

Vector and Raster Methods for Creating Coastal Vignettes

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Representing where land and water meet can be done using a number of methods, some of which are called coastal vignettes. Coastal vignettes symbolize the water from the shoreline towards open water. A vignette is usually thought of as a drawing (i.e., symbolized graphic mark) that gradually fades into the surrounding background leaving an undefined edge (Loggia.com 2003).

Various methods exist to achieve this effect. On historic maps, a set of contours parallel to shore highlight the water areas along coastlines. On more recent maps, gradation of color is often used, ranging from white along shore to the blue used for the open water areas (USGS 2002). Because lighter values are associated with “less” of something, this approach leads the map reader to the impression that coastal areas are shallower than open water areas – an impression that we often want to propagate because of its general truth (Robinson, et al. 1995; Tufte 1991; Tufte 1997). Additionally, the white areas near shore may be associated with the white water of breaking waves along beaches.

In this paper, we demonstrate how to create coastal vignettes to symbolize the water using two different methods for creating a gradation in color – Buffers and Euclidean Distance. One method uses multiple buffer rings either of the same size or of gradually and consistently greater distances, for example, using narrower buffers near land and widening them towards open water. The other method uses a raster surface that represents distance from shoreline. For each method we show you how to use both the tools from ArcGIS 8.x and the tools that are available in the geoprocessing framework of ArcGIS 9.0 (ESRI 2004).



Figure 1. Coastal vignettes emphasize the land-water interface. The left half of this map uses coastal vignettes created with the buffer method, while the vignettes on the right half were created using the raster Euclidian distance function. Both methods yield almost identical results depending on the settings used to create and symbolize the vignettes.

USING BUFFERS TO CREATE COASTAL VIGNETTES

The first method involves a vector approach using multiple buffer rings. First, we describe how to create the vignette using buffer rings of the same size.

