

Effect of Industrial Pollution on Fish in River Nile

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Abstract: Industrial wastewater discharged in River Nile exerted negative effects, leading to continuous deterioration of its water quality, and affected greatly River Nile's fish health where they implicated fish tissue, induced changes in behavioral, physiological and histological levels, in addition to reduce the growth and reproduction or even affect the survival of early life stages. The presence of these contaminants limits fish population either directly via mortality or indirectly by suppressing or contaminating the food base. This alters the structure of natural fish community, collapse River Nile water fisheries with the result of declining fish populations and reduced fish production.

[Mohammad M. N. Authman and Mona S. Zaki. **Effect of Industrial Pollution on Fish in River Nile**. *Researcher* 2018;10(1):65-68]. ISSN 1553-9865 (print); ISSN 2163-8950 (online). <http://www.sciencepub.net/researcher>. 10. doi:[10.7537/marsrj100118.10](https://doi.org/10.7537/marsrj100118.10).

Keywords: Effect; Industrial Pollution; Fish; River; Nile

1. Types of industrial pollutants and their effects on water quality and fish productivity

1.1. Types of industrial pollutants

River Nile exposed to many industrial pollutants include heavy metals, pesticides, phenolic compounds, petroleum compounds, detergents, fertilizers, nutrient materials, acidic compounds, wash waters from heating and cooling operations...etc. All these pollutants have exerting damaging effects to ecosystem and fisheries (**Hamza, 2009**).

1.1.1. Thermal pollution

A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural aquatic environment at a higher temperature, the change in temperature decreases oxygen supply, and affects ecosystem composition. Fish and other organisms adapted to particular temperature range can be killed by the abrupt change in water temperature known as "thermal shock" (**Deane and Woo, 2009**).

In River Nile, the thermal pollution may occur due to the hot water arrived to it at electric stations as a result of using the Nile water through the cooling system of the electric stations (**Elewa et al., 2001**).

1.1.2. Heavy Metals

In fact, the trace quantities of metals present in water may be of natural origin. Heavy metals are dispersed throughout the modern environment mainly as a result of pollution from a variety of industrial sources, such as galvanizing, electroplating, batteries, cement, chlorine, caustic soda, electrical conductors, manufacture of alloys, pigments and paint, leather industries, rubber, textiles and chromium factories. Entering these metals to aquatic ecosystem possess a serious threat due to their toxicity, long persistence

and bioaccumulation in the food chain (**Abdallah, 2012**). Fish, is the higher level of the food chain, accumulate large quantities of these xenobiotics. However, this accumulation depends upon their intake and elimination from the body (**Abdallah and Morsy, 2013**). Heavy metals can be taken up into fish either from ingestion of contaminated food via the alimentary tract or through the gills and skin (**Drevnick et al., 2006**).

Essential metals such as iron, copper, zinc and manganese play a vital role in biological systems, whereas mercury, lead and cadmium are toxic, even in trace amounts. Interestingly, the essential metals can also produce toxic effects at high concentrations (**Sivaperumal et al., 2007**). Moreover, the toxicity of metals to fish is significantly affected by the form in which they occur in water. The ionic forms of metals or simple inorganic compounds are more toxic than complex inorganic or organic compounds. The toxic action of metals is particularly pronounced in the early stages of fish development (**Vinodhini and Narayanan, 2008**).

1.1.3. Pesticides

In fact, the highly presence of pesticide in aquatic bodies is due to the outfall from pesticide manufacturing factories and runoff from agricultural fields (**Al-Kahtani, 2011**). Pesticides are not highly selective but are generally toxic to non-target organisms such as fish (**Kundat et al., 2010**).

The term "pesticide" is used to include any chemical used to control an unwanted organism. They are characterized by their high lipophilicity, persistence and toxic biological effects in the environment (**Barakat, 2012**). Because of their toxicity, pesticides affect the ecology of the receiving bodies of water and bioaccumulate, affecting fish. In

the majority of cases pesticides have the potential to cause damage to fish. The most toxic pesticides are those based on chlorohydrocarbons (e.g. DDT, dieldrin), organophosphorus compounds, carbamates, substituted urea (herbicides), synthetic pyrethroids, and metallic compounds (fungicides).

Besides the active ingredient, pesticide formulations contain a number of other chemicals which may sometimes be much more toxic to fish than the active ingredient itself (Said and Hamed, 2005). When a pesticide enters the aquatic environment, the active ingredient may undergo chemical and biological degradation. In some cases the degradation products may be more toxic to fish than the original active ingredient (Crestani *et al.*, 2006). For example, parathion is biodegraded to form paraoxon, which is a more toxic compound (U.S.EPA, 2006).

The Egyptian permissible limits according to **Egyptian Environmental Law no. 4 (1994)** stated that the pesticides residue in water should be 0.2 mg/l of individual pesticide.

