URBAN GROWTH VS. DEVELOPMENT SUITABILITY USING RASTER OVERLAY

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Outline

- ## Supply-side:
  - What are the areas that may be **environmentally 'sensitive'** to development but where **development may be infringing** in the coming years?

- ## Demand-side:
  - What are the areas that are **not environmentally sensitive** to development where we would like to **encourage development** in the coming years?

- Step 1: Urban locations change between 1992 and 2001
- Step 2: Most efficient counties
- Step 3: The Sensitive Lands in PA Counties (1992)
- Step 4: The Sensitive Lands developed in 2001
- Step 5: The Urban Land Use in 2001 - Urbanization
- The Urban Land Use in 2001 - Preserve
- Step 6: Four categories of Environment Sensitivity Index and Future Urbanization
- Step 7: Two important type pf developed area

Data Structure

- ## Shapefile:

  - Pennsylvania counties including 1990 and 2000 population totals (Census)

  - Four-lane Highways, 2005 (U.S. DOT)

- ## Raster (all grid-cells are 500m)

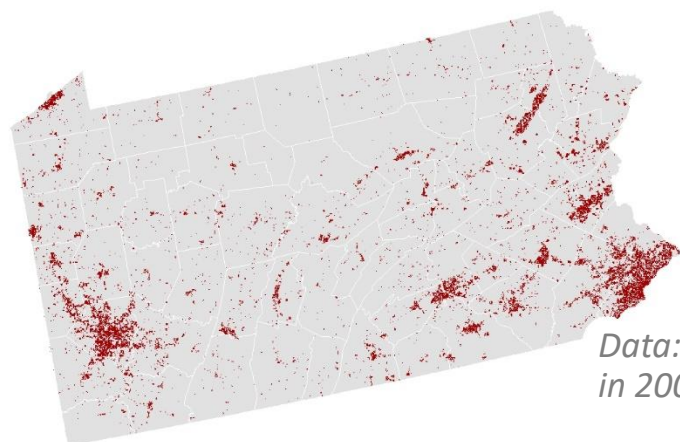 - Urban land cover in 1992 (USGS)

  - Urban land cover in 2001 (USGS)

  - Farm land cover in 1992 (USGS)

  - Forest land cover in 1992 (USGS)

  - Pasture land cover in 1992 (USGS)

  - Water bodies (including wetlands, lakes and rivers) (NWI, USGS)

  - Slope (USGS)

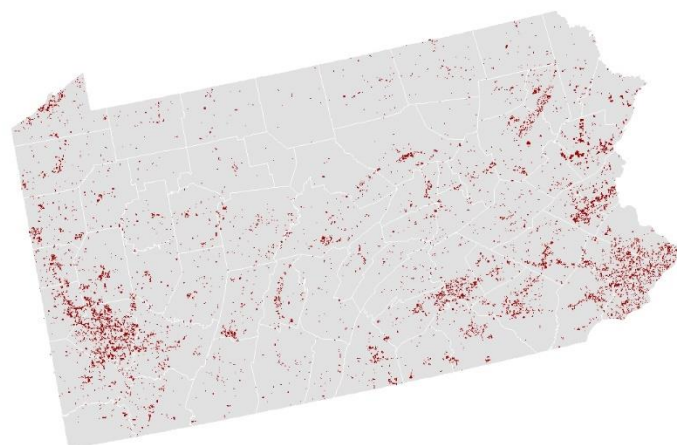 - Pennsylvania boundary

- ## Raster Skills

  - Raster Calculator

  - Euclidean Distance

  - Zonal statistics

  - Reclassify
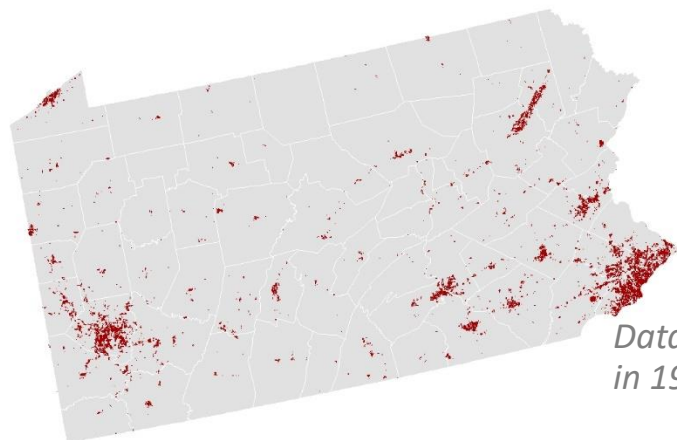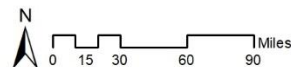
Data: Urban land cover in 1992 (USGS)

Data: Urban land cover in 2001 (USGS)

New urbanized locations between 1992 and 2001

■ Urbanized Locations
□ PA Counties

Step 1: Urban locations change between 1992 and 2001

- **Urbanized locations in 1992**
- In 1992, the number of grid cells of urbanization is 10393.

