



# Spatial Analyst - Cost Distance Analysis

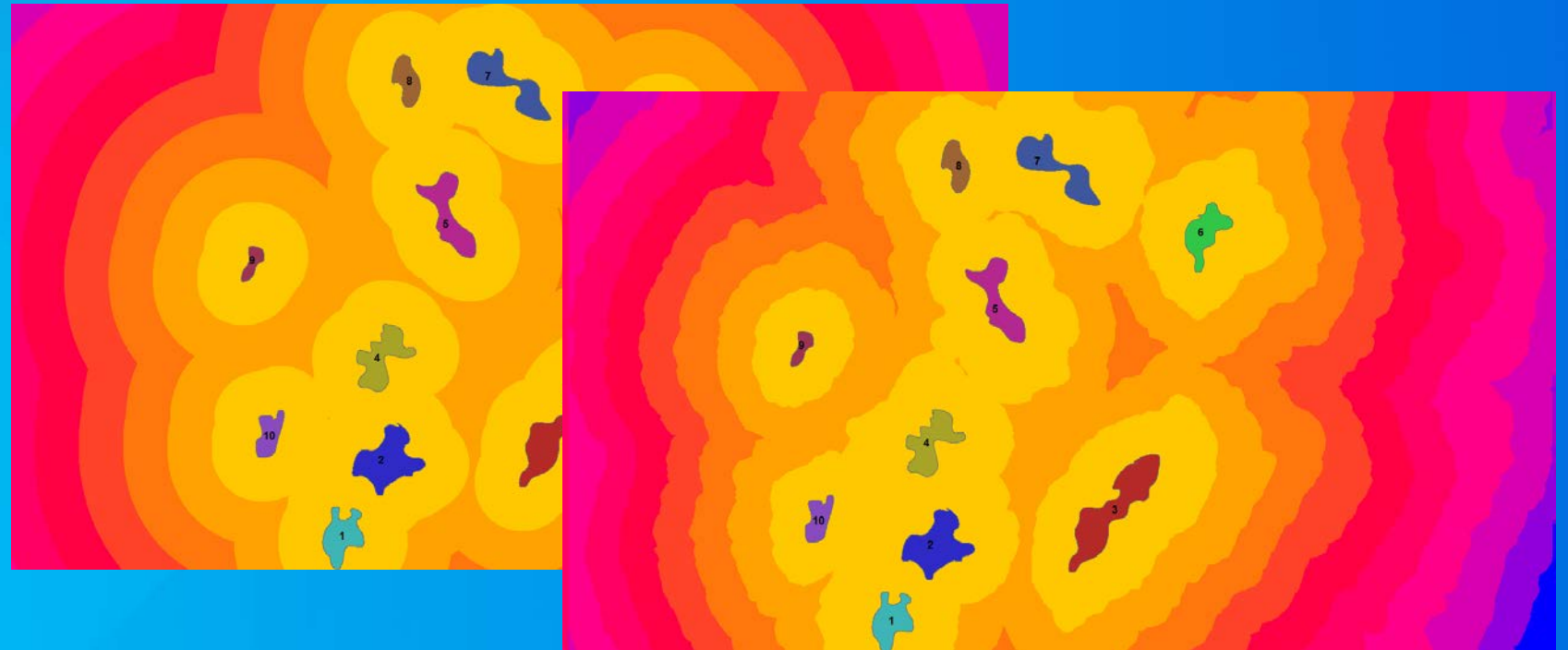
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# Cost distance analysis - Outline

- What is cost distance analysis
- The two step process
- Adding complexity
- Corridor analysis
- Demo

# What is cost distance analysis

- One of the most common applications in Spatial Analyst
- Euclidean distance – as the crow flies
- Cost distance – as the phenomenon moves across the landscape
- Based on cost
  - Preference
  - Energy expended
  - Time
  - Dollars
  - Risk



## Problems addressed by cost distance analysis

- **Constructing a road to a proposed shopping center**
- **Conserving wildlife corridors between habitat patches**
- **Supplying and reinforcing military troops in a deployment**
- **Providing movement paths for fire fighters between posts**
- **Locating a pipeline to connect energy fields to a refinery**
- **Siting electrical lines**

# Two step process for performing cost distance analysis

- **Cost Distance tool**

- **Input**

- Sources – starting point
- Cost surface – cost per map unit for travel

- **Output**

- Cost distance – total accumulative least-cost for each cell to reach a source
- Back link – direction to move from each cell to reach a source
- Cost allocation – for each cell, which is the least-cost source

