

Urban Growth vs. Development Suitability

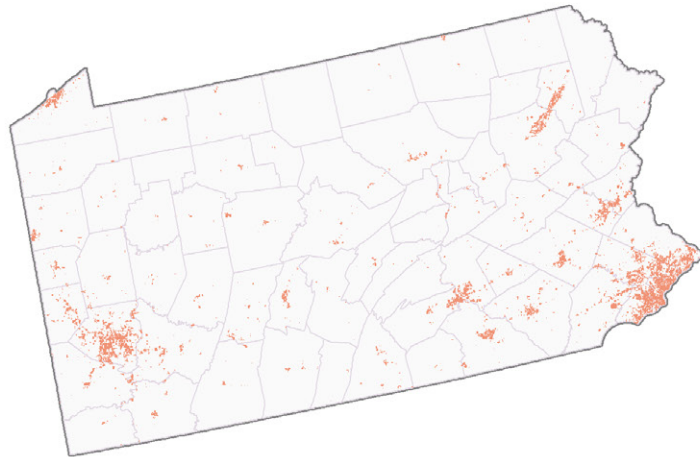
Assignment 3 Raster Overlay

Name: Kefan LONG

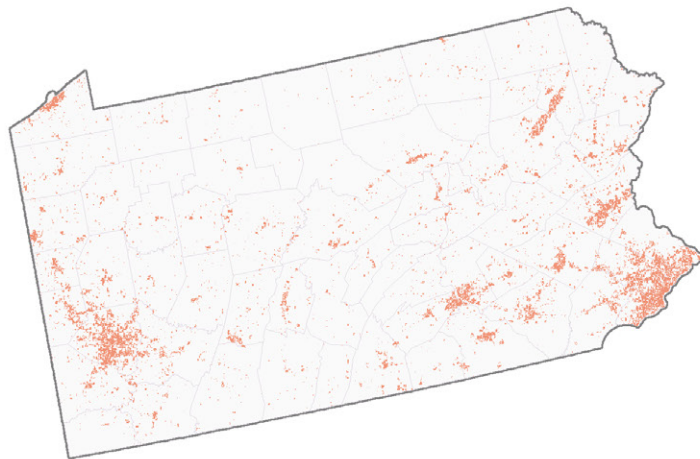
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Step 1: Calculating the converted area.

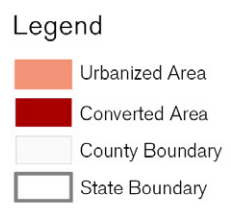
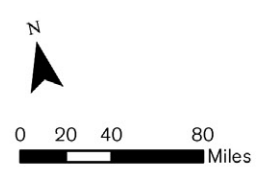
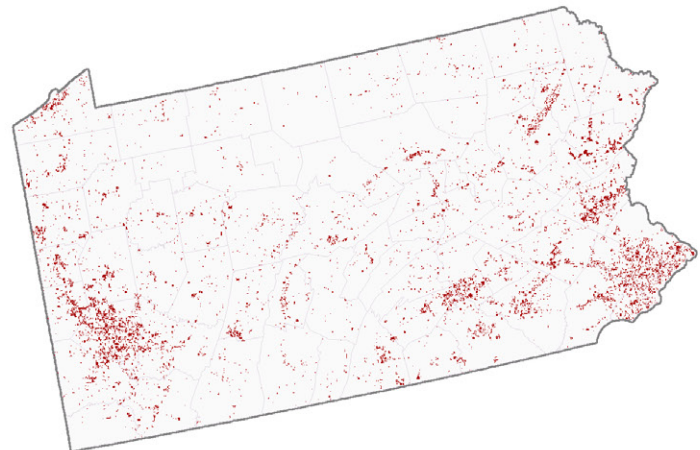
Urbanized Area in 1992



Urbanized Area in 2001



Area Converted between 1992 and 2001



The number of grid-cells converted from non-urban to urban is 12418. All the grid-cells are 500m*500m.

Step 2: Zonal statistics.