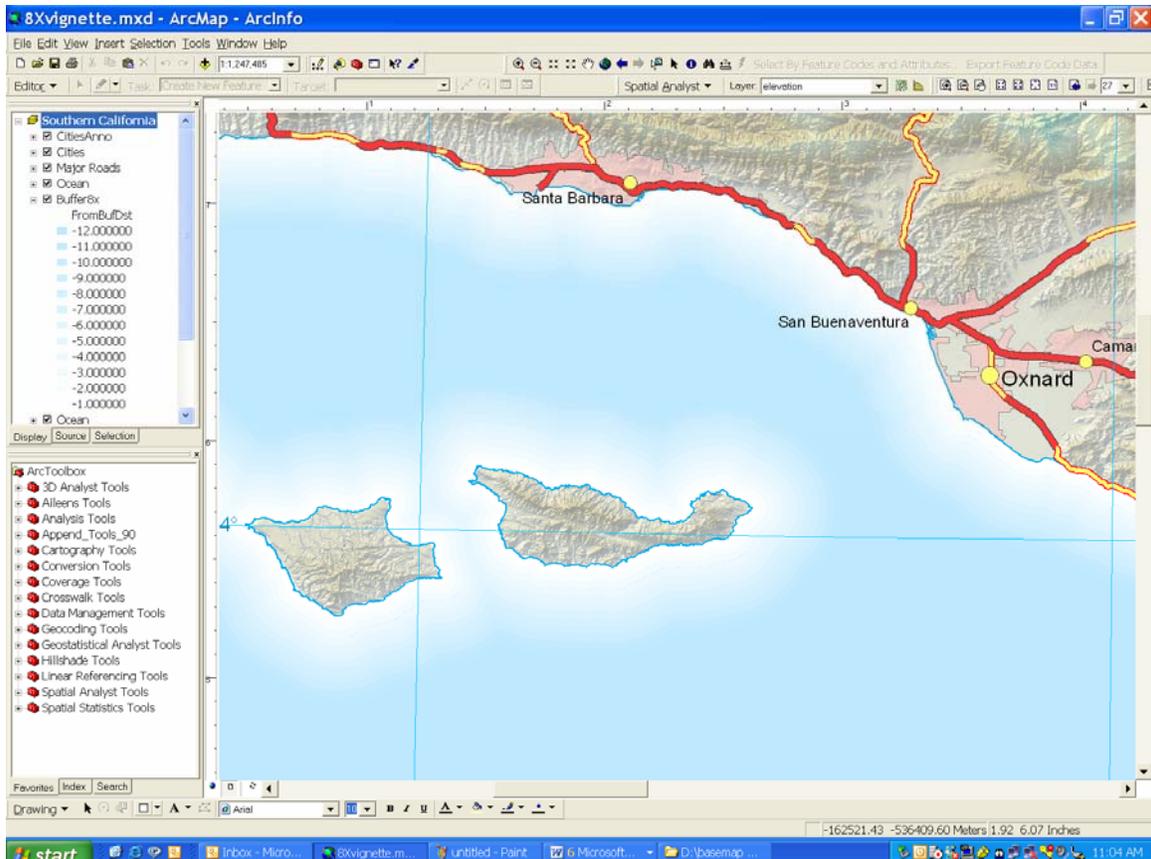


Figure 2. Coastal vignette created with the Buffer Wizard using multiple buffers.

To create multiple buffer rings in ArcGIS 8.x, use the Buffer Wizard which can be selected from the Tools menu. In 9.0, add the Buffer Wizard through the Customize dialog (click the Commands tab, click Tools and drag the Buffer Wizard to any toolbar on your interface).

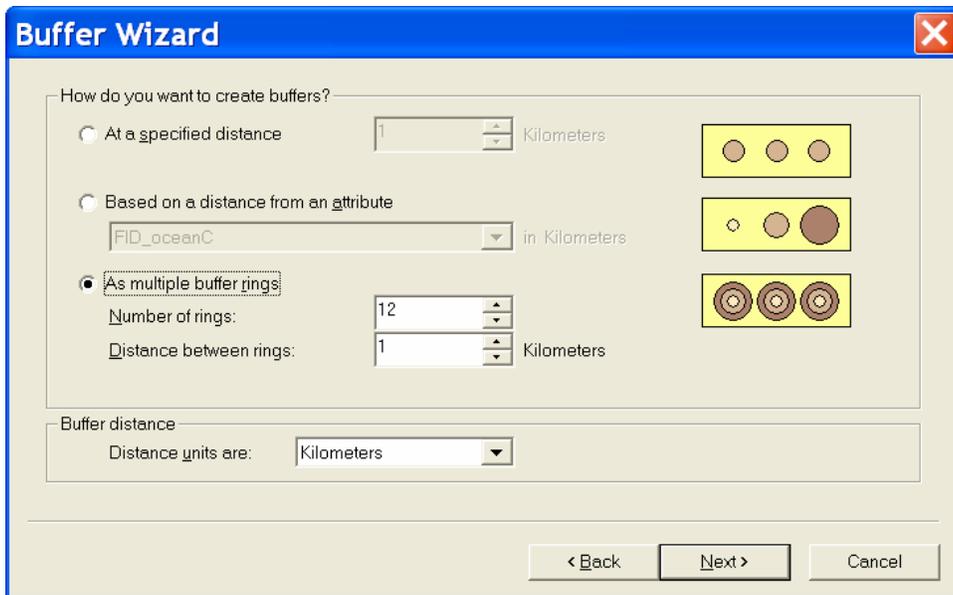


Figure 2: The Buffer Wizard is set to buffer the Ocean layer with twelve rings one kilometer apart.

In the 8.x Buffer Wizard, select the layer you want to buffer. To create the coastal vignettes, you can either use a land layer, like the United States, or a water layer, like a polygon of a lake. Select “As multiple buffer rings” and set a suitable number of rings and distance between rings. If desired, set the units for the buffer distances. The more rings, the smoother the display – if the intervals are not too large.

In the next dialog box, it does not really matter for coastal vignettes which option is used for dissolving barriers. Select “Only outside the polygon” if buffering a land polygon layer, and use “Only inside the polygon” if buffering a water polygon layer, as in our example. Save the buffers in a new feature layer.

Buffers can also be created using the ArcGIS 9.0 geoprocessing Multiple Ring Buffer tool.

