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Landsat-7 Image of Shanghai

This image was created with 30-m resolution multispectral data collected by Landsat-7 satellite on July 3, 2001.

Allow the Buffalo to Roam: A GIS-Buffalo Commons Instructional Unit

Paul R. Baumann
Department of Geography
State University of New York
College at Oneonta
Oneonta, NY 13820 U.S.A.

Abstract

The short-grass area of the Great Plains of the United States is a large, sparsely population region, which at one time was the home to millions of American buffalo. By the late 19th century, the buffalo had been basically eliminated from the region. For the last fifty years the region has faced major out-migration and dwindling employment opportunities. Due to these conditions, a proposal dubbed the "Buffalo Commons" was introduced in 1987, which would return the short-grass area to the buffalo. Such a proposal is not likely to materialize but a new national park based on the short-grass ecology and the buffalo might be feasible, especially if it would generate the economy through tourism. This paper discusses a GIS instructional module designed to have students select a location for a "Buffalo Commons" national park. Keywords: Buffalo Commons, geographic information systems, Map Viewer, short-grass region, Great Plains.

In 1987, Frank and Deborah Popper put forth a very controversial proposal about the future of the Great Plains in the United States. The proposal was quickly dubbed the "Buffalo Commons" since it involved putting back almost one-fourth of the Great Plains into an ecological park centered on the bison. On the western Great Plains, between the Rocky Mountains and the tall-grass expanses of the eastern Great Plains, lies the short-grass region, which extends from Montana to New Mexico covering large portions of 10 states. The short-grass plains are rolling-to-flat, nearly treeless, semiarid (less than 20 inches of rain per year), and lightly populated (over 300 counties recording population loss in each of the last six decades). Large sections of the area are becoming deserted and the economy is based primarily on agriculture and extraction industries. Needless to say the Buffalo Commons proposal was not readily accepted since it showed signs of government intervention, private land loss through condemnation, and large-scale bureaucracy. In the intervening years the Poppers have modified their original proposal and the people on the short-grass plains are beginning to realize that some changes are needed in order to survive. The buffalo is returning mainly through private herds (244,000 animals) and Native American herds (7,000 animals). Maybe it is time to think about a new national park based on the short-grass ecology and centered on the buffalo. This park would be nowhere the size originally suggested by the Poppers and it would generate an economy through tourism. The author offers a course entitled "Geography of Anglo America" and spends a considerable amount of time discussing the Great Plains. As part of the Great Plains section of the course, the students are introduced to a GIS (geographic information systems) instructional module dealing with finding a location for a Buffalo Commons Park. This paper presents this module and discusses how it was developed and how it is used in the course.

Software

Basically two software packages are employed with this instructional module: MapViewer, developed by Golden Software, and Paint, a Microsoft product available on all Windows machines. MapViewer is a simple software package to use but at the same time provides powerful cartographic capabilities. Included with the software are a number of geographic coordinate databases and some limited attribute databases. A coordinate database exists for every state in the United States and includes the coordinates outlining every county within a state. Each of these state databases stands as an independent database but since they were constructed using the same coordinate system, several states can be loaded at the same time into the software to produce a larger region. All the databases used to create the larger region can be saved as one coordinate database under a new name.

MapViewer permits one to customize the coordinate databases by removing county polygons. Thus, one could load all ten states that contain sections of the short-grass plains, and then, remove the counties outside the short-grass area such as the tall-grass and the Rocky Mountain counties.

However, for this instructional module, the author elected to keep all of the counties in the relevant states. The tall-grass and mountain areas help delimit the short-grass plains for the students. Also, for the present time the author has limited the module to the five northern states in the Great Plains. More emphasis is placed on this section of the Great Plains in class lectures than the southern portion of the region. In addition, the Northern Great Plains has 291 counties for which attribute data have been collected and entered into an attribute database. Some of the attribute data were not available in digital form and had to be inserted manually. To include the Southern Great Plains would require adding data for another 532 counties. Figure 1 provides a location map of the Northern Great Plains.

MapViewer provides other coordinate databases of the United States. These databases include roads, railroads, water bodies, streams and federal administrative areas. From the administrative areas database, national parks were cut out using MapViewer and put into a separate database. Also, Native American reservations were removed and placed into another database. The water bodies and stream databases were merged to form a water database. Finally, the interstates were extrapolated from the road database. National parks and interstates are key features in the tourism economy of the region. Native American reservations and water areas are key items in where buffalo might be maintained. These four items are superimposed on a student's map along with the attribute data that were selected.

