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Predicting taste and odor events in Kansas reservoirs

Algal blooms are a common occurrence in Kansas reservoirs. Blooms of cyanobacteria, or blue-green algae, are of particular concern because several species can produce chemical compounds (i.e. geosmin and 2-methylisoborneol – MIB) that often cause drinking water to taste and smell bad. In addition, cyanobacteria can accumulate at the surface of reservoirs resulting in thick layers of unsightly surface scums, and cyanobacteria can affect water quality conditions leading to depletions in water column dissolved oxygen concentrations. Therefore, understanding what factors influence cyanobacterial blooms is an important goal of both water treatment personnel and reservoir managers.

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A number of physical, biological, and chemical factors are related to cyanobacterial growth and production. For example, a stagnant or stable water column due to lack of wind action, increases in nutrient (mainly nitrogen and phosphorus) and sediment concentrations, and the absence of zooplankton which graze on algae are all factors that have been shown to contribute to cyanobacterial blooms. However, relationships between these variables can be very complex and are often reservoir or watershed specific. Furthermore, the effect of these factors on cyanobacteria can vary from year to year even within individual reservoirs. For these reasons, it has been very difficult to predict taste and odor events in advance of their occurrence. To address this issue, the Kansas Biological Survey (KBS), a non-regulatory research unit at the University of Kansas, has recently begun to study taste and odor events in drinking water reservoirs throughout the state as part of a project funded by the Kansas State Water Plan Fund. The goal of our research is to develop a set of relatively simple tools or predictive models that can be used as an early warning system to predict when reservoirs are most likely to experience cyanobacterial blooms and taste and odor events. Benefits of this ability include modification of water treatment procedures to prevent taste and odor compounds from making it into the treated drinking water.

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Reservoir Sampling, Model Development, and Reservoir Monitoring

Scientists at KBS sampled five reservoirs during the summer and fall of 2006: Big Hill, Clinton, Cheney, Gardner, and Marion. During each sampling event a number of water quality parameters were measured including pH, temperature,

Example of a cyanobacterial bloom resulting in a dense surface scum in a Kansas reservoir.

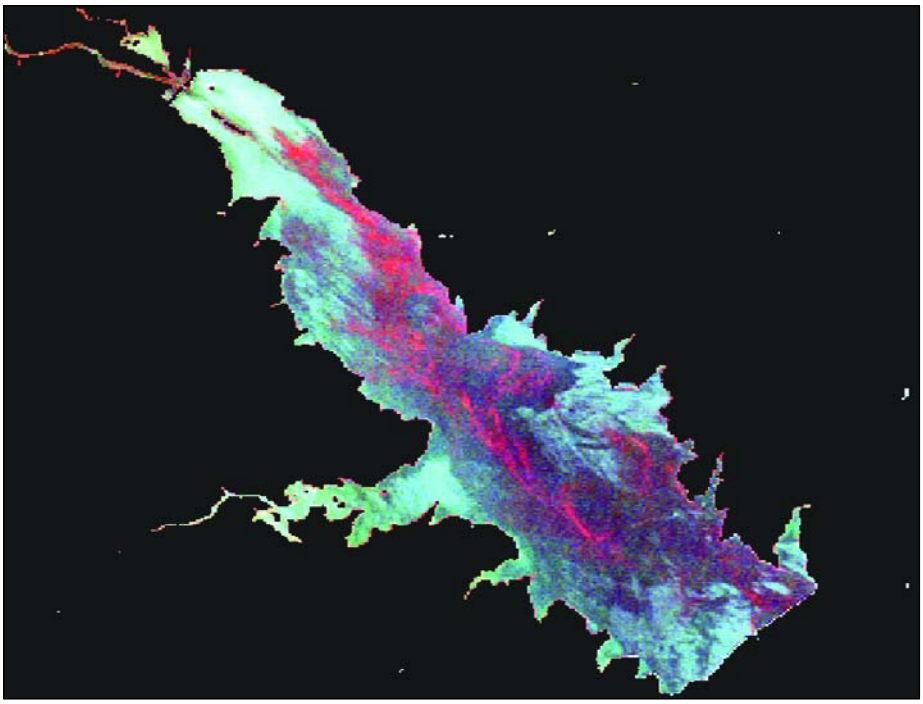
conductivity, turbidity, and dissolved oxygen. Water samples were also returned to the KBS laboratory for analysis of nutrients, algal biomass (chlorophyll *a*) and species composition data, and geosmin concentrations. (Geosmin, which literally translates to "*earth smell*", is an organic compound with a distinct earthy flavor and aroma, and is responsible for the earthy taste of beets. The human nose is exquisitely sensitive to geosmin, able to detect it at concentrations down to 10 parts per trillion.) These data were also combined with additional water quality data that was collected by local, state, and federal agencies from these five reservoirs in previous years. The resulting data set is currently being used to determine if one or more water quality parameters are correlated with geosmin concentrations, and can therefore be used to estimate when geosmin will be high in an individual reservoir. From this, we hope to develop relatively simple predictive models that can then be used to determine when taste and odor events are most likely to occur, and ultimately influence treatment decisions.

