content (mg/L)	Origin	Phase
Pb	0.1 to 0.8	Gasoline Industry: 35% Rain: 50% Suspended Solids	Suspended Solids
Cd	-	Industry: 35% (combustion) Rain: 20% Tyre wear	Dissolved
Zn	0.3 to 0.8	Industry: 35% (waste incineration) Rain: 30% Tyre wear Corrosion of metal objects	Dissolved

The eroding and leaching of urban surfaces, in addition to leaching from the atmosphere, is only one of the sources of contaminants that are found in runoff water from metropolitan areas. Since there is evidence to show that runoff may contribute considerably to micropollutants, there is an urgent need to quantify and define the pollution levels of diverse runoff water sources (roofs, roads, etc.). This is because there is a pressing need to do so. The physicochemical characteristics of these streams are altered when they pass over urban surfaces, as can be shown in Table 3.

Table 3: Average rainwater quality

Parameters	Symbol & unit	Rainfall	Roof runoff	Road runoff
Hydrogen potential	pH	4.9	6.2	6.4 - 7.5
Electric Conductivity	CE (μS/cm)	32	80	108
Suspended Matter	SM (mg/L)	17.5	22 – 40	64 – 140
Chlorines	Cl^- (mg/L)	0.9 - 1.6	0.8	6 – 125
Iron	Fe (μg/L)	3 – 4.8	5.6	16 - 62.2
Sulphates	$SO4^{2-}$ (mg/L)	160-223	1200	4200 – 10400
Lead	Pb (μg/L)	5 – 76	23 – 104	128 – 311
Cadmium	Cd (μg/L)	0.6 – 3	0.7	1.9 - 6.4
Copper	Cu (μg/L)	1.5 – 12	27 – 235	62 – 108
Zinc	Zn (μg/L)	5 – 80	24 – 290	220 – 603
Polycyclic Aromatic Hydrocarbons	PAH (ng/L)	86 – 145	500	240 – 3100

Minerals and organic materials are regularly introduced into hydrosystems by the runoff water that water from roads collects. As can be seen in Figure 1, these additions cause alterations in the physical, chemical, and biological aspects of the host environment, which will ultimately result in eutrophication or adverse effects on the species. These occurrences are largely caused by the salts of nitrate and phosphate, which are the predominant culprits.

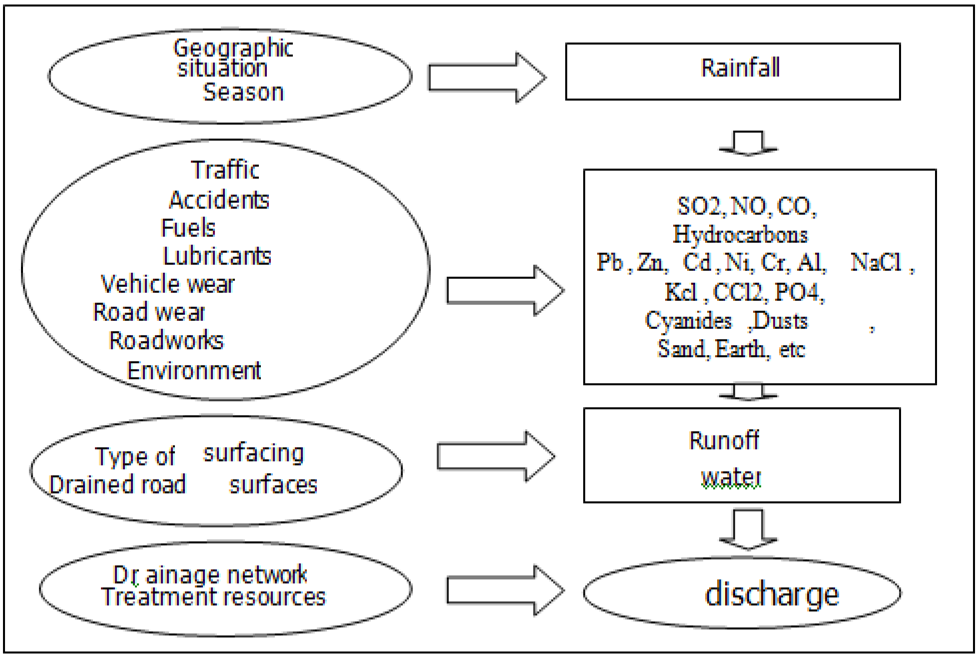

Figure 1: Pollution cycle of runoff water.