- **Urbanized locations in 2001**
- In 2001, the number of grid cells of urbanization is 18255.

- **New urbanized locations between 1992 and 2001**
- Between 1992 and 2001, there are 12418 grid cells converted to urbanized location.

RASTER CALCULATOR

Rowid	VALUE	COUNT
0	-1	4556
1	0	599226
2	1	12418

          2001   --   1992
0-1 = non-urban – urban
1-1 = urban – urban   0-0 = non-urban
1-0 = urban – non-urban : **urbanized**

Step 2: Most efficient counties

- **Urban Land Growth**
- Use the *Zonal Statistics (as Table)* tool to sum the amount of urban land growth (value of 1) by **county** between 1992 and 2001

- **Population Change**
- Calculate the change in population by **county** (this comes from 1990 and 2000 census'). *Field Calculator*

- **Land Conversion Per Resident**
- Calculate the amount of urban land conversion per new resident by dividing the amount of urban land conversion between 1992 and 2001 by 1990-2000 population growth. *Field Calculator*

- *Input data:*
- *Pennsylvania counties including 1990 and 2000 population totals (Census)*
- *New urbanized locations between 1992 and 2001*

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- *Pennsylvania counties including 1990 and 2000 population totals (Census)*

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- *Pennsylvania counties including 1990 and 2000 population totals (Census)*

Step 2: Most efficient counties

This table illustrate (a) the amount of urban land conversion by county. (b) the amount of population growth by county. (c) the ratio of land conversion to per resident growth.

As we seen from the table, the most efficient land conversion is the **Lackawanna county.** The most inefficient is the **Cameron County**. Because the ratio stands for the land conversion per new resident, it will reflect the efficiency of the land development. Besides, this ratio reflects the reality of the development according to every individuals.

And also, there are some counties which population is reduced or not change, however the urbanization process is increasing or reducing.

County Name	Urban Land Growth	Population Growth	Land Conversion Per Resident
Lackawanna	**116**	**59**	**1.966**
Northumberland	74	299	0.247
McKean	39	353	0.110
Jefferson	80	918	0.087
Lackawanna	116	59	1.966
⋮	⋮	⋮	⋮
Cameron	**0**	**7270**	**0**
Cambria	139	0	0
Allegheny	652	0	0
Washington	138	0	0
Philadelphia	**-46**	**0**	**0**
Luzerne	135	-9359	(0.014)
Delaware	-12	697	(0.017)
Beaver	191	-5504	(0.035)
Westmoreland	233	-4974	(0.047)
Clarion	71	-390	(0.182)
Indiana	59	-111	(0.532)
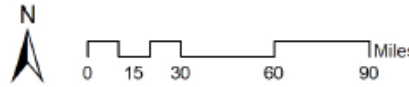
Step 3: The Sensitive Lands in PA Counties (1992)

- **Combine raster layers (water, farm, pasture & forest)**

- Use *Raster Calculator* to combine the different 1992 environmental rasters into a composite "1992 sensitive lands" raster.

- *Reclassify* this new sensitive lands raster which consist of two values, 0 and 1, where 1 is sensitive land areas and 0 is not sensitive.

- **Sum sensitive lands by county in 1992**

- Use the *Zonal Statistics (as Table)* command to summarize the amount of sensitive lands by county in 1992
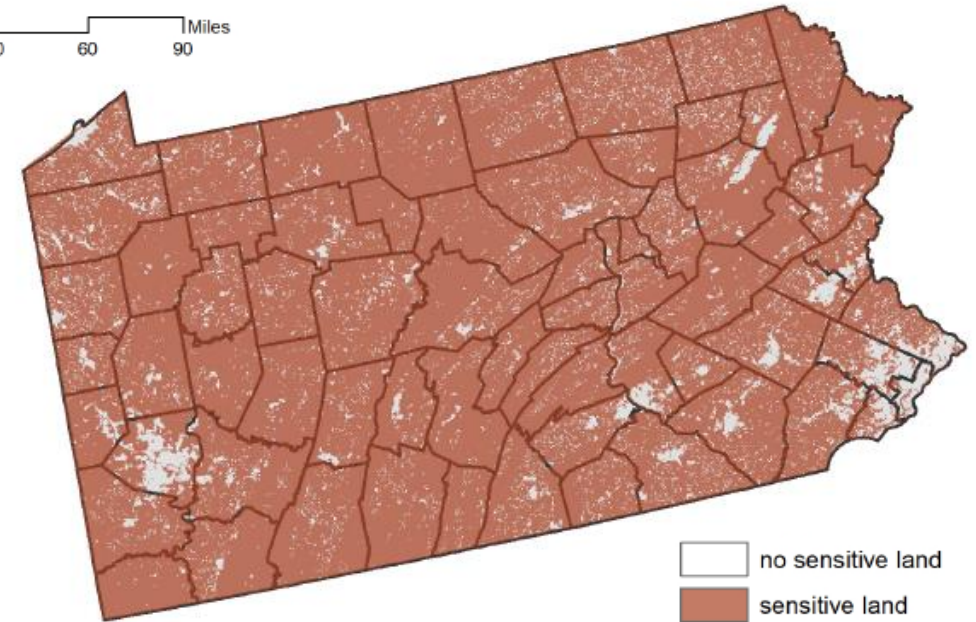
sensitive land in 1992

