KAHRU · BROWN (Eds.)
Monitoring Algal Blooms

The incidence of harmful algal blooms appears to be increasing in European waters, in Asia, and along the Atlantic coast. The data available for this observation, however, is patchy and in fact, data for earlier periods is completely non-existent. The traditional technique to identify and monitor phytoplankton includes microscopic examination of water samples collected aboard research vessels. The information provided by this methodology is often limited in temporal and spatial scope because of the limitations of shipboard sampling and the enormous amounts of time and effort which are involved in analyzing the samples. New techniques are required to furnish appropriate information in order to identify and monitor algal blooms. This book explores these new techniques in depth.

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Monitoring Algal Blooms
New Techniques for Detecting Large-Scale Environmental Change

M. Kahru · C. W. Brown
Editors

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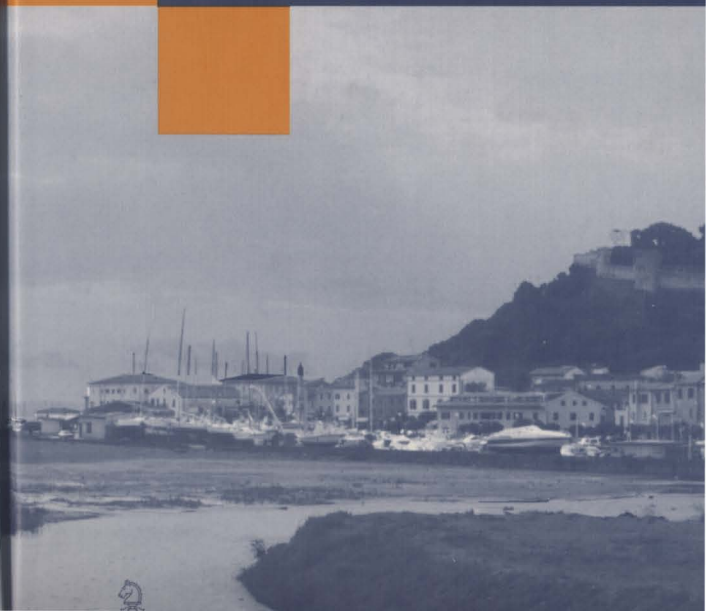

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Monitoring Algal Blooms:

New Techniques for Detecting Large-Scale Environmental Change

Springer

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PREFACE

High concentrations or "blooms" of phytoplankton are an important phenomena in the aquatic environment and have recently received considerable attention—both negative and positive—because of their often profound affect on the environment. These short-term biological events often play a significant role in several biogeochemical cycles, with the highest rates of transfer between elemental reservoirs occurring during or immediately after blooms. For example, the sinking of the diatom-dominated spring blooms represents a rapid conduit of organic carbon to the benthos in the oceanic "biological pump," the biologically mediated process by which atmospheric carbon dioxide is transferred to the ocean's interior. More "steady state" conditions, such as characterized by flagellate dominated communities in oligotrophic waters during summer, may contribute little to the transfer of carbon to depth.

Algal blooms also reflect the prevailing environmental conditions and can be useful in assessing water quality. The various classes of phytoplankton are adapted to different environmental conditions. Consequently, tracking the frequency and taxonomic composition of algal blooms over time provides a method to monitor the health of the aquatic environment.

Algal blooms also affect the environments in which they grow. Much of the recent attention to algal blooms has focused on their negative repercussions. These harmful algal blooms (HAB) have resulted in the death of marine animals, mass mortalities of wild and farmed shellfish, and human illness and death from consumption of contaminated shellfish or fish. Identifying these blooms, monitoring their presence, and predicting their occurrence would provide vital information to alleviate the impact of these financially debilitating and potentially life-threatening events.

Furthermore, the incidence of harmful algal blooms (HAB) appears to be increasing, with the expansion and higher frequency of their occurrence prompting some investigators to call it "the global, ongoing epidemic of novel phytoplankton blooms."[1] The data available for drawing these conclusions, however, are often patchy and missing for earlier periods. The lack of data may also cause erroneous conclusions about the factors precipitating their occurrence. For example, the highly toxic and publicized *Chrysochromulina* bloom of 1988 in Scandinavian waters was associated with anthropogenic effects such as nutrient loading and acid rain leachates.[2] Doubts about this argument, however, have been raised because the bloom was not observed in subsequent years. It is clear that techniques to accurately detect and monitor the occurrence of algal blooms are needed.

