M.Sc. Remote Sensing and GIS
RT-202

Geographic Information System

Unit-III

3.3 Raster Based Spatial Data Analysis – Part-II

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Cont…
Overlays

- **Raster overlays** are relatively simple compared to their vector counterparts and require much less computational power .
- Despite their simplicity, it is important to ensure that all overlain rasters are coregistered (i.e., spatially aligned), cover identical areas, and maintain equal resolution (i.e., cell size).
- If these assumptions are violated, the analysis will either fail or the resulting output layer will be flawed.

- The mathematical raster overlay is the most common overlay method. The numbers within the aligned cells of the input grids can undergo any user-specified mathematical transformation.
- Following the calculation, an output raster is produced that contains a new value for each cell. As you can imagine, there are many uses for such functionality.
- In particular, raster overlay is often used in risk assessment studies where various layers are combined to produce an outcome map showing areas of high risk/reward.

Input 1

1	3	3
2	2	4
1	1	3

+

Input 2

10	11	11
10	12	12
11	14	12

Output

11	14	14
12	14	14
12	15	15

- **The Boolean raster overlay** method represents a second powerful technique, the Boolean connectors AND, OR, and XOR can be employed to combine the information of two overlying input raster datasets into a single output raster.
- Similarly, the **relational raster overlay** method utilizes relational operators (<, <=, =, <>, >, and =>) to evaluate conditions of the input raster datasets.
- In both the Boolean and relational overlay methods, cells that meet the evaluation criteria are typically coded in the output raster layer with a 1, while those evaluated as false receive a value of 0.

- Overlay processes place two or more thematic maps on top of one another to form a new map.
- Overlay operations available for use with vector data include the point-in-polygon, line-in-polygon, or polygon-in-polygon models.
- Union, intersection, symmetrical difference, and identity are common operations used to combine information from various overlain datasets.
- Raster overlay operations can employ powerful mathematical, Boolean, or relational operators to create new output datasets.

Scale of Analysis

- Raster analyses can be undertaken on four different scales of operation:
  - local,
  - neighborhood,
  - zonal, and
  - global.

- **Local operations** can be performed on single or multiple rasters. When used on a single raster, a local operation usually takes the form of applying some mathematical transformation to each individual cell in the grid.
- For example, a researcher may obtain a digital elevation model (DEM) with each cell value representing elevation in feet. If it is preferred to represent those elevations in meters, a simple, arithmetic transformation (original elevation in

  feet x 0.3048 = new elevation in meters) of each cell value can be performed locally to accomplish this task.

Input Raster

456	416	364	326	243
448	364	315	276	218
359	325	268	234	164
306	296	201	133	44
274	231	184	65	5

↓

Output Raster (x10)

4560	4160	3640	3260	2430
4480	3640	3150	2760	2180
3590	3250	2680	2340	1640
3060	2960	2010	1330	440
2740	2310	1840	650	50

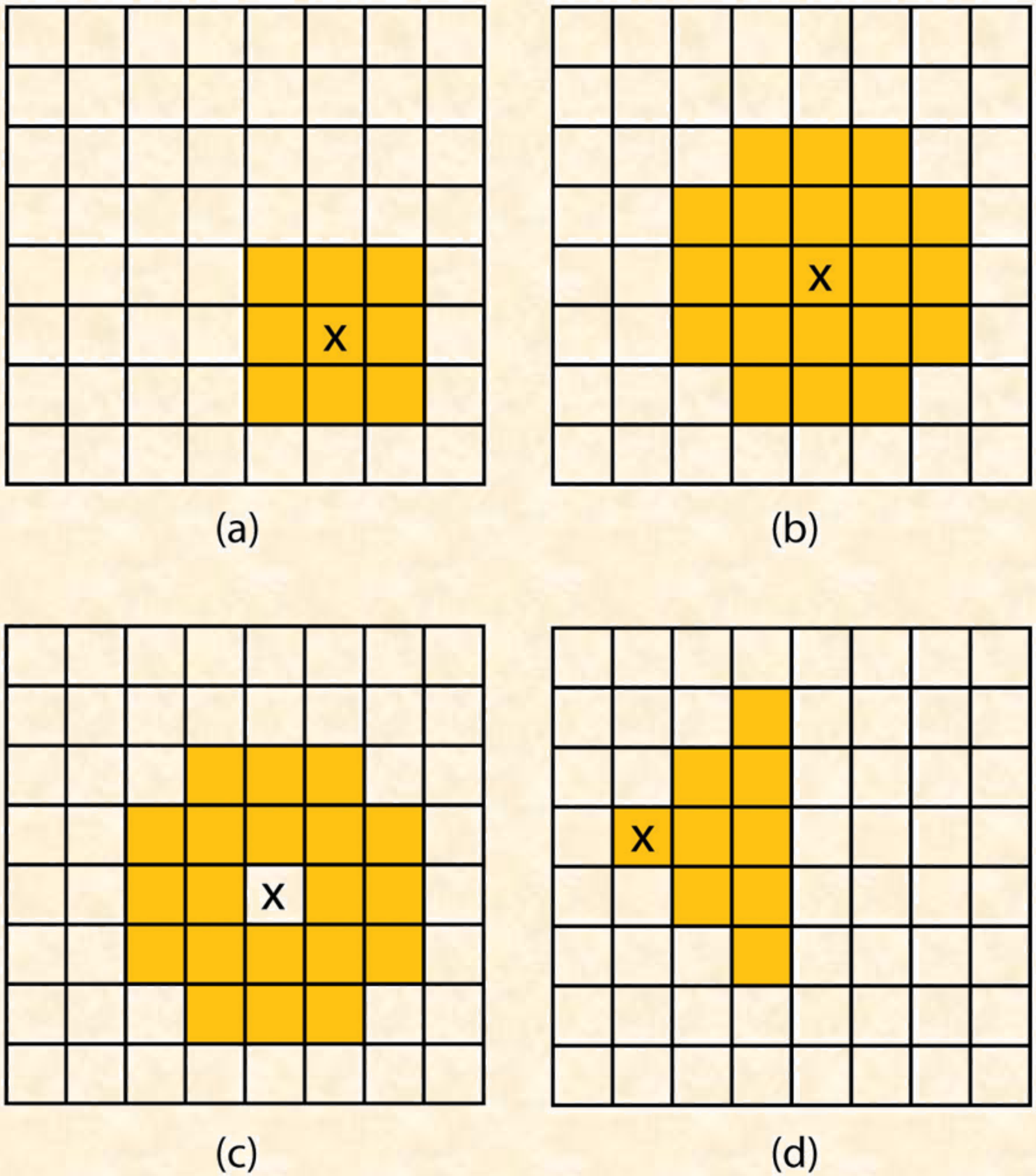
- When applied to multiple rasters, it becomes possible to perform such analyses as changes over time.
- Given two rasters containing information on groundwater depth on a parcel of land at Year 2000 and Year 2010, it is simple to subtract these values and place the difference in an output raster that will note the change in groundwater between those two.
- These local analyses can become somewhat more complicated however, as the number of input rasters increase. For example, the Universal Soil Loss Equation (USLE) applies a local mathematical formula to several overlying rasters including rainfall intensity, erodibility of the soil, slope, cultivation type, and vegetation type to determine the average soil loss (in tons) in a grid cell.

