



## Review Paper

# Distribution and assessment of pesticide residue contamination level in fish from Indian rivers and their residual impact on environment: A review

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## Abstract

*Pesticides are major problem of environmental pollution in the river, lake, ponds, and many estuary ecosystems. Pesticides are used worldwide for the purpose of agricultural consumption and control the pest and insect. Previous widespread use of pesticides in the past and constrained current practice resulted in the river pollution. Most of the Indian rivers pass over a large number of villages, cities, agricultural fields and some of the industrial areas. Therefore, a large portion of wastes and sewages produced from these different areas goes into the rivers. The rivers search out totally contaminated due to release of hazardous substances, dyes, fertilizer and other toxic materials. Most of the hazardous chemicals do not mortify; therefore contaminant stabilizes in the aquatic system. Almost all of the pollutants detected in river fish were mostly banned pesticides, which should be dealt legally.*

**Keywords:** Organochlorine pesticides (OCPs), organophosphorous pesticides (OPPs), river fish samples, environmental health risk assessment.

## Introduction

Environmental pollution by pesticides is a very dangerous problem for aquatic and bio-aquatic ecosystem; however pesticides are also helpful to farmers for agricultural crop production. India is one of the main production and consumption center of pesticides because most of the food and vegetables growing and export activities are carried out over here<sup>1</sup>. Pesticide contamination of river water has been well accepted as a worldwide problem for the health risk evaluation for the environment. According to World Health Organization (WHO) information, most of the developing countries are using about 20% pesticides<sup>2</sup>. Major role to polluting environment by pesticides when released into the bio-aquatic system. The harmfulness of pesticide to organism usually depends on the amount present in the environment<sup>3</sup>. Pesticides play main function in chronic damage and obtain in a number of pathological routes. The altering cell membranes structure of lipoproteins affected by accumulation of hazardous chemicals which is in control for their mixed concentration in tissues<sup>4</sup>.

Today, Indian rivers are one of the greatest polluted rivers in Asia. According to the literature survey of India and other countries, most of the rivers were contaminated with hazardous chemicals above the limits of Environmental Protection Act standards. The most popular rivers of India are Ganga, Yamuna, Brahmaputra, Kaveri, Godavari, Gomti and Hooghly rivers. All these rivers are contaminated with pesticides. Most of the countries have banned OCPs due to the possible toxic effects to human and their impact on environment<sup>5</sup>.

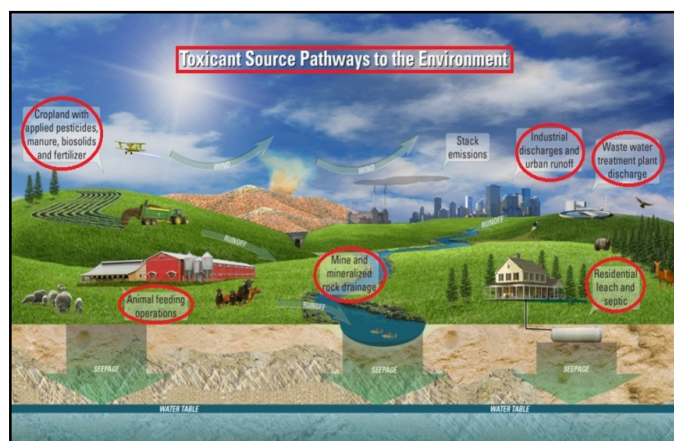
## Sources of the pesticides in the environment

The main source of pesticide discharge into the bio-aquatic system is due to their production, exposure and lack of careful handling in farmland, which leads to contamination of water which is harmful to the human health and aquatic environment<sup>6</sup>. Pesticides enter in the river, lake or estuary by the leaching from farming runoff and waste deposits through atmospheric deposition (Figure-1). The conditions of environment like water, soil, air and temperature can be useful to determine the accumulation, transport and distribution of pesticides in the associated media. Many biological and ecological factors are responsible for the long term accumulation of pesticides<sup>7</sup>. River water and sediment is natural sink serve as environmental reservoirs for pesticides. Because of their more persistence and low mobility, pesticides contaminants to biotic system as a result of accumulation of sediments<sup>8</sup>.

