Leibniz Association

ZMT LEIBNIZ CENTRE for Tropical Marine Research

HUMBOLDT TIPPING

# Policy Brief 2025/1

# Red Tide Impacts and Adaptation Strategies: Insights from a Participatory Research Process

In 2022, 16 participatory workshops took place along the coast of Peru (Sechura, Paracas and Lima), bringing together fishers, aquaculture operators, government officials and scientists. The goal was to explore the causes and socio-economic impacts of red tides, also known as harmful algal blooms (HABs). HABs occur when phytoplankton proliferates excessively, often forming large, discolored patches in the ocean that can pose significant risks to human activities and ecosystems. The workshops aimed to:

(1) Understand local perceptions of red tides and their socio-economic impacts,
(2) Develop adaptation strategies for an improved management of HABs,
(3) Identify solutions that align with the needs and realities of local communities and key sectors.

Participants developed fuzzy cognitive maps to illustrate the complex relationships between social, economic and environmental factors related to harmful algal blooms (see map below). The causal weights assigned to these relationships enabled a ranking of the perceived key drivers and impacts, and also informed the simulation of potential outcomes for the adaptation strategies. The individual maps were then aggregated into a single model representing the collective perspective of all participants on red tide impacts and adaptation strategies.

## IMPACTS OF RED TIDES

(Harmful Algal Blooms, HABs)

**Loss of scallop production** due to oxygen depletion.

**Socio-economic consequences on mariculture**, such as closures, lower income, debts and loss of jobs.

**Indirect consequences on the communities:** increased competition for marine resources, impacts on related sectors (processing, transport, restaurants) and seasonal migration.

**Fish mortality and strandings** due to low oxygen levels, affecting artisanal fishers due to temporary loss of catch.

**Health risks** due to stranding of aquatic organisms and/or toxins.

**High levels of toxins** can lead to closures and extra monitoring costs, with some cases of human poisoning.

**Negative impact on tourism and recreational activities** due to changes in ocean colour, odours and strandings.

This document summarizes the main findings of the participatory research process, including a comparison of the adaptation options prioritized by different stakeholder groups, as well as the most effective strategies (both implemented and potential) for reducing the impact of red tides. The outlined recommendations are based on the collective model and insights from in-depth focus group discussions.

***We thank all participants for their support and valuable contributions!***

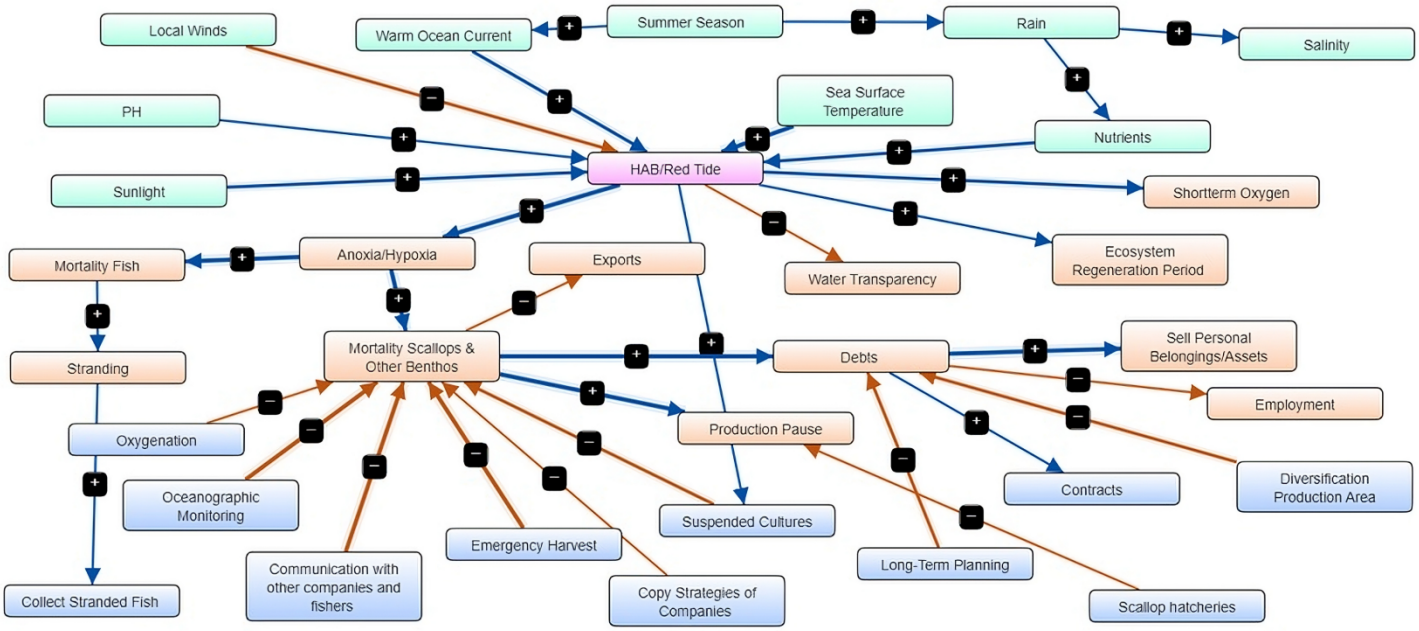


***Figure 1.*** *Example of one of the 16 conceptual maps representing the concepts and relationships linked to Harmful Algal Blooms, identified during a workshop with scallop producers in Sechura: causes (in green), impacts (in red), and adaptation strategies (in blue).*

## ADAPTATION STRATEGIES

The **frequency of red tides is expected to increase** in the future due to climate change and human influence.

During the workshops, **38 adaptation strategies** were identified, most of them related to mariculture activities. Key strategies include toxin monitoring, emergency harvests, income diversification, changes in harvesting schedules, suspended cultivation, and improved transparency in research and monitoring.

→ Despite existing efforts, large-scale mortality due to red tides continues to occur. **Early warning systems and emergency protocols** were seen as primary measures, but have not yet been implemented.

For small-scale aquaculture producers, **income diversification** is seen as the key adaptation pathway.

Large companies have more adaptation options, based on **suspended culture, hatcheries, scientific information & monitoring, in-house infrastructure, robust communication networks and access to financial capital**.

**Key obstacles** – especially for small-scale producers – include late warnings, poor communication of monitoring results, absence of emergency protocols, limited access to processing infrastructure, fragmented governance and a lack of established markets for alternative products.

## RECOMMENDATIONS

1. **Establish an early warning system** with real-time information and clear emergency protocols. This includes higher monitoring frequency in summer months, recommendations on emergency harvests, reduced bottlenecks in processing infrastructure and support for the transition to suspended culture.
2. **Strenghten communication** between actors and ensure practical access to research and monitoring results.
3. **Provide financial support** to enable diversification of activities during months unfavourable to mariculture.
4. **Foster coordination between sectors** like mariculture, fisheries (PRODUCE), public health (MINSA), tourism (MINCETUR) and industries with environmental impact (OEFA), through an inter-institutional committee.
5. **Raise awareness** among the public and key sectors (i.e. health and tourism) about the risks of red tides, including possible health impacts from toxins and mass strandings.
6. **Investigate the role of human-driven coastal pollution in HAB dynamics**, and assess the broader socio-economic impacts of HABs beyond.

IMPRINT

This Policy Brief is part of a series aiming to inform policy-makers on the key results of the ZMT research projects and provide recommendations to policy-makers based on research results.

The series of ZMT Policy Briefs can be found at https://www.leibniz-zmt.de/en/

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