

The possible consequences of perchlorate accumulation in fresh water bodies due to floods and its effect on fishes

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Despite the catastrophic notoriety, floods bring in some inherent benefits. Floods and landslides play an important role in modifying several features and dynamics of natural ecosystems. Soil erosion is an accompanying process of floods. Floods transport the eroded soil containing organic matter and minerals down to low lying areas (Poff et al., 1997), mostly near river mouths resulting in the formation of highly fertile delta and sand bars. During floods, the river overflows and submerges a large area of land and fills wetlands, thus facilitating groundwater recharging. Flood water also establishes connectivity between aquatic habitats. For many species, floods trigger breeding, migration and dispersal.

There are different routes through which aquatic pollution happens. Based on the source, pollution can be of two types namely point source pollution and nonpoint source pollution. In point source pollution there is a direct contamination of waterways. An example is the discharge of industrial waste from a factory drain into a river. When pollutants are washed along from a distant place by runoff due to heavy rains and floods into a water body, it is called nonpoint source pollution. Pollution caused by storm water runoff from nonpoint source is one of the most serious threats to aquatic systems. As the flood water runs over and through the watershed, it picks up and carries several contaminants and pollutants such as plastic grocery bags, pesticides, fertilizers, detergents etc together with eroded soil. These contaminants then get into lakes

and oceans. The pesticides from plantations and agricultural fields enter the water bodies during floods by the same mechanism. In such areas, the storm drains and roadside ditches often contain stagnant water characterised by low oxygen and polluted with organic waste, plastic and other pollutants. Heavy rains and floods clean up the drains and flush pollutants and soil into nearby rivers and streams. Rivers in Kerala are found to be highly polluted due to thoughtless dumping of slaughter and organic wastes. They have also become the sites for discharge of sewage and a variety of pollutants from both industrial and domestic sources. Nonpoint source pollution is associated with the formation of large 'dead zones' (areas with minimal oxygen) in the ocean and poses threats to the marine life and especially to the coral reef ecosystems around the world.

Increased delivery of water into fresh water bodies by floods results in a decrease in water conductivity (a measure of the concentration of ions in the water) in tandem with a change in pH, depending on the nature of the contributing water sources. The temperature of the receiving water body may also be affected by the gushing water, although the degree and direction of influence vary according to the nature of the source of receiving waters. The strong erosive power of water during floods increases the movement of sediment as well as mobilise pollutants within the sediment (e.g. heavy metals, pesticides, organic compounds) which may be transported along with the flood water. During floods, larger fish tend to seek refuge in areas of lower water velocity, often moving into backwaters or side channels. When overbank flooding occurs, fish will colonise in the floodplain and may get trapped as the water recedes. However, the small fish, particularly the early life stages (eggs and fry) are most vulnerable to the impacts of floods as they lack the strength to swim to areas of low flowing water. Other effects of severe flood include loss of habitat and biodiversity, dispersal of weed species, pollution, lower fish production, changes in the structure and functions of wetlands etc.

The severe flood that happened in Kerala on the month of August 2018 resulted in the overflowing of several rivers and lakes including the major rivers, Periyar, Pampa and Bharatapuzha. Aluva is one of the major Industrial centres of the state situated on the banks of river Periyar. The ammonium perchlorate experimental Plant (APEP), situated on the

banks of river Periyar in Aluva, has been dumping the toxic effluent into the Kochi back waters. It is found that the samples taken from the loading point have a high level of toxic pollution with a pH value of 1.2. Several studies near Keezhumad have revealed that here, the wells are contaminated with perchlorate. The famous Sivarathri festival is celebrated on the sand banks of Periyar, with fireworks. So is the case with Thrissur pooram. In general, it can be said that fireworks are a part of almost all temple festivals (Utsavams and Poorams) as well as some church festivals. Perchlorate is widely used in fireworks and its use contaminates air, soil and water. There are hundreds of quarries operating in several parts of the State. They also use large quantities of toxic explosives like chlorate and perchlorate for rock cracking

The Impact of perchlorate on water bodies

This study examines the flood related issues of pollution due to perchlorate containing compounds in water bodies. Studies on halo oxygenated acids, such as chlorate and perchlorate assume significance as they are of international concern with respect to water quality. Perchlorate anion consists of a tetrahedral array of oxygen atoms around a central chlorine atom. Perchlorate is a strong oxidizing anion and has recently gained public attention following its detection in well water and drinking water in several areas. Perchlorate is ubiquitous and has been found to be present in soil, vegetation, ground water and also in surface water in several places. The non-volatile and stable nature of perchlorate anion has allowed it to be present in drinking water aquifers. Perchlorate is commercially available as ammonium perchlorate (AP) which is a highly energetic compound. It is used as an oxidizer in solid rocket propellant. It is also used as an oxidizer in flares, pyrotechnics, explosives and numerous other applications. AP is highly water soluble and mobile in aqueous environment. The primary toxicity of this compound is attributed to its effect on disruption of iodide uptake in the thyroid gland owing to its similarity in ionic radius to iodide. Several treatment technologies such as ion exchange, air stripping, carbon adsorption etc. are employed for the removal of perchlorate from contaminated water.

Properties of perchlorate

Perchlorate salts have low vapour pressure and hence cannot volatilize

and oceans. The pesticides from plantations and agricultural fields to enter the water bodies during floods by the same mechanism. In urban areas, the storm drains and roadside ditches often contain stagnant water characterised by low oxygen and polluted with organic waste, plastics and other pollutants. Heavy rains and floods clean up the drains and flush pollutants and soil into nearby rivers and streams. Rivers in Kerala are found to be highly polluted due to thoughtless dumping of slaughterhouse and organic wastes. They have also become the sites for discharge of sewage and a variety of pollutants from both industrial and domestic sources. Nonpoint source pollution is associated with the formation of large 'dead zones' (areas with minimal oxygen) in the ocean and poses threats to the marine life and especially to the coral reef ecosystems around the world.

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