County Name	Amount of Sensitive Land	County Name	Amount of Sensitive Land	County Name	Amount of Sensitive Land	County Name	Amount of Sensitive Land
Montour	1207	Sullivan	4130	Mercer	6238	Warren	8203
Philadelphia	1308	Lackawanna	4243	Venango	6242	Clinton	8217
Delaware	1735	Northumberland	4370	Cambria	6334	Luzerne	8293
Union	2903	Montgomery	4459	Allegheny	6811	York	8329
Snyder	3028	Columbia	4470	Wayne	6854	McKean	8996
Lehigh	3180	Adams	4768	Chester	6946	Lancaster	8998
Lebanon	3316	Blair	4825	Franklin	7063	Bedford	9301
Lawrence	3318	Cumberland	5038	Schuylkill	7168	Westmoreland	9468
Northampton	3453	Perry	5085	Butler	7263	Crawford	9486
Carbon	3542	Dauphin	5094	Fayette	7296	Potter	9887
Juniata	3601	Pike	5182	Erie	7400	Somerset	9887
Cameron	3641	Greene	5289	Elk	7606	Centre	10152
Wyoming	3702	Clarion	5567	Susquehanna	7612	Tioga	10401
Mifflin	3786	Monroe	5652	Indiana	7630	Clearfield	10549
Forest	3948	Bucks	5679	Washington	7872	Bradford	10611
Fulton	4006	Jefferson	6000	Berks	7910	Lycoming	11364
Beaver	4057	Armstrong	6073	Huntingdon	8125	Total Number	414167

Step 4: The Sensitive Lands developed in 2001

- **Combine raster layers (new urbanized locations between 1992 and 2001 & sensitive land in 1992)**

- Use *Raster Calculator* to combine the grid from step 1 (areas that changed from non-urban to urban) with the sensitive lands grid of 1992

- *Reclassify* this new sensitive lands raster which consist of two values, 0 and 1, where 1 is the places where recent urban growth was most threatening to sensitive lands in 1992

Layer1: New urbanized locations between 1992 and 2001 from step 1
-1: non-urban
0: urban or non-urban
1: **urbanized**

Layer2: Sensitive lands grid of 1992 from step 3

0: not sensitive land;
1: sensitive land areas

Raster Calculator

-1;   0;   1;   2

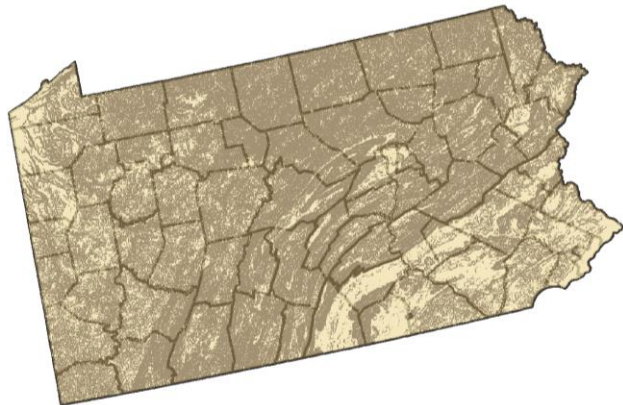*Reclassify*

0   1: Developed Sensitive Land in 1992
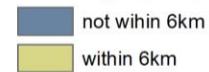
Step 4: The Sensitive Lands developed in 2001

- **Summarize the number of grid cells that sensitive lands developed**

- Use *Zonal Statistics (as Table)* to Summarize the results by county

- From the table, we can easily find the Allegheny is the County which has recent urban growth was most threatening to sensitive lands in 1992.