The map created through MapViewer can be copied, and then, pasted into Paint. MapViewer like most mapping/GIS packages does a nice job in technically creating a map but lacks the versatility to produce attractive looking cartographic essentials such as scales, north arrows, legends, titles, and sources on maps. It can produce these essentials but not in the manner frequently desired. Paint is a simple graphics editor program. A base map was created in Paint with most of the cartographic essentials organized in the desired manner and the maps produced in Mapviewer were simply superimposed on the base map. Figure 2 shows the base map, which includes all of the map essentials plus some map cosmetics. It does not have a map but the large open area is where the map will be placed.

Attributes

The GIS database for the instructional module consists of seven attributes, which are listed below. The attributes relate to the counties throughout the Northern Great Plains. They are organized as indices ranging from "0," least desirable condition, to "1," most desirable condition. As indices the attributes can be mathematically merged without one attribute overpowering another attribute due to the size of its data values.

The seven attributes reflect some of the major demographic, economic, and social conditions on the short-grass plains. In developing such a database other attributes were considered as well as the number of attributes. However, the instructional goal of the module is to get the students to think through what are the best attributes to use in determining a location for the park. If the attributes are complex in what they are trying to measure, or if a great many attributes exist, the students might then become overwhelmed with how to handle all of the information. As it is they must select between three and five attributes. They cannot use all seven attributes. Allowing them to use all the attributes would be similar to the "black box" approach of dumping all of the data available into a computer without giving any thought about the nature of the data. In addition to being limited on the number of attributes they can use, the students must chose at least one attribute to be weighted. For example, if two of the attributes selected were population density and density of cattle, a student might feel that population density was more important than the

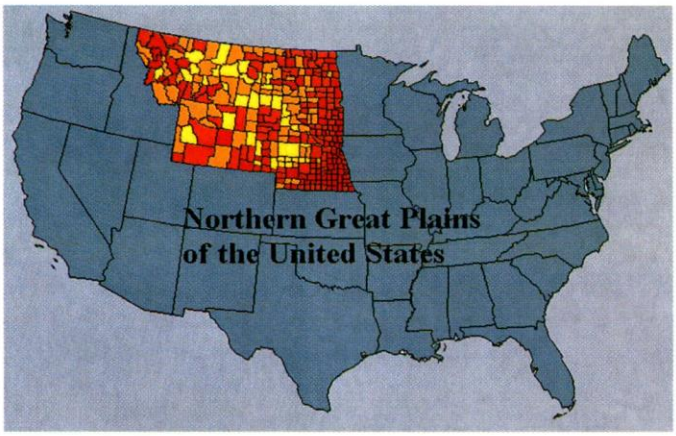

Figure 1 Northern Great Plains

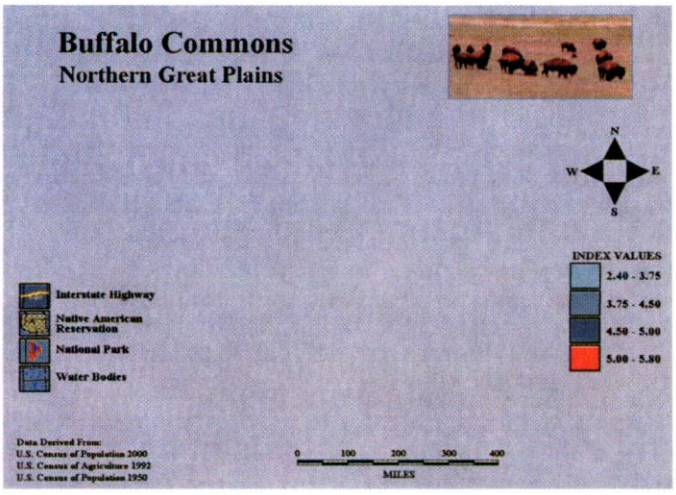

Figure 2 Base Map for Buffalo Commons Map

density of cattle and elect to weight that attribute index higher. The problem that the student faces is determining the magnitude of the weight. Is population density twice the importance of density of cattle or should it be higher? Students struggle in selecting what attributes to use, how many attributes to use, and how to weight the attributes being used. This struggle is just the type of instructional experience that the author is trying to create.