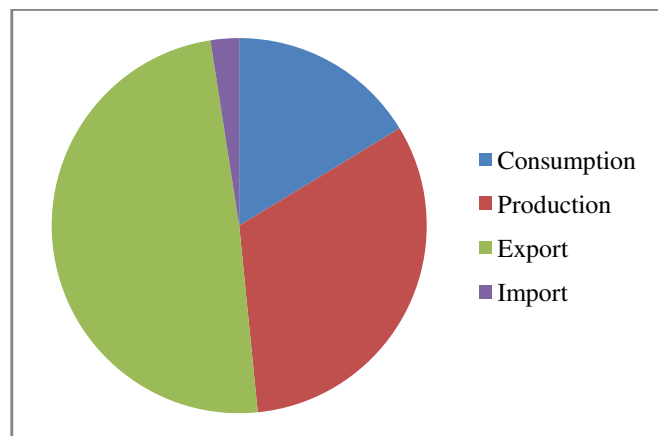
## Production and consumption of OCPs in India

Production and requirement for vegetables and fruits as a result of increasing population has led to significant rises in the consumption of a wide range of pesticides in agriculture sector. Some quantity of applied pesticides reaching the target organism and the remaining bulk contaminating the soil. Long term use of these toxic substances has given rise to several short and long term adverse effects to human. Some of the studies disclose that infant is more at risk to organophosphorus pesticides at less concentration. It indicates that there is a need to monitor OPPs in the field<sup>9</sup>.

Pesticides are hazardous chemicals; its pollution is a serious problem in India<sup>10</sup>. Pesticides are generally used for the purpose of agricultural activity but it come into human life directly or indirectly<sup>11</sup>. India manufacture pesticides on large scale export and use some of toxic pesticides like DDT, hexachlorocyclohexane (HCH) and pentachlorophenol (PCP). A large amount of endosulphan is produced and that is used for the purpose of rubber and cashew nut plantation in Kerala state. In Haryana, the state of India many samples were analyzed and detected to be contaminated with OCPs residues in milk, butter and other samples. In India since 1987, DDT was banned for the purpose of agricultural use<sup>12</sup>.



**Figure-1:** Toxicant source pathway to the Ecosystem.



**Figure-2:** Showing the pesticide production, consumption, export and import during the 2010 in India (MT).

DDT and HCH pesticide residues also found in potable water of regions of Haryana; India. Approximately 139,000 MT pesticides are produced yearly in India. Consumption and production of pesticides in 2010 was observed as 41,822 and 82,185 MT respectively. In 2010, the export and import of pesticide was observed 125,818MT and 6269MT in India respectively (Figure-2). Mainly two types of grades are produced by Indian pesticides industry, in which the first is a technical grade and second formulated<sup>13</sup>.

## Effects and toxicity of pesticides on Human health

The effects of pesticides may be caused by inhalation, skin contact and ingestion; these are the main ways to affect human health, in case of inhalation, breathing of pesticides during the agricultural activity like control the pest, kill insect on field or crop production, Skin problem may be caused by handling of pesticides during the control of pest to kill insect without gloves. Ingestion is also a main health risk to human beings, as pesticides are often consumed as a contaminant in water and fish. The effects of pesticides are the changes of pulmonary, hematological morbidity, inborn deformities and immune structure deficiencies. The toxicity of pesticide means extent rate of harm in individual, this may affect whole organism like an animal, bacteria, plant or else affect the subcomponents such as lungs<sup>14</sup>.

