

## ABSTRACT

Coastal regions are complex and dynamic environments where geological, chemical, biological, and physical interactions converge, making them critical ecological and socioeconomic hubs. However, these regions face growing threats from human activities, including industrialization, urbanization, and pollution, leading to habitat loss, biodiversity decline, and degradation of ecosystem services. Estuaries are particularly affected, as they act as vital filters for contaminants entering coastal areas through riverine inputs, atmospheric deposition, and direct discharges. This study focuses on the Bhavnagar coastline in the Gulf of Khambhat, Gujarat, India, an area characterized by significant industrial activity, complex hydrodynamics, and varied tidal patterns. The primary objective is to assess pollution levels and microbial community composition in coastal water and sediment across seven monitoring sites (Ghogha, Kuda, Mithivirdi, Sosiya, Alang, Sartanpar, and Gopnath) during pre-monsoon (PRM), monsoon (M), and post-monsoon (POM) seasons. Physico-chemical parameters and heavy metal concentrations were analyzed using standard methods, revealing notable seasonal variations that align with previous studies along the Gujarat coast.

Key findings include seasonal fluctuations in temperature, pH, total suspended solids (TSS), total dissolved solids (TDS), electrical conductivity (EC), salinity, dissolved oxygen (DO), and concentrations of chloride, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). Heavy metals such as lead (Pb), chromium (Cr), nickel (Ni), and cadmium (Cd) exceeded permissible limits, posing significant risks to both human health and marine life. The study also highlights the importance of sediments in coastal ecosystems, which act as both habitats and sinks for pollutants, particularly heavy metals. Microbiological analysis across different seasons revealed significant spatio-temporal variation, with the highest microbial isolates observed during the PRM season. Morphological, biochemical, and molecular characterization of selected isolates identified species such as *Fredinandcohnia humi*, *Bacillus safensis*, *Bacillus thuringiensis*, *Bacillus horikoshii*, *Bacillus pumilus*, *Bacillus cohnii*, *Bacillus licheniformis*, *Peribacillus huizhouensis*, *Bacillus sonorensis*, *Bacillus haynesii*, *Bacillus cereus*, *Bacillus fengqiensis*, *Priestia flexa*, *Fictibacillus phosphorivorans*, and *Staphylococcus hominis*. This research provides critical insights into the seasonal dynamics of pollution and microbial diversity in the Bhavnagar coast, addressing gaps in scientific understanding and offering valuable information for the sustainable management and conservation of coastal ecosystems in the Gulf of Khambhat.