

Review

Fish Kills Related to Harmful Algal Bloom Events in Southeast Asia

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Abstract: Fish kills in Southeast Asia are frequently associated with harmful algal blooms (HABs) and cause significant ecological and economic impacts and can have negative effects on the sustainability of aquatic ecosystems and the fisheries they support. This paper serves as a review of fish-kill events with focus on those related to HABs within the region. It examines the causative algal species, known mechanisms of fish mortality, and socio-economic consequences in order to better understand and manage this threat to sustainable fisheries. Fish kills have been reported across multiple countries within Southeast Asia, with notable hotspots in the Philippines, Malaysia, Singapore, Indonesia, and Thailand. The common harmful microalgal species span a diverse group including dinoflagellates (*Karenia* spp., *Karlodinium* spp., *Margalefidinium polykrikoides*, *Noctiluca scintillans*), raphidophytes (*Chattonella* spp.), diatoms (*Skeletonema* spp. and *Chaetoceros* spp.), and cyanobacteria (*Trichodesmium* spp.). These microalgae lead to fish kills through mechanisms such as hypoxia, physical gill damage, and ichthyotoxin production. Freshwater fish kills linked to HABs have also been documented for the Philippines, but there is no or limited information for the region. Our review highlights the widespread and recurring nature of fish kills, their impact on fisheries and aquaculture, and challenges in managing and mitigating their effects. There are efforts at enhancing management and mitigation using clay and early warning systems. However, it is essential to further improve monitoring efforts, the development and deployment of early warning systems, and viable and holistic mitigation strategies to protect the region's aquatic resources and dependent communities, especially as aquaculture and coastal development are increasing concurrent with a changing climate that can exacerbate the risks of fish kills and HABs in Southeast Asia.

Keywords: aquaculture; dinoflagellates; ichthyotoxic; harmful microalgae; hypoxia; raphidophytes; sustainable fisheries



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1. Introduction

Massive fish kills refer to the sudden and large-scale deaths of fish that can occur in brackish, marine, and freshwaters. Fish kills can be caused by several biotic and abiotic factors. Pollution from industrial waste, agricultural runoff, and improper waste disposal can introduce harmful substances into water bodies, leading to the death of fish and other