COA 690/790 GIS in Marine Science

Lecture 12
Spatial models and modeling

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Models in GIS

A model is a description of reality

It may be:

- Dynamic or Static

- Dynamic spatial models *e.g., hydrologic flow*
- Static spatial models *(or point in time)*
  e.g., land suitability analyses

Spatial Models

Focus on computer based models of spatial phenomena

Three classes:

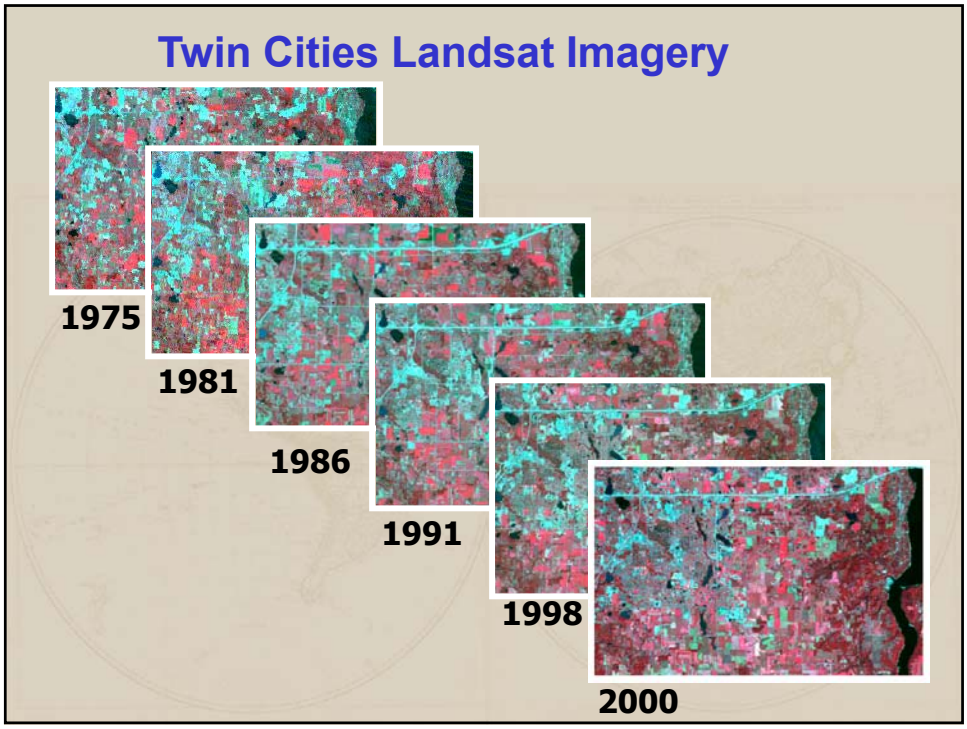
- Cartographic models
- Simple spatial models
- Spatio-temporal models