- **Cost Path tool**

- **Input**

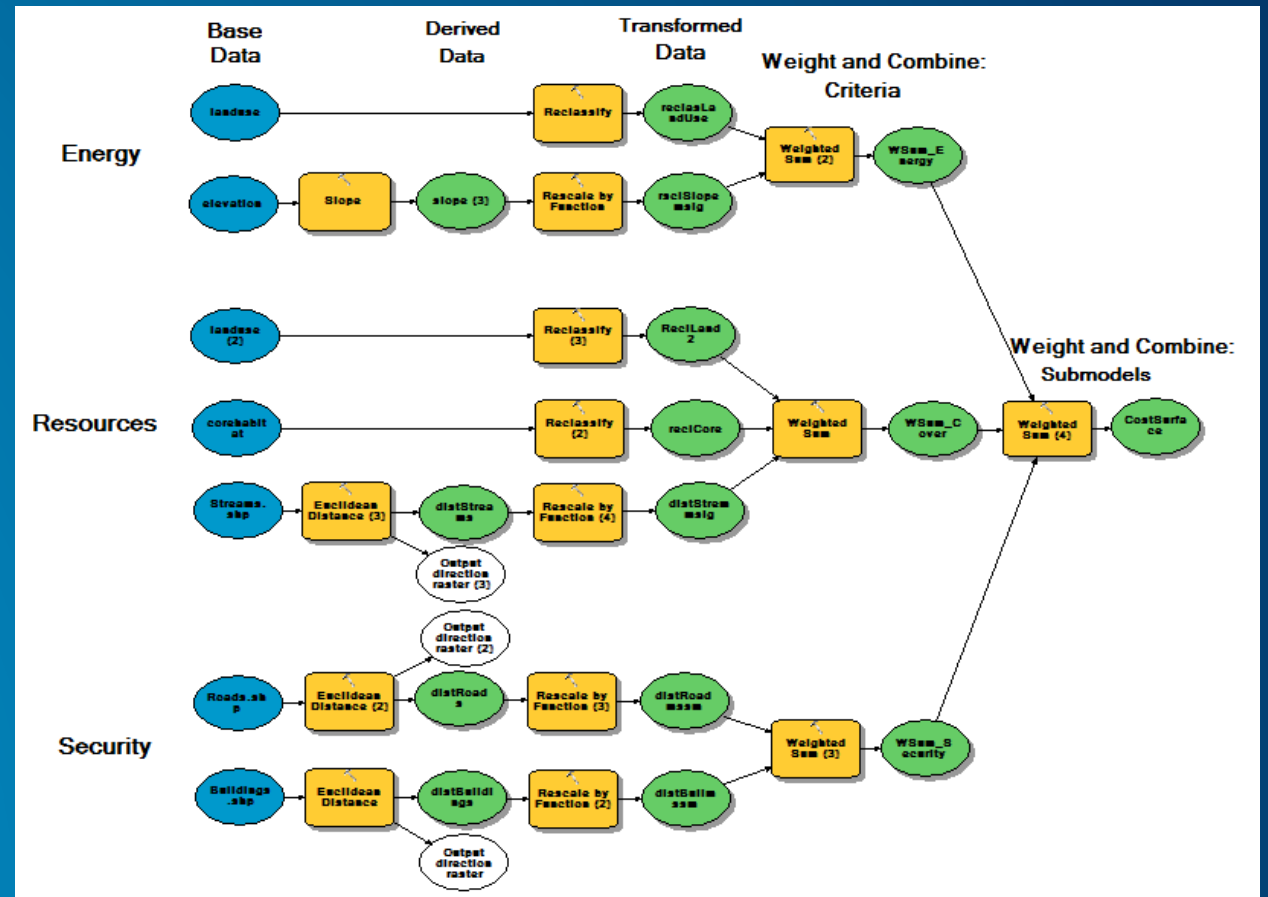
- Destination – ending point
- Cost distance and Back link output rasters from Cost Distance tool