1.1.4. Polychlorinated biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are a group of toxic and highly persistent organic compounds that consist of 209 congeners differing in the number and position of chlorine atoms on the two coupled biphenyl rings. These compounds have been identified as contaminants in almost all components of the global ecosystem including the air, aquatic and marine sediments, fish, wildlife and human adipose tissue, milk and blood (El-Kady *et al.*, 2007). Commercial PCB mixtures have been used in a wide variety of applications, including dielectric fluids in capacitors and transformers, heat transfer fluids, hydraulic fluids, lubricating and cutting oils, additives in pesticides, paints, copying paper, carbonless copy paper, adhesives, sealants, and plastics (El-Kady *et al.*, 2007).

Polychlorinated biphenyls have a high capacity for accumulation in the bottom sediments and in aquatic organisms depending on their fat content. The limits set by the Egyptian Standards for total PCBs in fish are 1 µg/g fresh wt (El-Kady *et al.*, 2007).

1.1.5. Phenols and phenolic compounds

Phenol and phenolic compounds are ubiquitous pollutants which come to the natural water resources from the effluents of a variety of industries such as coal refineries, phenol manufacturing, pharmaceuticals, industries of resin, paint, dyeing, textile, leather, petrochemical, wood, plastics, detergents, pesticides, petroleum refineries and pulp mills (Zaki *et al.*, 2011, 2012a and Das *et al.*, 2013). Phenols were frequently detected in sugar cane factories effluents as an end product of the organic treatment and hydrolysis of molasses (Eissa *et al.*, 2013). Phenol is lipophilic compounds which has a

high potential for accumulating along the trophic chain. Due to their toxicity and persistence, both the Environmental Protection Agency (EPA) of United States and the European Union (EU) have classified several phenols as priority pollutants (Michalowicz and Duda, 2007).

1.1.6. Oils and refined products

Oils and refined products are responsible for many of the recorded pollution incidents in surface waters (Berthe-Corti and Höpner, 2005). Such pollution arises either accidentally or operationally. Other important sources of oil pollution include the engineering, metallurgical industry, car, truck repair and service stations (Opsahl-Ferstad *et al.*, 2003). In River Nile, houseboats and motorized river vessels wastes are sources of oil pollution besides the accidental seeps from factories around the river. Actually, the constituents of crude oil are complex. It contains aliphatic, alicyclic, polyaromatic hydrocarbons (PAHs), oxygen, nitrogen and sulphur containing substances (Gad, 2011). The Egyptian permissible limits according to **Egyptian Environmental Law no. 4 (1994)** stated that the petroleum hydrocarbons residue in water should be at the following limit: 0.5 mg/l.

1.1.7. Detergents

Detergents are cleaning products derived from synthetic organic chemicals. Surfactants are the components mainly responsible for the cleaning action of detergents. Generally, detergents are xenobiotic compounds which are usually washed into water bodies and are made up of several compounds of which the active components are the surfactants (Ogundiran *et al.*, 2010).

1.1.8. Dyes

Chemical dyestuffs can be present in the effluents from textile production, food processing and paper mills. The toxicity of dyes depends on the physicochemical composition of the water, in water containing considerable amounts of organic matter the dyes are bound to these substances and their toxicity is decreased (Svobodová, 1993).

1.1.9. Fertilizers

Chemical fertilizers are considered one of the most interesting groups of environmental pollutants. They are introduced to the River Nile from industrial effluents of fertilizers factories at much higher rates than necessary for the primary productivity, affecting the living organisms as fish and increasing water eutrophication (Pesakovic *et al.*, 2003).

1.1.10. Hydrogen Sulphide (H₂S)

Hydrogen sulphide occurs in organically polluted waters from the decomposition of proteins. It is also present in industrial effluents including those from metallurgical and chemical works, paper pulp plants, and tanneries (Svobodová, 1993). Undissociated H₂S

is the toxic form. The toxicity of H₂S is dependent on pH because of a reduction in the ratio of the undissociated toxic H₂S to the less toxic HS ions. The toxicity of H₂S decreases with increasing water pH, at pH 9.0 about 1% is undissociated; at pH 6.7, 50%; and at pH 5, approximately 99% is present as H₂S. Hydrogen sulphide toxicity, especially with juvenile fish stages, is strongly influenced by temperature (Smith and Oseid, 1974).

1.1.11. Chlorine (Cl)

Active chlorine can be discharged into water courses from textile, food and paper industries (Boyd, 1990). Also, steam electric generating plants use chlorine as an algicide and fungicide to prevent slime build-up that decreases the efficiency of the cooling system (Bass et al., 1977).

1.1.12. Cyanides

Cyanides do not occur naturally in waters; it is commonly found as a contaminant in wastewaters from various industries including metal cleaning, plating, electroplating, metal processing, automobile parts manufacture, steel tempering, mining, photography, pharmaceuticals, thermal processing of coal, ore leaching, plastics, etc. (Chu et al., 2001; Dash et al., 2009). Also, illegal cyanide fishing is one of the major sources of cyanide pollution in aquatic environment (Authman et al., 2013). The US Environmental Protection Agency considered cyanide is a priority pollutant and proposed a freshwater acute and chronic cyanide criterion as 22 and 5.2 mg/l, respectively (U.S.EPA, 2009).

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