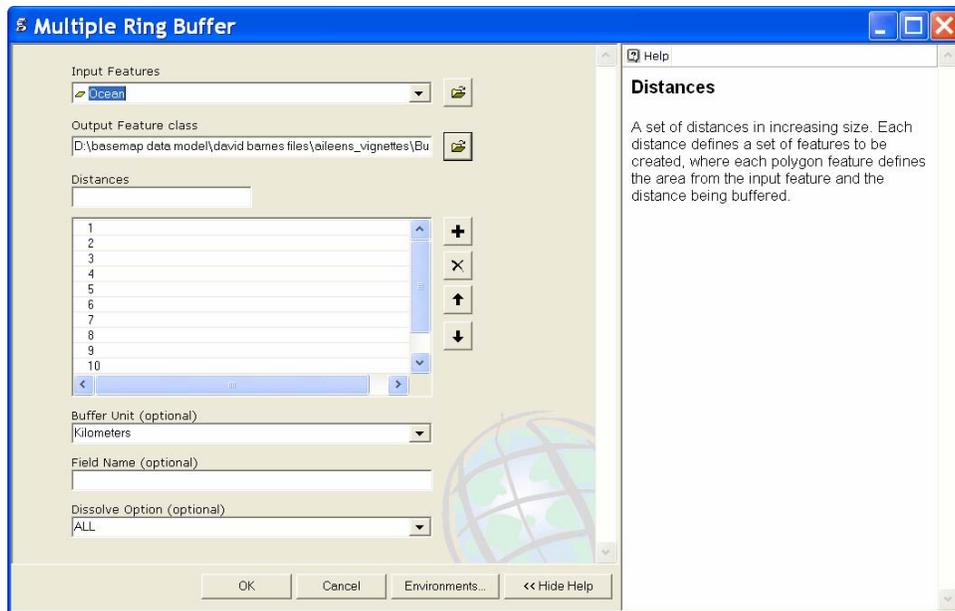


Figure 3. The Multiple Ring Buffer Tool in ArcToolbox.

The Multiple Ring Buffer tool is an Analysis Tool in the Proximity Toolset. The main difference between this and the Buffer Wizard is that the geoprocessing tool requires you to set the distance for each ring. The geoprocessing tool also allows you to make rings of different sizes, for example, to increase the width of the rings farther from the coast. If you want all your rings to be the same size, it is easier to use the Buffer Wizard instead because the width of each ring does not need to be input.

Symbolizing the Buffers

Once the vector buffers have been created using one of the two methods described above, they are ready to be symbolized.

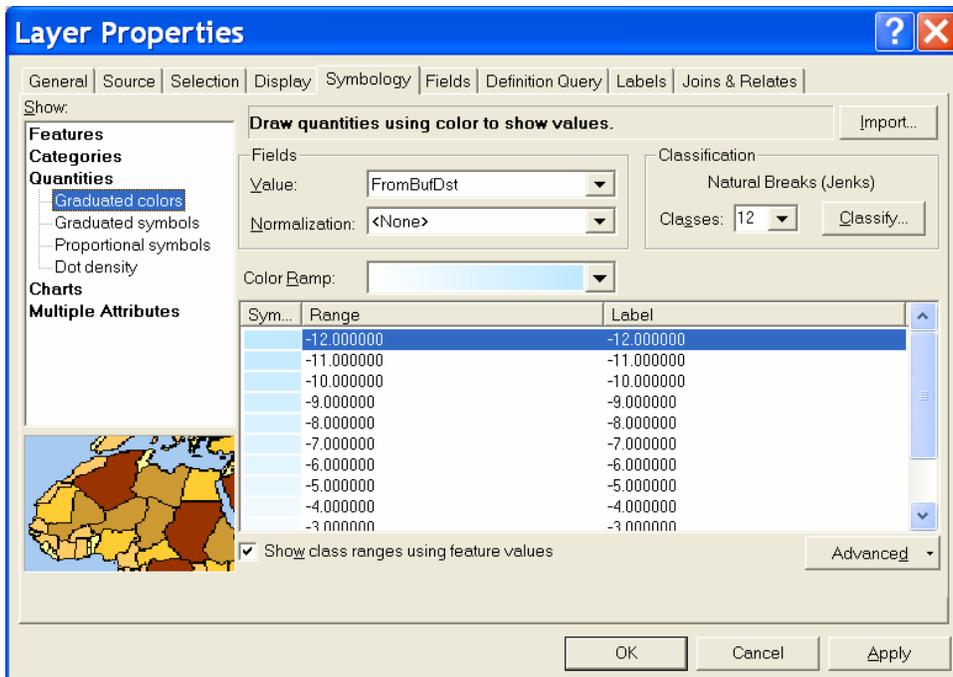


Figure 4. The Layer Properties dialog box where you can set the display of the vector coastal vignette created using buffers.