It is also possible for rain to erode or corrode urban surfaces, which may result in the presence of certain toxins in runoff water. Rain has the capacity to do both of these things. It is possible for this to take place, for example, when dirt, sand, and gravel seep in from surfaces that are not sealed, when asphalt degrades and exposes hydrocarbons, and when metals seep in from surfaces that are not sealed.

To summarise, precipitation has the potential to pollute the habitats of the hosts. As a result of dry periods, a wide range of items are collected by roads, gutters, pavements, and central squares. All of these chemicals are carried away by the first rainfall flush, which effectively removes a significant amount of them from the surface. The polluting components, which are dispersed throughout the water mass and eventually collect, pollute all of the items that are eroded away. Research conducted by Chocat et al. in 1993 was able to demonstrate that the first water flush has the potential to produce severe pollution, with levels that are equivalent to or even higher than those of urban effluent. The quantity of precipitation that must be received in order to ensure that eighty percent of the total mass of pollution is transported by the first thirty percent of the volume flowing is referred to as the "first flush," as stated by Saget et al. (1996).

Wastewater Treatment

Municipal sewage treatment plants in several countries use biological and physiochemical methods to clean up the effluents that are discharged from urban areas. It has been stated by Emmanuel (2004) that wastewater treatment facilities have the capability to decompose organic molecules and change the chemical composition of mineral components that are present in urban wastewater. The treatment of wastewater in agglomerations may be accomplished by the use of a variety of techniques that are based on physical, chemical, and biological processes. When it comes to the treatment of wastewater, there are normally four processes that are utilised: screening, degritting, primary treatment (settling, sedimentation), secondary treatment (biological), and tertiary treatment (physicochemical) (coagulation, flocculation, filtering, disinfection).

It is possible to determine the level of treatment that is required for different types of wastewater by comparing the amount of pollution that natural streams are able to tolerate with the amount of pollution that is produced by a variety of industrial activities and municipal wastewater. By using this approach, one is able to ascertain which treatment process is most suitable for the analytical characterisation of municipal liquid effluents that are produced by a certain region or company. Consequently, treatment techniques are fine-tuned in order to stabilise the total pollutant load of the wastewater (industrial effluent in addition to municipal liquid wastes) in the region that is being considered. Fresenius et al. (1990) state that treated water, which is also referred to as treated wastewater, is either reused or returned into the environment of the host once the treatment process has been completed. Sludges, on the other hand, may be recycled, stored, transformed, or burnt before being disposed of.

Nevertheless, research on municipal sewage treatment facilities has shown that certain compounds are not able to be treated and end up being released into the environment (Kosmala, 1998; Kümmerer, 2001). Figure 2 shows that when a plant's efficiency reaches its limit, it will be overwhelmed by the amount of urban effluents flowing into it, and the pollutants will be released into the environment (Emmanuel, 2002).

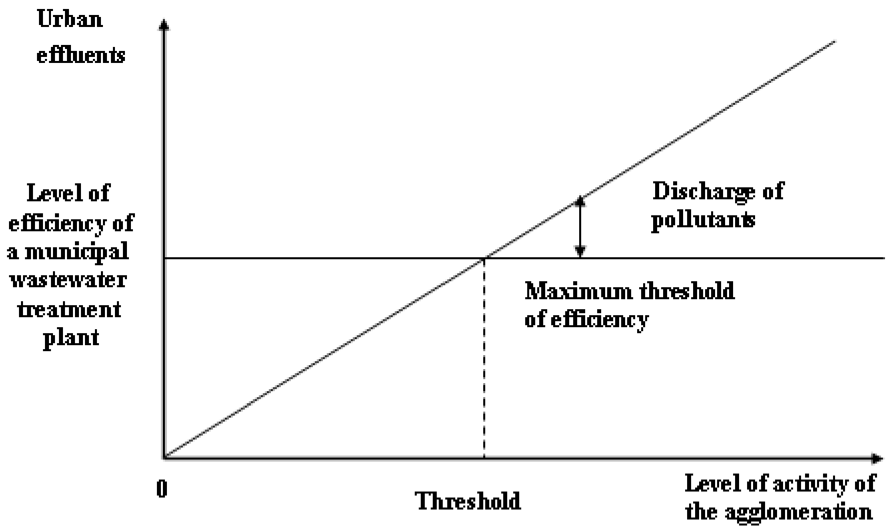

Figure 2: Human activity's effects on ecosystems

Therefore, the chemical compounds that are released by municipal sewage treatment plants have the potential to cause biological imbalances as well as other forms of environmental contamination. In the absence of conditions that would let these compounds to degrade, the pollutants will remain in the environment for an extended period of time, hence creating risks to the species that inhabit the ecosystem in the short, medium, and long term (Emmanuel, 2004).