## Effects and toxicity of pesticides on ecological system

Pesticide residues enter in to fish during bioaccumulation period; these contaminants cause physiological changes to fish species such as metabolism disturbance. The distribution of such chemicals in aquatic system mainly depends on solubility of the molecules in water<sup>15</sup>. Aquatic systems play significant role in transferring pesticides to humans via food webs. Pesticide residues are extensively dispersed in environment, so necessary to recognize the contamination in water system<sup>16</sup>. OCPs compounds are highly toxic substances. DDT is sprinkled in the public places. HCHs have worldwide issues because of wide toxicity. The bio aquatic system having probable harmful impact on human beings. HCHs isomers are found to be accumulated in food chain which is a risk to environment<sup>17</sup>. Acute toxic effects may influence the reproduction of bio aquatic species, primarily, the disturbance of predator-prey link and damage of biodiversity. The concentration of these pesticides is increasingly magnified in fish tissues and they are shifted up in the food web<sup>18</sup>. Due to pesticide poisoning death of fishes were reported by Central Inland Fisheries Research Institute (CIFRI) from Karola River, Jalpaiguri West Bengal, India<sup>19</sup>.

The enzyme and hormone-disrupting changes have been caused by pesticides on fish and other aquatic organism. Some of the fishes are very sensitive to hormone and enzyme disruptors. In most of the studies reported, the changes have been shown in fish and other aquatic organism by chronic exposure of pesticides, such as inhibition of enzymatic activity, behavioral and physiological changes. Some of the organs for example liver, kidney, brain are mainly at a risk, have also been affected due exposers of pesticides, changes in metabolic conditions and the symptoms of fish abnormalities like problem in respiration, convulsions and changes in locomotion. Endosulfan was found to be very toxic to the tadpoles of three anuran amphibian tadpoles near Barak Valley, Assam. In the case of pyrethroid compound, fishes such as guppies and mirror carp were contaminated with deltamethrin. A high level of synthetic

pyrethroid cypermethrin was found in fish (*Oryzias latipes* and *Daphnia*); these compounds are very toxic for fish and other aquatic organism. *Esomus danricus* was found to be very sensitive to malathion compound<sup>20</sup>. Some of the organochlorine pesticides are major oxidation products such as endosulfan sulphate, and sediment as a result of biological transformation by bacteria. Severe contact to OCPs such as endosulfan, at ecosystem surface water and food chain was found to cause impacts on significant biological parameters, usually<sup>21</sup>.

### Contamination of pesticides in river fish

The distribution and persistence of banned hazardous were found in fish of Indian river (Table-1). Saravana's report, showed endosulfan in prawn *Macrobrachium malcolmsonii*. Endosulfan is very toxic substance for living organism; prawn is affected by exposure to endosulfan<sup>22</sup>. Rivers and lakes are contaminated by industrial effluents and pesticides can harmfully affect the prawn fishery. The behavioral physiological changes may occur in prawn *Macrobrachium lamerri* by toxic pesticides in fresh water. The changes of locomotor activity and neuromuscular junction, causing excitation, paralysis and convulsions have been seen in prawn<sup>23</sup>. The presences of OCPs in worldwide levels, fish samples were detected in Ero river, Nigeria<sup>24</sup>. For the investigation of  $\Sigma$ HCH and  $\Sigma$ DDTs residues in fish samples of El-Khairia city Egypt, the samples were collected and analyzed from local market and the presence of OCPs residues in fish specimens were detected<sup>25</sup>. Concentration of OCP residues in muscles of fish specimens were found from Istanbul Strait and predominant substance dieldrin was found<sup>26</sup>. Zelickova<sup>27</sup> reported, the concentration of  $\Sigma$ DDTs and  $\Sigma$ HCH were found in fish mussel's samples of Nove Mlyny reservoirs in southern Moravia, Czech Republic on Dyje river, in which  $\alpha$ -HCH was the predominant isomer<sup>27</sup>. The distribution level of persistent OCP residues were investigated in fish tissue samples from Zhaoyuan, China<sup>28</sup>.

