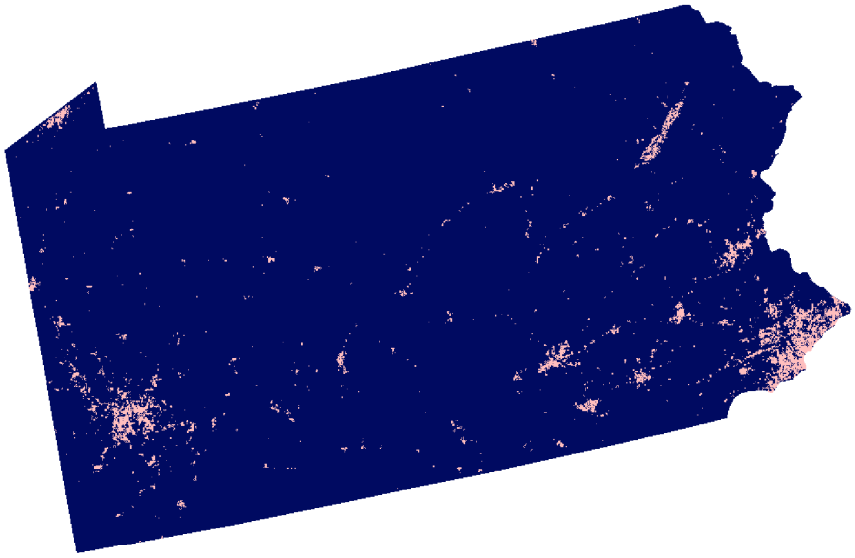
Urban Growth vs. Development Suitability Using Raster Overlay