KBS personnel collecting water quality data at a Kansas reservoir.

In order for the models to be effectively used, water quality conditions must be monitored within individual reservoirs. Therefore, we are currently testing several methods that will allow water treatment personnel to effectively monitor water quality conditions with relative ease. For example, traditional methods of measuring either algal biomass in general, or cyanobacterial biomass in specific, tend to be very time consuming and require a great deal of training and resources. As a result, samples are often not processed in a time frame that allows for management decisions based on current reservoir conditions and therefore they provide little predictive power. However, there are several alternative methods for measuring or estimating cyanobacteria that would allow managers to monitor reservoir conditions and make real-time management decisions. Two of these include the use of *in situ* water quality meters and remotely sensed data.

Water quality meters that are programmed to collect data at daily or even hourly intervals can be placed within individual reservoirs to monitor water quality conditions in real-time. These meters can be equipped with a number of probes that measure water quality (e.g. temperature, pH, turbidity) and biological (e.g. total algal biomass and cyanobacterial biomass) data that can then be downloaded directly or be monitored online by treatment personnel. Data from these probes can then be used in the predictive models to provide real-time signals for use in management decisions related to taste and odor events.

Remotely sensed imagery from satellites can also be used to monitor the development of algal blooms in reservoirs. Using remotely sensed imagery, managers can monitor blooms not only as they develop, but also as they dissipate over time. Furthermore, remotely sensed data can be used to create seasonal and interannual reservoir condition maps that depict spatial patterns in algal blooms within reservoirs.



Satellite image of Marion Reservoir from July 2003. Red areas indicate high algal biomass. This type of imagery can be used to monitor the development of cyanobacterial blooms in reservoirs over time.

Taste and Odor Workgroup

An integral part of this project was the creation of the *Drinking Water Taste and Odor Workgroup*, consisting of scientists and representatives from university, state and federal agencies, and water treatment facilities. The workgroup was established to help translate our scientific research finding into practical water resource management and treatment strategies. The workgroup has met several times over the past year and posts its meeting notes, presentations, and other relevant information on line at: http://www.cpcb.ku.edu/progwg/html/tando.htm.

How you can help us

The participation of water treatment personnel is indispensable to the overall success of this project, and there are several ways in which you can get involved. We are requesting any previously collected data from your drinking water reservoir on past taste and odor events. Observations including the frequency, severity, and duration of past events will be very useful in determining how severe of a problem taste and odor events are within the state as a whole. Furthermore, if you have any parallel water quality data collected during these events (e.g. nutrients, chlorophyll *a*, geosmin), this could be used to help develop better predictive models. Alternatively, it is possible that if we knew when past events occurred, we could obtain data that may have been collected during these events by state or federal agencies. Please send any available data or information to:

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We are also asking you to notify KBS of taste and odor events as they occur in your drinking water reservoirs. You are not expected to quantify these events, but use your own professional experience and judgment to make a determination to alert us. Please contact us if you believe that your reservoir is at the beginning of a possible algal bloom or taste and odor event. This information will help us in our attempt to understand the conditions that allow blooms to develop.

Finally, if you have any ideas or suggestions of how our research could be used or implemented we would like to hear from you. A very important goal of this project is to ensure that our research ultimately results in usable treatment strategies. Therefore, your input is crucial. Please contact us at the address above with suggestions or ideas.