

NEAP V1.0: BACKGROUND TO THE RISK ANALYSIS APPROACH

Introduction

The most common symptom of eutrophication is excessive algal growth – either at a relatively constant level of ‘greenness’, or sudden explosions of biomass and algal aggregation to form what are commonly called scums or blooms.

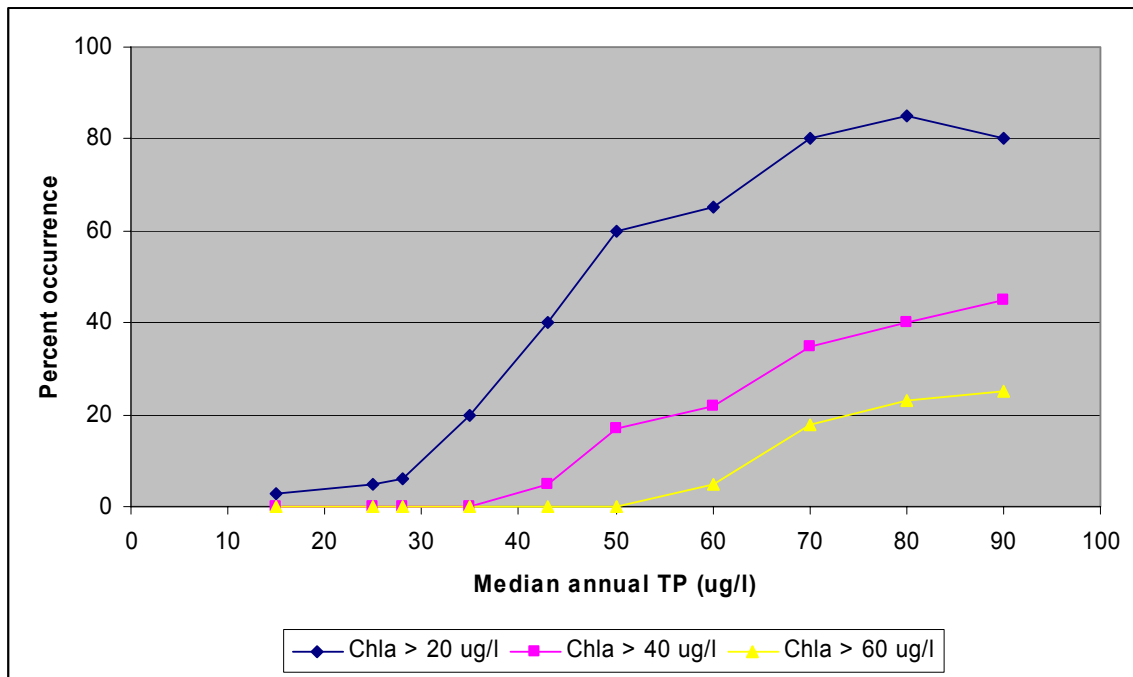
Generally it is the peaks of algal development (the blooms) that cause the management problems in most reservoirs. In severely enriched (eutrophic to hypertrophic) systems the problem worsens in that the duration of the blooms is extended and, in some cases, near permanent.

The preferred approach to managing anthropogenically-impacted reservoirs is to aim to control the frequency with which blooms occur. This is achieved by identifying the ambient level of phosphorus at which there occurs a marked increase in the incidence (= percentage occurrence) of algal growth at a specified level, e.g. chlorophyll-a levels exceeding $20 \mu\text{g l}^{-1}$.

Analysis

In the following example (Figure 1) it can be seen that for levels of chlorophyll-a in excess of $20 \mu\text{g l}^{-1}$ there is a rapid increase in the percentage occurrence at a median phosphorus concentration of approximately $25 \mu\text{g l}^{-1}$ (as total phosphorus, TP); for chlorophyll-a $> 40 \mu\text{g l}^{-1}$ the breakpoint is slightly in excess of $40 \mu\text{g l}^{-1}$ and for $> 60 \mu\text{g l}^{-1}$ chlorophyll-a the rise starts at a median TP in excess of $60 \mu\text{g l}^{-1}$.