- **Neighborhood operations** represent a group of frequently used spatial analysis techniques that rely heavily on this concept. Neighborhood functions examine the relationship of an object with similar surrounding objects. They can be performed on point, line, or polygon vector datasets as well as on raster datasets. In the case of vector datasets, neighborhood analysis is most frequently used to perform basic searches. For example, given a point dataset containing the location of convenience stores, a GIS could be employed to determine the number of stores within 5 miles of a linear feature (i.e., Interstate 10 in California).

- Neighborhood analyses are often more sophisticated when used with raster datasets. Raster analyses employ moving windows, also called filters or kernels, to calculate new cell values for every location throughout the raster layer’s extent. These moving windows can take many different forms depending on the type of output desired and the phenomena being examined.
- For example, a rectangular, 3-by-3 moving window is commonly used to calculate the mean, standard deviation, sum, minimum, maximum, or range of values immediately surrounding a given “target” cell

- The target cell is that cell found in the center of the 3-by-3 moving window. The moving window passes over every cell in the raster. As it passes each central target cell, the nine values in the 3-by-3 window are used to calculate a new value for that target cell. This new value is placed in the identical location in the output raster. If one wanted to examine a larger sphere of influence around the target cells, the moving window could be expanded to 5 by 5, 7 by 7, and so forth. Additionally, the moving window need not be a simple rectangle. Other shapes used to calculate neighborhood statistics include the annulus, wedge, and circle

Common Neighborhood Types around Target Cell "x": (a) 3 by 3, (b) Circle, (c) Annulus, (d) Wedge



- **A zonal operation** is employed on groups of cells of similar value or like features, not surprisingly called zones (e.g., land parcels, political/municipal units, waterbodies, soil/vegetation types). These zones could be conceptualized as raster versions of polygons. Zonal rasters are often created by reclassifying an input raster into just a few categories.
- Zonal operations may be applied to a single raster or two overlaying rasters. Given a single input raster, zonal operations measure the geometry of each zone in the raster, such as area, perimeter, thickness, and centroid. Given two rasters in a zonal operation, one input raster and one zonal raster, a zonal operation produces an output raster, which summarizes the cell values in the input raster for each zone in the zonal raster.

Input Raster

5	3	4	4	4
2	1	4	2	6
8	4	3	5	3
4	2	4	3	2
6	3	3	7	4

+

Zonal Raster

1	1	1	1	3
1	1	1	1	3
2	2	3	3	3
2	2	3	3	3
2	2	3	3	3

Output Raster of Zonal Means

3.125	3.125	3.125	3.125	4.0
3.125	3.125	3.125	3.125	4.0
4.5	4.5	4.0	4.0	4.0
4.5	4.5	4.0	4.0	4.0
4.5	4.5	4.0	4.0	4.0

- Global operations are similar to zonal operations whereby the entire raster dataset’s extent represents a single zone. Typical global operations include determining basic statistical values for the raster as a whole.
- For example, the minimum, maximum, average, range, and so forth can be quickly calculated over the entire extent of the input raster and subsequently be output to a raster in which every cell contains that calculated value.

Input Raster

456	416	364	326	243
448	364	315	276	218
359	325	268	234	164
306	296	201	133	44
274	231	184	65	5

↓

Output Raster of Global Mean

248.5	248.5	248.5	248.5	248.5
248.5	248.5	248.5	248.5	248.5
248.5	248.5	248.5	248.5	248.5
248.5	248.5	248.5	248.5	248.5
248.5	248.5	248.5	248.5	248.5

Keynote

- Local raster operations examine only a single target cell during analysis.
- Neighborhood raster operations examine the relationship of a target cell proximal surrounding cells.
- Zonal raster operations examine groups of cells that occur within a uniform feature type.
- Global raster operations examine the entire areal extent of the dataset.