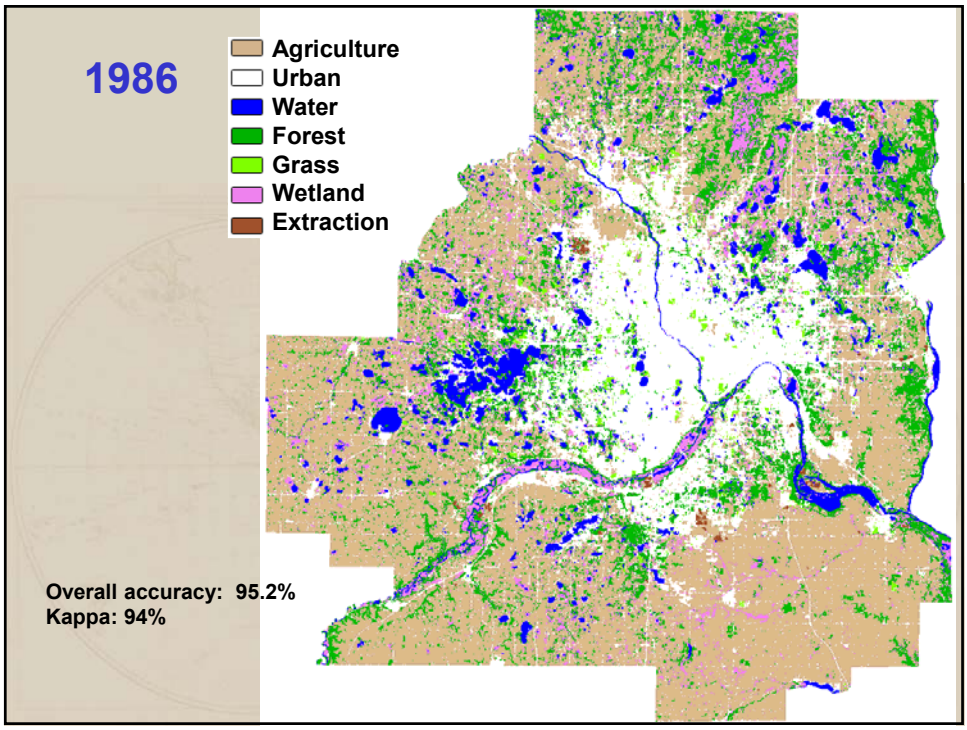
Cartographic models

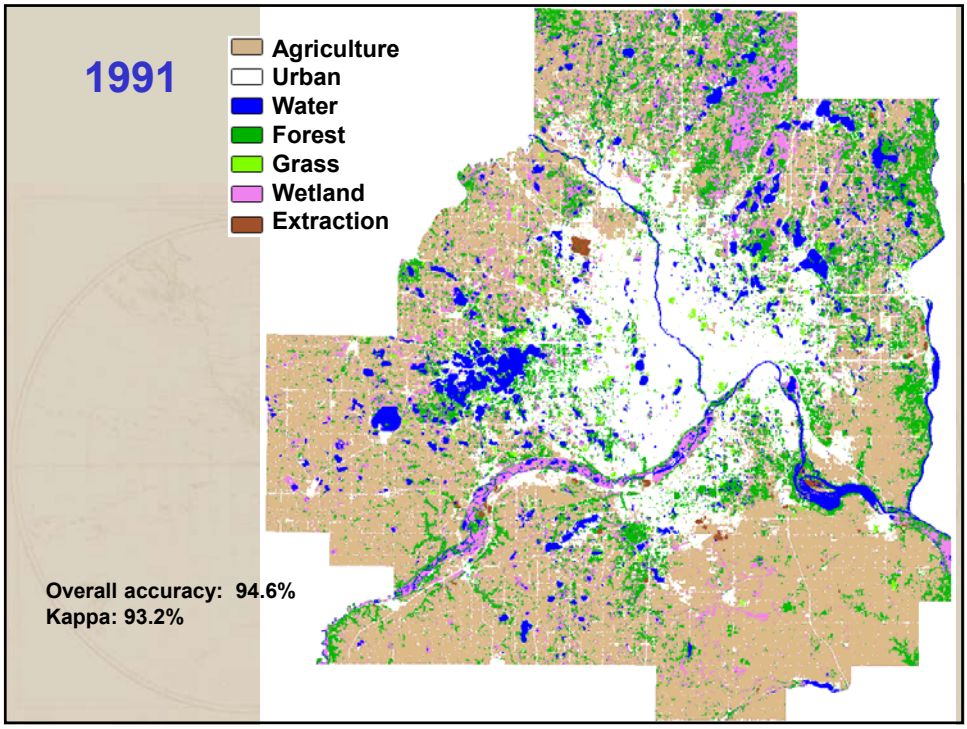
Application of spatial operations such as buffers, interpolation, reclassification, and overlay to solve problems

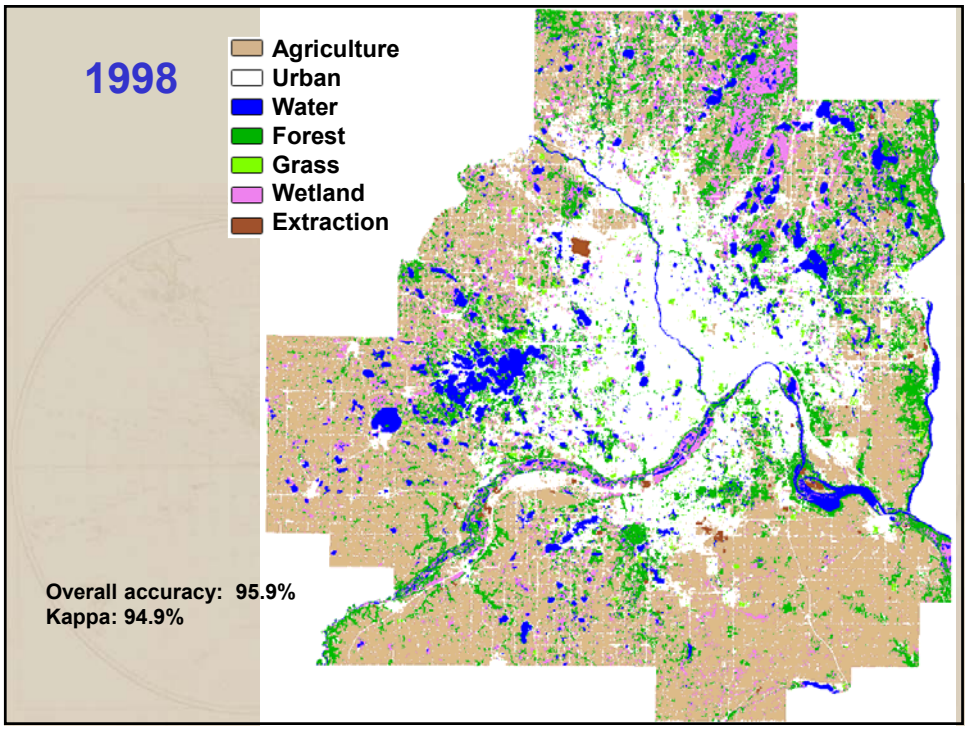
For example, suitability analyses; classification of land according to its utility for a specific use.

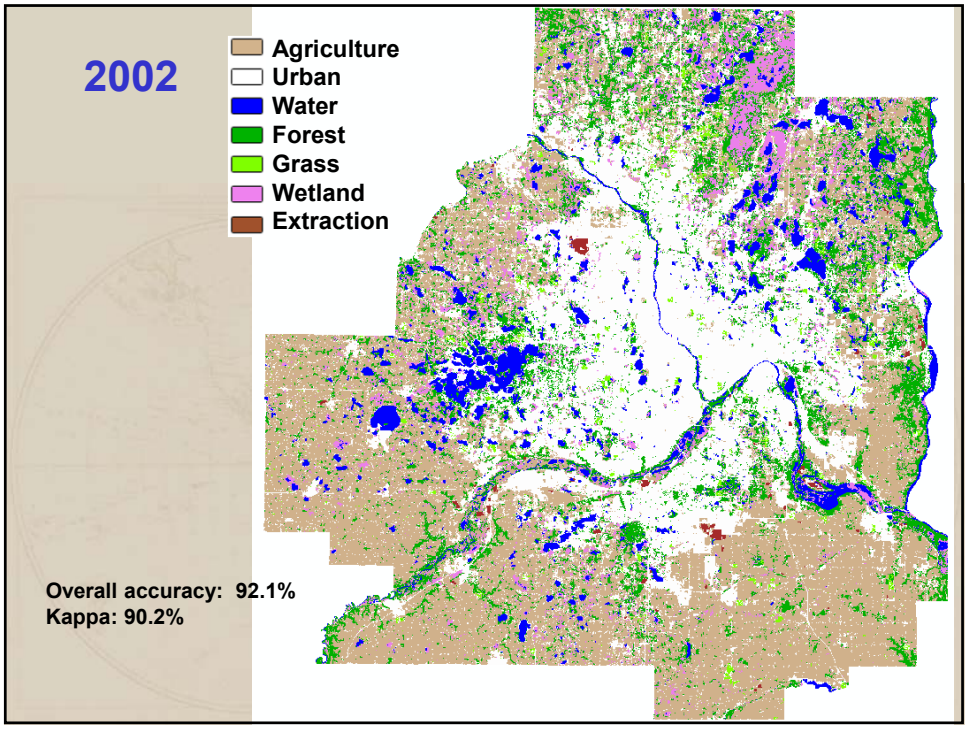
- Often temporally static *(features represented at a fixed period of time)*
- Values don't change during the model
- It may include a temporal component when it compares change through time *(comparing vegetation in 1990 to vegetation in 2000)*