Right click the name of the buffer layer in the Table of Contents to see its properties (Figure 4). In the Layer Properties dialog under the Symbology tab, select Quantities and then Graduated colors. Set the color for the buffer class farthest from land to the blue that will be used for the water outside the coastal area, and set the color for the class nearest to land to white (Figure 5).

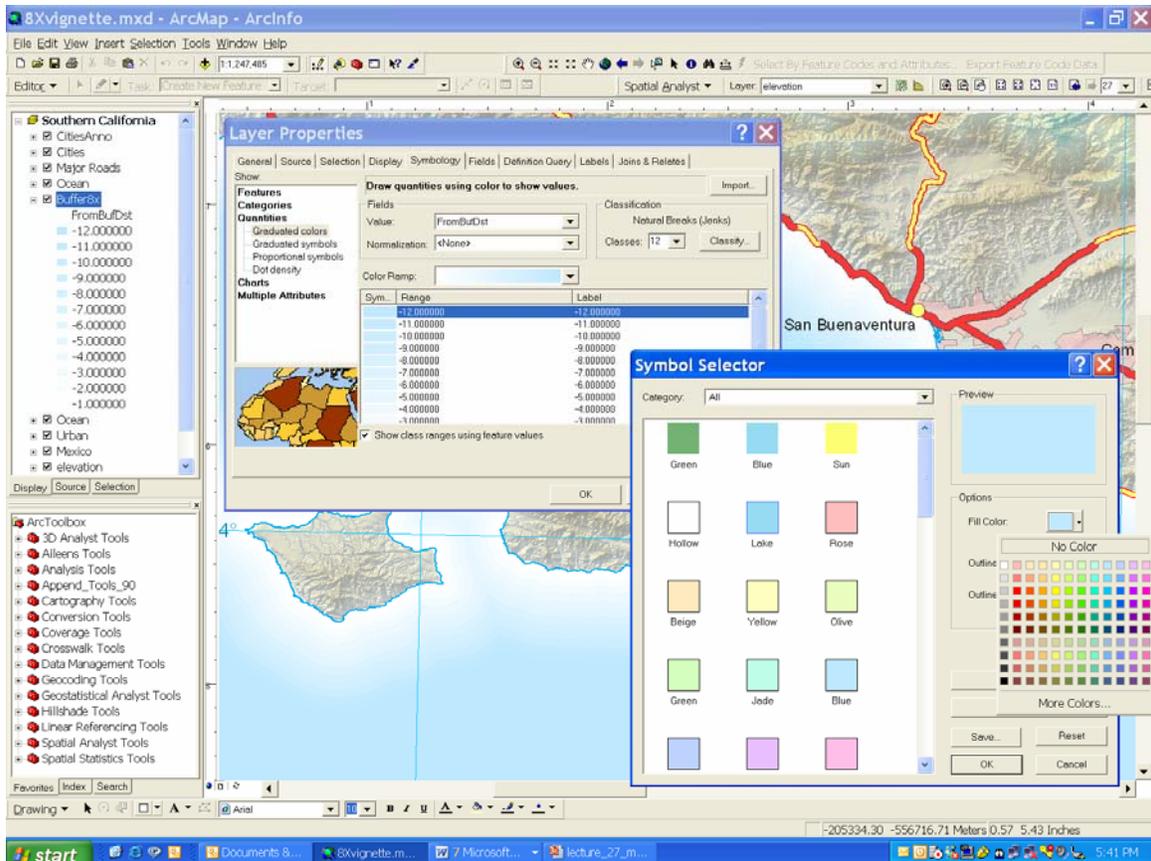


Figure 5. Setting the color of the blue for the buffer farthest from land – it should be set to the same color used to show the rest of the water.

Select the first and last classes together using the Control key, then right-click on the color patch in the display and choose Ramp Colors (Figure 6). This applies a blue to white color ramp to all of the vector buffers using the two classes you specified as endpoints.