- **Output**

- Least-cost paths – the least-cost path

# How to create cost surface

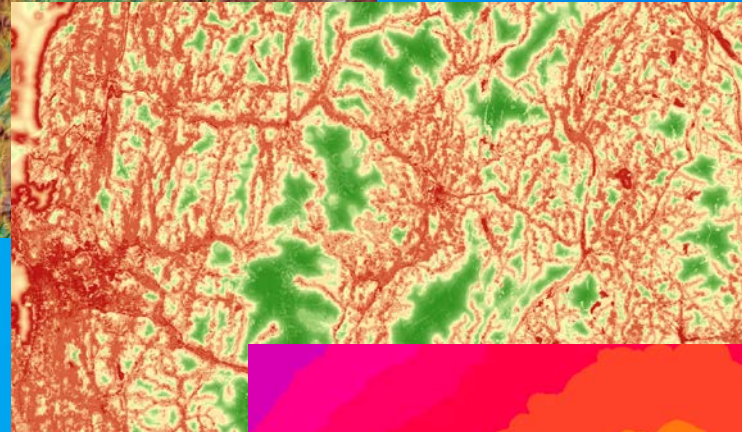
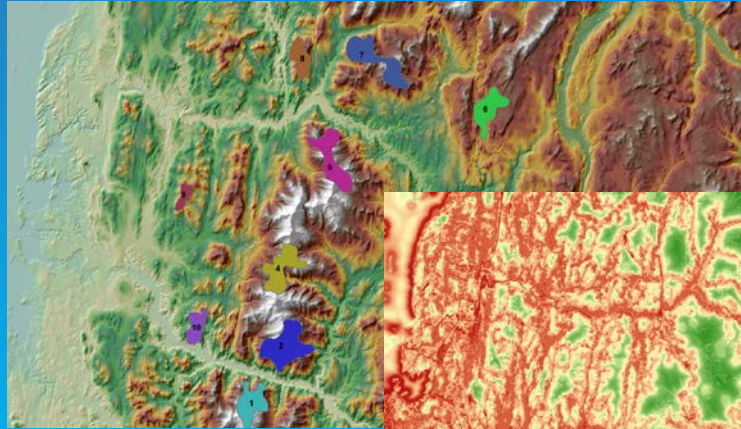
- Similar to creating a suitability model
- Cost per map unit to move through the cell
- The lower the cost the better
- Diagonal accounted for



# Step 1: How to perform the cost distance analysis

The Cost Distance tool

- Sources
- Cost surface
- Output distance raster – for each cell, total least-cost to each cell to reach least-cost source

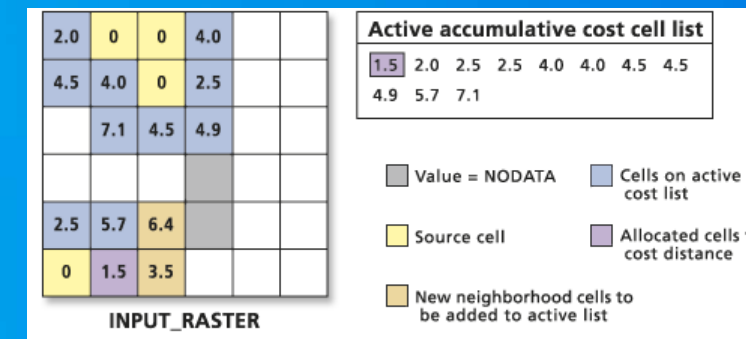
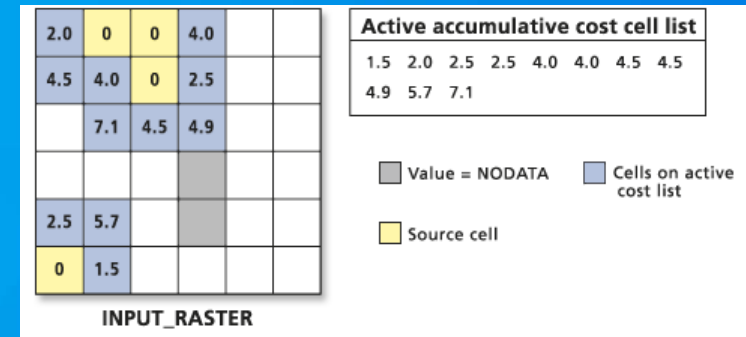
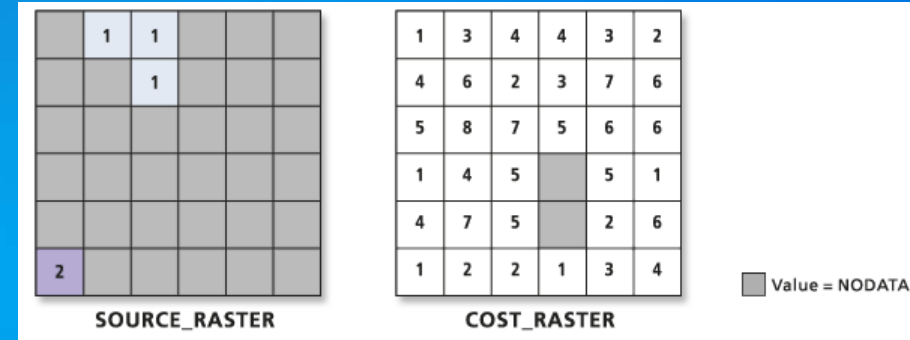
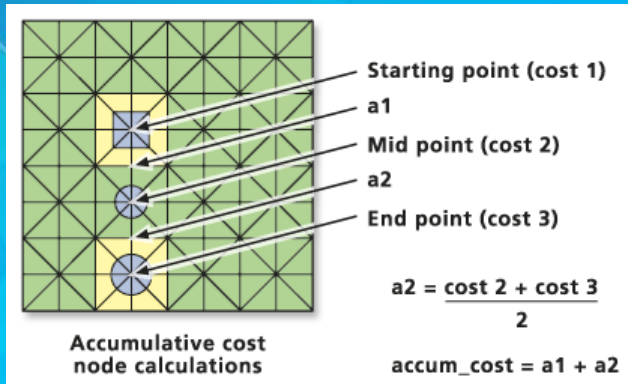


