Name: Date: Class/Hour:

APPLYING SPATIAL INFORMATION TO BIOMASS MANAGEMENT

INTRODUCTION

Selecting a site for a biomass conversion or processing facility is critical to the overall success of any biomass-based renewable energy project. While numerous factors such as land price and availability, competing commodity prices, and region-specific financial incentives influence site selection, one of the most important factors to consider is the proximity of the biomass resource(s) to the facility itself. This exercise will focus on understanding one of the tools used to evaluate spatial distribution of biomass resources in the U.S. and will discuss factors that influence biomass production potential.

A Geographic Information System (GIS) is a system designed to gather, organize, analyze, and display spatial data. The three primary components of any GIS are: 1) computer software, 2) spatial data, and 3) trained personnel. Spatial data defines a location or area using points, lines, polygons, or pixels. All GIS Software uses an underlying database management system for storage and management of data. The software allows the user to select, or "query", information in the database based on their specific need. A GIS can be developed using software that resides on a computer (Such as ArcGIS or GRASS) or can be web-based, where the software resides on a networked server (Google Earth or the Biofuels Atlas). In general, web-based programs are easier to use but they have fewer analysis capabilities and the user is limited in their ability to customize databases.

Spatial data is represented as individual files, called layers, which are added to a base map with defined geographic coordinates. The layers contain features such as lines, polygons, points, or even individual pixels to which additional information, called attributes, can be added. Layers typically represent similar geographic features such as roads, water features or municipal boundaries and can be turned on or off, depending on the user's preferences. GIS software provides a window for viewing, selecting and querying spatial data.

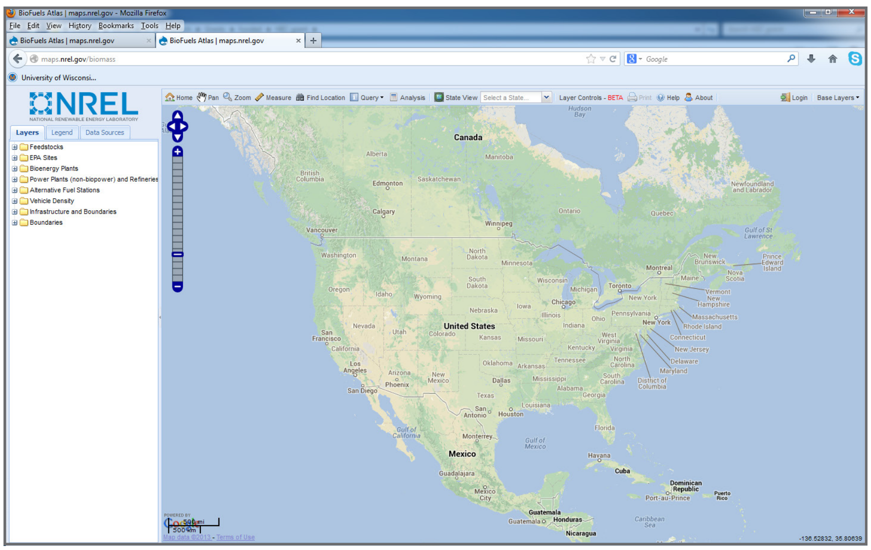
Spatial analysis involves using spatial data to generate and analyze spatial information, such as distance, area, location, crop yields, et cetera, for a specific purpose. While becoming proficient in the use of a specific GIS software package for analysis of spatial information is beyond the scope of this laboratory investigation, by working through the following exercise you will gain a better understanding of the structure and capabilities of modern GIS systems as they relate to biomass/biofuel management.

PROCEDURE

PART !: BECOMING FAMILIAR WITH BIOFUELS ATLAS

The Biofuels Atlas was developed by the National Renewable Energy Laboratory (NREL) with funding from the U.S. Environmental Protection Agency and Department of Energy. Though the Biofuels Atlas has limited capabilities compared to most GIS software, it has functions that make it a valuable tool for gathering general information about a region's biofuel production potential. In addition to the Biofuels Atlas, the NREL maintains other mapping tools for investigating other renewable energy sources including wind, solar, geothermal, and hydrogen.

