COMPREHENSIVE ENVIRONMENTAL MANAGEMENT OF AN URBANIZED WATERSHED UTILIZING MULTIMEDIA GEOGRAPHIC INFORMATION SYSTEM

Michael S. Haire, Director, Maryland Department of the Environment, Technical and Regulatory Services Administration, 2500 Broening Highway, Baltimore, Maryland 21224, United States

For decades, the restoration of the Chesapeake Bay Estuary and its associated tributaries has been the foremost environmental initiative in the Mid Atlantic region of the United States. Since the 1950's, a number of effects to evaluate the ecological health of the Chesapeake, identify pollution sources, and craft and implement management strategies have proven unsuccessful for one major reason, the effort did not consider a holistic, watershed wide approach.

Consequently, while individual regions of the mainstem Bay and its tributaries could be characterized as eutrophic or contaminated by toxic chemicals, a comprehensive quantification of all sources of nutrients, metals, organics, etc. was never compiled, and therefore it was very difficult to develop and implement effective basin wide pollution reduction policies.

In 1983, the states of Maryland, Pennsylvania, and Virginia, the District of Columbia, the Chesapeake Bay Commission, and the United States Environmental Protection Agency joined in a unified partnership to restore the Bay. Leaders of these jurisdictions recognized that the Bay's problems could not be solved by any one of them acting alone. In 1992, they acknowledged that the Bay was in decline because of changes in the watershed as a whole, and likewise, that the Bay's restoration is dependent upon a watershed-wide solution.

In 1987, the Bay partnership signed the Chesapeake Bay Agreement, a coordinated effort to discuss nutrient enrichment of the mainstem and tributaries. The agreement committed the signataries to reduce, before the year 2000, 40% of the amount of phosphorus and nitrogen entering the system from all controllable sources - both point and nonpoint.

Over the last decade, the Chesapeake Bay Restoration effort has focused on two major pollution control issues; nutrient enrichment and toxic chemical contamination.

In 1989, the Bay partnership adopted the Chesapeake Bay Basin Wide Toxics Reduction Strategy. As stated in the strategy:

> "Our goal is a Chesapeake Bay free of toxics by reducing or eliminating the input of chemical contaminants from all controllable sources to levels that result in no toxic or bioaccumulative impact on the living resources that inhabit the Bay or on human health."

The strategy focuses on the identification and geographical targeting of Regions of Concern - areas with documented chemical contaminant related impacts.

Recent advances in the field of Geographic Information Systems (GIS) technologies have provided the ability to "look" at large spatial regions of the Chesapeake in a systematic and integrated manner. Utilization of GIS capability has allowed water quality and resource managers to evaluate the relationships between observed environmental conditions (water chemistry, fisheries distributions, sea grass abundance) with possible controlling factors (point source pollution, land activities, etc.). In some applications, environmental managers have coupled hydrologic, water chemistry and ecological computer models to GIS analysis in an effort to evaluate the environmental response to possible pollution control technologies and various land use decisions.

In Maryland's portion of the Chesapeake Bay watershed, this "place based" approach has been applied in the Baltimore Harbor region to address the two priority management initiatives:

1. Achievement of a 40% Nitrogen and Phosphorus loading reduction into the Harbor to address the eutrophications and low dissolved oxygen issue, and the
2. Development of a toxics substance reduction strategy for the Harbor. The strategy is intended to identify major sources of the significant contaminants, define the distribution of contaminants in the Harbor, and provide a tool for allocating pollution loads to point and nonpoint sources.

To date, the nutrient reduction strategy has relied heavily upon the GIS to characterize environmental conditions such as land uses and soil types by watershed basin and effectively manage the limitless combinations of these conditions and ultimately integrate this information with computer simulation models. Using global positioning system (GPS) and LORAN navigation systems, the GIS was able to locate point source nutrient locations and couple these locations with monitoring data enabling researchers an efficient means of compiling point source loadings within watershed basins. Output from computer models was then incorporated into the GIS and integrated with point source contributions to achieve a total loading by subwatersheds and cumulative loads by tributary. This enabled researchers to target specific areas within the tributaries where policy and restoration efforts would be better focused. Incorporating ambient environmental data allowed for the continued monitoring of restoration efforts and progress in an easily understood means.

Currently, total nitrogen has been reduced by 32%, and total phosphorus by 54%.

Progress in the development and implementation of the Baltimore Harbor Toxics Reduction Strategy has also been impressive. To date, the Toxics Strategy has relied on the GIS in a way similar to the Tributary Strategies efforts. However, the Baltimore Harbor Toxics Reduction Strategy involved a much more defined area, smaller in geographic scope. This allowed for and required more detailed point source identification using both GPS and field knowledge. In this effort, the GIS was used to combine point sources, detailed drainage boundaries, sediment sampling data, and water quality data to target specific problem areas. Additionally, the GIS was used to design water quality sampling strategies and provide exact coordinates to field personnel who then arrived at those points using GPS and LORAN navigation systems.

Aside from the analysis and data management roles that the GIS played in both of these efforts, it is its ability to communicate, in laymen terms, the environmental problems and the results of these efforts to the public and other stakeholders.

Over the next 2 years, the results of both the nutrient reduction and toxics reduction initiatives will be instrumental in the process to identify assimilative capacities of the Harbor's aquatic ecosystem, and to make regulatory decisions with regards to allocating loads to point and nonpoint sources. GIS technology will continue to support those management decisions.