The traditional technique to identify and monitor phytoplankton is microscopic examination of water samples collected aboard research vessels. The information provided by this methodology is often limited in temporal and spatial scope because of the limitations of shipboard sampling and the enormous amount of the time and effort involved in analyzing the samples. Visible satellite imagery provides a synoptic perspective, but with few exceptions, does not yet have the ability to discriminate between different phytoplankton taxa nor is it effective during inclement weather. New techniques, or adaptations of traditional ones, are required to furnish appropriate information in order to identify and monitor algal blooms.

This book presents the results of seven studies that employ novel techniques as a means to detect and monitor algal blooms. Though these investigations were conducted principally within the ocean, the techniques used are applicable in all aquatic environments. The first three chapters demonstrate the use of the Advanced Very High Resolution Radiometer (AVHRR) onboard the polar orbiting National Oceanic and Atmospheric Administration (NOAA) satellites to monitor large-scale algal blooms and water turbidity.

In chapter 1, R.P. Stumpf and M.L. Frayer use AVHRR imagery to monitor the deteriorating environmental conditions in the Florida Bay. This chapter examines seven years of spatial data and reveals variations in the temporal trends and spatial patterns in water turbidity.

In chapter 2, J.F.R. Gower presents results of detecting and monitoring "bright" algal blooms along the West coast of North America detected in AVHRR imagery. These events have heretofore been largely unrecorded.

In chapter 3, M. Kahru shows how data from various satellites, primarily AVHRR, have been used to compile a decadal time series of the distributions of surface floating cyanobacteria blooms in the Baltic Sea. These diazotrophic cyanobacteria are of major regional concern because of their toxicity and nutritive effect on the Baltic ecosystem.

In chapter 4, K. Kononen and J.-M. Leppänen demonstrate how the combination of laboratory studies, in situ sampling from ships of opportunity and research vessels, and satellite monitoring help explain the different bloom forming mechanisms and patterns of two functionally similar, but ecologically different, cyanobacteria species.

In chapter 5, A. Harashima and co-authors present results of an intensive study of algal blooms and related biogeochemical cycles in the adjacent seas of Japan using a flow-through monitoring system deployed on an operational ferry.

In chapter 6, G. Johnsen and co-authors use a time-series of hydrographical, optical, chemical and biological data collected by the SEAWATCH buoy system to identify, monitor and account for the algal blooms in North Western European waters.

In chapter 7, M.R. Abbott and R.M. Letelier discuss the status of bio-optical drifters and how these near-surface, quasi-Lagrangian measurement systems provide new insights into the functioning of ecosystems in the California Current and the Southern Ocean.

Due to the large amount of current research on algal blooms around the world, this book is not intended as a comprehensive review of all available methods. Relatively recent reviews of HAB studies can be found elsewhere.[3,4] Instead, these chapters provide a sample of the various approaches that have been applied to investigate this important field of study.

We thank the publisher for providing the opportunity to produce this compilation, as well as their assistance and patience in publishing what we hope to be an important contribution to an ever growing area of interest in monitoring algal blooms.

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CHAPTER 1

Use of AVHRR Imagery to Examine Long-Term Trends in Water Clarity in Coastal Estuaries: Example in Florida Bay

Richard P. Stumpf and Megan L. Frayer

Abstract

Satellite imagery provides a means of investigating both changes in environmental conditions and conditions prior to the establishment of monitoring programs. Florida Bay, at the southern tip of Florida, USA, has shown environmental deterioration beginning in the late 1980s. The decline has been manifested by algal blooms and a substantial decrease in water clarity. The Advanced Very High Resolution Radiometer (AVHRR) can provide information on the water clarity conditions in the Bay and provide guidance for understanding the development of algal blooms. This chapter demonstrates the use of AVHRR in time series studies through an examination of seven years of data from December 1989 to June 1996. The imagery shows a seasonal variation in water clarity, with the most turbid (highest attenuation) water in the winter. On average, Florida Bay has shown no trend in water clarity over the 7 years. However, sections of the Bay show different responses: during the winter, the north-central Bay has become

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