Indiscriminate pesticide use for fishing in the River Ganga raises alarm

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The usage of synthetic pyrethroid pesticides in harvesting crustaceans and their impact on vast open water systems have been studied less. Here, we briefly review the rampant use of pesticides targeting lucrative giant freshwater prawn Macrobrachium spp. in the lower stretch of the River Ganga in West Bengal, India. This is practised primarily by illegal fishers, releasing commercially available liquid pesticides into the river water. Fish caught by applying such toxic chemicals can be dangerous for human consumption. In addition, the irreversible adverse impacts of this illegal fishing on aquatic ecosystems warrant stringent action plans by the government and environmental agencies to protect the aquatic flora and fauna.

The effect of pesticide exposure on aquatic ecosystems has been an important area of research for a long time. Research has shown that synthetic chemicals have led to imbalances in fish composition and abundance at an alarming rate. The persistent nature of the chemicals used for quick fishing practices manifests threats to the aquatic ecology as a whole. Fish harvesting with synthetic pesticides enhances catch efficiency and overall quantity expeditiously. Risks associated with the application of ichthyotoxins and their impacts on freshwater ecosystems are prevalent in several countries in Africa, Asia and some parts of Europe[1]. River Ganga, the longest river in India, is a transboundary river whose ichthyofaunal diversity has been well-documented for the past 100 years. The River Ganga has nourished a vast population of fish for centuries, and the majority of the fish are harvested using gill nets, cast nets, passive fish traps, or occasionally plant-based fish poisons. The mischievous practice of fishing with pesticides poses serious harm to the environment and society. Through conversations and discussions related to the fishing activity, pertinent information was gathered from the fishermen who continue to fish the River Ganga daily. According to the information gathered from the fishermen, there is continuous poaching in the lower and some areas of the upper Hooghly estuary, using pesticides belonging to the synthetic pyrethroid group. This is particularly prevalent in areas extending from Nabadwip to Balagarh (23°20′41.86″–23°6′46.79″N to 28°24′18.18″–88°22′33.89″E) (Figure 1) in West Bengal, India. However, the use of pesticides for fishing in the River Ganga has not been made public. Hence, we conducted surveys with the participation of local fishermen to determine the prevalence of this detrimental practice across the River Ganga. We believe this information offers valuable insights into the challenging issues associated with illegal fishing and its consequences on the ecosystem.

The survey data on the use of these chemicals for fishing indicates that this practice is very common in the lower reaches of River Ganga. This malpractice occurs within a gap of two weeks. Previously, endosulfan was widely utilized for this purpose, but it was banned in India in 2011. Nowadays, synthetic pyrethroid pesticides such as cypermethrin and deltamethrin are widely used under various brand names for fishing (Figure 2). As per the representation of the local communities in the studied area, illegal intruders appear from neighbouring areas, specifically the villages adjacent to the river. They target the lucrative freshwater prawn (*Macrobrachium* spp.), which commands high prices in the market. Apart from this, a variety of Small Indigenous Fish species are caught rampantly as the bye catch, including *Puntius* spp., *Gudusia chapra*, *Salmostoma*

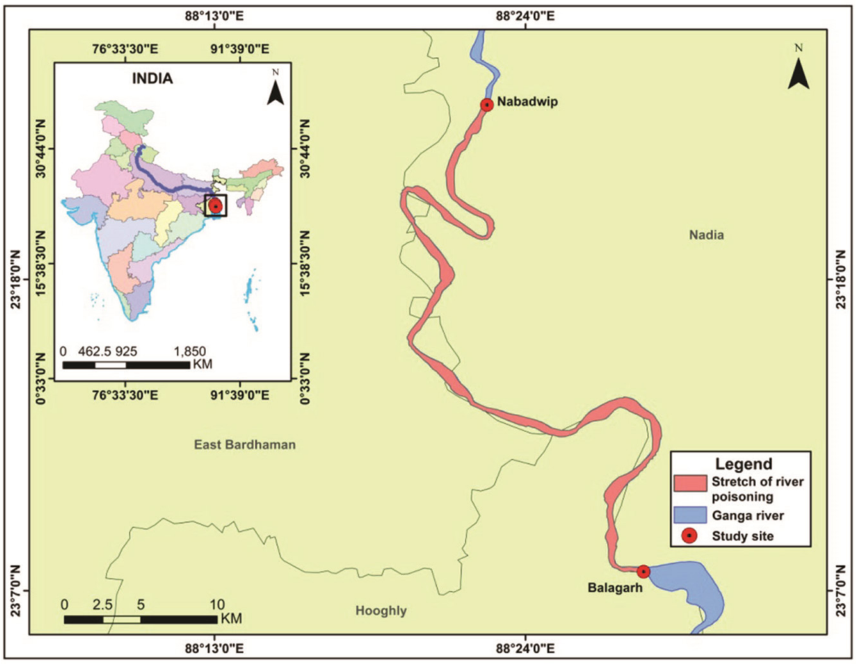

Figure 1. Location of the study sites in the River Ganga.

