Harmful Algae 60 (2016) 11–26

Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal

Review

An overview of cyanobacterial bloom occurrences and research in Africa over the last decade

L.L. Ndlela[a,b,*], P.J. Oberholster[a,b], J.H. Van Wyk[b], P.H. Cheng[a]

[a] Council for Scientific and Industrial Research, 11 Jan Celliers Road, Stellenbosch, 7600 South Africa
[b] Department of Botany and Zoology, Faculty of Science, Stellenbosch University, Matieland 7600, South Africa

ARTICLE INFO

Article history:
Received 30 June 2016
Received in revised form 7 October 2016
Accepted 7 October 2016
Available online xxx

Keywords:
Cyanobacteria
Africa
Microcystis
Anabaena
Cylindrospermospis
Climate change

ABSTRACT

Cyanobacterial blooms are a current cause for concern globally, with vital water sources experiencing frequent and increasingly toxic blooms in the past decade. These increases are resultant of both anthropogenic and natural factors, with climate change being the central concern. Of the more affected parts of the world, Africa has been considered particularly vulnerable due to its historical predisposition and lag in social economic development. This review collectively assesses the available information on cyanobacterial blooms in Africa as well as any visible trends associated with reported occurrences over the last decade. Of the 54 countries in Africa, only 21 have notable research information in the area of cyanobacterial blooms within the last decade, although there is substantial reason to attribute these blooms as some of the major water quality threats in Africa collectively. The collected information suggests that civil wars, disease outbreaks and inadequate infrastructure are at the core of Africa's delayed advancement. This is even more so in the area of cyanobacteria related research, with 11 out of 21 countries having recorded toxicity and physicochemical parameters related to cyanobacterial blooms. Compared to the rest of the continent, peripheral countries are at the forefront of research related to cyanobacteria, with countries such as Angola having sufficient rainfall, but poor water quality with limited information on bloom occurrences. An assessment of the reported blooms found nitrogen concentrations to be higher in the water column of more toxic blooms, validating recent global studies and indicating that phosphorous is not the only factor to be monitored in bloom mitigation. Blooms occurred at low TN: TP ratios and at temperatures above 12 °C. Nitrogen was linked to toxicity and temperature also had a positive effect on bloom occurrence and toxicity. *Microcystis* was the most ubiquitous of the cyanobacterial strains reported in Africa and the one most frequently toxic. *Cylindrospermopsis* was reported more in the dry, north and western parts of the continent countries as opposed to the rest of the continent, whilst *Anabaena* was more frequent on the south eastern regions. In light of the entire continent, the inadequacy in reported blooms and advances in this area of research require critical intervention and action.

Contents

* Corresponding author at: Council for Scientific and Industrial Research, 11 Jan Celliers Road, Stellenbosch, 7600 South Africa.
E-mail address: LNdlela@csir.co.za (L.L. Ndlela).

http://dx.doi.org/10.1016/j.hal.2016.10.001
1568-9883/

1. Introduction

Water depletion in developing countries has been a crisis for decades (Falkenmark, 1989). Over the past decade, substantial evidence has been presented on the looming water crisis in Africa. Although social factors and energy generation systems contribute to the strain on water availability, environmental factors are also significant contributors. Some of the factors attributed to this depletion are anthropogenic activity, pollution, phosphorous and nitrogen loading (Vörösmarty et al., 2010). In African countries, the supply of potable water is an eminent issue, with water quality affected by the inadequacy of water purification plants and lack of knowledge in chlorine dosing being some of the reasons (Momba et al., 2006). These issues are further compounded by contamination during storage of purified water from plants to point-of-use stages (Massoud et al., 2010). The contamination of water results from a variety of factors, and a more imminent source of contamination in both reservoirs and water bodies is algal blooms (WHO, 2011).

In nature, excessive phosphorous and nitrogen loading have consequently been found to result in eutrophication, which then cause the proliferation of algae, leading to algal blooms (Carpenter, 2005,Yang et al., 2008). Algal blooms are a natural phenomenon that occasionally occurs with nutrient loading from anthropogenic and natural activity in water bodies. Historically, these blooms were not always considered harmful and were more prevalent in summer months (Mowe et al., 2015). However, with the rise in global temperatures through climate change, there has been a rise in algal blooms, particularly in coastal countries (Oberholster et al., 2009a). Of particular significance are harmful algal blooms (HABs). The phenomenon of harmful algal blooms came to the fore over fifteen years ago, when the simultaneous increase in anthropogenic activity and climate change resulted in an increase in eutrophication and subsequently, algal blooms. These are defined by having a negative environmental impact and are primarily caused by microalgae (Zingone and Enevoldsen, 2000). Although various micro-algal species can be present under bloom conditions, the algae of concern are cyanobacteria, also known as blue-green algae. Cyanobacteria are a group of microorganisms that exist as filaments or single cell. They may also present as colonies under different environmental conditions (Ma et al., 2014). They are larger than bacterial cells but are able to photosynthesize. Their production of the phycobilin pigment results in a bluish tint at high concentrations, which has led to them being coined as blue-green algae (Stocks, 2013). These algae are of major concern during algal blooms due to their potential production of cyanotoxins when in large numbers. Cyanotoxins have potentially fatal effects on human and animals exposed to contaminated water (Paerl et al., 2001).

Though Africa has been known to lag behind in research and information sharing, quite a few countries have reported algal blooms and toxicity, especially in the recent years. Consolidation of information in this review has been through the assessment of available journals, theses and reports from various internet sources and contact with relevant authors in the field of cyanobacterial blooms. This review aims to provide the context of cyanobacterial blooms in Africa and assess the current state of cyanobacterial blooms in Africa over the last decade, although in some cases, the information may date as far back as the year 2000.

2. Overview of global reports of cyanobacteria

Increased temperatures, salinity and anthropogenic activities have resulted in cyanobacteria gaining greater advantage over other phytoplankton in freshwaters (Paerl and Huisman, 2009). Europe, Asia and America have documented just under half of their lakes as eutrophic, with reports that at least 25% of reported blooms are/were toxic (Bláha et al., 2009).