

A water quality index for use with diatoms in the assessment of rivers

Guy Bate*, Pat Smailes and Janine Adams

Department of Botany, University of Port Elizabeth, PO Box 1600, Port Elizabeth 6000, South Africa

Abstract

Water quality is commonly reported with respect to the minerals that comprise the total dissolved solids, often together with COD, BOD, pH and other components. For ease of use by consumers, the quality parameters are mostly related to usage, i.e. water quality for domestic use, livestock or irrigation, etc. When diatom populations are used as water quality indicators a different system is necessary because diatoms are mostly good indicators of the total dissolved solids. A system to report water quality as an index or class is proposed using data collected from the Swartkops River system, which has pristine headwaters but which becomes progressively polluted downstream. The data included in the index encompass water quality values that cover more than 90% of the 212 river sites sampled from all the phytogeographical areas of South Africa.

Keywords: epipellic diatoms; river water quality; water quality index

Introduction

There is a great need for good quality water throughout the world and this is no different in South Africa. Consumption is beginning to exceed supply in many areas as the population grows, with industrial and agricultural requirements increasing in proportion. Most rivers in South Africa have been modified, primarily by weirs and dams, to increase their year-round ability to supply water for agriculture, industry, municipal and human purposes. Many of these modifications have resulted in a reduction of water quality within the rivers because return flow from irrigated agricultural lands and sewage purification works has increased the total dissolved solids in many rivers. Due to agricultural activities, erosion has become a problem and this has increased the already naturally high turbidity of many rivers.

The Department of Water Affairs and Forestry (DWAF) at Resource Quality Services monitors the water chemistry of many rivers in South Africa. However, the chemistry at any given time is a snapshot of the water quality at the time of sampling. The temporal variation of most water quality variables is usually high in lotic environments (France and Peters, 1992; Chambers et al., 1992; Cattaneo and Prairie, 1995) and biological monitors can be beneficial if they can accurately assess the water quality with a lower degree of variability than can the snap-shot samples at different sites and of specific water quality variables (Stevenson and Pan, 1999).

In 1996 DWAF, the Water Research Commission (WRC) and the Department of Tourism, Environmental and Economic Affairs (DTEEA) initiated the National Biomonitoring Programme for Aquatic Ecosystems (NBPAE). The objective was to design a programme to monitor the health of aquatic ecosystems throughout the country and to provide information that might be used to manage water systems (Hohls, 1996). Arrays of biological indices have, and are, being tested for practical use and interpretation. These indices

include the South African Scoring System Version 5 (SASS5, based on macroinvertebrates), the Index of Biotic Integrity (IBI based on fish) and the Riparian Vegetation Index (RVI). A suite of secondary indices is also used to interpret the biological indices. These include habitat assessment indices, the Hydrological Index, the Water Quality Index (WQI) and geomorphological indices.

The use of benthic diatoms in South Africa for water quality assessment has been briefly considered, but until recently the shortage of expertise in identification made a diatom index unsuitable for use (Uys et al., 1996). Despite this, in South African river systems, diatoms have been studied extensively since the early 1950s (e.g. Cholnoky, 1953; Cholnoky, 1960; Cholnoky, 1968; Archibald, 1983) and efforts have been made to relate diatom associations to water quality (e.g. Archibald, 1983; Schoeman, 1979; Schoeman and Archibald, 1986). However, none of these has included the complete suite of parameters routinely measured by Resource Quality Services. Hence, these earlier observations are incomplete by present-day standards.

The distribution of benthic algae in a river is the result of a complex series of interactions between hydrological, water quality and biotic factors. Short-term differences in community composition are driven by immigration of cells, differences in growth rate between populations and loss processes such as death, emigration, sloughing and grazing. Poulin and Williams (1998) estimated that there are 10 million diatom species world-wide of which only about 11 000 have been identified to date. However, Bate et al. (2004) have shown during an extensive survey of South African rivers that the number of dominant benthic diatom species is remarkably low. Lange-Bertalot (2000) suggested that part of the international species pool is cosmopolitan and Bate et al. (2004) have confirmed this because most of the dominant species found in the South African rivers were already recorded in the international literature.

Benthic microalgae become abundant where water systems are impacted by anthropogenic influences. Diatom autecology has been studied in various parts of the world and diatom indices for the assessment of water quality have been developed (e.g. Prygiel and Coste, 1993; Kelly and Whitton, 1995). Various researchers have been able to infer successfully the trophic conditions at a sampling

* To whom all correspondence should be addressed.

☎ +2733 330 5252; e-mail: bate@telkomsa.net

Received 10 March 2004; accepted in revised form 27 July 2004.