Land Conversion Efficiency in Different PA Counties

County Name	Population Change	Conversion Efficiency	Converted Grid-Cells	County Name	Population Change	Conversion Efficiency	Converted Grid-Cells
Lackawanna	59	1.949	115	Lehigh	27850	0.009	244
Northumberland	299	0.258	77	Wyoming	5434	0.008	44
McKean	353	0.110	39	Carbon	10812	0.008	84
Jefferson	918	0.087	80	Monroe	50065	0.008	384
Mercer	4134	0.049	202	Somerset	7903	0.007	58
Lawrence	3585	0.046	165	Northampton	26018	0.007	188
Blair	2357	0.045	106	Potter	1698	0.007	12
Venango	1855	0.044	81	Cumberland	26529	0.007	186
Lebanon	2708	0.043	116	Union	8583	0.007	60
Fulton	933	0.036	34	Berks	36913	0.007	252
Crawford	4786	0.035	168	Montour	4257	0.006	24
Tioga	1661	0.035	58	Lancaster	52055	0.005	269
Erie	5964	0.033	194	Juniata	4797	0.005	22
Perry	1743	0.026	46	Bucks	38793	0.004	168
Dauphin	8754	0.025	218	Pike	30740	0.004	122
Schuylkill	3280	0.024	80	Wayne	20068	0.004	75
Fayette	4490	0.022	100	Huntingdon	9090	0.003	31
Bedford	2264	0.020	46	Adams	23189	0.003	67
Greene	1902	0.020	38	Sullivan	4180	0.003	12
Mifflin	2307	0.019	44	Forest	5016	0.003	13
Armstrong	4132	0.017	72	Chester	53626	0.002	134
Franklin	10485	0.016	168	York	58042	0.002	135
Snyder	4215	0.014	59	Philadelphia	-68940	0.001	-45
Clinton	3883	0.013	52	Cameron	7270	0.000	0
Lycoming	11148	0.013	147	Delaware	697	-0.011	-8
Montgomery	24762	0.013	324	Cambria	-12183	-0.011	140
Clearfield	11549	0.013	151	Allegheny	-55123	-0.012	656
Columbia	6574	0.013	85	Washington	-10436	-0.013	136
Elk	2086	0.012	26	Luzerne	-9359	-0.014	134
Bradford	6691	0.011	74	Beaver	-5504	-0.034	188
Butler	26479	0.010	266	Westmoreland	-4974	-0.047	236
Warren	5256	0.009	49	Clarion	-390	-0.185	72
Centre	19168	0.009	174	Indiana	-111	-0.532	59
Susquehanna	7002	0.009	62				

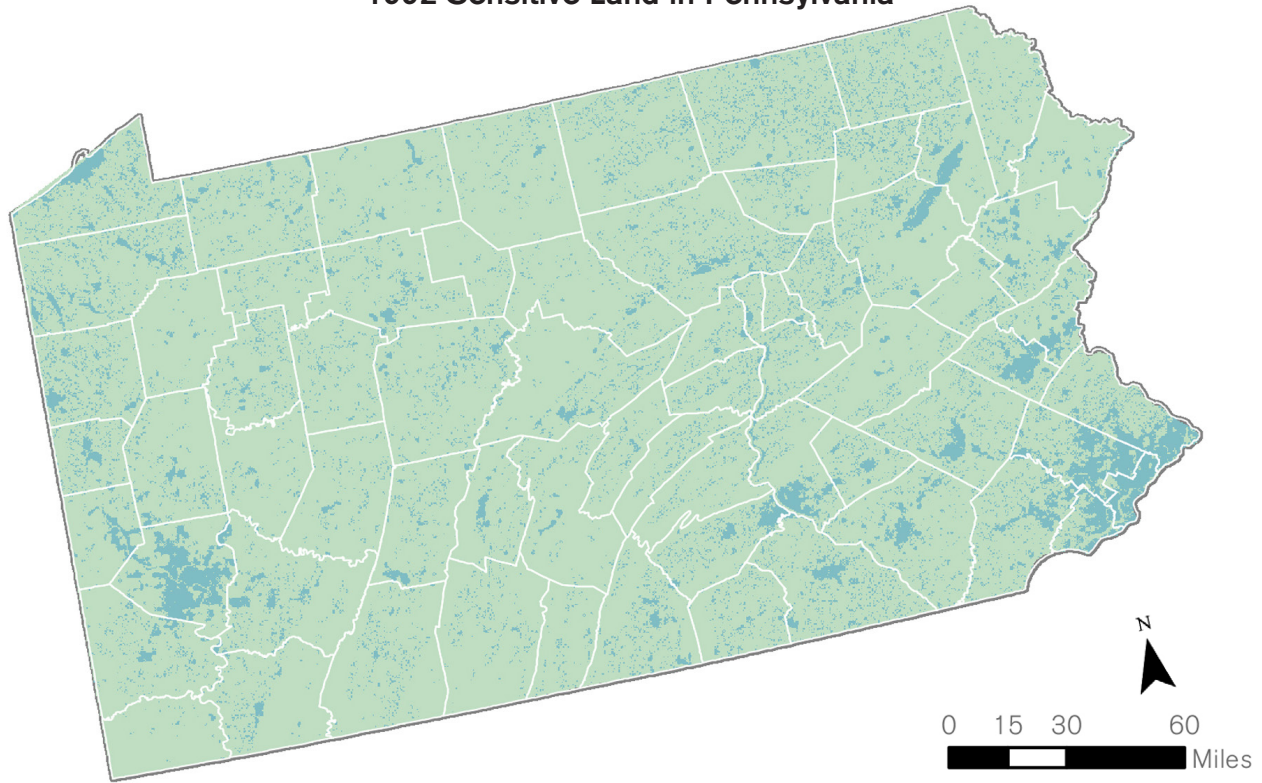
The Population Change is calculated by population of 2002 minus 1992. The Conversion Efficiency is the average grid-cell number per changed population.