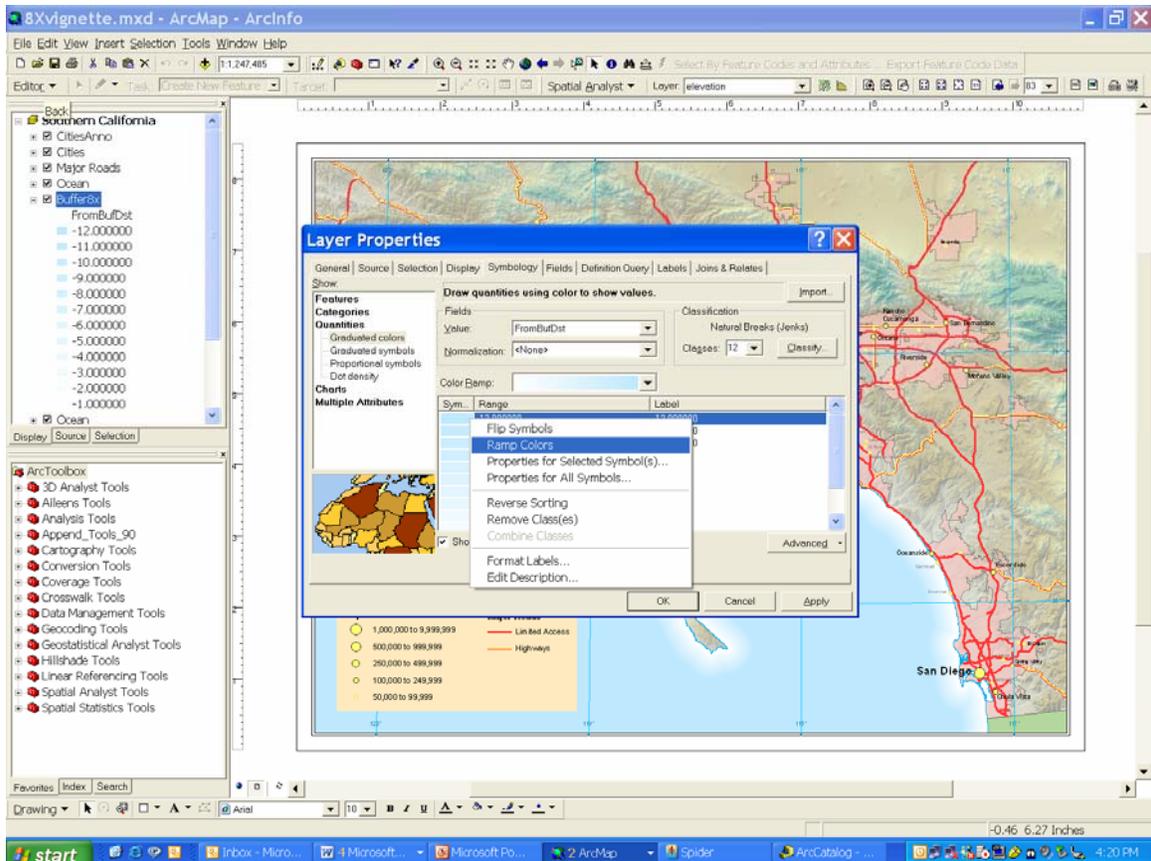


Figure 6. The context menu used to ramp the colors between blue for the buffer ring representing the deepest water and white for the buffer ring representing the buffer ring nearest land.

Note that in our example we used twelve buffers, but to get a smoother effect you can use more. The number of buffers you choose will depend upon the size of area mapped as well as how smooth you want the color progression to appear.

There are a number of advantages to using vector buffers for coastal vignettes, including smaller file size and the fact that you do not need the Spatial Analyst extension to create the rings. It is also easier to assign specific colors to any given band. There are some limitations, however. Once the buffers have been generated, the width cannot be extended or contracted. Note, however, that if you use overlapping disks instead of non-overlapping rings, you can remove buffers – set this option on the miscellaneous tab in the advanced settings utility. Also, with fewer rings, the distinction between bands of color might be too obvious. With the next method, a raster approach allows you to change the degree of color gradation of and other symbology options to produce different results very easily.