The seven attributes are:

1. Population Density, 2000
2. Average Farm Size (in acres), 1992
3. Density of Cattle, 1992
4. Cropland as a Percent of Total Farmland, 1992
5. Total Land
6. Population Change, 1950-2000
7. Tall-grass

If land is going to be acquired to develop a large park, knowing where the people are presently located is essential. Since the counties throughout the region vary considerably in area size, using population density rather than number of people creates a better picture of the population situation. The county with the lowest population density is assigned the highest index value and the one with the highest density the lowest index value. If people have to be displaced to create the park, it is best to displace as few as possible. With respect to average farm size, the county with the highest farm size is given the highest index value and the one with the lowest farm size the lowest value. It would be easier to purchase a few large farms to create a park than a large number of small farms. Traditionally, ranching has been one of the major economic activities on the short-grass plains; consequently, cattle density is an important attribute. Counties with high densities might have healthy farming economies and land prices might be high. Thus, high densities were assigned low index values. Students are made aware that they must consider large feedlot conditions that could create high densities, and the location of cities and towns that might produce low densities.

Cropland was initially calculated as a percent of the total farmland, and then converted into index values. High percent values received low index values. Large cropland areas within the Northern Great Plains are generally associated with grain farming rather than ranching. These areas have slightly higher population densities and smaller farms than found on the short-grass plains. To acquire a large section of land here would require more effort and money, thus, the low index value. Total land deals with the amount of area within a county. Counties with more land were assigned higher index values. The size of counties increases as one goes from the eastern, and more humid, sections of the Northern Great Plains to the western, and more arid, sections. County size frequently reflects the level of settlement development. The population change index introduces the major internal and out-migration patterns that have occurred throughout the region between 1950 and 2000. Of the 291 counties within the region, 195 have decreased in population size in the last fifty years. Surprisingly a number of the short-grass counties in Wyoming have shown growth mainly due to coal production within the last twenty-five years and the fact that population levels were so low initially that a slight increase created a high percentage increase. Counties with high declines in population were given high index values. Population decline indicates fewer people to deal with in getting the land needed for a park. Finally, the tall-grass index was ascertained by determining those areas with high wheat and other grain productions. These are more humid areas with better soil and topographic conditions for farming. To acquire land in these areas would be an expensive proposition. Consequently, tall-grass areas received low index values. Historically, the tall-grass areas had more buffalo than the short-grass areas but the Buffalo Commons concept is based on the short-grass plains.

Course

This module is one of three GIs instructional projects presented in the course, which is a regional course covering the United States and Canada. The students are told on the first day of class that the course will not deal with all major regions in the United States and Canada at the same level of detail and that more time will be spent on certain regions. One of these regions is the Great Plains. Six lecture hours are devoted to the Great Plains plus two sixty-minute videos. The videos are the *American Buffalo: Spirit of a Nation*, which deals with the relationship between the buffalo and Native Americans on the Great Plains, and the *Fate of the Plains*, which provides a good coverage of the population and farming issues on the Great Plains plus a major discussion on the Buffalo Commons.

Students in the course are mainly education majors and geography majors. Most of them have had no experience with GIS and possess limited computer knowledge. After each of the three projects, including the Buffalo Commons project, are completed, a PowerPoint presentation is prepared based on the work that has been done and the presentation is provided to any student in the class that might want it. The education students generally request having a copy of the presentation since they might use it in the future to prepare a lesson plan. Enrollment in the course is limited to 30 students.

In addition to the textbook, each student is required to purchase a Zip disk. They submit it to the author before each project and he places on it a series of readings relevant to the project. In the case of the Buffalo Commons project, the readings cover the Great Plains, the buffalo, and the Buffalo Commons. Also, a series of maps are included that show the geographic distribution of each of the seven data attributes. All of their work on a project plus their final project paper is placed on the Zip disk. The final paper must be submitted in Microsoft Word. The papers are graded in Word and returned to the students on the Zip disk. The students enjoy doing everything electronically; however, when the disks are

returned to them in class, they must wait until the class is over to find out their grade, at which point there is a mad rush to the nearest computer lab.

Map Construction

The course has a student teaching assistant who has the technical background to create the desired map for each student. The students are not expected to have any GIS or computer skills. The student teaching assistant spends about one hour with each student for each of the three projects. This person is also involved in the maintenance and updating of the attribute databases.

A student makes a one-hour appointment with the teaching assistant within an established two-week period when the maps for all of the students must be processed. Before coming to the appointment for the Buffalo Commons project, students must have determined what attributes will be used and how much to weight them. Students are permitted to make some minor changes in their attribute and weight selection during the appointment session but they need to have worked through the logic of their selection beforehand.