Figure 2. Local branded pesticides used for illegal fishing practices.

bacaila, *Cirrhinus reba* and other small catfishes (*Heteropneustes fossilis*, *Eutropiichthys vacha* and *Clupisoma garua*). During the high tide, when the water level rises, illegal intruders manually disperse the chemicals in the river. The fishing operation lasts 4–5 h close to the banks of the river, where the flow is generally lower than the mid-channel. These pyrethroid pesticides trigger 'knock down' action in crustaceans, reducing resist ance in the sodium channel of the central nervous system and inducing them to jump above the water surface. A single harvest may yield 5–6 kg of fish, with 60% of the catch being crustaceans. Similar findings were also reported in the Nicaragua river throughout the year, where corn flour mixed with pesticide are enticed for luring prawns and crabs[2]. Pesticides dumped into river water allegedly cause immediate negative consequences, such as unpleasant odours and unsafe fishing. Moreover, the invasion of non-natives into the fishing zone raises concerns about the risk of survival and even ruins communal harmony.

Although researchers have documented the presence of certain pesticide residues in fish and in the surface waters of the River Ganga, the frequency and deliberate use of pesticides for fishing are still unaddressed. The poisoning harms larger fishes and affects smaller fishes, frogs, snakes, crabs, shrimps, aquatic insects and microorganisms. They might also cause mutations in amphibians and insects. Moreover, juvenile fishes are more susceptible to these chemicals, and such detrimental effects on juvenile fishes and reproductive adults may threaten river fish population dynamics. The threat of bioaccumulation looms as birds and otters consume poisoned fish while wild animals drink water from poisoned rivers. A huge portion of the population uses this river water for drinking, which would severely affect human health. Our recent study on detecting synthetic pyrethroid pesticides in fish tissues collected from the River Ganga (Farakka and Balagarh stretch) (Table 1) found that nearly every fish species was contaminated with specific pesticides. However, their concentration was found to be below the limits to pose any risk to human health. Furthermore, none of the synthetic pyrethroids was detected in any of the water samples from the study area, except bifenthrin (0.03 μg/l). This could be due to the high photo instability of pyrethroids. On the other hand, prolonged exposure may be the reason for their accumulation in fish. Our recent study also demonstrated that long-term exposure to cypermethrin, even at an environmentally relevant dose, may affect the reproductive potential of fish (Table 2). Therefore, fishermen have been warned to be vigilant and avoid eating contaminated fish. The practice is recognized, and no enforcement

Table 1. Residues of synthetic pyrethroid pesticides in fish tissues (μg/kg w/w) and water (μg/l) from the River Ganga (Farakka and Balagarh stretch), India

Fishes	λ cyhalothrin	Fenvalerate	Bifenthrin	Σ pyrethroids
Rita rita	3.39 ± 0.01	2.71 ± 0.03	2.66 ± 0.05	8.76
Tenualosa ilisha	3.48 ± 2.46	2.83 ± 2	2.67 ± 0.51	8.99
Labeo rohita	6.97 ± 3.69	4.96 ± 2.65	9.60 ± 7.5	21.52
Notopterus notopterus	3.79 ± 1.9	2.77 ± 1.39	2.85 ± 1.45	9.42
Labeo calbasu	3.71 ± 2.04	2.79 ± 1.53	2.75 ± 1.51	9.25
Sperata seenghala	3.43 ± 2.42	2.75 ± 1.95	2.71 ± 1.92	8.89
Cirrhinus sp.	BDL	BDL	BDL	BDL
Labeo catla	7.46 ± 0.37	5.15 ± 0.14	8.17 ± 0.08	20.79
Hypophthalmichthys molitrix	7.49 ± 0.4	5.14 ± 0.09	7.99 ± 0.55	20.62
Macrobrachium rosenbergii	BDL	BDL	BDL	BDL
Puntius sp.	11.84 ± 7.35	5.17 ± 3.01	7.04 ± 5	24.05
Lepidocephalichthys guntea	BDL	BDL	BDL	BDL
Channa punctata	5.54 ± 2.89	3.94 ± 1.63	5.61 ± 3.73	15.08
Water	BDL	BDL	0.03	0.03

Source: Ref. 3; BDL, Below detection limit.