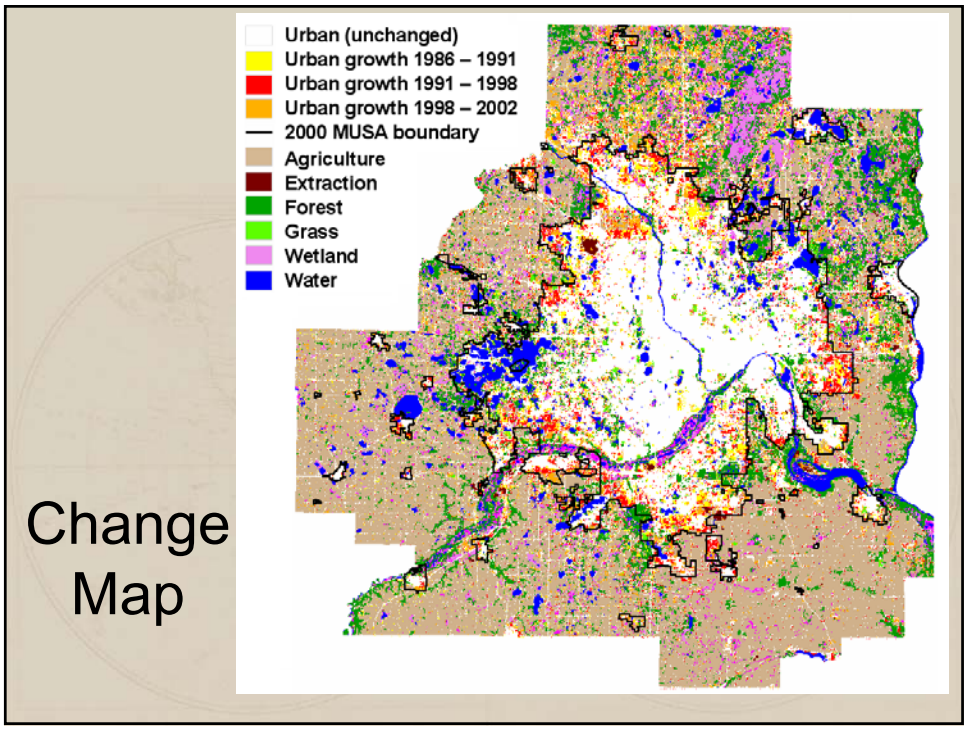

Twin Cities Landsat Imagery
1975
1981
1986
1991
1998
2000


1986
Agriculture
Urban
Water
Forest
Grass
Wetland
Extraction
Overall accuracy: 95.2%
Kappa: 94%


1991
Agriculture
Urban
Water
Forest
Grass
Wetland
Extraction
Overall accuracy: 94.6%
Kappa: 93.2%


1998
Agriculture
Urban
Water
Forest
Grass
Wetland
Extraction
Overall accuracy: 95.9%
Kappa: 94.9%


2002
Agriculture
Urban
Water
Forest
Grass
Wetland
Extraction
Overall accuracy: 92.1%
Kappa: 90.2%


Change Map
Urban (unchanged)
Urban growth 1986 – 1991
Urban growth 1991 – 1998
Urban growth 1998 – 2002
2000 MUSA boundary
Agriculture
Extraction
Forest
Grass
Wetland
Water

Simple spatial model

- Apply mathematical equations
- Predictions

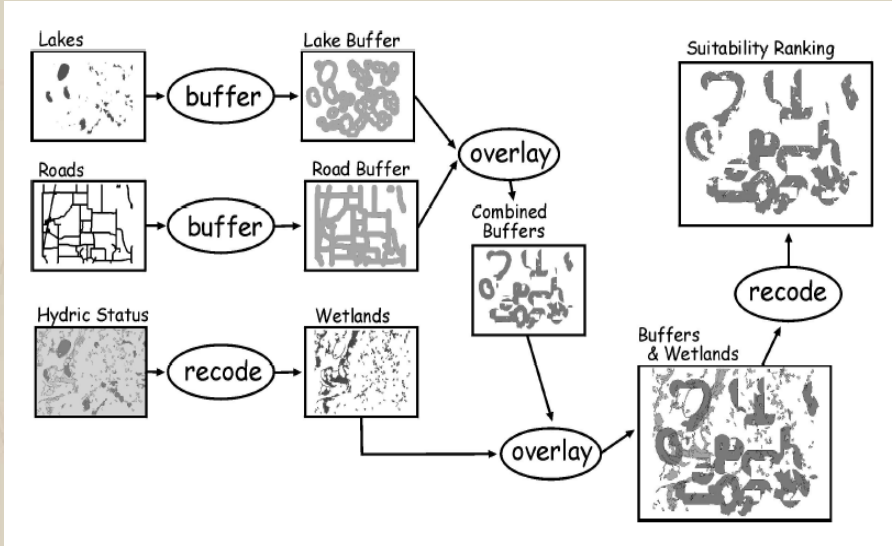
Spatio-temporal models

- Dynamic in both space and time
- Time passes explicitly within the running of the model
- Changes in time-driven process operate on spatial variables

Cartographic modeling

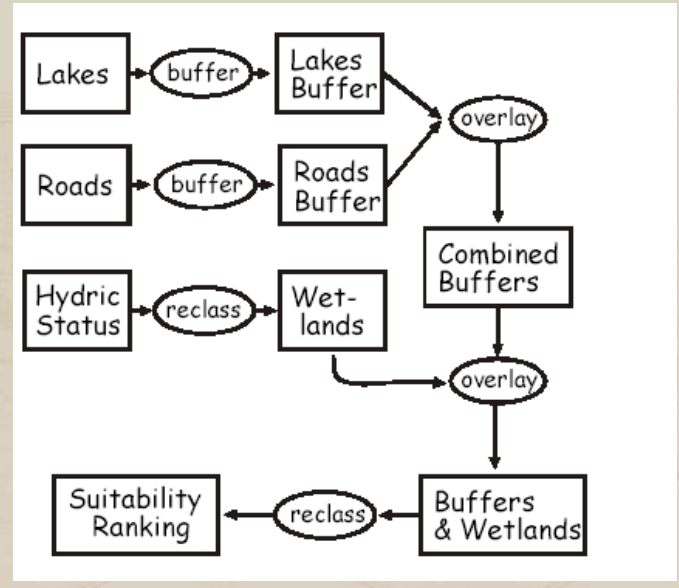
Combine general data sets, functions, and operations in a sequence to answer questions, typically producing an output map from various input maps