# Step 1: How to perform the cost distance analysis

## The Cost Distance tool (continued)

- Iterative approach

- Formula





# Step 1: How to perform the cost distance analysis

The Cost Distance tool (continued)

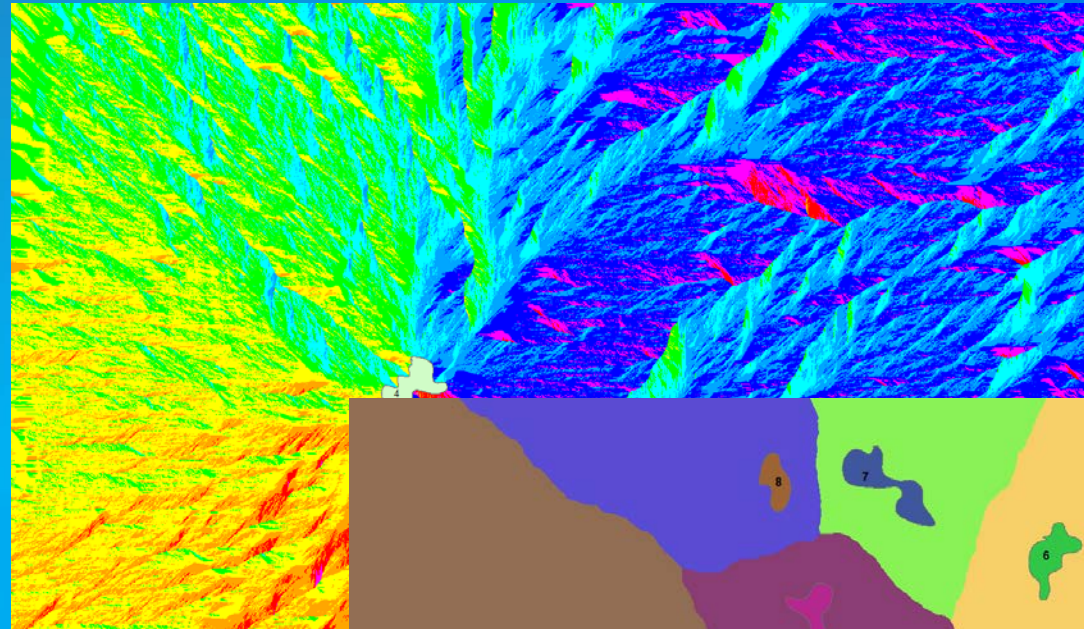