Effects of the Principal Pollutants in Urban Wastewater on Ecotoxicity and Aquatic

Biodiversity Pollution

According to Ramamade (2000), any substance that is wholly created by people and is either brought to a biotope where it was previously absent or affects the composition of the biotope's water, air, or soils when it is naturally present is considered to be a human-made material. The majority of the time, the quantity of a pollutant and its bioavailability are the factors that define how it affects the biodiversity of an ecosystem.

Toxicological levels and concentrations of contaminants are as follows: There is no component of a product that is inherently harmful. As well as the concentration, the effects of it are determined by the kind of organism that is able to absorb it. The idea that "Sola dosis fecit venenum" (which translates to "All things are poison and nothing is without poison; only the dosage makes a thing a poison") was initially articulated by Paracelsus in the 16th century and serves as the foundation for a modern framework in the field of toxicology. This theory is shown by the concept of dose-response, which is also known as the effect of exposure-dose. The principle that states that the same toxic substance can have different effects depending on the dosage and duration of exposure is the basis for the terms "acute toxicity" and "chronic toxicity." Acute toxicity refers to the effects of a single high dose of a chemical substance, while chronic toxicity refers to the effects of exposure to low doses repeated over time. Both of these terms are derived from this principle (Keck and Vernus, 2000). "Special toxicity" is a category that is designated for substances that, if they are exposed to them for a lengthy period of time, have the potential to cause cancer or issues with reproduction.

The connection between concentrations and reactivity for a dangerous substance seems to be a sigmoid curve once an ecotoxicological test has been completed. In contrast to a control, the data are often summed together and reported as a concentration that either produces toxicity in fifty percent of the population (such as immobilisation or death) or inhibits the activity of organisms in fifty percent of the population (such as luminescence or growth). This concentration, which is referred to as the Efficient Concentration 50 (EC50), is the median value that was found based on the dose-response relation. As the sample's toxicity reduces, the effective concentration of the substance drops as well.

There is a disadvantage to the link between ecotoxicity and EC50, which is that the relationship is negatively connected. In order to measure toxicity in a manner that is not only straightforward to manage but also directly proportional to the damage, the United States Environmental Protection Agency (USEPA) recommends the use of Toxic Units (TU). In order to ascertain the latter, one may use the formula that is as follows:

$$\text{Toxic Units } TU_{50} = 100 / EC_{50} \ (EC_{50} \text{ in \% volume}) \qquad (1)$$

In order to characterise the ecotoxicity of chemical compounds, Directive 93/21/CEE provides a classification system that is based on the outcomes of bioassays conducted on fish, daphnia (crustaceans), and green algae (European Commission, 1992):

- Very toxic : $EC_{50} < 1$ mg/L;
- Toxic : 1 mg/L $< EC_{50} <$ 10 mg/L
- Noxious : 10 mg/L $< EC_{50} <$ 100 mg/L
- Non toxic : $EC_{50} >$ 100 mg/L

The toxicity and bioavailability of contaminants are as follows: According to Newman and Jagoe (1994), one definition of bioavailability is the degree to which an organism is able to absorb a contaminant when it is present. According to Campbell (1995) and Hudson (1998), the three processes that govern this concept are assimilation inside the organism via the lipid membrane, fixation to transmission vectors, and dispersion from the solution to the surface of the membrane.

Sex hormones, which are endocrine blockers, antibiotics, which have several resistances to bacteria, and anti-cancer and antineoplastic drugs, which are genotoxic, are the three primary types of pharmaceuticals that are being examined for their impact on aquatic biodiversity.

