An Animated Display for Water Quality Data in Maryland's Tidal Waterways

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Abstract

The Chesapeake Bay and its surrounding tributaries are a valuable resource both recreationally and commercially. The Maryland Department of Natural Resources (DNR) monitors the water quality by measuring the abundance of various parameters, such as dissolved oxygen, with monitoring stations located throughout the tidal waterways. Our goal was to develop a web application that would display this data over time to help researchers picture the time-structure of the parameters and be used as a visual educational tool for the public. In this technical report we describe the use of our application and the implementation details.

1 Introduction

The Chesapeake Bay and its surrounding tributaries are a valuable resource both recreationally and commercially [2]. The tidal waterways provide a habitat for over 3,600 species of plants and animals [1]. The Maryland Department of Natural Resources (DNR) monitors the health of this ecosystem by measuring the abundance of various parameters at over 80 long-term monitoring stations located throughout the waterways [3]. Past analyses of this data has been helpful in determining the nutrient trends in the waters and assessing the success of DNR funded projects.

The parameters of particular interest for our display were dissolved oxygen, chlorophyll, total dissolved nitrogen, total dissolved phosphorous, and total dissolved NO_2. Dissolved oxygen is an important resource for aquatic wildlife which can become stressed or parish at low levels. Chlorophyll is a measure by which algae levels can be evaluated, where an increase in algae is associated with an increase in chlorophyll. Nitrogen and phosphorus are important nutrients for aquatic wildlife, though excesses of these nutrients introduced to the ecosystem through human activities such as fertilizer runoff can be detrimental to the ecosystem. Excess nitrogen (including NO_2) in the water can cause an over-stimulation of aquatic plant and algae which can result in clogging water intakes, blocking light in deep waters, and eutrophication (a a reduction in dis-

solved oxygen due to an increase in mineral and organic nutrients) [4]. Excess phosphorus can also lead to eutrophication [5].

Our team developed a web application to display the station readings on these parameters over time using an animated map. The purpose of this map is to help both the public and DNR understand the general trends in the data through a visualization. Our map takes a data set generated by the long-term monitoring stations and displays a map with indicators as to the quality of the water for the given parameter. Section 2 describes the map features and the implementation details. Section 3 discusses how to implement the map on one's website for the setup one wishes.

2 Map Features

The map shown is generated from the Google Maps web application. Above the map is a title that displays the description of the data set and a drop-down lets the user choose between the aforementioned parameters to be conveyed in the size and color of the map markers. On the right of the map are text and controls that let the user interact with the data. On the top is text that conveys the current time according to the animation. Radio buttons let the user control the flow of time. The step functionality should be available to all users, though the play functionality requires the user to be using a browser with a standard implementation of the JavaScript interval object (i.e. all browsers other than Internet Explorer 7 and lower). A slider is presented below the radio buttons that lets the user adjust the speed at which days go by when in play mode (if the user does not have an HTML 5 enabled browser, they are presented with a text-box displaying an editable speed). Another slider presents the user with the ability to modify the stay time, the number of days after the reading that the station is still displayed on the map.

The next portion of the controls shows the parameter information. This includes a description of the parameter and the threshold values used for the color and size determinations. Details for setting these threshold values are discussed in Section 3. At the bottom of the control display is a table showing the station readings that have been previously mapped. Scrolling over a row pauses the timer and displays that reading in the map.

3 Implementing the Map

The map utilizes the Google Maps V3 API. An API key must be specified for the location of the map in order for the mapping functions to work. Details for setting up an API key can be found at the Google Maps API Tutorial . The other dependencies of the map are the MarkerWithLabel extension from the Google Maps Utility Library V3 [6] and the Moment.js [7]. Both are included in the assets/js directory.

To adapt the map to new data sets, the user only needs to specify new

data files for the csv files in the assets/data directory. There are three data files that are required: stations_readings.csv, stations_information.csv, and map_values.csv. Each of these files must be named in this manner and have to be specified as tab delimited (as opposed to the normal comma separated), that is values within rows are separated by tabs where rows are separated by newline commands (standard spreadsheet programs such as Microsoft Excel and Open Office have options to export csv files in this manner). The stations_readings.csv file is a table with headers StationName (the station i.d., i.e. CB1.1), SampleDate, and then the appropriate parameters (the program allows for any ordering of the parameters and additional parameters may be included but will be ignored) with respective values below. The stations_information.csv file is a table with headers (in order) StaCmpCode, StaCode, StaGroup, StaName, StaTrib, StaDescrip, StaLocation, lat, long with the respective values below. It can also contain additional (but ignored) parameters.

The final file is the map_values.csv file. This file has is a table with headers Description, StartDate, EndDate, SmallSize, MediumSize, LargeSize, DOLow, DOHigh, CHLAHigh, CHLALow, TDNHigh, TDNLow, TDPHigh, TDPLow, NO23High, NO23Low and the appropriate information in the row below. The description is the string shown on the web page above the radio buttons. Note that it is here that the implementer species the start and end dates, the size of the circles, and the threshold values for the parameters. By specifying these values in the map_values.csv file, the program will update accordingly.

References

[1] Chesapeake Bay. National Wildlife Federation Website, `www.nwf.org`.

[2] The Value of Wetlands. U.S. Fish and Wildlife Service Website. `www.fws.gov`.

[3] Maryland's Department of Natural Resources: Eyes on the Bay. `www.eyesonthebay.net`.

[4] Nitrogen and Water. U.S. Geological Survey. `ga.water.usgs.gov`.

[5] The Effects of Urbanization on Water Quality: Phosphorus. U.S. Geological Survey. `http://ga.water.usgs.gov/edu/phosphorus.html`.

[6] Google Maps Utility Library V3. `code.google.com/p/google-maps-utility-library-v3`.

[7] Moment.js. `momentjs.com`.

[8] Google Maps API Tutorial. `https://developers.google.com/maps/documentation/javascript/tutorial`.