According to the chart above, all the counties have areas urbanized from 1992 to 2001 with positive value of converted grid-cells. Meanwhile, some counties-Indiana, Clarion, Westmoreland, Beaver, Luzerne, Washington, Allegheny, Cambria and Philadelphia-are losing population.

A higher value in conversion efficiency means that with same population grown, the increased urban area is larger, thus more efficient. Judging from this standard, Lackawanna and Northumberland are the most efficient counties, whereas Clarion and Indiana are least efficient ones.

Step 3&4: Sensitive Area

1992 Sensitive Land in Pennsylvania



Number of Sensitive Grid-Cells by PA County			
NAME	Sensitive Grid-Cells	NAME	Sensitive Grid-Cells
Erie	5930	Northampton	2725
Bradford	9259	Schuylkill	6777
Tioga	9538	Indiana	7297
Potter	9514	Snyder	2702
McKean	8560	Beaver	3537
Warren	7446	Mifflin	3576
Wayne	6431	Lehigh	2266
Susquehanna	6719	Huntingdon	7845
Crawford	8119	Blair	4453
Wyoming	3215	Cambria	5823
Lackawanna	3569	Juniata	3392
Elk	6935	Westmoreland	8520
Forest	3735	Berks	6764
Venango	6096	Allegheny	4096
Cameron	3539	Dauphin	4153
Pike	4904	Perry	4823
Lycoming	10256	Bucks	3816
Sullivan	3801	Lebanon	2899
Mercer	5297	Washington	7213
Clinton	7859	Montgomery	2406
Clarion	5052	Cumberland	4146
Luzerne	7264	Bedford	8941
Jefferson	5659	Lancaster	7923
Columbia	3890	Franklin	6292
Clearfield	9722	Somerset	9416
Centre	9528	Chester	5695
Monroe	4864	York	7027
Northumberland	3849	Fulton	3831
Butler	6637	Fayette	6895
Montour	1066	Philadelphia	286
Armstrong	5856	Adams	4355
Union	2684	Delaware	899
Carbon	3306	Greene	
Lawrence	2812		



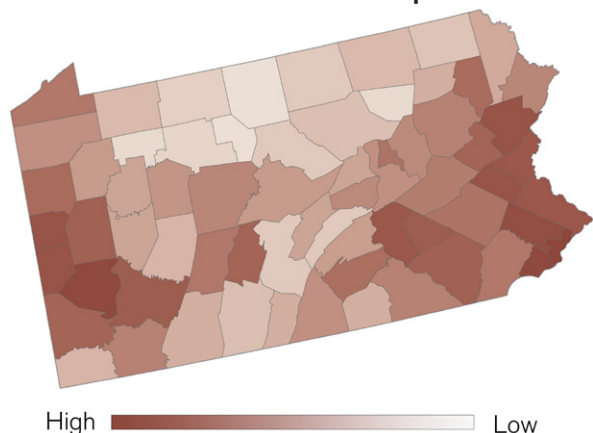
As we can see from the 1992 Sensitive Land Map, most of the area in Pennsylvania are covered by sensitive types of land. And the total number of sensitive grid-cell is 369843.

Step 5: Converted Sensitive Grid-Cells

Converted Sensitive Grid-Cells by PA County

NAME	Converted Sensitive Grid-Cells	Total Number in 1992	Ratio	NAME	Converted Sensitive Grid-Cells	Total Number in 1992	Ratio
Philadelphia	42	286	0.146853	Northumberland	44	3849	0.011432
Delaware	83	899	0.092325	Crawford	92	8119	0.011331
Allegheny	285	4096	0.06958	Franklin	71	6292	0.011284
Montgomery	132	2406	0.054863	Jefferson	62	5659	0.010956
Lawrence	100	2812	0.035562	Centre	99	9528	0.01039
Beaver	118	3537	0.033362	Venango	62	6096	0.010171
Lehigh	73	2266	0.032215	Perry	47	4823	0.009745
Monroe	141	4864	0.028988	Armstrong	55	5856	0.009392
Bucks	94	3816	0.024633	Union	25	2684	0.009314
Northampton	66	2725	0.02422	Mifflin	33	3576	0.009228
Dauphin	98	4153	0.023597	Clarion	45	5052	0.008907
Westmoreland	178	8520	0.020892	Wayne	51	6431	0.00793
Lebanon	59	2899	0.020352	Adams	32	4355	0.007348
Lancaster	149	7923	0.018806	Fulton	28	3831	0.007309
Butler	124	6637	0.018683	Wyoming	23	3215	0.007154
Carbon	61	3306	0.018451	Somerset	67	9416	0.007116
Blair	82	4453	0.018415	Indiana	50	7297	0.006852
Washington	132	7213	0.0183	Greene	34	5211	0.006525
Lackawanna	64	3569	0.017932	Bradford	57	9259	0.006156
Mercer	94	5297	0.017746	Warren	44	7446	0.005909
Cumberland	72	4146	0.017366	Bedford	51	8941	0.005704
Montour	18	1066	0.016886	Lycoming	58	10256	0.005655
Berks	113	6764	0.016706	Susquehanna	36	6719	0.005358
Chester	89	5695	0.015628	Tioga	46	9538	0.004823
Erie	92	5930	0.015514	Juniata	16	3392	0.004717
Cambria	88	5823	0.015112	Huntingdon	37	7845	0.004716
Schuylkill	92	6777	0.013575	Clinton	36	7859	0.004581
Fayette	91	6895	0.013198	McKean	34	8560	0.003972
York	91	7027	0.01295	Elk	23	6935	0.003317
Luzerne	94	7264	0.012941	Sullivan	9	3801	0.002368
Pike	63	4904	0.012847	Forest	8	3735	0.002142
Clearfield	123	9722	0.012652	Potter	12	9514	0.001261
Snyder	33	2702	0.012213	Cameron	3	3539	0.000848
Columbia	46	3890	0.011825				