- Back link

6	7	8
5	0	1
4	3	2

□ Source cell

Back-link positions

- Cost allocation

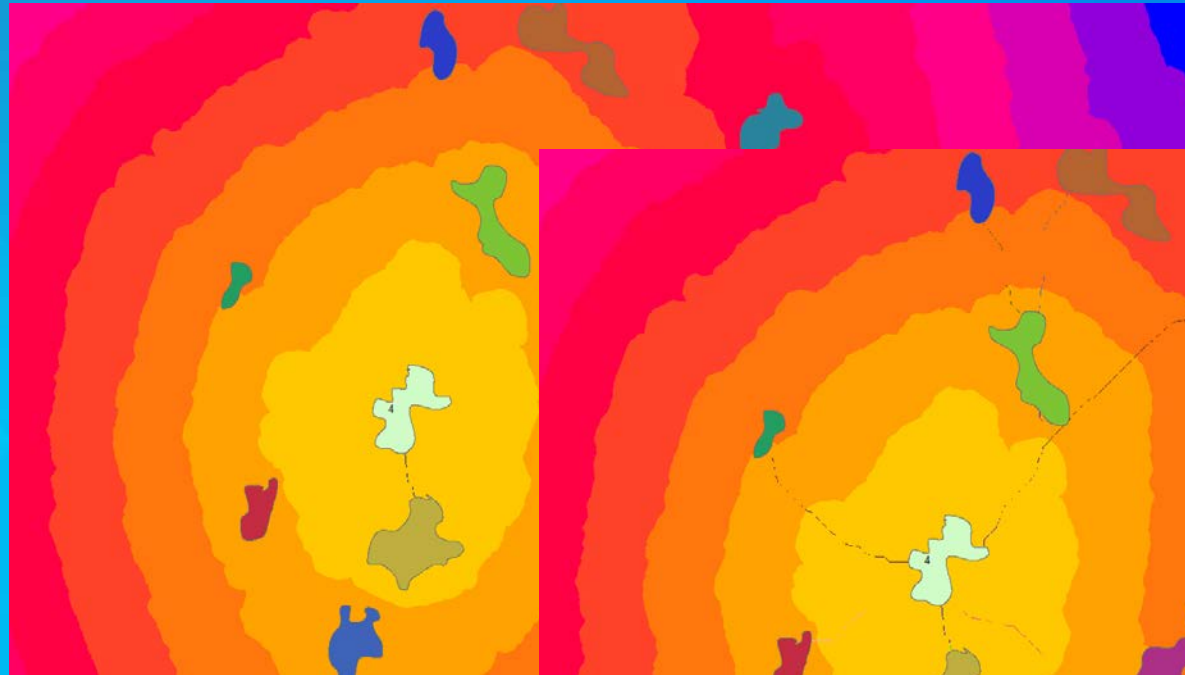


## Step 2: How to create the least-cost path

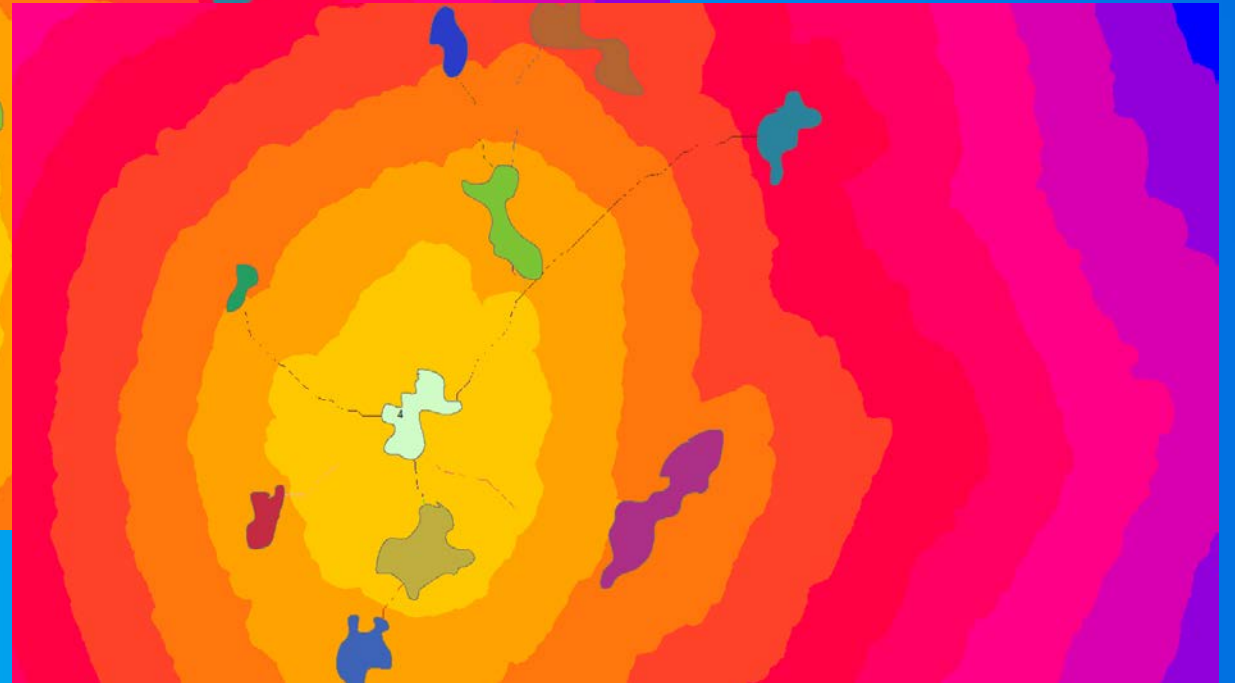