Cartographic modeling

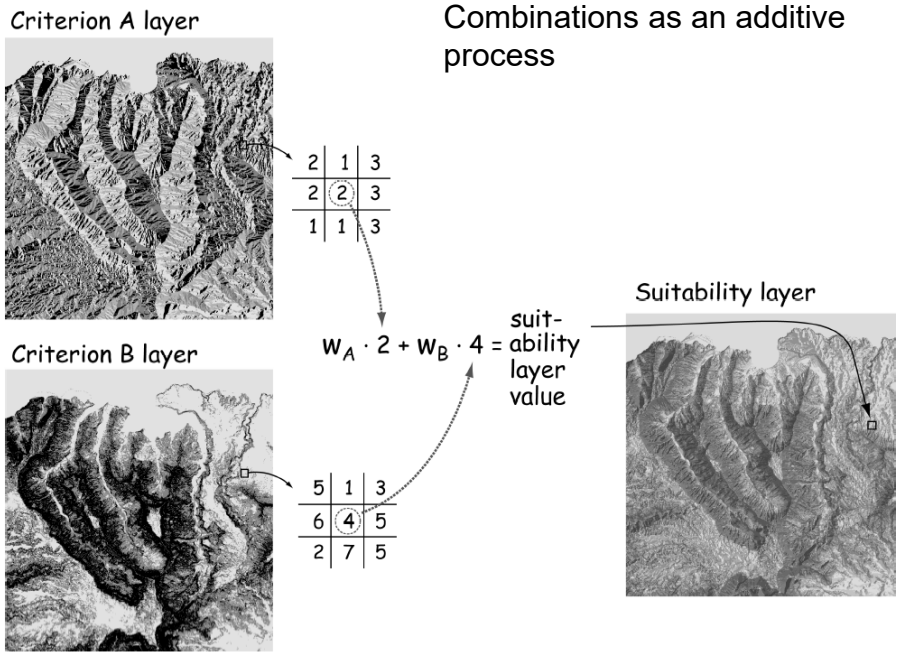


Cartographic models

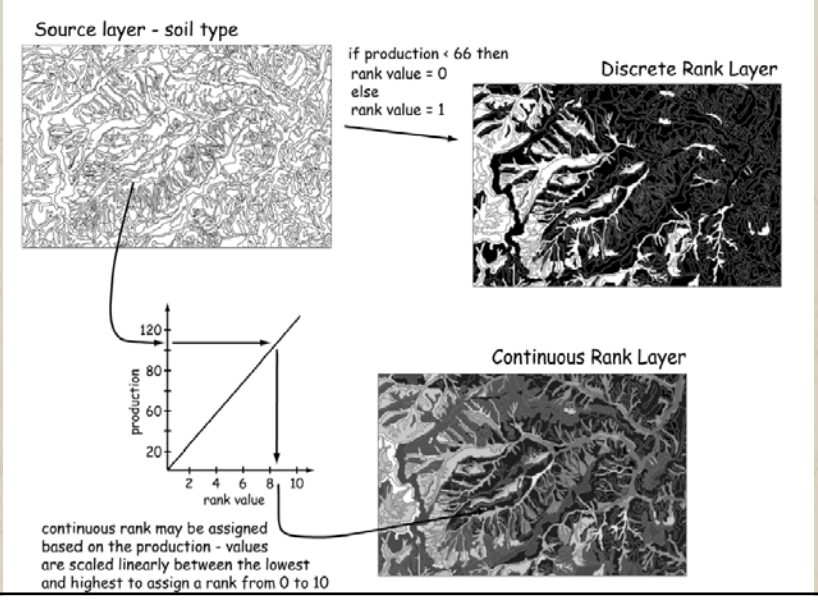
Often represented with flowcharts; graphically representing the spatial data, operations and their sequence