A study conducted on the breakdown of drugs in water has shown that endocrine blockers, which are particular sex hormones, have the potential to have an effect on aquatic life at concentrations lower than 1 µg/L. Estradiol, a female sex hormone, is one example of a substance that has the potential to modify the sexual characteristics of some fish at concentrations as low as 20 ng/L by Ralox (1998). One other hormonal indication of pollution in aquatic environments is estradiol.

There is a widespread belief that the emergence of these resistances may be traced back to ambient antibiotic residues, which have the potential to produce multiple resistances in bacteria. Therefore, if it comes to the treatment and management of certain infectious diseases, these substances provide a significant risk to the general population's health.

Genotoxicity is a potential side effect of the bulk of the drugs that are administered in hospitals. These treatments are either anti-cancer or anti-antineoplastic in nature. There is an important family of drugs known as antineoplastic agents, which are concerned with both health and the environment. Carcinogenic, teratogenic, and mutagenic properties are already well-established for these substances.

The process of oxidation, which results in the production of just water and carbon dioxide, is one of the three basic outcomes that occur when pharmacological compounds are exposed to aquatic settings. The environmentally friendly properties of the drug could be incorporated into this situation. Despite the fact that the substance is lipophilic and very resistant to degradation, sewage treatment plant sludge is nevertheless able to absorb a small quantity of it. During the process of metabolization, these compounds are converted into metabolites, which have a structure that is hydrophilic in contrast to the structure of the mother molecules, which are lipophilic. In spite of this, the mother and daughter chemicals continue to be persistent and are discharged into the environment of the host after having passed through the sewage treatment systems of the facility. This presents a threat to aquatic life in the event that the metabolites demonstrate their ability to function. There are several well-known instances of this situation, including clofibrate and the metabolite clofibric acid. According to CSTEE (2001), Table 4 provides a comprehensive breakdown of the six categories of human medical drugs that pose the greatest threat to aquatic ecosystems.

Table 4: The six major medication classes' ecotoxicity to aquatic life

Groups	Extremely toxic	Very toxic	Toxic	Slightly toxic	Non toxic

	EC_{50}<0.1 mg/L	EC_{50}<0.1 - 1 mg/L	EC_{50} 1 - 10 mg/L	EC_{50} 10 - 100 mg/L	EC_{50} >100 mg/L
Analgesics			D	D,E	
Antibiotics	A	B			
Antidepressants		D			
Anti-epileptics			C		D,E
Antineoplastic agents		A		D,E	
X-ray contrast agents					A,B,D,E

A-Bacteria, C-Cnidaria, D-Crustaceans, and E-Fish are the taxonomic groups that are most vulnerable to the disease.

Two of the most prevalent uses of radioelements are in the field of nuclear medicine and the energy industry specifically. In the field of medicine, colloidal solutions that include the radioactive elements 90Y and 198Au are injected into the cavities of the body, often at dosages that range from 100 to 200 mCi. There is a significant amount of this concentration that does not exit the body as trash that is eliminated. However, when 131I is administered orally, the bulk of it is removed in the urine, reaching a percentage of sixty to seventy percent. According to Rodier (1971) and Erlandsson and Matsson (1978), the doses that are used for the treatment of thyroid malignancies vary from about 100 mCi for diagnostic reasons to over 100 □Ci for the treatment of thyroid cancer. According to Erlandsson and Matsson (1978), radioelements 99Tcm and 201Tl, which are used in nuclear diagnostics, are easily accessible at a variety of sites within the drainage system.

There is evidence that some radioelements have a bioamplification impact on aquatic biocenosis, which may be found in research that investigate the issue of radioactive contamination of aquatic ecosystems. In point of fact, research conducted in the United States has shown that the average amount of contamination in salmon that were infected with 32P in the Columbia River was 1.5 Bq.g-1. This might result in "isolated" individuals exposing their bones and organs to 0.3 millisieverts of radiation per year, which is equivalent to twenty percent of the maximum dosage that is permitted (Ramade, 1998), if they consumed forty kilogrammes of salmon on an annual basis.