Conversion Ratio Map



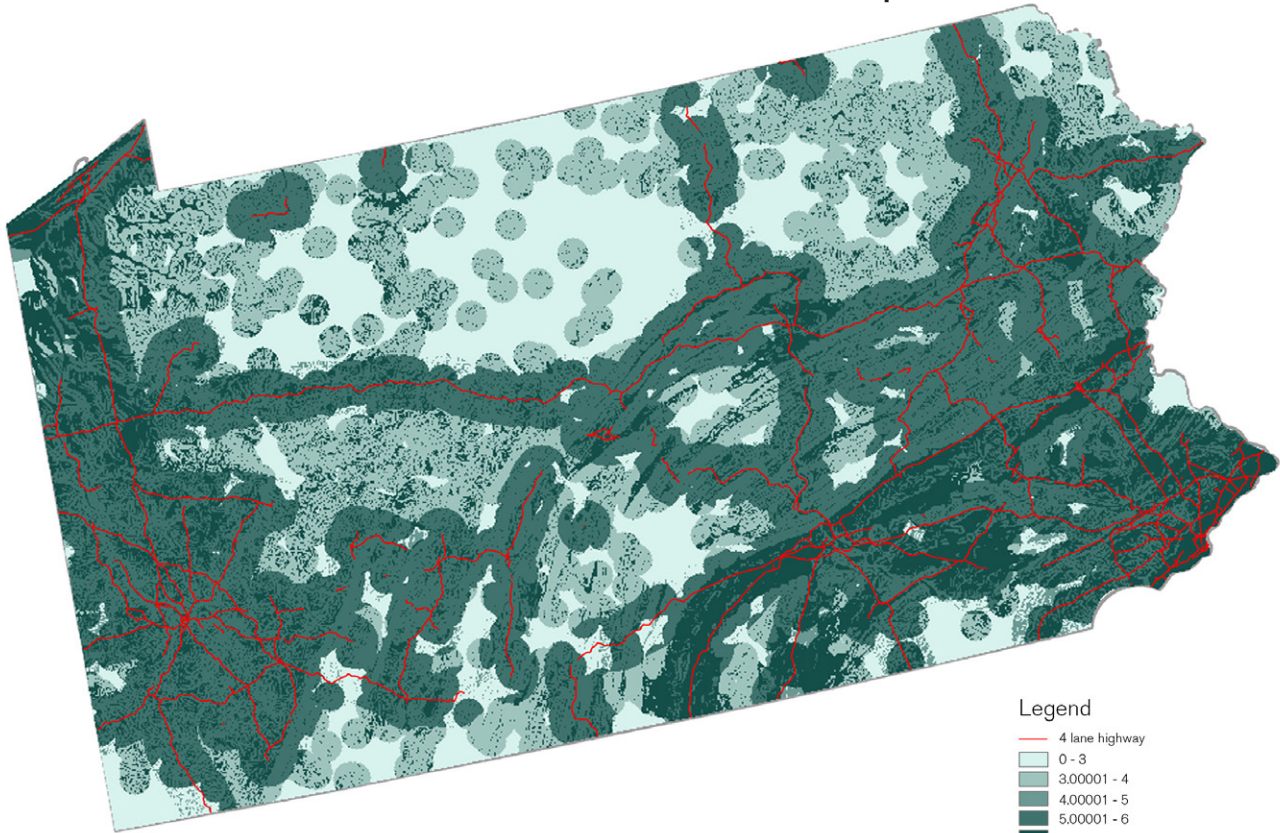
The ratios of converted sensitive grid-cells show that larger portion of sensitive lands in Philadelphia and Delaware have turned to urban in 2001.

According to the map which combines the ratio and location, it is obvious that southwestern and eastern Pennsylvania are losing larger portions of sensitive land. In other words, sensitive land within these regions is most threatened.