USING EUCLIDEAN DISTANCE TO CREATE COASTAL VIGNETTES

It is also possible to make coastal vignettes using a raster method that uses the Euclidean Distance function. This raster approach calculates for each cell the Euclidean distance to

the closest “source” cell – that is, the nearest shoreline cell. If the input source data is a feature class, it will first be converted internally to a raster before the Euclidean analysis is performed. Conceptually, the Euclidean algorithm works like this: for each cell, the distance is calculated to each source cell by calculating the hypotenuse with the x-max and y-max as the other two legs of the triangle. This calculation derives the true Euclidean, not cell, distance. The shortest distance to a source is determined, and if it is less than the specified maximum distance, the value is assigned to the cell location on the output raster.

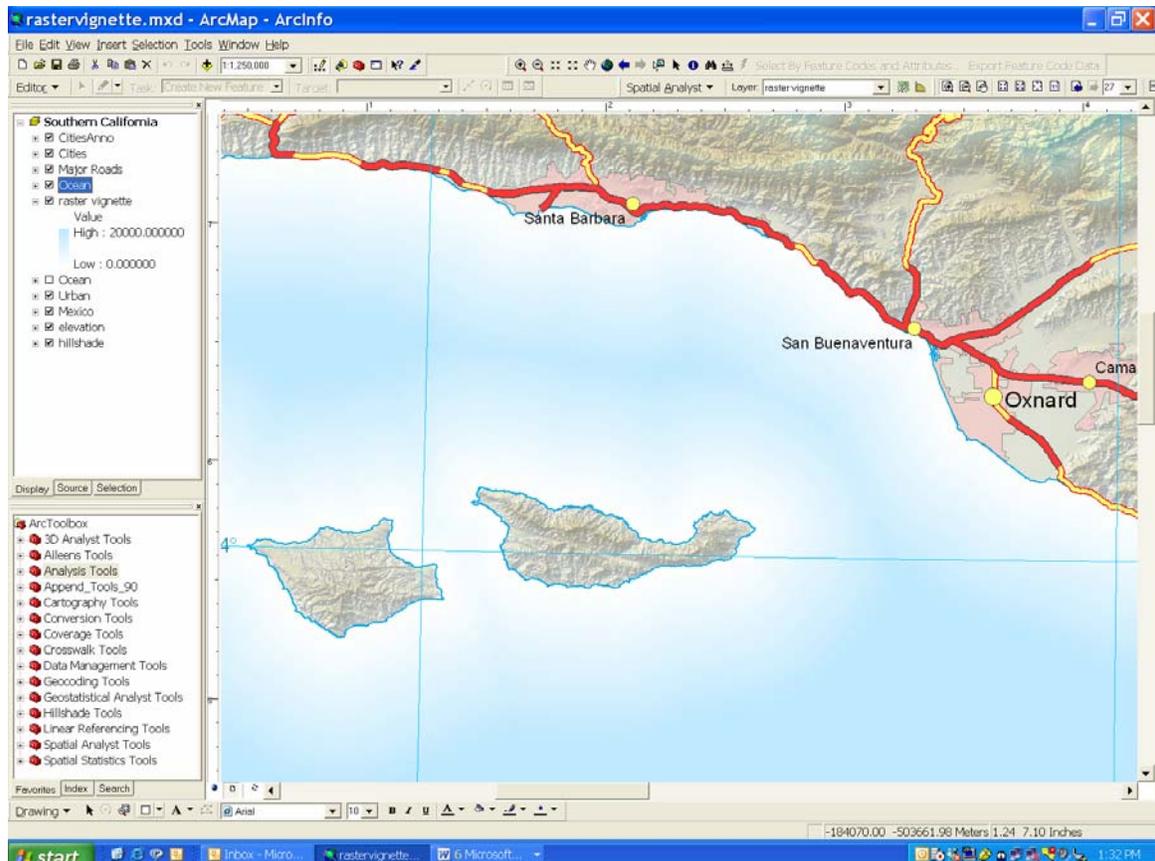


Figure 6. Coastal vignette created with the Euclidean distance function in Spatial Analyst.

The Euclidean Distance function can be accessed either through the Spatial Analyst extension or through the Spatial Analyst tools in the geoprocessing framework of ArcToolbox. Note that the Spatial Analyst methodology will work for 8.1+ and the geoprocessing method works with 9.0+. We first describe the Spatial Analyst method.