Amount of Organophosphorus pesticides (OPPs) (chlorpyrifos, diazinon, fenitrothion and dichlorvos) were investigated in fish samples of four kinds of different species from Alau dam, Konduga Borno state Nigeria, by using GC/MS Shimadzu (GC-17A) with electron capture detector<sup>29</sup>. Chlorpyrifos was detected in biota samples (algae, fish and daphnia) from Ebro river basin, Spain<sup>30</sup>. Masia<sup>31</sup> reported, the contamination of OPPs in fish samples of Guadalquivir river<sup>31</sup>. The concentration level of carbofuran, deltamethrin and endosulfan were found in fish tissue samples from Ravi river, Pakistan<sup>7</sup>. The presence of diazinon residues was found in fish (*Chrysichthys furcatus* and *Tilapia zilli*) specimens of Warri river Nigeria<sup>32</sup>. Presences of pesticides were found in fish tissue samples of Indus river<sup>33</sup>. Belenguer<sup>34</sup> reported, the presence and distribution of OPP residues such as chlorpyrifos, dimethoate, ethion and diazinon in fish samples of Jucar river, Eastern Spain. The presence of chlorpyrifos, dichlorvos, propiconazole, fenitrothion and diazinon residues were observed in fish (Lagoon Tilapia) specimens from Lagoons: Ghana<sup>35</sup>. During study of persistent

OPP, pyrethroid and carbamate residues have been detected in fish (*Prochilodus costatus*) samples of Sao Francisco river, Brazil<sup>36</sup>. A high concentration of organophosphorus pesticides was also found in fish samples from Tripoli local market at Libya, and results showed that 4.7611ng/g dimethoate was present, which is higher than maximum residues limits, according to WHO<sup>37</sup>.

**Table-1:** Persistent organochlorine pesticides residue ranges in different fish species from Indian River.

Location	$\Sigma$ DDTs (ng/g)	$\Sigma$ HCH (ng/g)	Ref.
Mahi River, Gujarat	BDL-850.30	BDL-962.89	38
Tighra Reservoir Gwalior	ND-1.68	ND	39
Kaveri River	BDL-12.3	2.1-51.7	40
Ennore creek, Chennai	ND-5.83	ND-2.34	41
Ganga River, Kolkata	ND-13.23 ppm	ND-8.31 ppm	42
Fresh water, Punjab	ND-0.014 mg/kg	ND-0.007 mg/kg	43
Gomti River, Lucknow	ND-8.60	ND-4.38	44
Ganges River, Haridwar	3700	110	45
Ganges River, Kanpur	300	77	45
Ganges River, Allahabad	120	57	45
Ganges River, Farakka	60	28	45
Ganges River, Patna	1300	110	45
Ganges River, Patna	160	77	45
Ganges River, Patna (Dolphin)	13000	610	45
Mariadhar River	31000	860	45
Ganges River, Chhapra	64000	1100	45
Ganges River, Patna	63000	1100	45
Ganges River, Patna	30000	1900	45
Ganges River, Patna	21000	1900	45
Kaveri River	0.05-3.31	0.07-74.34	46
Kaveri River	0.05-3.28	0.04-54.23	46
Ganges River, Varanasi	5891.63, 2018.19	3535.72, 2428.28	47
Ganges River, Basin	7.58, 3.34	3.06, 1.36	47
Gomti River, Jaunpur	7582.68, 3338.9	3061.12, 1360.24	47
Gomti River	5.891, 2.018	3.54, 2.43	47
Market Fish, Ludhiana, Punjab	11.00	18.00	48

ND=Not detected, NS=Non stated, BDL= Below Detection Limit.

## Conclusion

Pesticide residues detected in almost all the rivers, though banned, but they were now continuously detected in environmental matrix such as river water, fish and sediment in different regions of India. According to Bureau of Indian Standard (BIS), the maximum concentration of pesticide residues in potable water should be less than 1000ng/l for the drinking water. The pesticides which have been banned in India, according to Environmental protection Act (EPA) under Section 5 of the Insecticides Act, 1968, are still detected in the environmental samples which indicates the illegal use of these pesticides and illegal production, which is a crime. There is a need of monitoring plan and legal amendments should be maintained to avoid pollution. Environmental pollution by hazardous chemicals and other banned chemicals in natural ecosystems have been a major problem, since some of the OCPs are persistent and bioaccumulated in aquatic system, which may cause dangerous effects on human as well as animal health. Literature review showed that highly toxic pesticides are still being used and there is an urgent need of an enforcement of rules to control the production and application of such pesticides.

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