The number of grid cells that were sensitive lands developed upon in 2001 is 4677.

Step 6: Future Urbanization Map

Future Urbanization Index Map



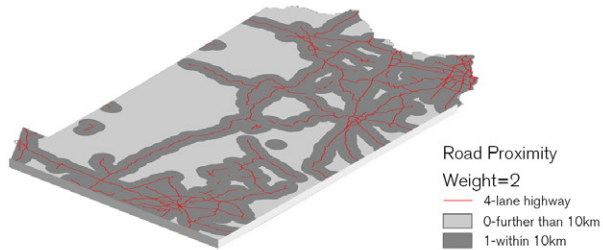
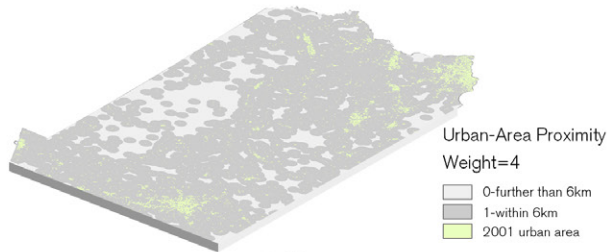
Legend

- 4 lane highway
- 0 - 3
- 3.00001 - 4
- 4.00001 - 5
- 5.00001 - 6
- 6.00001 - 9
- State boundary

0 7.5 15 30 Miles

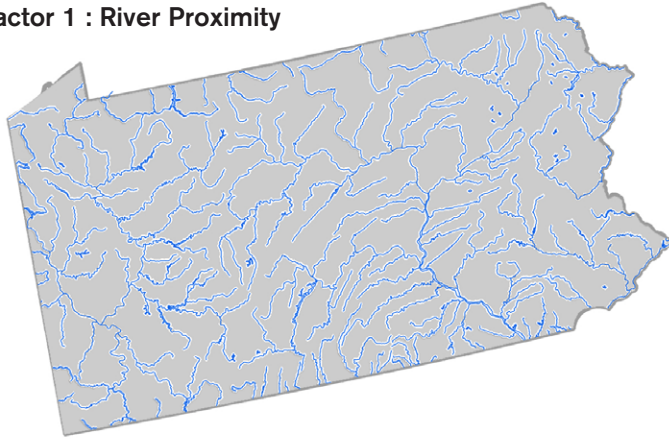


Overlay Factors, Value and Weight



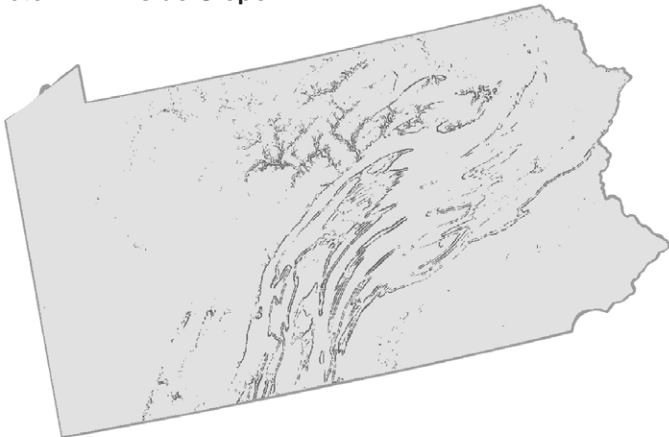
Step 6: Decision factors for Overlay Analysis and Value Given

Factor 1 : River Proximity



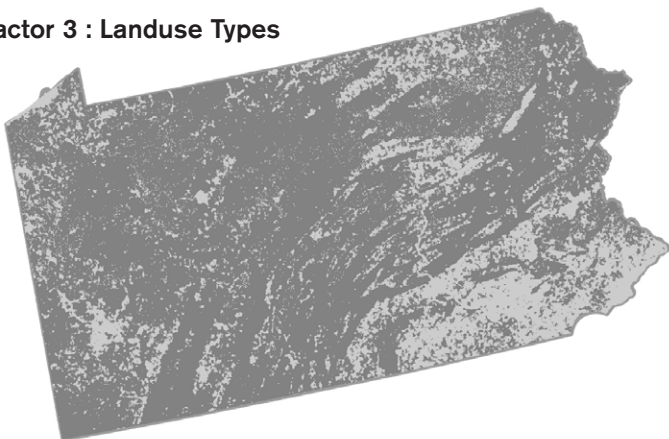
- Rivers of Pennsylvania
- 0 - Distance further than 1000 meter to rivers or developed areas
- 1 - Undeveloped area within 1000 meter of rivers

Factor 2 : Hillside Slope



- 0 - Hillsides with slopes of less than 15%
- 1 - Hillsides with slopes of 15% or more