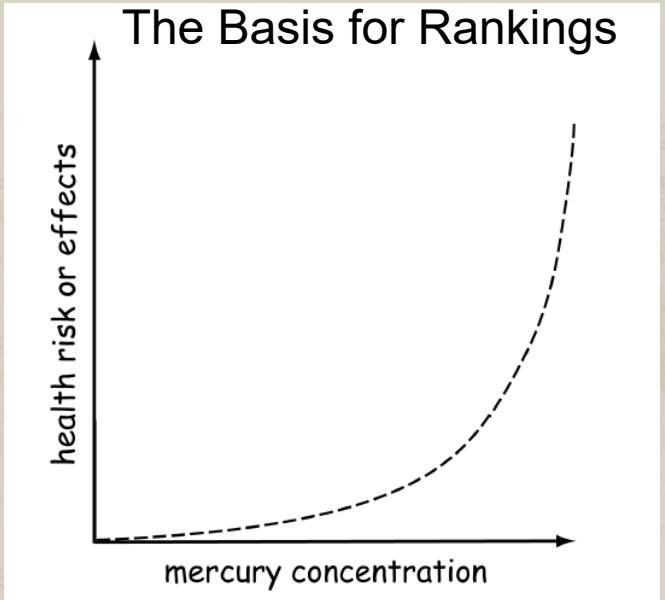
Combinations as an additive process



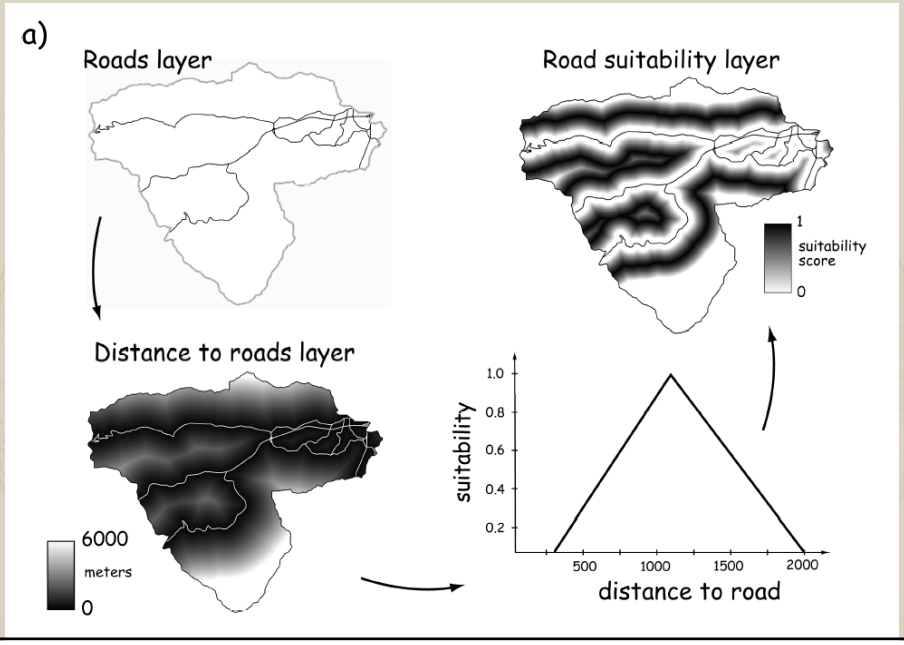
Discrete and Continuous Rankings



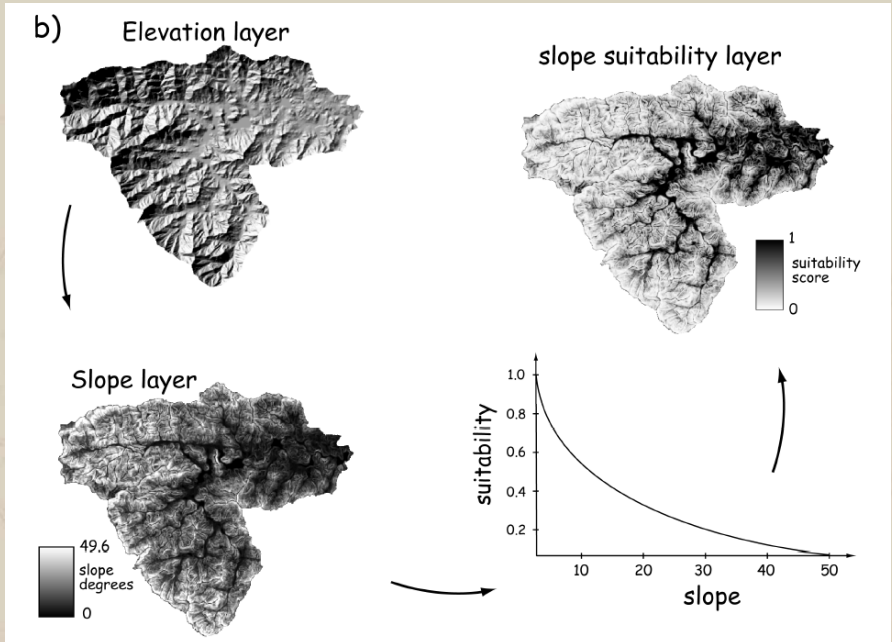
The Basis for Rankings

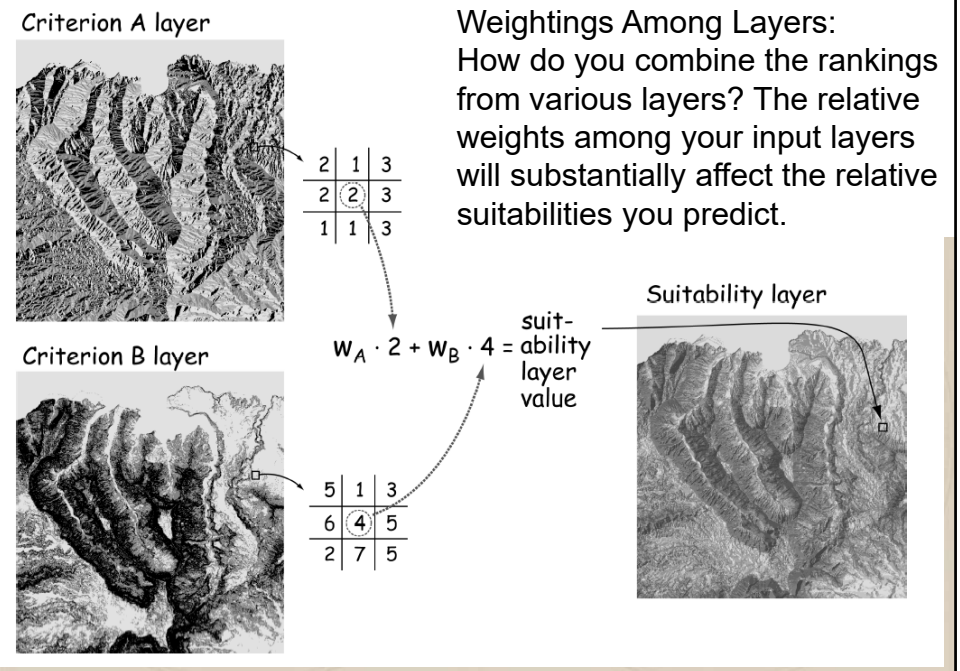


Example Weightings – Distance to Roads



Example – slope suitability ranking



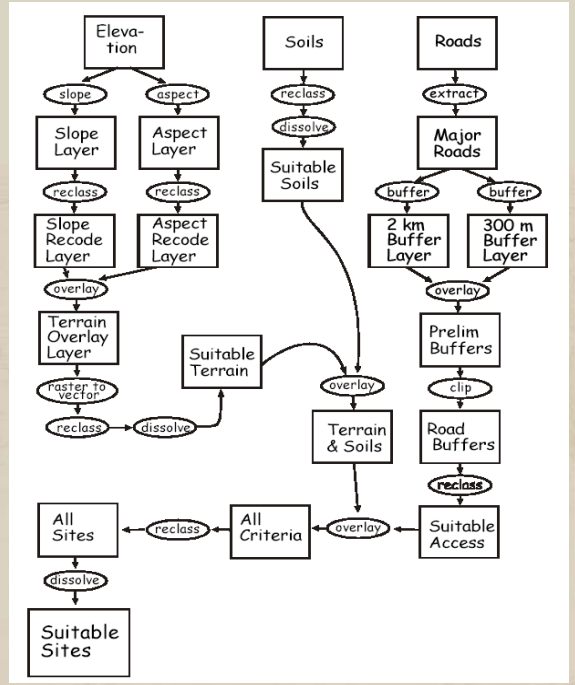


Weightings Among Layers:
How do you combine the rankings from various layers? The relative weights among your input layers will substantially affect the relative suitabilities you predict.