Table 2. Endocrine disruptive toxicity of cypermethrin to environmentally relevant concentration (0.7 μg/l) in *Labeo catla* (Ham, 1822)

The alterations in circulating sex steroids, genes and hormones linked to the hypothalamic-pituitary-gonadal axis and stress response	
GnRH in brain tissue	Downregulation (0.52 fold)
Kiss1	Downregulation (0.98 fold)
Kiss2	Downregulation (0.15 fold)
Fish gonadotropin *FSH*	Downregulation (0.50 fold)
Yolk precursor protein *Vtg*	Downregulation (0.40 fold)
Superoxide dismutase activity	20.83%, 14.28% and 17.49% increment in serum, liver and kidney tissues respectively
Catalase activity	16.15%, 33.86% and 22.95% increment in serum, liver and kidney tissues respectively

Source: Ref. 4.

action has yet been taken against it by any administrative bodies.

The specific factors revolving around this course of action reside particularly in the simple and sure harvest of the crustaceans, less effort and related fishing expenses. A concerted effort is required to curtail this despicable activity in the country's most revered river system. More awareness should be raised by highlighting the harmful aspects and enforcing the law prohibiting toxic fishing in the River Ganga. Measures like strict fishing regulations and continuous outreach programmes are necessary to maintain the natural river system. There is little or no information in the scientific literature. So, more emphasis should be placed on the research, for proper monitoring, understanding why it persists, to what extent it is carried out, and quantifying and assessing the level of exposure and risks to human health.

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Time to move to higher gears for better disaster management

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Since the 2005 National Disaster Management Act, India has improved disaster management, notably reducing deaths through early warning systems. However, economic losses from disasters are rising. Shifting to impact-based forecasting could enhance responses by predicting specific impacts, like flooded areas, enabling targeted actions and better disaster management.

Natural disasters cannot be prevented, but with adequate preventive, precautionary and mitigation measures, we can significantly reduce the intensity of adverse impacts of natural disasters. For instance, during 1999, a super cyclone created havoc in Odisha (Orissa), resulting in the death of about 9843 people and causing severe destruction of infrastructure. But, in 2013, a cyclone of similar intensity, named '*Phalin*', resulted in no more than 47 lives lost. Such a drastic reduction in the death rate was possible due to improved efforts of disaster risk management by all the stakeholders. Similar progress has been made in reducing the loss of lives due to other natural disasters. This significant progress can be attributed to the evolution of an effective and efficient management structure that was developed by the Government of India. One can identify different phases in the evolution of the Disaster Management, as follows.

Phase I – till 1990: During this period, there was no specific approach towards disaster management and the practices followed by the colonial government were generally followed. A series of disasters, such as the famines of 1900, 1905, 1907 and 1943, and the Bihar–Nepal earthquake of 1937, led to the evolution of a relief-based approach. In the event of a disaster, during the post-disaster phase, a Relief Department under a Relief Commissioner for each province used to be set up, with overall control by the Central Relief Commissioner. Relief Commissioners were to ensure the functioning of 'Food for work' programmes, while the role of the Central Relief Commissioner was limited to the dispatch of material and resources to the affected areas. During the post-independence times, the same policy of relief was continued. However, through Five Year Plans, disasters like floods were highlighted under 'Irrigation, command area development and flood control'. For instance, the construction of multipurpose river projects was undertaken to control floods on the one hand and provide irrigation to large tracts of land on the other, but the disaster management remained as activity-based, functioning under the Relief Departments. The primary responsibility of managing the disasters remained with the respective state governments, while the role of the central government remained largely supportive in terms of physical and financial resources like transport, warning, the interstate movement of food grains, etc.

Phase II – from 1995 to 2005: During this phase, there were significant international developments in the field of disaster management initiated by the United Nations Organization, such as the declaration of the 1990s as the International Decade of Disaster Reduction; United Nations Conference on Environment & Development, Brazil, 1992 (AGENDA 21); Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation 1994; Hyogo Framework for Action (HFA) 2005–2015 with a bearing on domestic disaster management policy. With the enactment of the Disaster Management Act in 2005, disaster management has undergone a paradigm change from earlier Rescue and Relief to a proactive institutionalized structure, from a single faculty domain to a multi-stakeholder setup, and from a relief-based approach to a 'multi-dimensional pro-active holistic approach