Factor 3 : Landuse Types

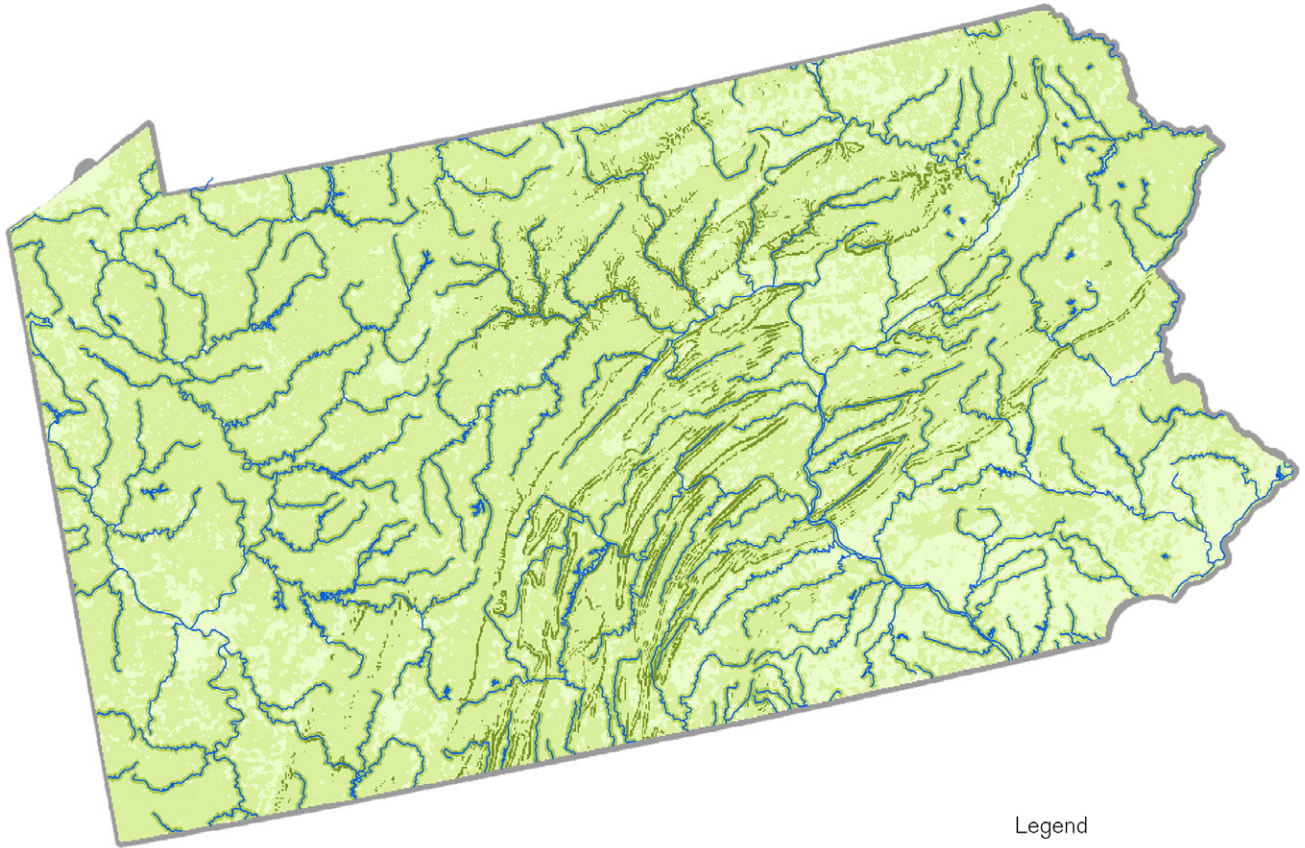


- 0 - Areas in other Use
- 1 - Areas in active farm and forest use

I choose the weight and value mainly by the cost of restoring after being influenced. The restoration in a steep area is extremely hard, so I gave the factor of slope a very large weight, 5. For lands beside a river or are forests or farms, it seems to have little difference in restoring the lands themselves. But taking the large, state-scaled or nation-scaled network of rivers, it seems that restoring lands beside a river costs more in curing the river problems that are caused by surrounding areas. So I gave the river proximity with a weight of 3, and the landuse with 1.

Step 6: Environmental Sensitivity Index

Environmental Sensitivity Index Map

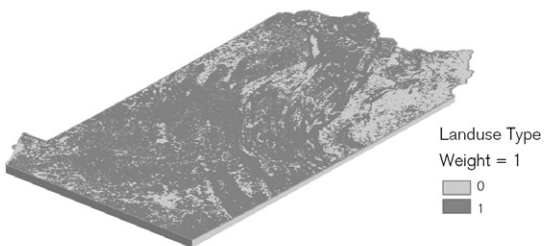
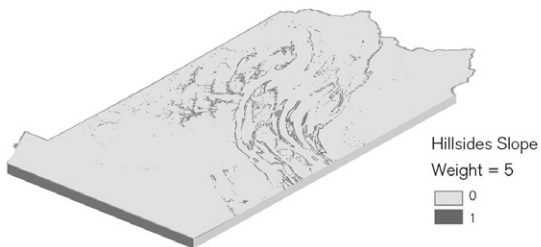
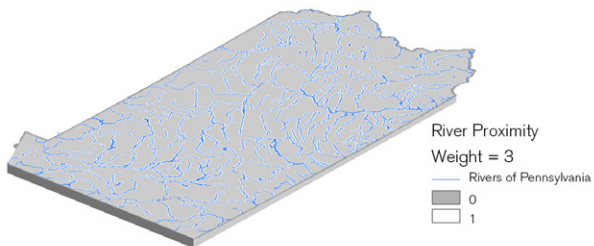