Dissolving enzymes for water include: Products that "remove dirt" by a mix of physical and chemical processes are referred to be detergents respectively. Surfactants were the subject of a regulation that was issued on the 28th of December in 1977 and published in the Official Gazette on the 18th of January in 1978. The order stipulated that the biodegradability of detergents must be at least 90 percent. Surfactant is a component of detergents that contributes to the surface or tensioactive properties of the detergent agent. The majority of detergents are made up of things like these organic components. The critical micellar concentration (CMC) of these samples in water results in the formation of a film that is both discontinuous and brittle. The presence of this coating inhibits sunlight and oxygen from accessing the water, which often results in a biological imbalance and, in the case of an aerobic biological treatment reactor, the emergence of anaerobic zones over the medium and long term. The process of eutrophication may also be facilitated by it in natural aquatic environments.

On the other hand, the hydrophobic or lipophilic non-polar component of surfactants is an insoluble hydrocarbon chain. The hydrophilic polar component of surfactants is made up of negatively charged ions that are easily hydrated. There are two sources of these toxic substances for aquatic organisms: the chemical synthesis of synthetic surfactants (cationic, anionic, non-ionic, and amphoteric), and the biological creation of these compounds by microorganisms such as bacteria and fungus (bio-surfactants) (Talmage, 1994; Edwards et al., 2003).

Cationic and anionic surfactants are often more dangerous than non-ionic surfactants. Cationic surfactants are particularly dangerous. Experiments were carried out by Emmanuel and colleagues (2005) on three distinct types of surfactants, and they discovered that this was indeed the case (Table 5). Triton X-100, which is a non-ionic component, calcium trimethylammonium bromide, which is a cationic component, and sodium dodecyl sulphate, which is an anionic component, are the three components.

Table 5: Acute toxicity of surfactants on *Vibrio fischeri* and *Daphnia* (Emmanuel et *al*, 2005)

Bioassays	Units	CTAB	TX 100	SDS
EC_{50} 30-mn *Vibrio fischeri*	mg/L	1.02	63.6	0.276
EC_{50} 24-h *Daphnia*	mg/L	0.024	38.05	29.21

Combined effects of pollutants on aquatic organisms: "Independent joint action" refers to the situation in which components act on separate action sites and do not influence each other's biological responses. "Similar joint action" refers to the situation in which components act on the same sites and do not affect each other's biological responses. "Combined action" refers to the situation in which components act on multiple action sites and do not influence each other's responses. Bliss (1939) classified the effects of mixture components on living things into three categories. On the other hand, "Synergistic action" is a phenomenon that takes place when the reaction of a combination cannot be identified based on the reactions of its separate components. This approach is often used while doing research on mixes. To decide the response of a combination, each of its constituents must collaborate with one another. According to Groten et al. (2001), these interactions are more visible when the components of the combination are engaged in enzymatic transformation or have an influence on metabolism. This is as shown by the fact that these interactions are most noticeable.

According on the results of the first research carried out by Bliss (1939), Plackett and Hewlett (1952) devised this classification system (Table 6) for the combination of two substances. This classification was based on the findings of the original study. The term "Similar joint action" refers to the presence of action sites that are identical to one another, "Dissimilar" refers to the presence of different action sites, "Non-interactive" refers to the absence of any influence from one product on the biological response of the other product (i.e., additive interaction), and "interactive" refers to the presence of effects that are either more than additive (synergistic) or less than additive (antagonistic).

Table 6: Categorization of two substances' interactions

	Similar joint action	*Dissimilar joint action*
Non-interactive	*Simple similar*	*Independent*
Interactive	*Complex similar*	*Dependent*

Both additive and antagonistic, as well as "synergistic," adverse effects may be caused by combinations of pollutants on the organism that is the target of the contamination. The fact that compounds in a combination have an impact that is hostile to one another indicates that the combined ecotoxicity of the substances is less detrimental than the sum of the toxicities of the substances individually. In an additive reaction, each reaction adds to the total until it achieves the hazardous response of the combination. This continues until the maximum toxic response is reached. The occurrence of synergistic reactions takes place when the total responses of a combination are larger than the sum of the responses of its separate components.

There are a variety of models that may be used in order to carry out quantitative analysis of mixes. It was Brown (1968) and Sprague (1970) that used the phrase "Toxic Unit" for the very first time. The TU of a drug may be determined by dividing the dose of the material by the EC50 of the substance on the organism in question. It is feasible to indicate the toxicity of a combination by adding up the TUs of the two components individually. This is because TUs are dimensionless relations, which means that they can be represented in this manner. It is considered that the toxicity is cumulative, given that the total TU is assumed to be 1. The total TU will be considered to be more than additive if it is more than 1, and it will be considered to be less than additive if it is less than (1).