- Also the total number of the grid cells that were sensitive lands developed upon in 2001 is the 4677.
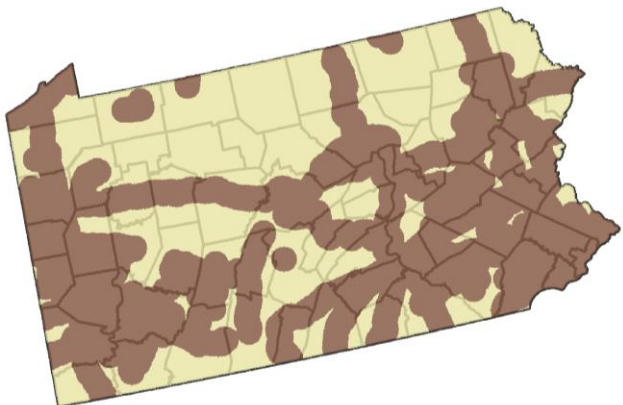
County Name	Developed Sensitive Lands	County Name	Developed Sensitive Lands
Cameron	3	Jefferson	62
Forest	8	Lackawanna	64
Sullivan	9	Pike	64
Potter	12	Northampton	66
Juniata	16	Somerset	67
Montour	18	Franklin	71
Wyoming	23	Cumberland	72
Elk	23	Lehigh	73
Union	25	Blair	82
Fulton	28	Delaware	83
Adams	32	Cambria	88
Snyder	33	Chester	89
Mifflin	33	York	91
Mckean	34	Fayette	91
Greene	34	Erie	92
Susquehanna	36	Crawford	92
Clinton	36	Schuylkill	92
Huntingdon	37	Mercer	94
Philadelphia	42	Luzerne	94
Warren	44	Bucks	94
Northumberland	44	Dauphin	97
Clarion	45	Centre	99
Tioga	46	Lawrence	100
Columbia	46	Berks	113
Perry	48	Beaver	118
Indiana	50	Clearfield	123
Wayne	51	Butler	124
Bedford	51	Washington	132
Armstrong	55	Montgomery	132
Bradford	57	Monroe	141
Lycoming	58	Lancaster	149
Lebanon	59	Westmoreland	178
Carbon	61	Allegheny	285
Venango	62	Total Number	4677
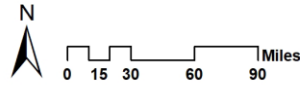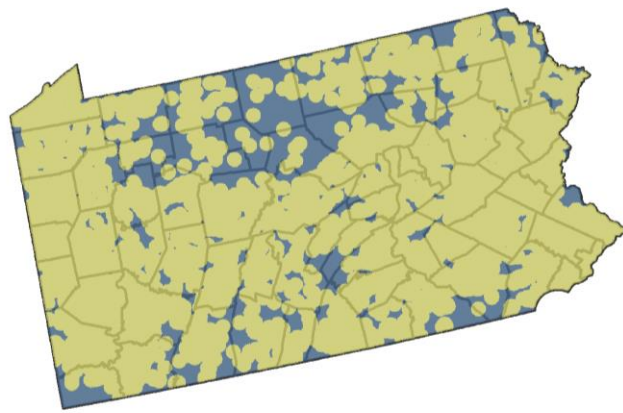
Existing Urban Development
- not within 6km
- within 6km

Slope
- slope>2%
- slope<=2%

4-Lane Highway
- not within 10km
- within 10km
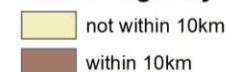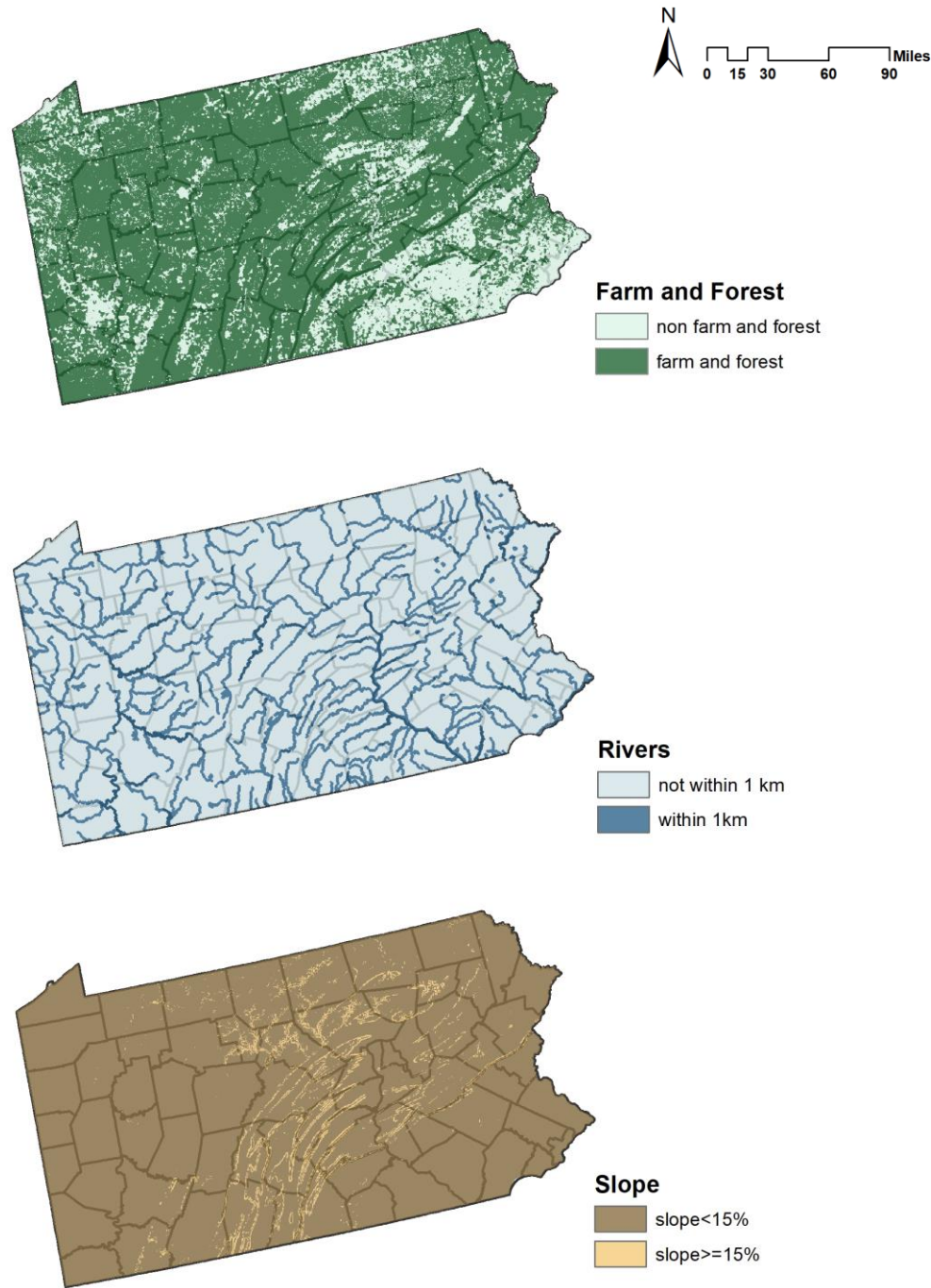
Step 5: The Urban Land Use in 2001 - Urbanization