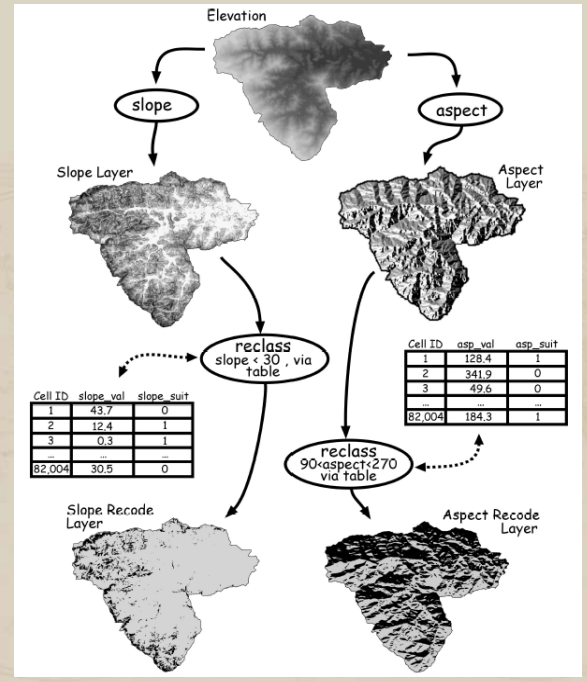
Rank Order Determination of Weights

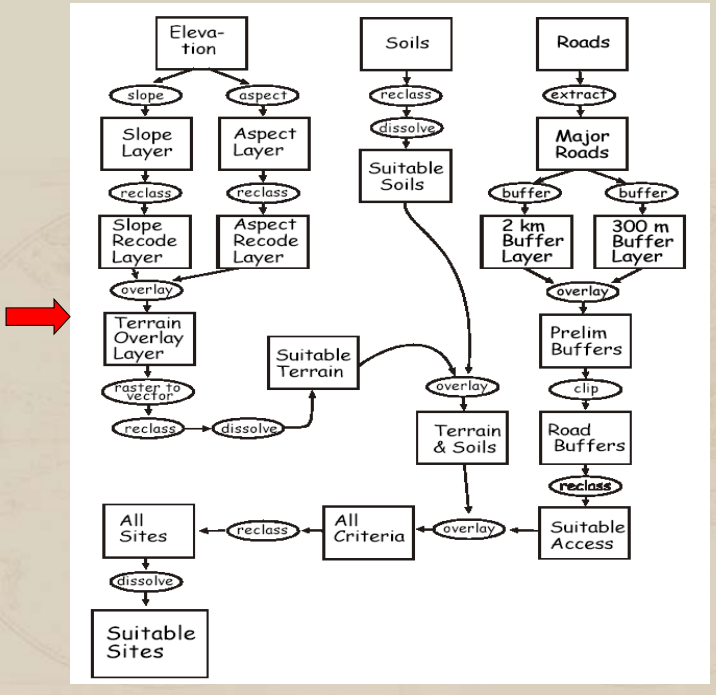
Criterion	Rank	Numerator $(n - r_i + 1)$	Weight $\frac{(n - r_i + 1)}{\sum_{k=1}^{n}(n - r_k + 1)}$
distance to nearest competitor	2	4-2+1 = 3	3/10 = 0.3
distance to major road	3	4-3+1 = 2	2/10 = 0.2
parking density	4	4-4+1 = 1	1/10 = 0.1
parcel cost	1	4-1+1 = 4	4/10 = 0.4
		$\sum_{k=1}^{n}(n - r_k + 1) =$ 10	

General Criteria	Refined Criteria
Slopes not too steep	Slopes < 30 degrees
Southern aspect pre-ferred	90 < Aspect < 270
Soils suitable for septic system	Specified list of septic-suitable soil units
Far enough from road to provide privacy, but not isolated	300 meter < distance to road < 2000 meters