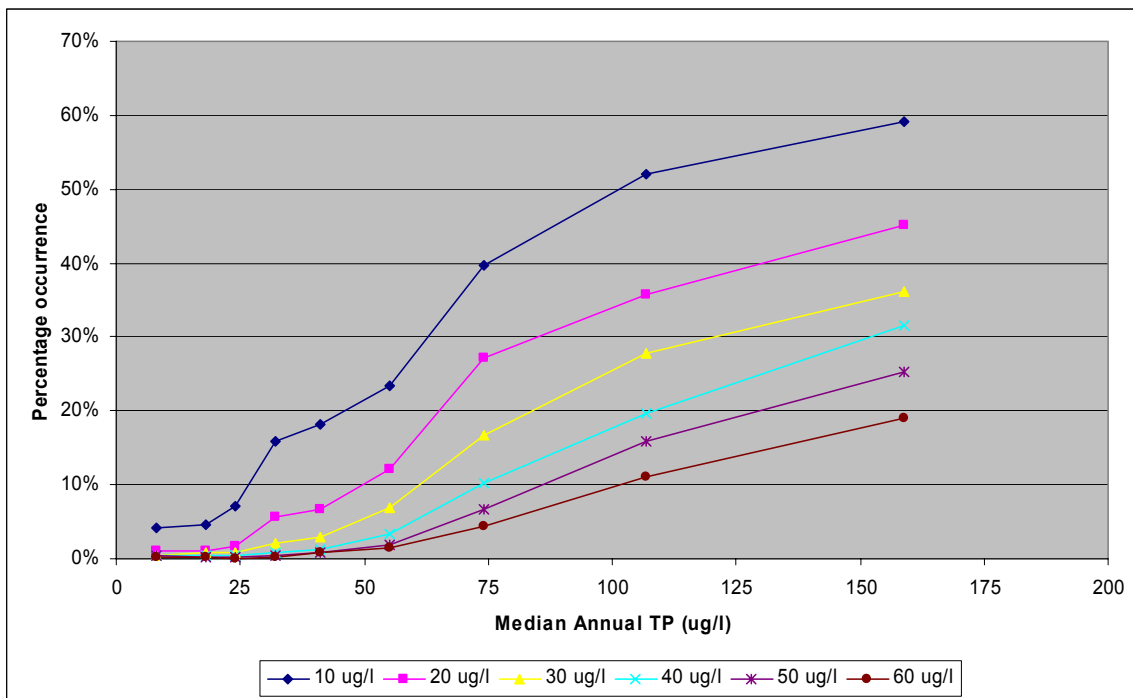
Figure 1: Percent occurrence of chlorophyll-a concentrations in excess of specified levels (example scenario).



It is generally accepted that chlorophyll-a levels persistently in excess of $20 \mu\text{g l}^{-1}$ pose problems for the treatment of raw potable water. As concentrations increase problems pertaining to recreational and direct abstraction uses become relevant. Algal blooms are generally defined as conditions with chlorophyll-a levels $> 40 \mu\text{g l}^{-1}$.

A large number of South African impoundments are characterized by high ambient levels of phosphorus – and with a national median of $55 \mu\text{g l}^{-1}$ as total phosphorus. A combined analysis of 40 reservoirs was used to produce Figure 2.

Figure 2: Percent occurrence of chlorophyll-a concentrations in excess of specified levels for a set of 40 SA reservoirs.



This analysis reveals that for a median concentration of $55 \mu\text{g l}^{-1}$ levels of chlorophyll-a will be experienced 12% of the time and blooms, i.e. chlorophyll-a levels $> 40 \mu\text{g l}^{-1}$, 5% of the time. This closely reflects the observed situation.

Obviously nutrient-poor reservoirs do not conform to this approach. At the other end of the scale, i.e. high ambient nutrient concentrations, individual reservoir analyses reveal a high and persistent level of chlorophyll. Bloemhof Dam (Figure 3) has $50 \mu\text{g l}^{-1}$ TP as its lower limit. Under such conditions it can be anticipated that sustained and problematical levels of algal development will be encountered, and the analysis confirms this. In the case of Bloemhof Dam chlorophyll-a levels in excess of $20 \mu\text{g l}^{-1}$ are encountered 50% of the time, and blooms start to increase in frequency from a concentration of $70 \mu\text{g l}^{-1}$. As the median TP for Bloemhof Dam is $86 \mu\text{g l}^{-1}$ TP it is clear that the dam will be problematical for much of the year.

A similar situation exists for Bon Accord Dam (Figure 4), with a marked across-the-board increase in chlorophyll-a occurring at a TP level of $60 \mu\text{g l}^{-1}$. As there are no “low” TP levels the precise breakpoints cannot be determined but are likely to lie at the $25 \mu\text{g l}^{-1}$ TP.

Figure 3: Percent occurrence of chlorophyll-a concentrations in excess of specified levels in Bloemhof Dam.