Using the transformation function provided by MapViewer, the teaching assistant multiplies the indicated weight(s) against the desired index(ices) and then adds together the indices selected by the student. This process produces a new data column in the MapViewer worksheet. It is this column that will be mapped. In making the map, the number of map classes is established at four and the organization breakdown of the data is geometric. These parameters remain the same on each student map as well as the color selection for the map classes.

Next the teaching assistant adds the four information layers previously discussed, i.e. the national parks, Native American reservations, interstate routes, and water bodies. Figure 3 shows each of these layers placed on top of a sample index map. Since each of these items is handled as a separate layer, the teaching assistant can return to the index map layer and make changes for the student without reloading the other layers. At the same time the student can request that some of the layers be temporarily removed in order to study certain information on the map. The student is trying to determine where to place the Buffalo Commons. This decision does not have to be made at this point in time. The student can make the decision later. For the student who does make a decision during the appointment session, the teaching assistant can add to the final map a small symbol of a buffalo at the location selected.

The teaching assistant clicks the "Copy Entire Map" function in MapViewer and then minimizes the MapViewer window. Paint is accessed and the base map is loaded. The "Paste" function is clicked and the map appears over the base map. Two color chips appear at the bottom of the tool bar. Click on the bottom one to make the white area on the map transparent and allow the base map to appear. Navigate the map to the desired area on the base map. Since all of the map essentials except the class ranges are already established, very little additional work is required. The teaching assistant then adds the new class ranges and the map is finished. See Figure 4. The map is copied to the student's Zip disk. Next, Microsoft Word is accessed and the map is inserted as a picture file in a document. The document file is also saved on the student's Zip disk. The student will write his/her final report in the document file. A copy of the final map is also stored under a directory maintained by the teaching assistant in case something happens to the student's copy.

As a secondary map, it is possible to zoom in on a portion of the original map in MapViewer and insert it into Microsoft Word. Rather than copy the map, one has to press the Alt and PrtSc keys at the same time, and then, paste the map into Word. The process will move the entire Window screen in addition to the map and the map will not have any of the cartographic essentials.

To produce a final map and to insert it into Word takes the teaching assistant generally less than ten minutes. Most of the hour appointment time is used by the assistant helping the student to understand the entire process, refining the index map, and thinking about where a Buffalo Commons Park might be placed. The student teaching assistant plays a valuable role beyond the technical construction of the map. In addition to helping the students, this person keeps the instructor informed about problems being encountered by the students and where some clarification on the project might be needed. The assistant provides input on which students came well prepared for the project and which had given little thought about it.

Final Report

Although students can include background information in their final reports, they must identify what attributes they used, and more importantly, why they selected those particular attributes. They must also indicate which attributes were weighted, how much they were weighted, and why they were weighted. For many students the determination of the appropriate weighting of attributes is the hardest portion of the project. Next, students must discuss of the four information layers which ones were more important in their decision making process and why they were more important. Finally, they must indicate where they would locate the Buffalo Commons Park based on the work that they have done. Their decision should be mainly related to the map that they have created but other information might be included that is not reflected in the data. For example, a student might elect to place the park near a particular Native American reservation knowing that that group of Native Americans has a stronger link to the buffalo than other groups.

Of the three GIS instructional projects in the course, the majority of the students find this project the most interesting and challenging. The buffalo symbolizes much of the western history and lore in the United States and most people know