Marking (1977) developed the Additivity Index model by extending the TU model. This model was designed by Marking. This model intends to solve the problem of non-linearity of TU about 1, which is a problem that may be addressed by making adjustments. Belkhadir (1979) developed the design for the toxicity index model by using the formula that is as follows:

$$TI = \sum_{i=1}^{n} \left(Cmél / Cseul \right)_i \tag{2}$$

where Cmél is the substance's concentration in the mixture, Cseul is the substance's concentration in a pure solution, and TI is the substance's toxicity index.

For: TI = 1: the interaction of the effects is additive

TI > 1 : the interaction of the effects is antagonistic

TI < 1: the interaction of the effects is synergetic

When dealing with a mixture that contains more than two different compounds, you may make use of the Toxicity Index method to determine the general interactions that occur between the components. On the other hand, the additivity of effects-implying hypothesis TI=1 is being disputed and built upon by a large number of people. Therefore, according to Deneer (2000), the hypothesis may be broadened to include a range of 0.5 to 2 for the TI value. An additive effect is suggested by EIFAC (1980) for TI values ranging from 0.5 to 1.5.

The isobologram, which is a two-dimensional chart that shows the repercussions of interactions between substances, is the visual tool that is used the most often while doing research on the combined effects of two chemicals on an organism. The UT is shown on the ordinates and abscissa with regard to each individual material. The combination of two compounds, A and B, results in the formation of an ordinate UTB and an abscissa UTA. The curve is stable and straight, despite the fact that the impacts are additive in nature. On the other hand, according to Calamri and Alabaster (1980), a bottom-curve that is created to the left of the additivity isobole shows synergistic effects, whilst a top-curve that is obtained to the right indicates antagonistic effects. This model is often used by researchers in order to investigate the potentially dangerous behaviour of binary combinations (Warne, 2003). As a result of the fact that the right-hand isobol (figure 6) demonstrates that the interaction of the effects in the binary mixture can be quite different depending on the ratio of each component, this compromise between TU and TI makes it possible to observe how the effects of a binary mixture change with different ratios of the two components.

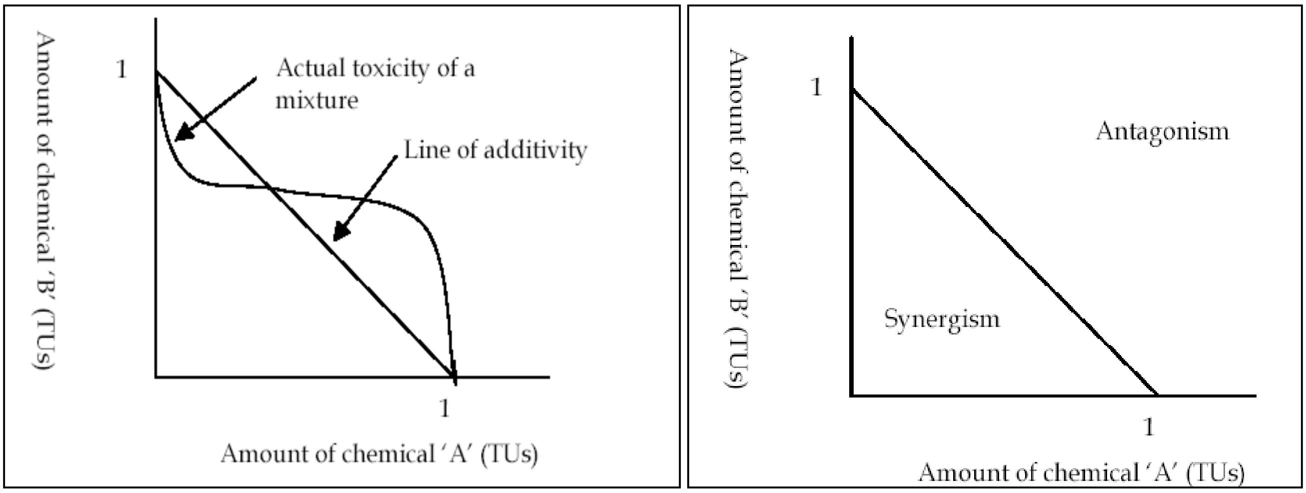

Figure 3: Instance of an isobologram

The majority of models are built on the additivity hypothesis as their basis. In the majority of instances, they make it possible for us to arrive at the conclusion that the ecotoxicological effects of a combination are additive, or that there is a divergence from additivity, which means that the components are either in conflict with one another or working together. Based on the findings of several studies, it has been claimed that the additivity of effects alone may be used to mimic the ecotoxicity of combinations. There are ten to fifteen percent of blends that have antagonistic cumulative effects, seventy to eighty percent of combinations have demonstrable additive effects, and the same percentages apply to cumulative synergistic effects.

