Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2018.23273

129 (2018) 1–13
October

A model to predict HAB occurrence near desalination plants in the Red Sea

Mohamed N. Gomaa[a,b,*], Mansour A. Al-Hazmi[c], Hatem E. Mohamed[d], David J. Mulla[e], Imen Hannachi[d], Kamel M. Sheikho[f], Ahmed M. Abouwarda[d], Essam A.H. Mostafa[d], Wayne W. Carmichael[g]

[a]*Biology Department, University of Jeddah, Saudi Arabia; email: mngomaa@gmail.com (M.N. Gomaa)*
[b]*Deanship of Scientific Research, King Abdulaziz University, Saudi Arabia*
[c]*Biological Sciences Department, Faculty of Sciences, King Abdulaziz University, Saudi Arabia; emails: mhazmi@kau.edu.sa (M.A. Al-Hazmi)*
[d]*Biology Department, Faculty of Science and Arts—Khulais, University of Jeddah, Saudi Arabia; emails: hatemelhady67@gmail.com (H.E. Mohamed), imenhan@yahoo.fr (I. Hannachi), ahmedabouwarda@gmail.com (A.M. Abouwarda), dressamahmad@gmail.com (E.A.H. Mostafa)*
[e]*Department of Soil, Water and Climate, University of Minnesota, St. Paul, MN 55108, USA; email: mulla003@umn.edu (D.J. Mulla)*
[f]*King Abdulaziz City for Science and Technology, Saudi Arabia; email: ksheikho@yahoo.com (K.M. Sheikho)*
[g]*Department of Biological Sciences, Wright State University, Dayton, OH 5435, USA; email: wayne.carmichael@wright.edu (W.W. Carmichael)*

Received 30 April 2018; Accepted 11 October 2018

ABSTRACT

Normal growth of phytoplankton means gradual growth that allows mixed community to grow and allow a gradual succession of other phytoplankton species with a balanced and high biodiversity. In the contrary, a rapid, large-scale growth of certain species of phytoplankton is defined as harmful algal bloom (HAB). HABs cause water quality issues in fresh, brackish, and marine waters worldwide. In the Red Sea, HABs hinder normal operation of desalination plants and can even lead to their temporary shutdown. This research has already detailed how wastewater discharge from Red Sea desalination plants helps trigger HABs. The primary objective for this paper is to help manage and even mitigate this problem through development of a model to be used along with satellite images and physicochemical monitoring analysis as an early warning system for HABs near desalination plants in the Red Sea. To develop the model, physicochemical data were collected by sampling three coastal areas near desalination plants at Jeddah, Al Shoaibah, and Al Qunfudhah from December 2014 to November 2016. A total of 1,944 water samples were collected. To understand the unique environment of the seawater around the desalination plant that may trigger HABs, 15 parameters were measured. These parameters were divided into two groups, growth indicators (phytoplankton count, chlorophyll, phycoerythrin, dissolved oxygen, and turbidity) and those that might trigger the growth (temperature, conductivity, salinity, pH, total dissolved solid [TDS], nitrate, nitrite, ammonium, phosphorous, and silica). It was found that the highest concentrations of chlorophyll at Al Qunfudhah often exceeded the critical threshold level of 2 to 5 μg/L, which indicates the presence of an algal bloom. However, at Jeddah and Al Shoaibah chlorophyll concentration did not exceed this level. The results showed that higher temperature, salinity, TDS, and pH may promote some HAB species in environments that promote less phytoplankton diversity. Nitrate, phosphorus, and silica were the major nutrients that can trigger HABs. Prediction equations were developed using data from those parameters that promote HAB occurrence.

Keywords: Physicochemical factors; HAB; Algae; Red Sea; Desalination plant; Algal bloom; Saudi Arabia

* Corresponding author.