First make sure the Spatial Analyst extension is enabled (click Tools, click Extensions, and make sure Spatial Analyst is checked) and the toolbar is on (if the toolbar is not on, click Tools, click Customize, then under the Toolbars tab, check Spatial Analyst).

In the Spatial Analyst dropdown menu, click Distance, then Straight Line. Choose the layer the distance is being calculated from – this is a polygon layer of the land area. Then

set the other parameters or use the defaults which are generally fine for creating coastal vignettes. For the purposes of our map, we set the cell size to 80. The number you use is relative to the units of the coordinate system the raster is stored in – these units can be checked in the Spatial Analyst options. Depending on the extent of area mapped and the processing capabilities of the computer, this number represents a balance between high enough resolution that the result is not too pixelated and low enough resolution that the processing is not too intensive.

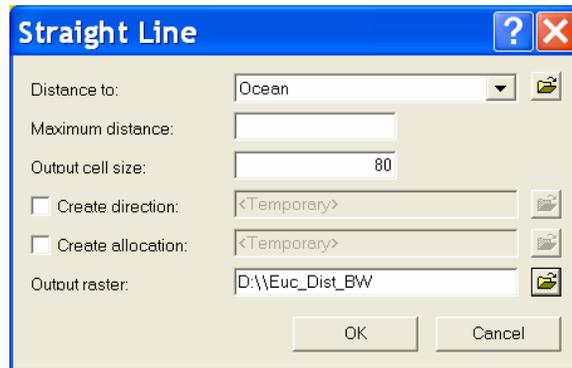


Figure 7. Setting the Euclidean Distance parameters in Spatial Analyst.

To use the geoprocessing tool, from ArcToolbox, click on Spatial Analyst Tools, click Distance and select the Euclidean Distance tool. Here you can set the same parameters as in the Spatial Analyst Straight Line tool.

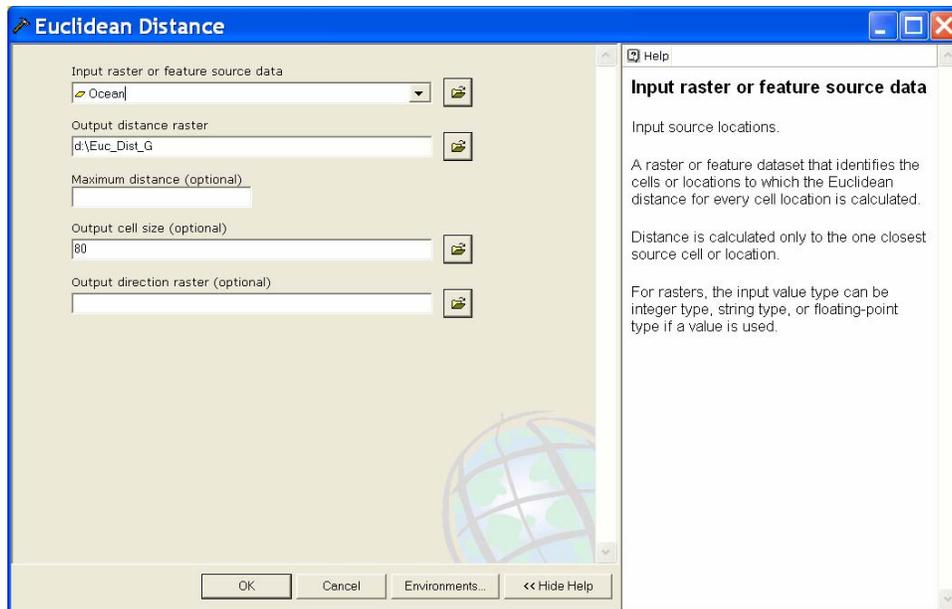


Figure 8. Setting the Euclidean Distance parameters in the Distance Tool in ArcToolbox.

Symbolizing the Euclidean Distance grid

Once you have created the Euclidean distance grid, you can symbolize it using the Layer Properties dialog. Two special effects were used to symbolize the raster in ArcMap: creating a custom algorithmic color ramp and stretching the raster values to fit the custom color ramp.