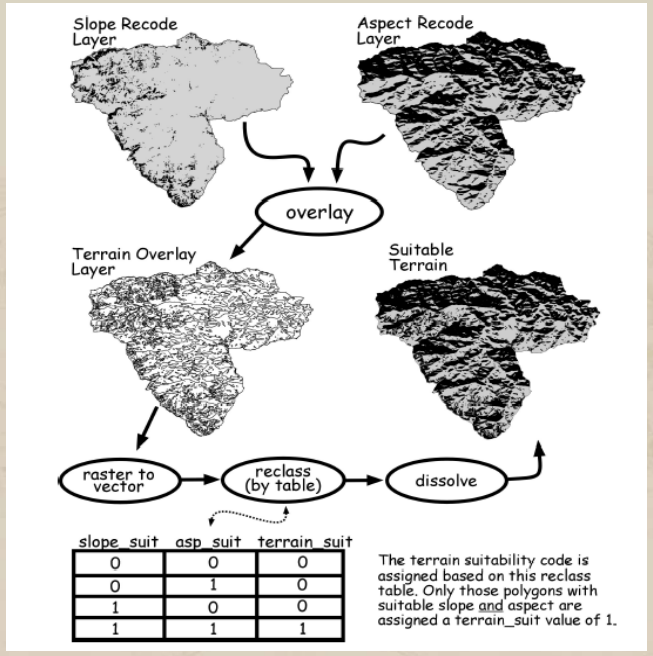


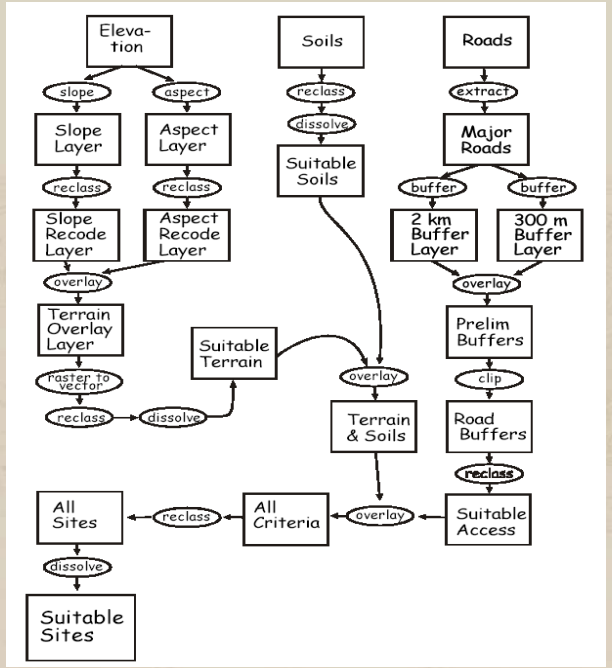
20 operations
15 data layers



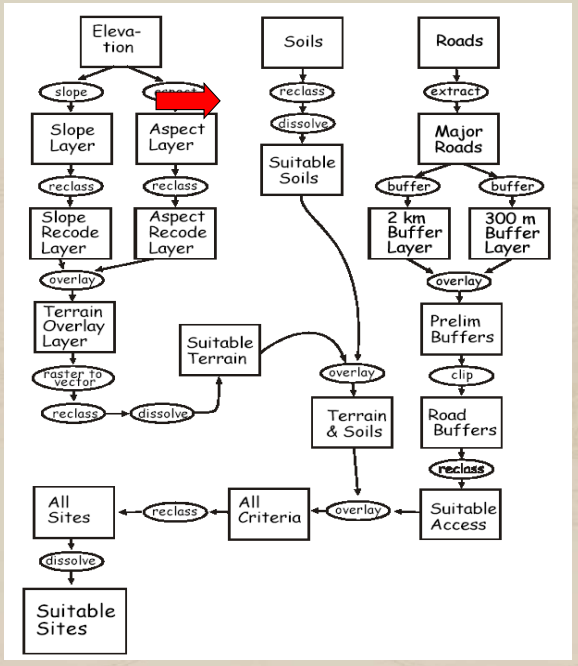


20 operations
15 data layers

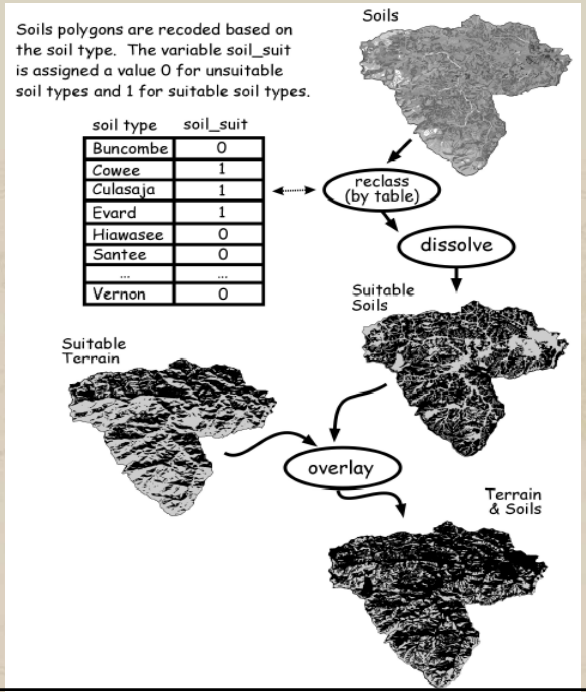


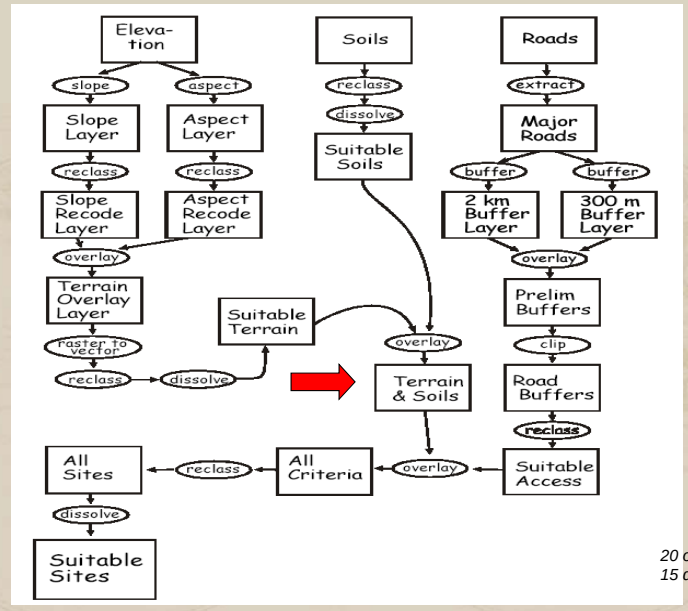


20 operations
15 data layers

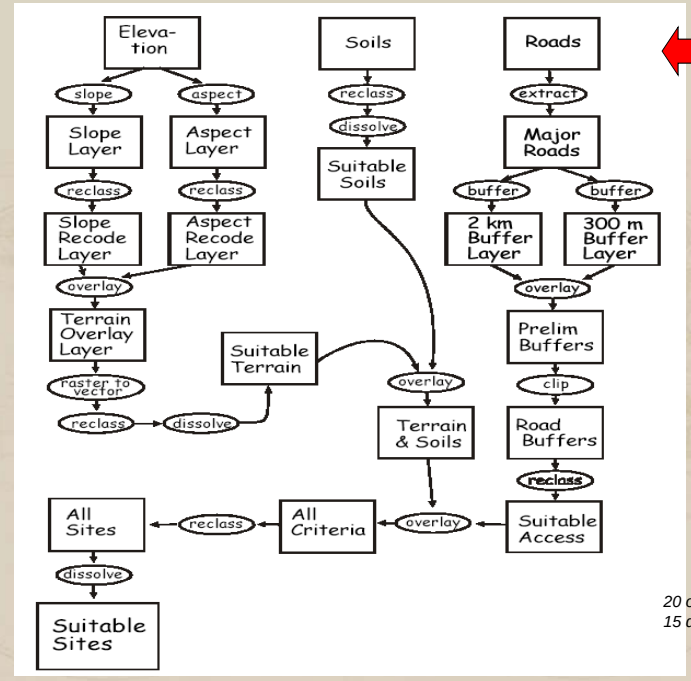


20 operations
15 data layers

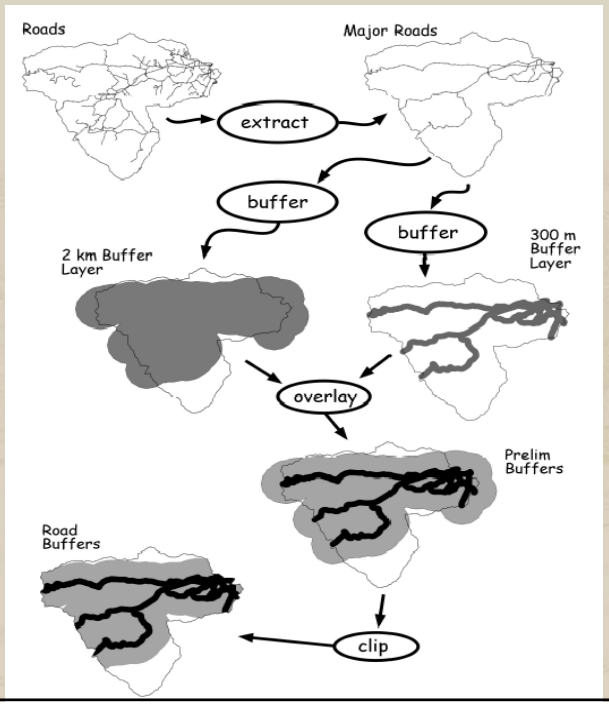


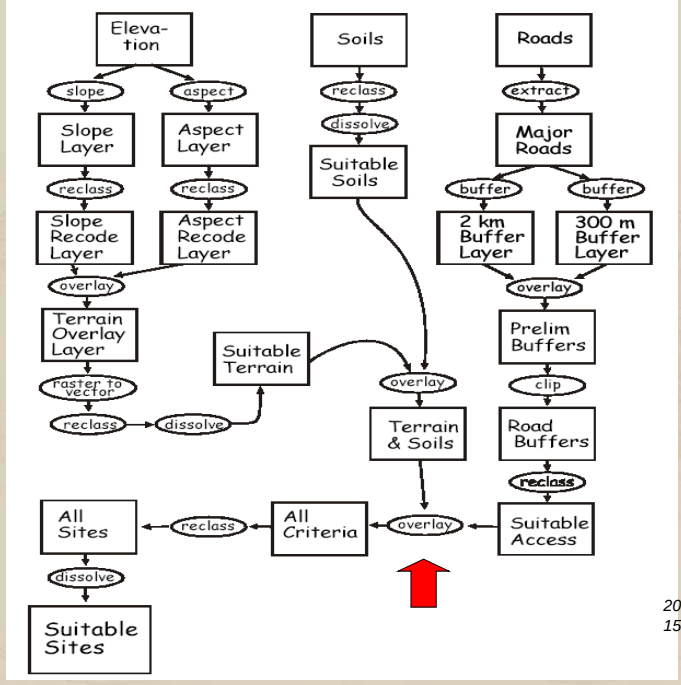


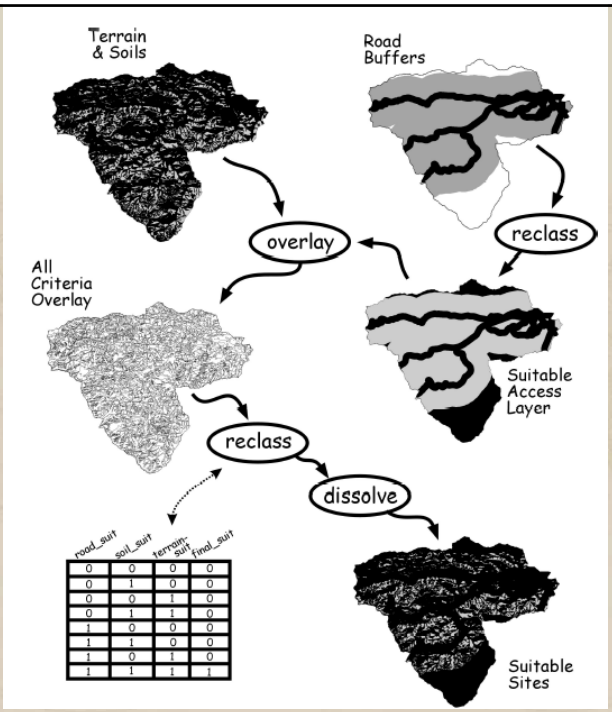
20 operations
15 data layers



20 operations
15 data layers


Roads
Major Roads
extract
buffer
buffer
2 km Buffer Layer
300 m Buffer Layer
overlay
Prelim Buffers
Road Buffers
clip


Eleva-tion
slope
aspect
Slope Layer
Aspect Layer
reclass
reclass
Slope Recode Layer
Aspect Recode Layer
overlay
Terrain Overlay Layer
raster to vector
reclass
dissolve
Suitable Terrain
Soils
reclass
dissolve
Suitable Soils
overlay
Terrain & Soils
Roads
extract
Major Roads
buffer
buffer
2 km Buffer Layer
300 m Buffer Layer
overlay
Prelim Buffers
clip
Road Buffers
reclass
Suitable Access
overlay
All Criteria
reclass
All Sites
dissolve
Suitable Sites
20 operations
15 data layers



Points to Remember:

•Make sure the problem is clearly specified and appropriate for GIS analyses
•Determine the spatial and attribute accuracy required for the analysis, and if existing data meet these requirements. Pay particular attention to inclusions and mmu
•Coordinate systems (including datums) have to be the same for all layers
•Need to know the extent of each layer....where you have data. If extents are different, think about how this will affect analyses?
•If you have both raster and vector data, which will you convert, and how?