Experimental approaches in situ:

In spite of the fact that the majority of studies involve the administration of pure products to laboratory animals in the form of monospecific tests (bioassays), more complex models may be produced via the use of methods such as microcosms and mesocosms, in addition to multispecific testing. It is becoming more difficult to evaluate the impact that pollutants have on the environment when using the data that is generated by these models.

Bioassays have their limitations when compared to habitats that are seen in the real world since they are dependent on controlled laboratory conditions and do not take into account interactions between different species. There are a number of criticisms that may be levelled against laboratory studies. One of these criticisms is that they are unable to accurately anticipate the direct and indirect consequences of pollutants on higher levels of biological organisation. Additionally, laboratory experiments are criticised for their lack of ecological realism (Forbes and Forbes, 1994). In order to circumvent the errors that are linked with chemical and biological measurements, researchers have proposed the idea of integrating chemical analysis with toxicity testing and field measurements of biokinetic behaviour (Kosmala, 1998).

In situ experimental methods are carried out with the intention of establishing a direct association between pollutants and biological affects. This is done with the intention of improving impact assessment by adding the realism of field work to the process. The use of eco-epidemiological investigations that are carried out on sentinel animals is one component of this approach. The purpose of these research is to bring attention to the detrimental effects that pollution has. This method also includes the imposition of toxic effects on plants and animals that are contained inside cages at the study site. "a system set up in which data on the exposure of animals to pollutants in the environment are regularly and systematically collected and analysed" (NRC, 1991) is how the United States Academy of Science describes sentinel species. The purpose of this system is to identify potential dangers to humans and other animals. Sentinel species are used to accomplish this.

CONCLUSION

The hazardous potential of certain pollutants has been evaluated in this study. The evaluation was based on a review of data that was not thorough and focused on the physicochemical features of urban effluents and their impact on environments that include aquatic ecosystems. Under some unrealistic circumstances, it is possible that urban effluents that include toxins will not do any damage to the environment. On the other hand, it has the potential to have a significant influence on both aquatic and terrestrial ecosystems in some instances, and it may also contribute to the quantitative and qualitative degradation of water resources, especially in regard to the loss of biodiversity. According to the findings of the physicochemical study of urban effluents, the majority of the chosen pollutants are present in levels that are more than the limitations that are established by the regulations that govern the discharge of wastewater into natural habitats. As a result of the fact that the toxicity of a material is related to its concentration, urban wastewater includes contaminants at measured amounts that have both short-term toxic consequences (such as mortality) and long-term harmful effects (such as malignancies, reproductive problems, and other similar conditions) on living animals like humans. In order to provide support for this concept, we have decided to include the results of toxicity testing as well as field measurements of the biokinetic behaviour of effluents. It has been determined via research on the biological effects of pollutants that urban effluents include substances that are detrimental to human health.

References

1. Académie des Sciences. Contamination des sols par les éléments traces: les risques et leur gestion. Raport no. 42, Paris: Lavoisier Tec&Doc, 1998, 440 p.

2. Alloway B.J. Soil processes and the behaviour of metals. In: Heavy metals in soils. Edited by B.J. Alloway, 2nd ed., London: Blackie Academic and Professional, 1995, pp11-37.

3. Belkhadir E.M. Etude sur l'écotoxicologie des hydrocarbures aromatiques legers en milieu dulçaquicole. *Thèse*. Université de Metz, Metz, 1979.

4. Bell P.R.F. Eutrophication and coral reefs—some examples in the Great Barrier Reef Lagoon. Water Research, 1992, 5:553–568.

5. Birge W.J., Black J.A. et Short T.M. A comparative ecological and toxicological investigation of a secondary wastewater treatment plant effluent and its receiving stream. Environmental toxicology and chemistry,1989, 8: 437-450.