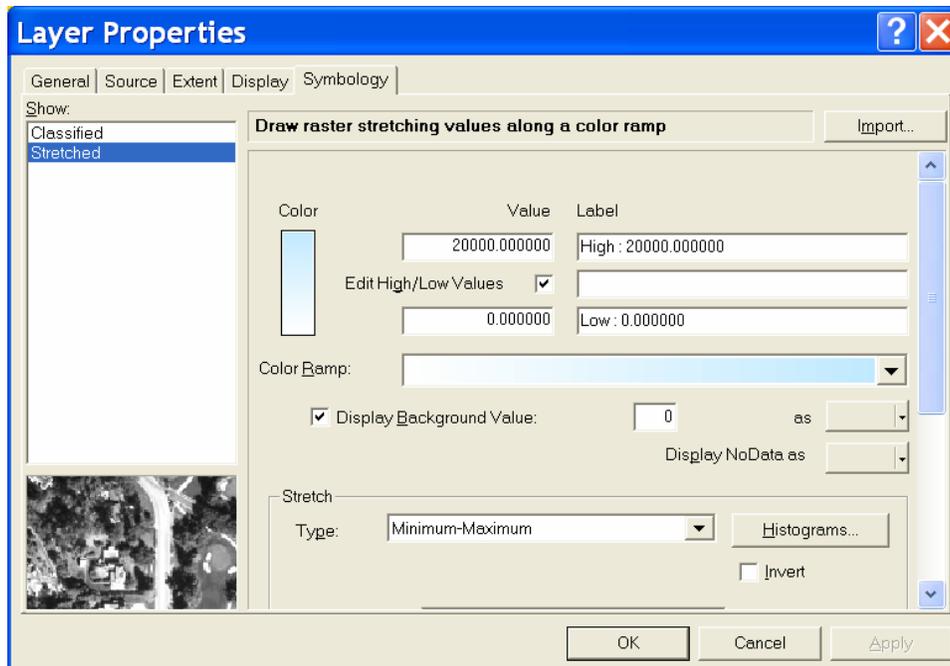


Figure 9. The Layer Properties dialog box where you can set the display of the raster coastal vignette created using Euclidean distance.

To create a custom color ramp, use the Style Manager (click the Tools menu, point to Styles, then click Style Manager.) On the left side of the dialog box, click on your personal style or another style in which you want to store the custom color ramp and then click on Color Ramps. On the right side of the dialog, right-click, point to New, and click Algorithmic Color Ramp. Set the first color to white and the second color to the blue you want to use for water (we selected Sodalite Blue from the color palette.) Click OK and type a name for the new color ramp you created.

To apply the color ramp to your raster grid, under the Symbology tab of the Layer Properties dialog box, select Stretched and select the color ramp you created. Select the Minimum/Maximum option so that you have the ability to change the high and low values to adjust the width of the vignette. The values are a function of the range of values in the Euclidean distance grid. The minimum is usually zero for the pixels near the shoreline; the maximum determines where the gradation of color stops so that the highest pixel values have the same color blue. By working with the histogram, you can change the application of the color ramp; this effectively allows you to make some of the same manipulations as with the buffer tool to control the buffer ring distances.

One of the advantages of using the raster Euclidean distance method to create coastal vignettes is this flexibility in symbolization of the extent of the vignette. If the classified

option is used instead of the stretched option, the effects are nearly identical to the buffer method. With this option, the class intervals and colors can be set individually or using a color ramp.

As with the buffer method, there are also a few limitations to this approach. Pixels along the shoreline will become apparent if the raster is too coarse for the map scale (that is, the cell size is too large). Also, larger file sizes result from using raster layers; although the file size can be reduced if converted to Mr. SID or some other compressed format image, drawing performance and output will not improve significantly.

Conclusion

This paper describes two methods for creating coastal vignettes with ArcMap. The vector method involves the creation of multiple buffers symbolized with colors graded from white near the shoreline to the blue used for the deeper ocean. This method has the advantage of being flexible in terms of the number and size of buffer classes. Vector buffers allow you to set the symbology of each of the bands, but once the buffers have been generated, you cannot change their width (i.e., extend or contract the buffers). With the second method, raster analysis is used to create a smoothed continuous surface that represents the distance from the shoreline. This method allows you to adjust the degree and width of color gradation by setting the minimum and maximum values (i.e., stretch the data to fit the chosen symbolization). Other raster symbology options (e.g., specifying a classified renderer and its associated options) can also be set to produce a variety of results. Depending on the settings used to create and symbolize the vignettes, both methods can yield almost identical results.

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