- *Factor 1: distance to existing urban (Weight: 4)*
- Within 6km of urban development in 2001 in PA counties
- Use the *Euclidean Distance Tool* to develop the maximum distance of 6km to existing area
- *Reclassify* the value of 1 and 0. Value of 1 means that area within 6km

- *Factor2: slope <=2 (Weight: 3)*
- slope less than 2% grade in 2001 in PA counties.
- Use the *Raster Calculator* to figured out "pa_slope_" <= 2

- *Factor3: distance to highways (Weight: 2)*
- within 10KM of 4-lane highways in 2001 in PA counties
- Use the *Euclidean Distance Tool* to develop the maximum distance of 10km to highway area
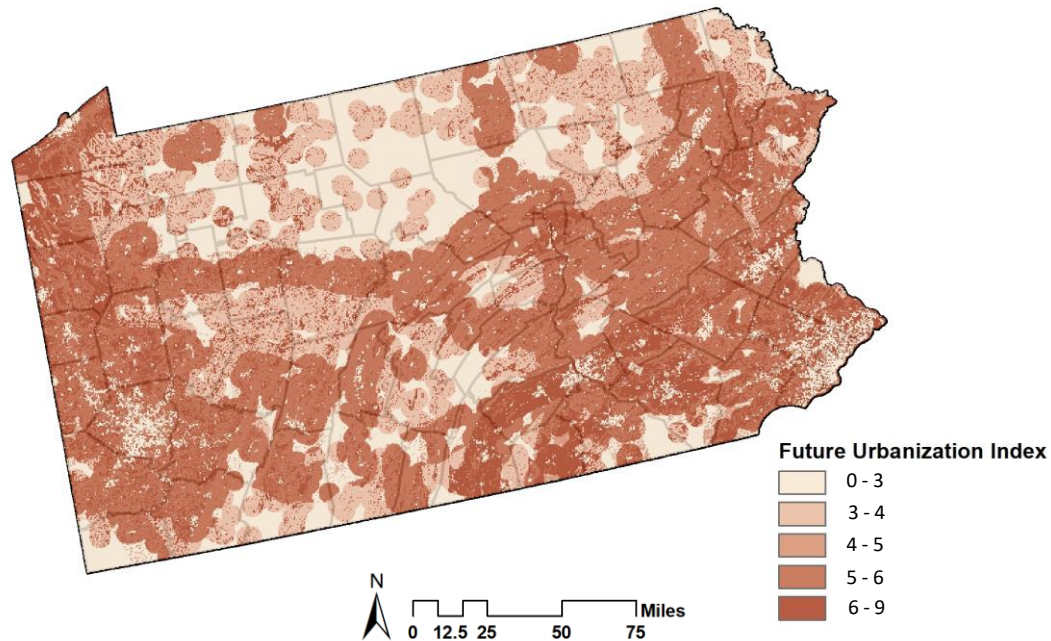- *Reclassify* the value of 1 and 0. Value of 1 means that the area of distance to highways within 0km

Farm and Forest
- non farm and forest
- farm and forest

Rivers
- not within 1 km
- within 1km

Slope
- slope<15%
- slope>=15%

Step 5: The Urban Land Use in 2001 - Preserve

- *Factor 1: in active farm and forest use (Weight: 4)*
- Active farm and forest use in 2001 in PA counties
- *Reclassify* the value of 1 and 0. Value of 1 means that in the farm and forest use area