6. Bliss C. I. The toxicity of poisons applied jointly. *Ann. Appl. Biol.*, 1939, 26, 585-615.

7. Boisson J.-C. Impacts des eaux de ruissellement de chaussées sur les milieux aquatiques, Etat des connaissances. Bulletin des laboratoires des Ponts et chaussées, 1998, 214: 81-89.

8. Brown V. M. The calculation of the acute toxicity of mixtures of poisons to rainbow trout. *Water Research,* 1968, 2, 10, 723-733.

9. Calamari D. and Alabaster J.S. An approach to theoretical models in evaluating the effects of mixtures of toxicants in the aquatic environment. Chemosphere, 1980, 9:533-538.

10. Campbell P.G.C. Interactions between trace metals and aquatic organisms: a critique of the free-ion activity model. In: Metal Speciation and Bioavailability in Aquatic Systems. Edited by A. Tessier and D.R. Turner. New York: John Wiley and Sons, 1995, pp45-102.

11. Chocat B., Thibault S., Seguin D. Hydraulique urbaine et assainissement. Lyon:Institut National des Sciences Appliquées, 1993.

12. COHPEDA (Collectif Haïtien pour la Protection de l'Environnement et un Développement Alternatif). Haïti: législation environnementale - Compilation de testes légaux haïtiens sur l'environnement. Port-au-Prince: COHPEDA, 1995, 274 p.

13. Colandini V. Effet des structures réservoirs à revêtement poreux sur les eaux pluviales : qualité des eaux et devenir des métaux lourds. Thèse de doctorat, Université de Pau et des pays de l'Adour, LCPC Nantes. 1997, 171p. + annexes.

14. Cserháti T., Forgács E., Gyula O. Biological activity and environmental impact of anionic surfactants. Environment International 2002, 28:337-348.

15. CSTEE Opinion on "Draft discussion paper on environmental risk assessment of non-genetically modified organism non-gmp; containing medicinal products for human use". Brussels:European Commission, Directorate General, 2001.

16. Deneer J. W. Toxicity of mixtures of pesticides in aquatic systems. *Pest Management Science,* 2000, 56, 6, 516-520.

17. Devez A. Caractérisation des risques induits par les activités agricoles sur les écosystèmes aquatiques. *Thèse*, Ecole Nationale du Génie Rural, des Eaux et des Forêts, 2004, 269p.

18. Diaz-Cruz M.S., Lopez de Alda M.J., Barcelo D. Environmental behavior and analysis of veterinary and human drugs in soils, sediments and sludge. Trends in Analytical Chemistry, 2003, Vol. 22, 6:340-351.

19. Dutka B.J. Foreword. In. Wells P.G., Lee K., Blaise C. (ed.), Boca Raton: CRC Press, 1998.

20. Edwards K.R., Lepo J.E., Lewis M.A. Toxicity comparison of biosurfactants and synthetic surfactants used in oil spill remediation to two estuarine species. Marine Pollution Bulletin, 2003, 46:1309–1316

21. Emmanuel E., Perrodin Y., Keck G., Blanchard J.-M., Vermande P. Effects of hospital wastewater on aquatic ecosystem. Proceedings of the XXVIII Congreso Interamericano de Ingenieria Sanitaria y Ambiental. Cancun, México, 27-31 de octubre, 2002. CDROM.

22. Emmanuel E. Evaluation des risques sanitaires et écotoxicologiques liés aux effluents hospitaliers. Thèse. Institut National des Sciences Appliquées de Lyon, 2004, 260 p.

23. Emmanuel E., Blanchard J-M., Keck G., Vermande P., Perrodin Y. Toxicological effects of sodium hypochlorite disinfections on aquatic organisms and its contribution to AOX formation in hospital wastewater. Environment International, 2004, 30:891-900.

24. Commission Européenne. Directive 91/271/CEE du Conseil, du 21 mai 1991, relative au traitement des eaux urbaines résiduaires Journal officiel n° L 135 du 30/05/1991 p. 0040 - 0052 ...

25. Commission Europénne. Directive 93/21/CEE de la Commission du 27 avril 1993 **-** Rapprochement des dispositions législatives relatives à la classification, à l'étiquetage et à l'emballage des substances dangereuses**.** Journal officiel L 110, 04.05.1993.