1. Go to Biofuels Atlas website, http://maps.nrel.gov/biomass.



Review the page to familiarize yourself with the layout of Biofuels Atlas. The window on the left allows the user to turn on or off specific layers and view legend and data sources of the layers, while the toolbar at the top allows the user to navigate, measure and query on the map itself. If any layers are on, turn them off using the "Layer Controls" button on the map window toolbar. We'll work with the layers later. Let's start by getting familiar with the navigation and measurement functions.

2. Zoom in to an area that includes the cities of Los Angeles, CA, Las Vegas, NV, and Phoenix, AZ. Do this either by clicking the "Zoom" tool and drawing a box on the map that includes these cities or by clicking the zoom scrollbar in the upper left corner of the map window, and using the "Pan" tool to navigate to the area. When finished, the map window should look like the figure on the next page.

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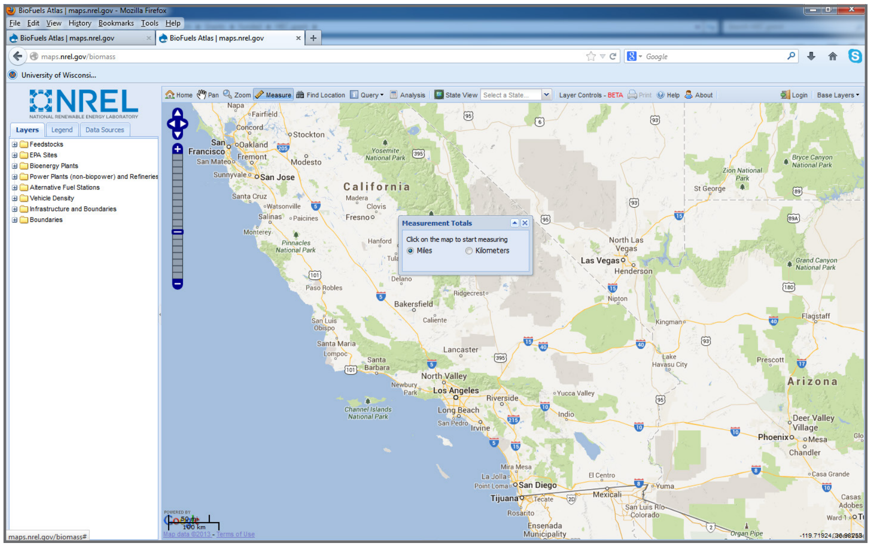
PROCEDURE (cont.)



3. Click on the "Measure" tool and determine the distance between Los Angeles and Las Vegas and between Las Vegas and Phoenix (in miles). Click once to start a measurement segment and twice to end the measurement.

   Los Angeles to Las Vegas: ______________________________

   Las Vegas to Phoenix: __________________________________

   Total Distance: _______________________________________

4. Next, click on "Find location". Type in the following address: 29200 College Farm Road, Platteville, WI

5. Investigate the area around the location using the zoom and pan features and by selecting different base map layers using "Base Layers" on the toolbar. Answer the following questions:

   Name of location: ____________________________________

   Nearest major (4 lane) highway:_________________________

   Nearest river: ____

   Nearest airport: _______________________________________

   Primary land use (forest, urban, agriculture, et cetera) in the area around the location:

   ____

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PART TWO: BASIC QUERY AND ANALYSIS

1. In the Layers window, open the folder labeled “Feedstocks” and subfolder labeled “Crop Residues”. Select “Corn Stover”. You will notice that the map now changes color to reflect county-based corn stover production estimates. Click on the “Legend” tab to see the production estimates and the “Data Sources” tab to learn how the estimates were made.

   Range in county-wide stover production does the map color indicate for this location:

   ____

   Explain generally how the corn stover production estimates were made:

   ____

   ____

   ____

   ____

   ____

2. Now click on the “Query“ dropdown menu from the toolbar. Select “By Point” and click on the location that was previously found (repeat step 1.4 if necessary). A window appears that shows the actual corn stover production estimate for the county.

   County: ____

   Tonnes/yr: _____________________________________

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3. Close the Query results window and now select “By Region” from the “Query” drop down menu and draw a rectangle around an area that includes the cities of Platteville, Dodgeville, and the location selected (you may have to zoom out). You will now notice that results are shown below the map widow for all of the counties included in the region you selected. List the additional county names and corn stover production estimates given:

   County: ______________________________

   Tonnes/yr: ______________________________

   County: ______________________________

   Tonnes/yr: ______________________________

4. We will now use the analysis button to retrieve selected layer and estimate county-level potential biofuel production within a specified distance from a point. Click “Analysis” and select the location found in step 1.4. In the window, select “Corn Stover” and specify a buffer distance of 20 miles. Click “Run”, and answer the questions below using the Bioenergy Resource Analysis Results. Note that results use county-level data and assumes a default biofuel (ethanol) yield and percent attainable resource.