- *Factor2: distance to rivers(Weight: 3)*
- Undeveloped sites within 1000 meters of river in 2001 in PA counties
- Use the *Euclidean Distance Tool* to figure out the maximum distance of 1km to rivers

- *Factor3: slope >=15 (Weight: 2)*
- hillsides with slopes of 15 degrees or more
- Use the *Raster Calculator* to figured out "pa_slope_" >= 15

Step 5: The Urban Land Use in 2001 – Urbanization & Preserve

- *Future Urbanization Index Map*

- *Environmental Sensitivity Index map*

Future Urbanization Index
- 0 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 9

N

Miles
0 12.5 25   50   75

Environmental Sensitivity Index
- 0
- 0 - 2
- 2 - 4
- 4 - 5
- 5 - 9

- Use the *Raster Calculator* to develop a "Future Urbanization Index Map"

- " distance to existing urban " * 4 + " slope <=2 " * 3 + " distance to highways " * 2

- 5 Quantile breaks.
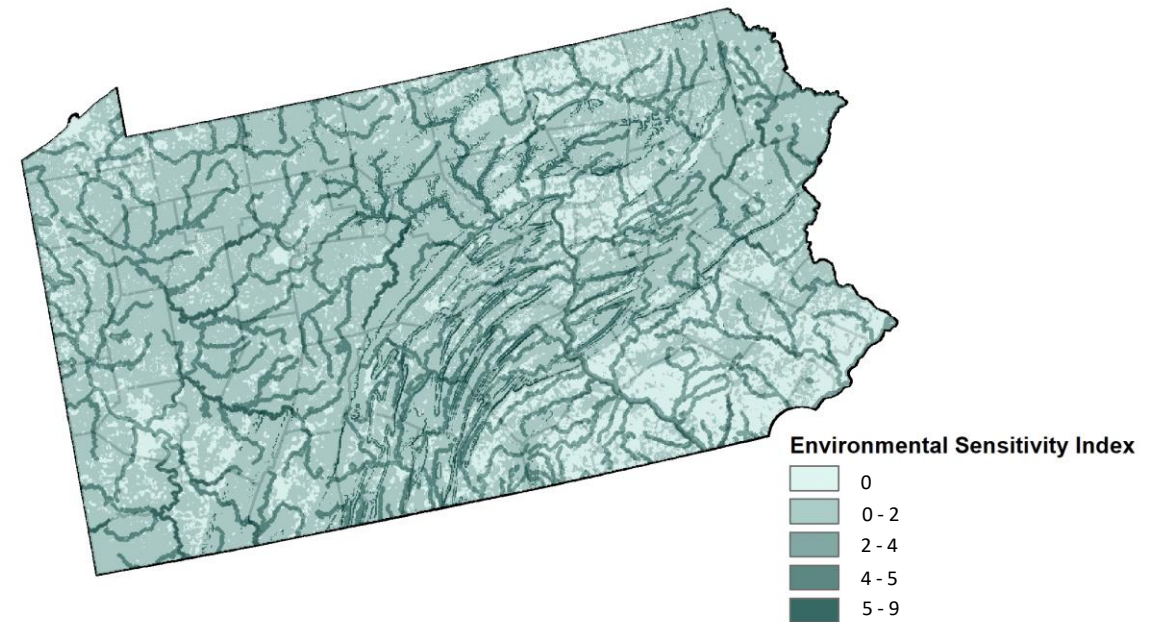
- Use the *Raster Calculator* to develop a "Environmental Sensitivity Index map"

- "slope >=15 " * 2 + "distance to rivers" * 3 + "in active farm use" * 4 + "in active forest use " * 4

- 5 Quantile breaks.

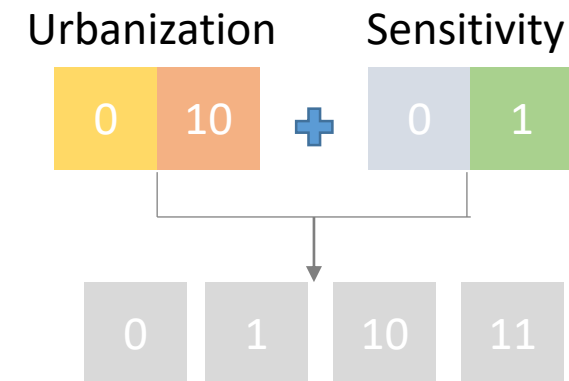# Step 6: Four categories of Environment Sensitivity Index and Future Urbanization

- In Urban Urbanization Index and Environment Sensitivity Map, *Reclassify* index where the top 3rd highest values are deemed 'most likely to be urbanized or sensitivity' (give these values a '1') and remaining values a '0'

- *Reclassify* Urban Urbanization Index map from 0 and 1 to 0 and 10.