Legend

- Rivers of Pennsylvania
- 0
- 0.00001 - 1
- 1.00001 - 3
- 3.00001 - 4
- 4.00001 - 9
- State boundary

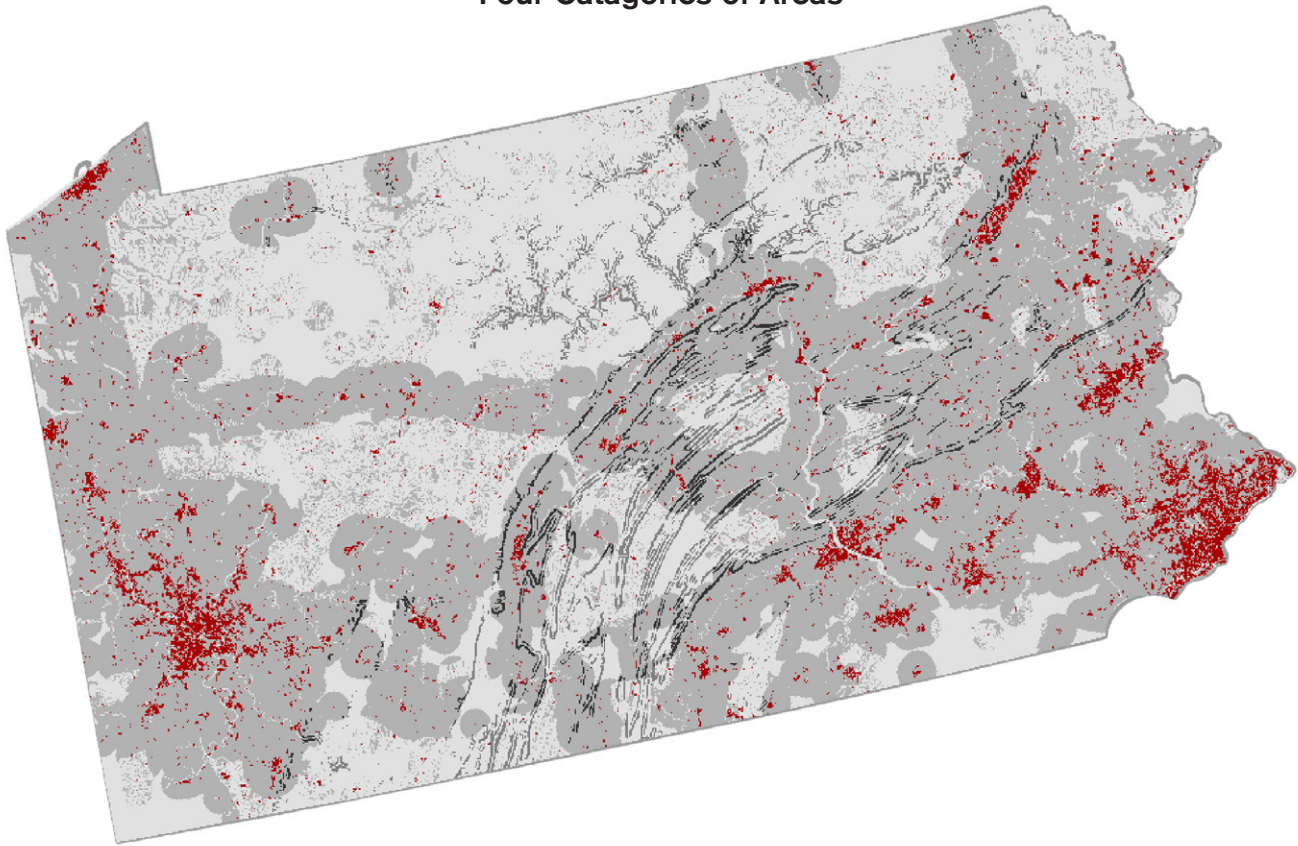


Overlay Factors, Value and Weight

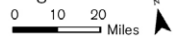


Step 7: Combining Two Maps

Four Categories of Areas



Legend



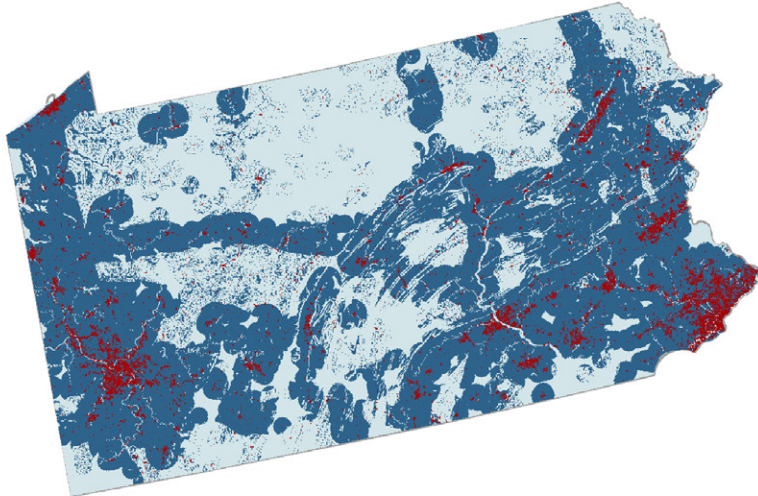
- 0 - Areas not environmentally sensitive and might not be developed
- 1 - Areas that are environmentally sensitive and might not be developed
- 10 - Areas that are not sensitive and might be developed
- 11 - Areas that are sensitive and might be developed
- Urbanized Area

Firstly, reclassifying Future Development Index Map and Environmental Sensitivity Index Map into two binary 1-0 maps. For both index maps, I gave the top 3rd value as '1', and other value were given value as '0'.

Since both index maps have turned to 2 values, and we need to discuss the meaning of both sides, I converted the Urban Map from 0-1 to 0-10. So the four different types of areas multiplied from 2 binary maps can be clearly shown.

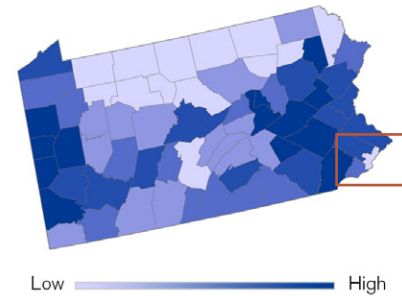
Step 7: Two Maps shows

Distribution of Value-10 Areas



- Areas that are not environmentally sensitive and might be developed
- Urban Area

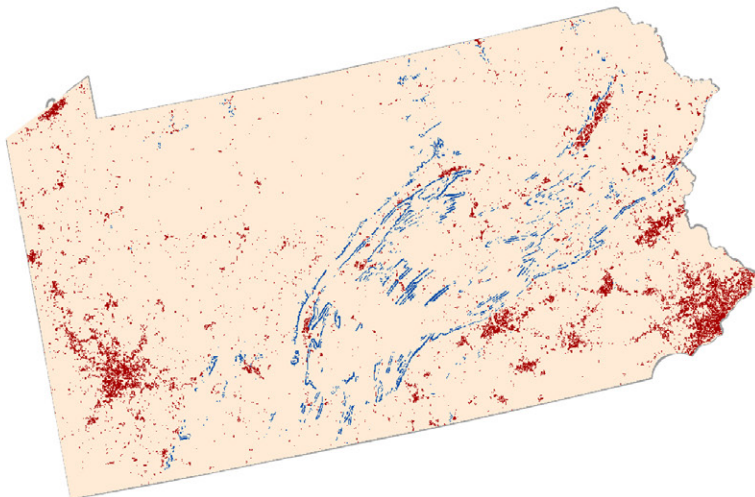
