# Using Cost Surface Analysis to Identify Areas for Wetland Migration

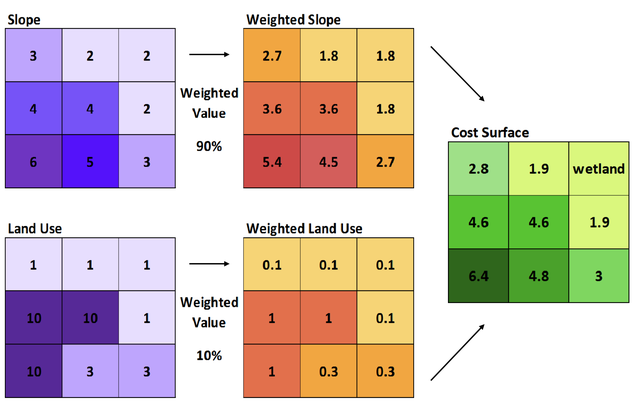
## Overview

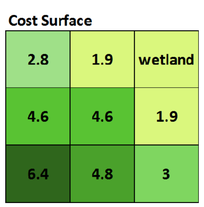
*Sea level rise is a documented reality that poses a threat to coastal areas.*

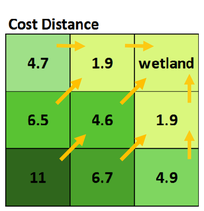
Coastal wetlands provide valuable ecosystem services, including protecting coastal development from storm surge. As sea level rises coastal wetlands would naturally relocate further in-land, however their migration is often impeded by existing development. Often referred to as "coastal squeeze", the inability of coastal wetlands to migrate inland would result in a loss of wetland habitats and the many ecosystem services they provide, especially that of protecting inland development.

This analysis demonstrates the use of GIS tools that can be used to identify coastal areas that would be suitable for wetland migration.

## Cost Surface and Cost Distance




Source: Arc GIS Desktop

*The Cost Surface and Cost Distance tools can be used to determine the least cost path from one point to another, based on variables and assumptions specified by the user.*

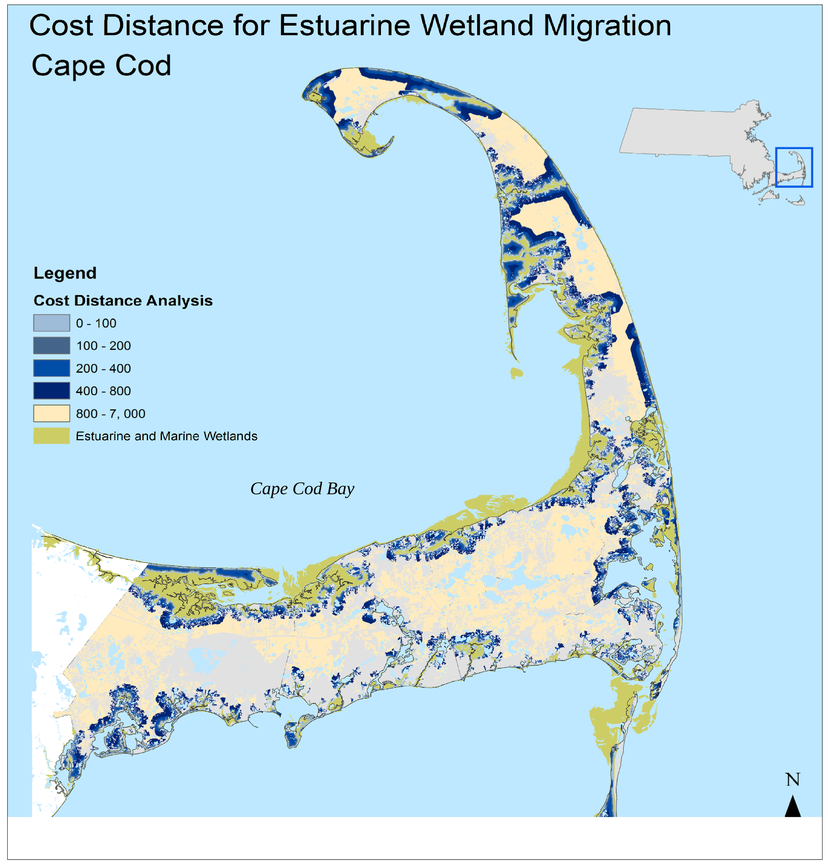
There can be multiple costs to travel. For example, variables important to the movement of wetlands include distance, slope and land use. Steeper slopes, developed land and further distances all represent higher costs of travel than flat slopes, open land and closer distances.