### The Cost Path tool

- Destination and the cost distance and back link output from the Cost Distance tool
- Creates the least cost path from the destination to the sources

- Best single path



- Each zone

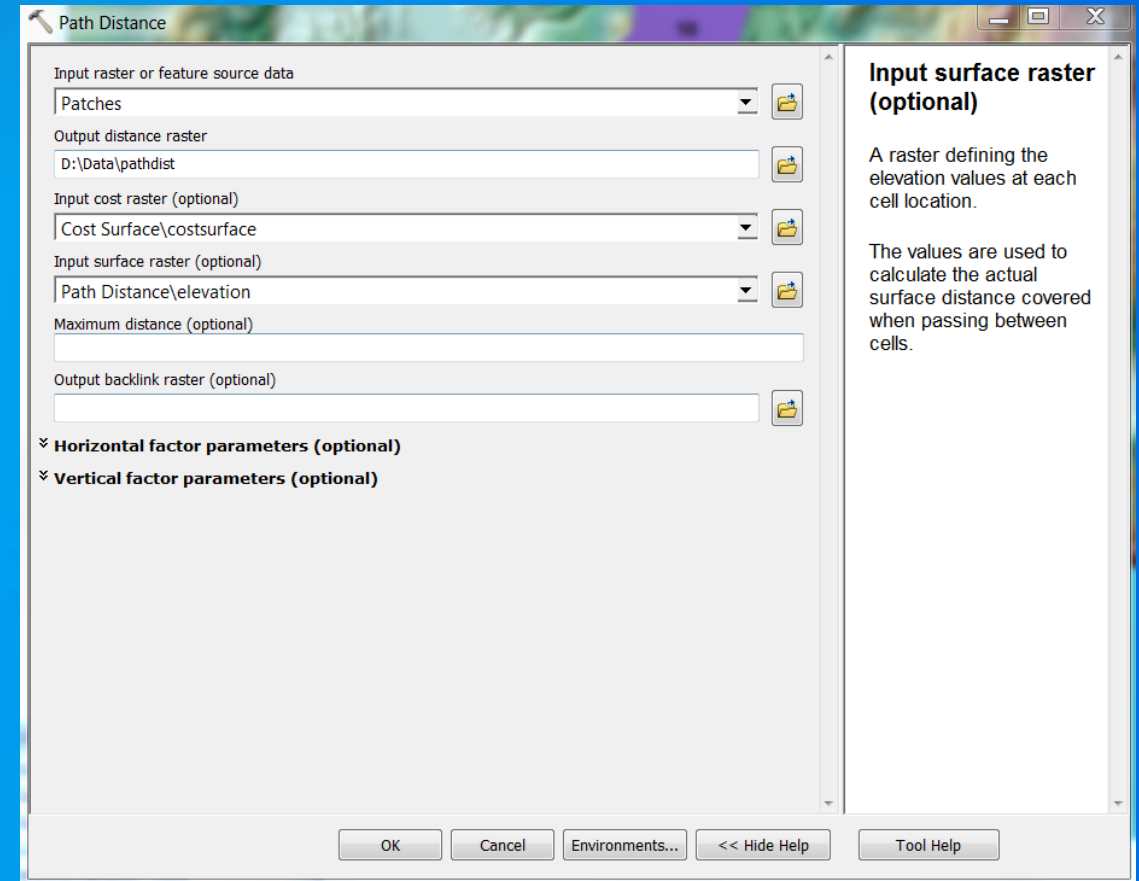
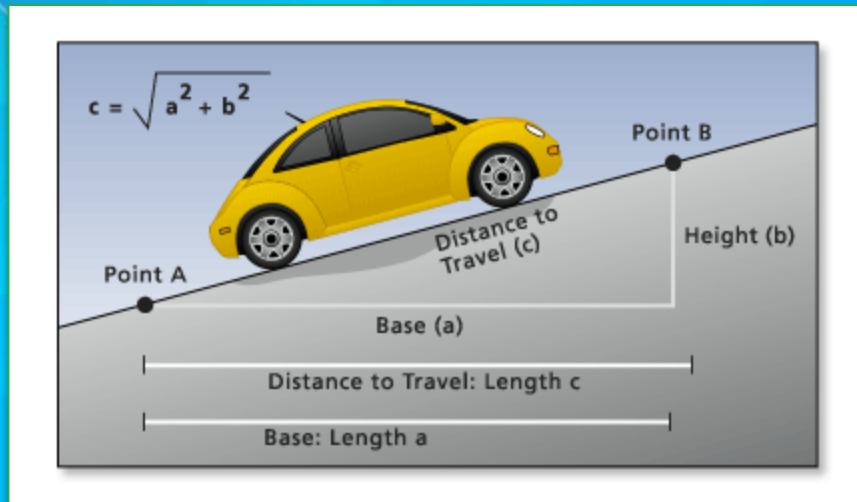