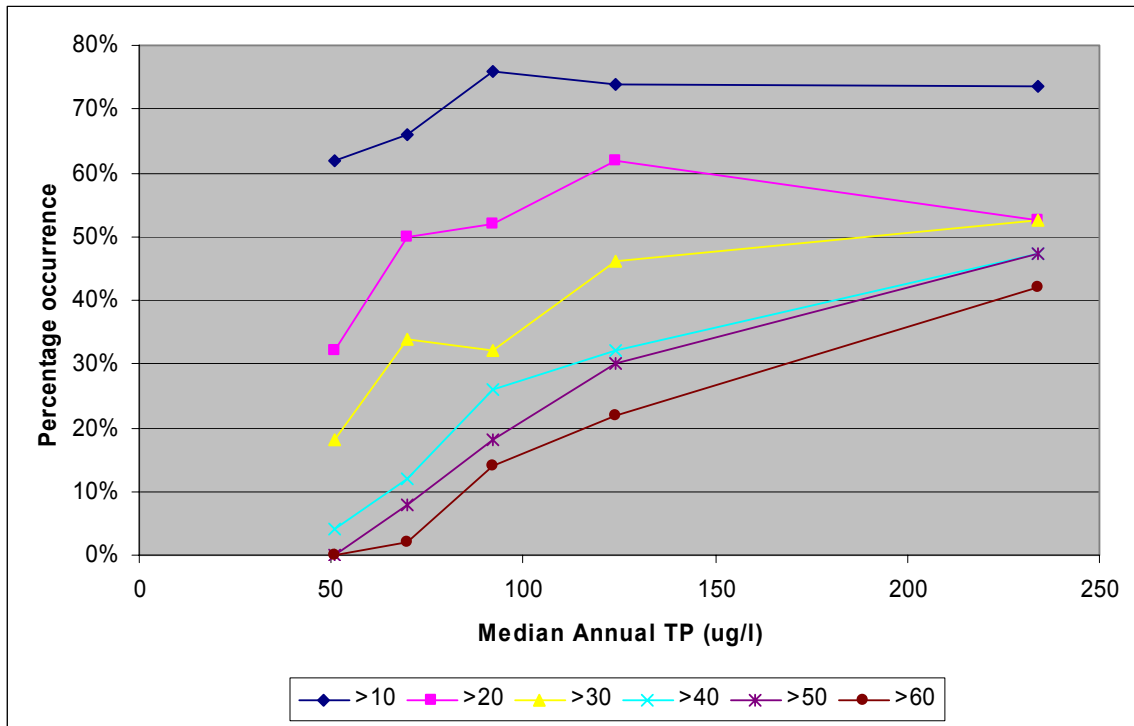
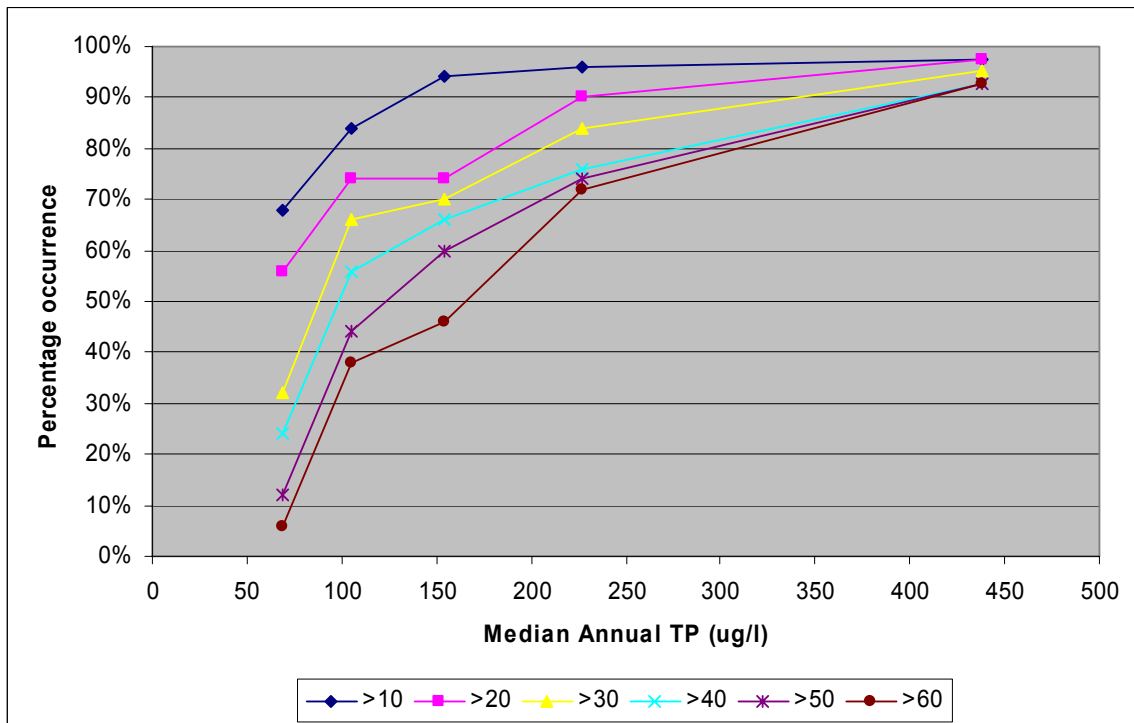


Figure 4: Percent occurrence of chlorophyll-a concentrations in excess of specified levels in Bon Accord Dam.



Based on this analysis, the following chlorophyll-a-based risk categories can be provisionally defined for South African reservoirs:

Median Annual TP ($\mu\text{g } \ell^{-1}$)	Low-level problems	Risk level	Blooms
0 - 5	Low		Negligible
5 - 14	Moderate		Low
14 - 25	High		Moderate
25 - 50		High	
50 - 150		Very High	
> 150		Extreme	