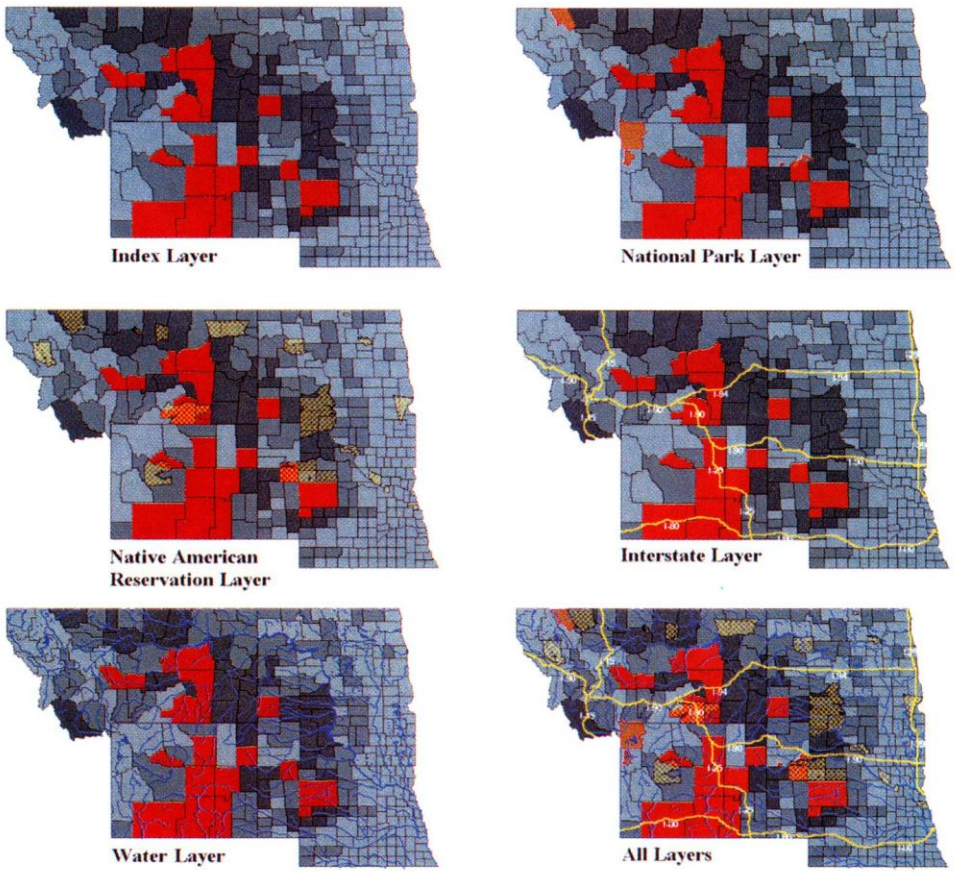

Figure 3 Individual Map Layers and Final Map

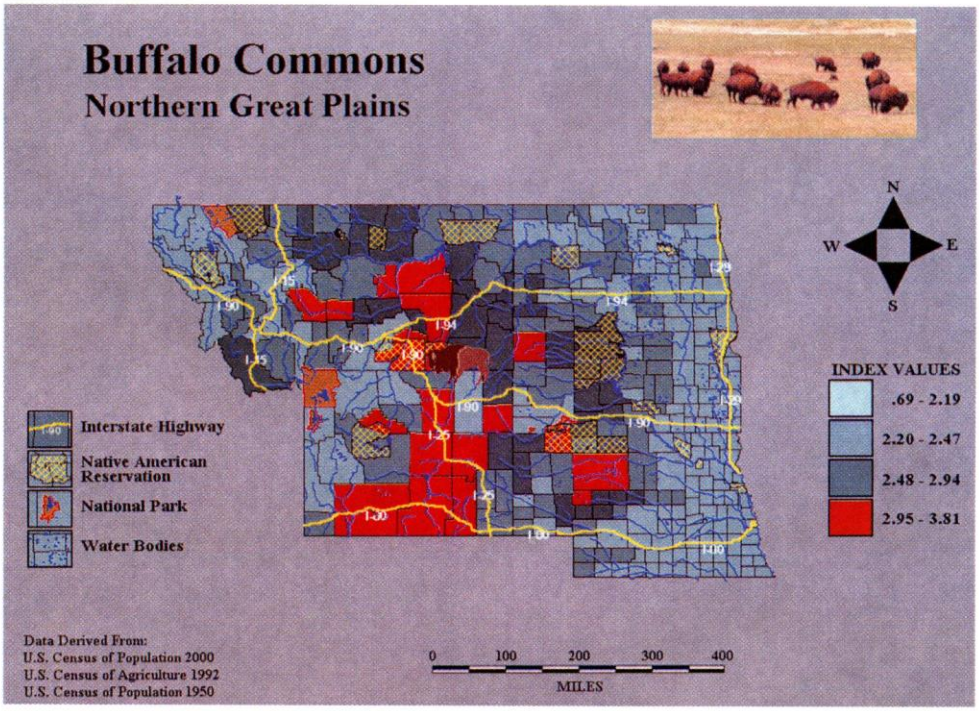

Figure 4 Final Map Inserted On Base Map

about its near extermination. Thus, bringing back the buffalo to the Great Plains in large numbers has a certain fascination to Americans. Working along the same approach the author is reworking one of the other course projects that is based on finding a location to reintroduce the Mexican wolf.

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