

# Modelling the Dispersion of Harmful Algal Bloom (HAB) in the Coastal Area of Oman Sea

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**Abstract** The increasingly growing world population and the contamination of rivers and coasts due to human activities have given rise to serious problems in the marine habitats. One of the most recent and challenging issues involves harmful algal blooms also known as red tides. The algal bloom has geographically spread in the entire coastal areas of the world, and the Iranian southern coast is no exception. However, any potential damage in coastal areas can be prevented by accurately predicting the dispersion and advection of the blooming species.

This study intended to examine the dispersion and advection of harmful algal cells through hydrodynamic modules MIKE 3-FM and ECO Lab, which simulated the hydrodynamics and quality of water as well as the distribution of chlorophyll-a across the southeast coast of Iran. After calibration of the model, the results of simulation were adequately consistent with the measured data on variations of chlorophyll-a, i.e. the cause of algal bloom. In fact, the modeling was successful in simulation of currents across the Gulf of Oman in hydrodynamic and quality terms. For validation of model the root mean square error (RMSE) is used. RMSE of calibrated and field data for chlorophyll a values equal to 0.016, obtained under 0.1 indicates that accuracy is very high and also for water level equal to 0.19, which represents the accuracy of hydrodynamic model is good. Since the dispersion of *Cochlodinium polykrikoides* was first observed at mid-April 2009 in the nearest station to the Strait of Hormuz. The bloom spread toward eastern stations of Chabahar at mid-May and then persisted for two months. The results were consistent with those obtained through software modeling on the dispersion of chlorophyll-a, the major cause of algal boom. The validated model in this study can be employed to provide on-time warning and prevent any adverse social and economic consequences.

**Keywords:** Harmful algal bloom, Nutrient, Chlorophyll a, Numerical modeling, Distribution

## 1. Introduction

Harmful algal blooms (HABs) possess potential for extensive negative impacts to fisheries, coastal ecosystems, public health, and coastal economies (Anderson et al., 2015; Van der Lingen et al., 2016). Harmful algae can adversely affect the outputs of seawater reverse osmosis worldwide. This red tide known as harmful algal bloom forced several seawater reverse osmosis SWRO plants in the Oman Sea and Persian Gulf region to reduce or shutdown Operation (Richlen, 2010; Villacorte, 2015). The geochemistry of surficial and core sediments of these regions show various along with flocculation processes have been extensively studied that are indicative of a changing aquatic environment from oxic to anoxic conditions (Karbassi, 1998; Karbassi et al., 2010; Biati et al., 2012; Vaezi et al., 2015; Parang et al., 2013).

In the coastal waters of Iran, as in most sensitive coastal regions of the world, phytoplankton blooms have occurred during the past two decades. When the population of phytoplankton exceeds one million cells per liter of water, algal bloom occurs and the high density of phytoplankton in the water changes its color to green, milky, red, brown, or orange. Among the main contributing factors are rising temperatures and the entrance of chemicals such as nitrate and phosphate caused by human activities (Han et al., 1995; Tang et al., 2004; Anton et al., 2008). A harmful algal bloom caused by *Cochlodinium polykrikoides* happened in September 2008 extending from the south of the Oman Sea to the Strait of Hormuz and the Persian Gulf and lasted for more than nine months (Richlen et al., 2010; Attaran Fariman, 2010; Fatemi et al., 2012).

Coastal waters are being deteriorated by the negative effects associated with the development of societies and industrial activities. Untreated discharge of urban and industrial wastewaters are among the main sources of pollution in coastal waters. (Attaran Fariman, 2010). One of the natural factors in the occurrence of red tide is the rising of warm currents that are rich in nutrients. Based on Herring's theory, winds that blow in the various seasons are one of the main causes of harmful algal blooms. These winds cool surface waters and raise the level of the deeper and warmer waters, which