The **weighted overlay** tool calculates the weighted value of each cell, for each variable's raster data. The overlay can then be used as an input for the **cost surface** tool, which creates a new raster that combines the values of multiple variables for each cell.

The **cost distance** tool uses the cost surface to generate the cumulative cost of each cell to the nearest source cell, in this case a wetland cell.

Tufts

***Cartographer:*** *Bronwyn Cooke* ***Date:*** *December 17th, 2010*
***Data Source:*** *Mass GIS, USGS, National Wetlands Inventory*
***Projected Coordinate System:*** *NAD 1983 State Plane MA*




1. Developed Land Value = No Data Land Use/Slope Weight = 90/10

## Methodology

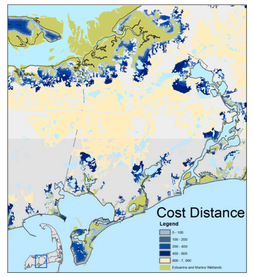
*Using reclassified raster data for slope and land use, a cost distance for wetland migration was derived using the weighted overlay and cost surface tools. The analysis was repeated three times using the same variables, but different values and weights to allow for comparison of the cost distance output.*

**Cost Surface** For all three analyses a value of one was assigned to cells with the flattest slope (suitable for wetland migration), and ten for cells with the steepest slope (not suitable for wetland migration).

Open land and other undeveloped areas were given a value of one (suitable for wetland migration). Land uses that were considered to be relatively easy to relocate, such as agriculture, were given a value of three. Developed land was assigned a value of "no data" in the first and second analysis and a value of 10 in the third. Cells that are assigned a value of no data are excluded from the analysis. Aquatic ecosystems, including freshwater wetlands and lakes, were rated with the same method, as it can be assumed that existing open water would not transition to wetland.

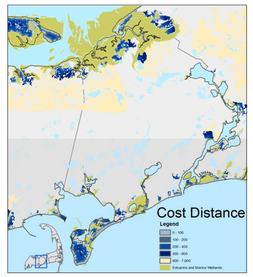
**Weighted Overlay** Slope and land use were given a weight of 10% and 90% respectively in the first analysis, and an equal weight in the second and third.

**Cost Distance** Using the raster data for estuarine and marine wetlands and the weighted overlay as inputs, the cost distance tool generated an output raster, showing for each cell the cumulative cost of travel away from the nearest wetlands cell.



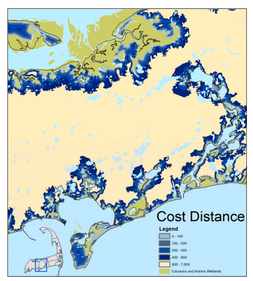

1. Developed Land Value = No Data Land Use/Slope Weight = 90/10

| | Acres |
|---|---|
| **0-100 (Least Cost)** | 22,707 |
| **100-200** | 6,395 |
| **200-400** | 9,187 |
| **400-800** | 12,462 |
| **800-7,000 (Greatest Cost)** | 51,722 |




2. Developed Land Value = No Data Land Use/Slope Weight = 50/50

| | Acres |
|---|---|
| **0-100 (Least Cost)** | 33,002 |
| **100-200** | 2,850 |
| **200-400** | 5,048 |
| **400-800** | 7,909 |
| **800-7,000 (Greatest Cost)** | 55,716 |




3. Developed Land Value = 10 Land Use/Slope Weight = 50/50

| | Acres |
|---|---|
| **0-100 (Least Cost)** | 38,781 |
| **100-200** | 8,456 |
| **200-400** | 13,941 |
| **400-800** | 21,771 |
| **800-7,000 (Greatest Cost)** | 94,280 |

## Results

*The cost distance tool identifies low cost areas for wetland migration, however output varies based on the parameters set by the user. Data for additional variables that impact suitability for wetlands would improve the validity of the results.*

The cost distance output of the first analysis identifies concentrated areas of low cost for wetland migration along the north eastern shore and along the southern shores of Cape Cod Bay. This is not surprising, as those areas have more open land. However, a closer look at the area along the north eastern shore underlines the fact that land use was weighted more heavily than slope, as the area was considered to be relatively low cost despite the steep slope. This demonstrates the importance of the values and weights set by the user.

Additional data inputs and higher resolution would provide more robust results. Suitability for wetlands depends on factors other than slope, distance, and land use. Accretion rates, sediment availability and tidal ranges are also influence the suitability of sites for wetland migration. Also, this analysis used a 30 meter cell size for ease of data management and processing, however a 5 meter cell size would provide better spatial accuracy.