- Use the *Raster Calculator* to combine Urban Urbanization Index map with environmentally sensitive index, have a new grid that contains the values 0, 1, 10 and 11.
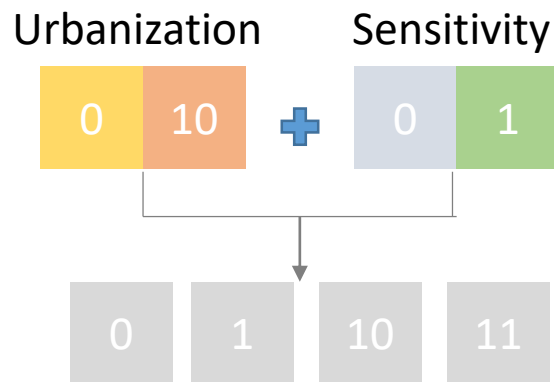
Step 6: Four categories of Environment Sensitivity Index and Future Urbanization

- ***The four categories stands for:***

- (0) -Area not environmentally sensitive And might not be developed.

- (1) -Area that are environmentally sensitive And might not be developed.

- (10)-Area that are not sensitive And might be developed.

- (11)-Area that are sensitive And might be developed.

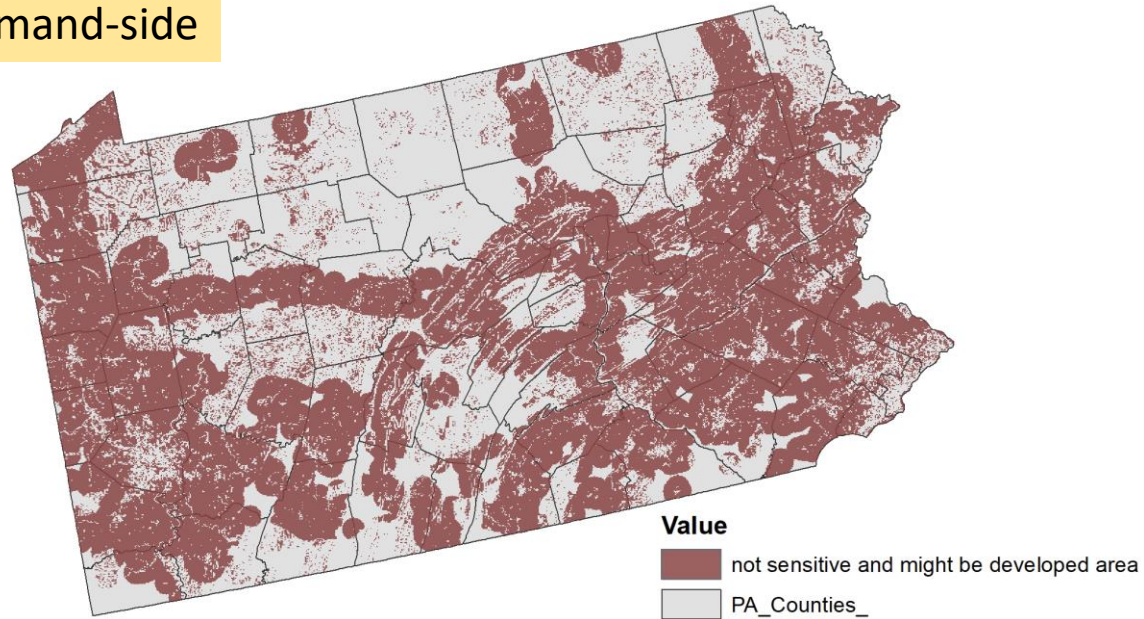**Four categories of Environment Sensitivity Index and Future Urbanization Map**