- Each cell

# Adding complexity

## Adding surface distance with the Path Distance tool

- Actual distance traveled
- Endure the cost longer because going uphill or downhill
- Surface raster
- The Path Distance tool

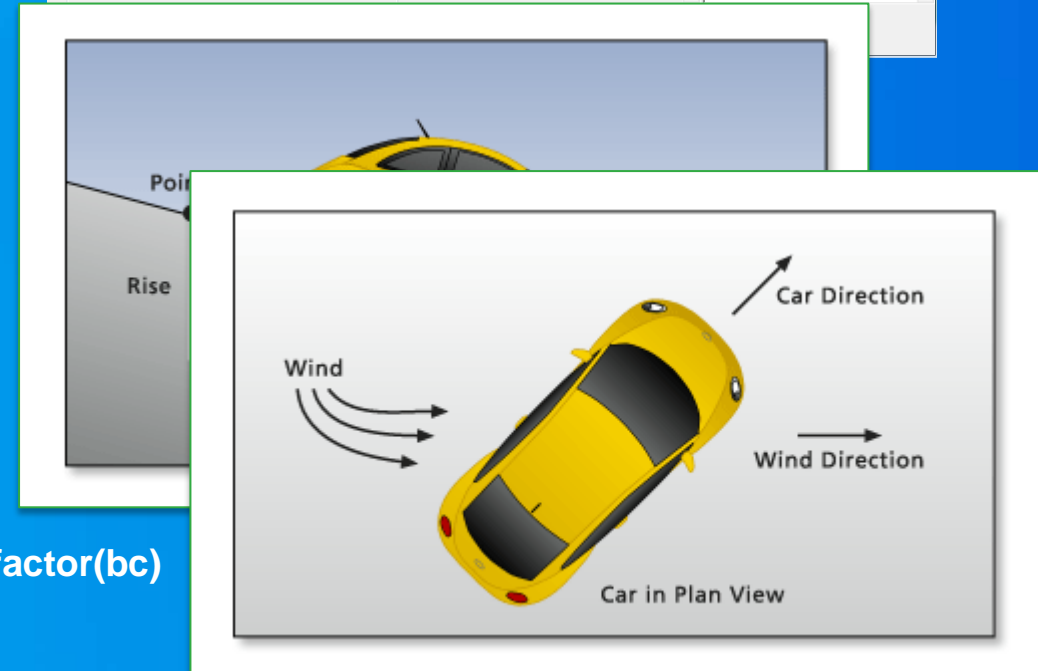
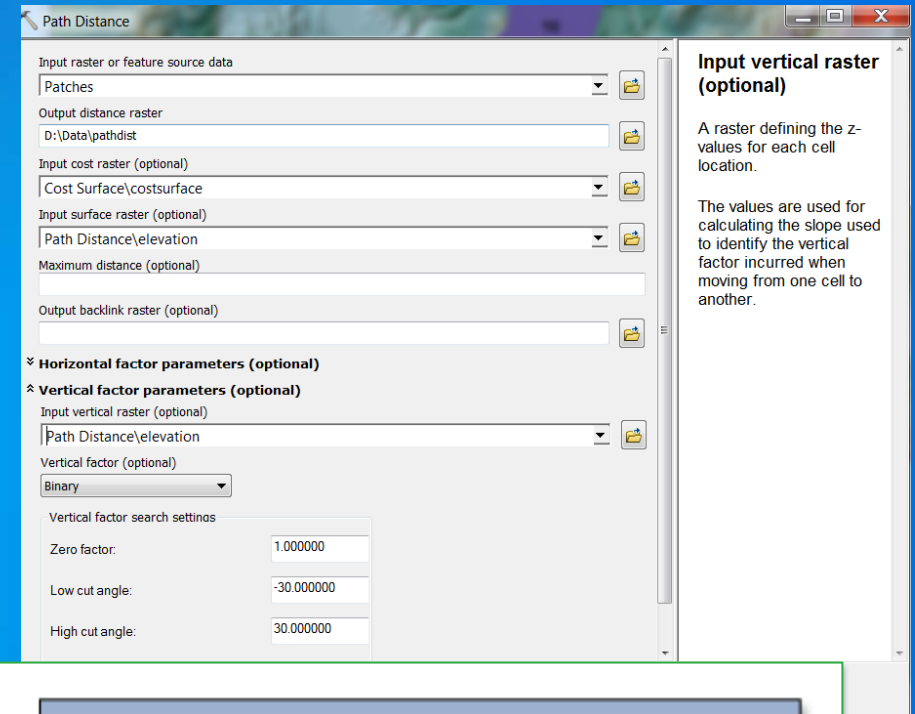