   Total tonnes/year corn stover production in analysis area:

   ____

   Total potential gallons biofuel production (using default conversion values):

   ____

   Potential gallons biofuel production if expected biofuel conversion is 70 gal/tonne and percent of resource attainable is 25%:

   ____

5. When finished, click Query>Clear Results and close the analysis window.

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6. Click on the State View dropdown. Select Kansas.

7. Explore the data shown in the results window. Notice that the data is separated into Fossil fuel, Bioenergy Production and Infrastructure, and Feedstocks categories

8. Select Download Results and Open the file in MS Excel. You will notice that the data summary and data sources have now been copied to an Excel workbook, with tabs separating summary data categories and data sources. Answer the following questions based on the data provided.

   Estimated gasoline usage in the state:__________________

   Current Ethanol Plant Capacity:________________________

   Feedstock with greatest potential for ethanol production and percentage of total potential ethanol production it represents:

   ____

PART THREE: ADVANCED QUERY

The last function that we will explore is the Advanced Query option. Performing an advanced query allows you to search various data layers and apply geographic and other constraints to the data. The information from this query is stored on a viewable table so you can analyze the results. By using an advanced query, you can combine multiple statements to find specific information to answer a question

We'll use the Advanced Query feature to identify a region that has two features that are favorable for a cellulosic ethanol plant: a large available biomass source and a high density of flex-fuel vehicles capable of utilizing the ethanol.

1. Click "Home" in the map toolbar and "Clear results" in the Query drop-down menu, and "Turn off all" under Layer Controls to reset the map.

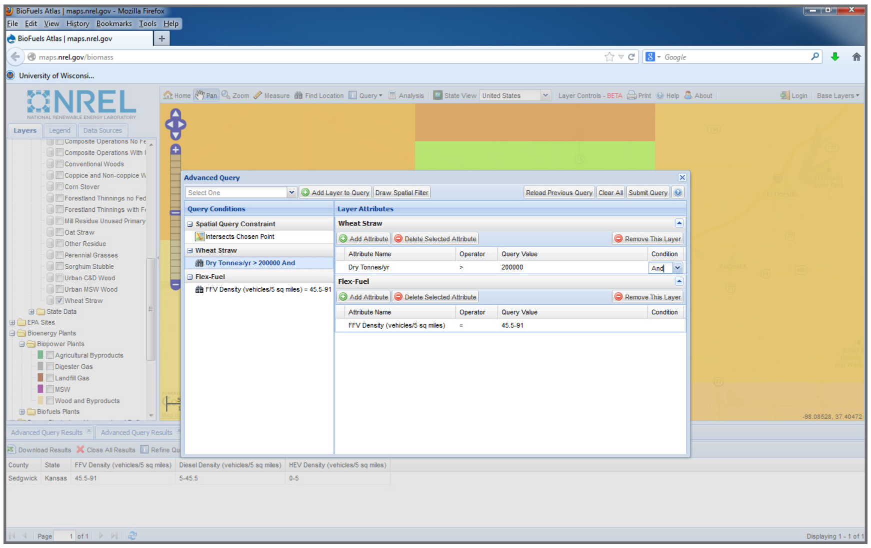
2. In the Layers window, select Feedstocks>Billion-Ton Study>County Data>Wheat Straw and Vehicle Density>Flex-Fuel.

3. Select "Advanced Query" from the Query drop-down menu. And "Clear all" to delete any previously saved queries.

PROCEDURE (cont.)

4. Select the layer "Wheat Straw" from the layer drop down in the advanced query window and then click "add layer to query". Under layer attributes, select "Dry Tonnes/yr" under attribute name, the greater than symbol under operator, and enter "100000" under Query value. Under condition, select "And".

5. Select the other layer "Flex-Fuel" from the layer drop down and add the layer to the query. Select "FFV density" under attribute name, the equals sign for the operator, and "45.5-91" for the query value. When finished, the Advanced Query window should look like this:



6. List the state and county that matched the query conditions.

State: ______________________________

County: ______________________________

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