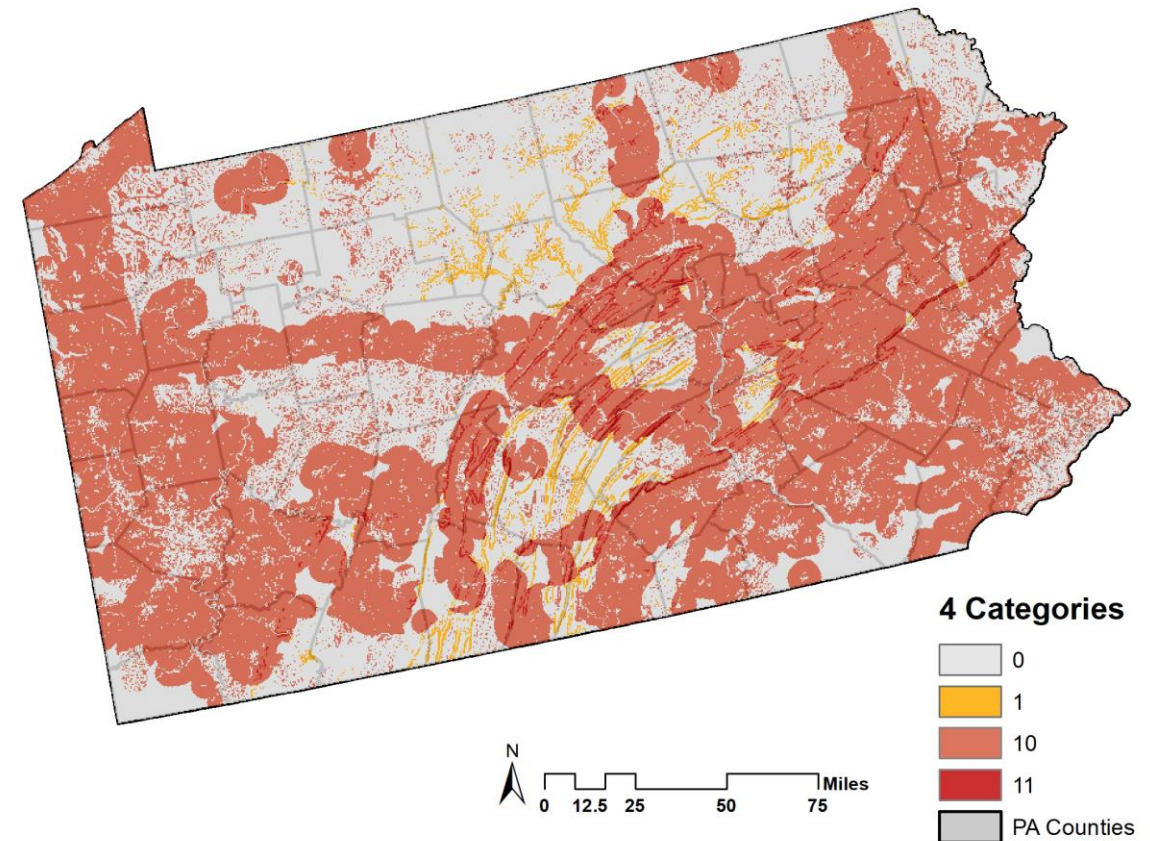
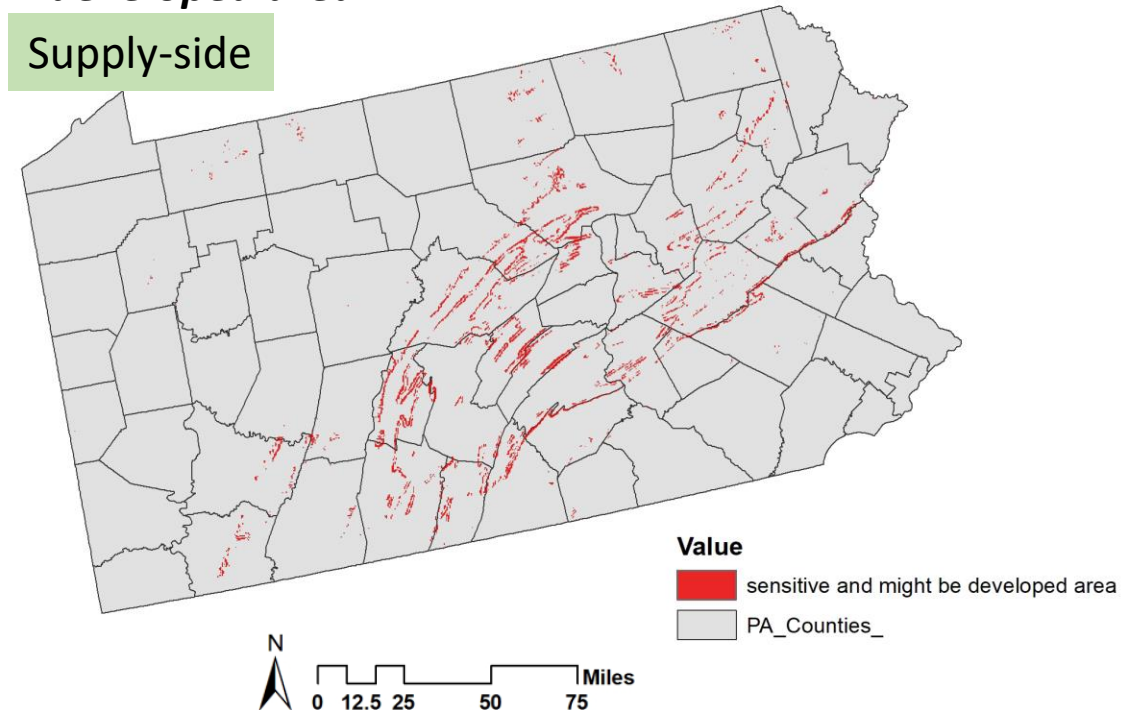# Step 7: Two important type pf developed area

- *Not environmentally sensitive and might be developed area*

Demand-side

- *Environmentally sensitive and might be developed area*

Supply-side

According to this two maps, the trend for the development we can see from the above map is mainly located in the eastern and western part of PA counties. The trend of the environmental sensitive we can see from the right map is mainly located in the central part of the PA counties.

Thank you

My website

SCAN ME

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