# Adding complexity

## Adding directionality with the Path Distance tool

- Adjustment to overcome going uphill and downhill
- Vertical factor
  - Surface raster endure cost longer
  - Vertical factor the additional cost to overcome the slope
- Horizontal factor
  - Additional cost to overcome a horizontal factor such as wind

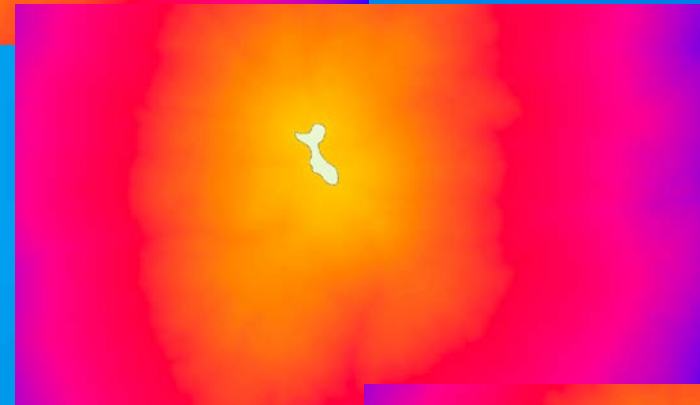
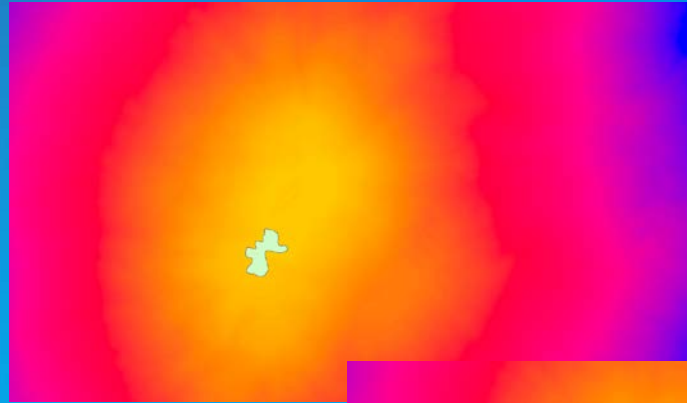
$$\text{Accum\_cost\_distance} = a1 + (((\text{Cost\_Surface}(b) * \text{Horizontal\_factor}(b)) + (\text{Cost\_surface}(c) * \text{Horizontal\_factor}(c))))/2) * \text{Surface\_distance}(bc) * \text{Vertical\_factor}(bc)$$



# Creating a cost corridor

## The Corridor tool

- Cost distance from source one
- Cost distance from source two
- Combine in the corridor tool
- Extract by Attribute tool to identify acceptable threshold



# Demo

## Cost distance analysis

Creating a cost surface

Cost Distance analysis

Cost Path

Adding complexity

Corridor



# Conclusion

- **Defining the cost units can be difficult**
- **Identifying which sources and destinations to connect can be difficult**
  - Generally to closest (Euclidean) sources
- **Cost does not account for**
  - Difference modes of travel from a source
  - Starting costs
  - Dynamic adjustment – getting tired
- **Creates the optimum least-cost solution**
  - Assumes memory
  - Has visited all locations



Understanding our world.