Ratio of value-10 Areas in PA County



From the overall distribution we can see that the areas suitable for development mainly locate on the eastern and southwestern Pennsylvania.

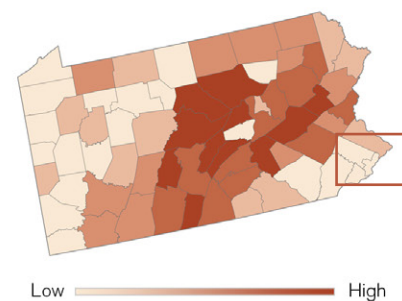
The ratio of potential developmental area in Philadelphia is smaller compared to surrounding counties. But the reason is that majority areas in Philadelphia have been urbanized. So it is harder for Philadelphia to find abundant areas for future urban development than other counties that surround it.

Distribution of Value-11 Areas



- Areas that are environmentally sensitive and might be developed
- Urban Area

Ratio of Value-11 Areas in PA County



From my calculation, sensitive areas under threaten of futrue development mainly locate on the middle Pennsylvania. For those counties with sensitive areas, future development must be carefully manipulated. Some preservational zones can be set beforehand to make sure these vulnerable areas can maintain a stable and healthy condition.

Philadelphia has almost no sensitive areas within. But that does not necessarily mean that future constructions, whatever hazardous influence they could generate, can be done without any caution. Since fewer areas are left undeveloped, future development should be more careful.