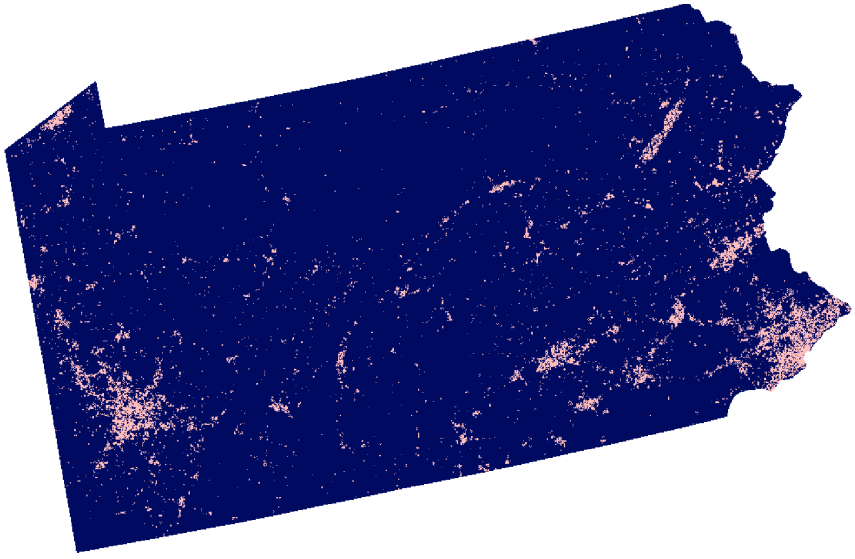
Hanyong Xu
Sep.20th, 2019

1. Urbanization Conditions

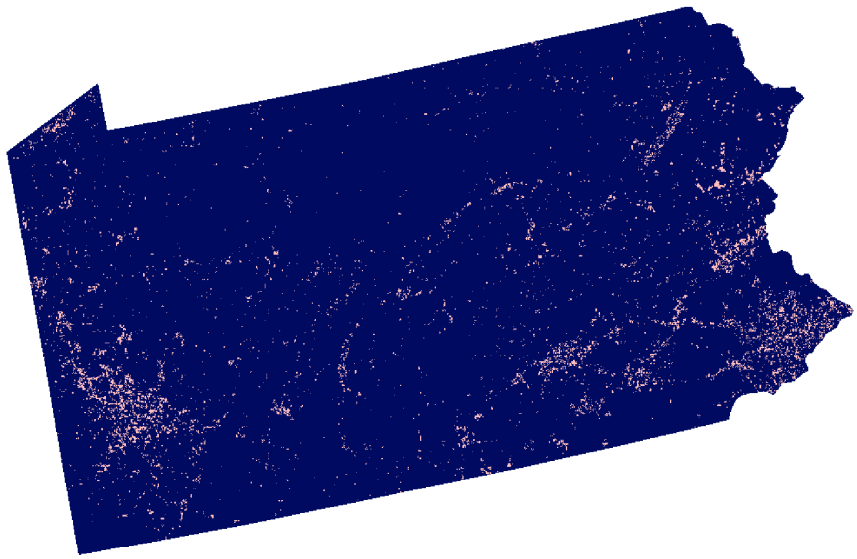
Pennsylvania Urbanization in 1992



Pennsylvania Urbanization in 2001



Pennslyvania Urban Area Change from 1992-2002



2. Urbanization Conditions - Counties

NAME	Net Urban Growth (km2)	Urban Growth (km2)	Population Growth	Ratio of Net Land Conversion to POP Growth (km2/person)
Indiana	11.00	21.75	(111)	(0.099098)
Westmoreland	77.00	102.50	(4974)	(0.015480)
Luzerne	94.50	73.50	(9359)	(0.010097)
Beaver	52.75	82.75	(5504)	(0.009584)
Allegheny	365.25	312.75	(55123)	(0.006626)
Clarion	2.50	19.25	(390)	(0.006410)
Washington	49.75	69.00	(10436)	(0.004767)
Philadelphia	220.00	53.75	(68940)	(0.003191)
Cambria	23.25	46.50	(12183)	(0.001908)
Forest	0.00	3.25	5016	0.000000
Sullivan	0.00	3.00	4180	0.000000
Wayne	1.00	19.75	20068	0.000050
Pike	3.25	33.00	30740	0.000106
Cameron	1.00	0.75	7270	0.000138
Potter	0.25	3.25	1698	0.000147
Adams	4.00	19.50	23189	0.000172
Wyoming	1.00	12.00	5434	0.000184
Susquehanna	1.75	16.50	7002	0.000250
Juniata	1.25	6.25	4797	0.000261
Monroe	14.25	103.75	50065	0.000285
Union	3.50	15.50	8583	0.000408
Montour	2.75	6.75	4257	0.000646
Huntingdon	6.00	11.00	9090	0.000660
Butler	19.75	77.75	26479	0.000746
Snyder	3.25	15.25	4215	0.000771
Centre	15.75	50.50	19168	0.000822
Carbon	11.75	29.25	10812	0.001087
Warren	6.00	15.75	5256	0.001142
Somerset	9.50	21.50	7903	0.001202
York	71.00	64.75	58042	0.001223
Bradford	8.25	22.50	6691	0.001233
Perry	2.25	13.75	1743	0.001291
Lancaster	69.50	99.50	52055	0.001335
Clinton	5.25	16.25	3883	0.001352
Clearfield	17.00	47.75	11549	0.001472
Chester	82.75	82.25	53626	0.001543
Columbia	10.25	26.00	6574	0.001559
Fulton	1.50	9.75	933	0.001608
Tioga	2.75	16.75	1661	0.001656
Berks	64.50	84.75	36913	0.001747
Armstrong	7.75	24.25	4132	0.001876
Northampton	57.00	72.00	26018	0.002191
Cumberland	60.00	66.75	26529	0.002262
Franklin	24.00	53.00	10485	0.002289
Lycoming	26.25	46.75	11148	0.002355
Greene	4.75	13.50	1902	0.002497
Crawford	12.00	49.00	4786	0.002507
Lehigh	76.00	86.25	27850	0.002729
Mifflin	7.00	14.75	2307	0.003034
Venango	5.75	24.75	1855	0.003100
Elk	7.50	10.00	2086	0.003595
Bedford	8.75	16.25	2264	0.003865
Bucks	176.75	115.50	38793	0.004556
Schuylkill	16.00	31.00	3280	0.004878
Fayette	27.25	43.25	4490	0.006069
Jefferson	5.75	22.75	918	0.006264
Lawrence	22.50	53.75	3585	0.006276
Lebanon	19.50	36.25	2708	0.007201
Mercer	31.00	64.50	4134	0.007499
Dauphin	69.50	81.50	8754	0.007939
Montgomery	242.00	176.75	24762	0.009773
Erie	72.50	73.00	5964	0.012156
Blair	32.25	42.75	2357	0.013683
McKean	5.00	13.25	353	0.014164
Northumberland	12.25	25.25	299	0.040969
Delaware	155.50	59.25	697	0.223097
Lackawanna	69.00	56.00	59	1.169479

— Most Efficient —

— Least Efficient —

Notice that both the net urban growth (which is the urban area difference between 2001 and 1992) and the urban growth(which is the urban area in 2001 that was converted from rural area in 1992) are calculated. In this analysis, it makes more sense to compare the net urban growth with the population growth, because a lot of counties have urban areas that were converted to rural areas over the years.

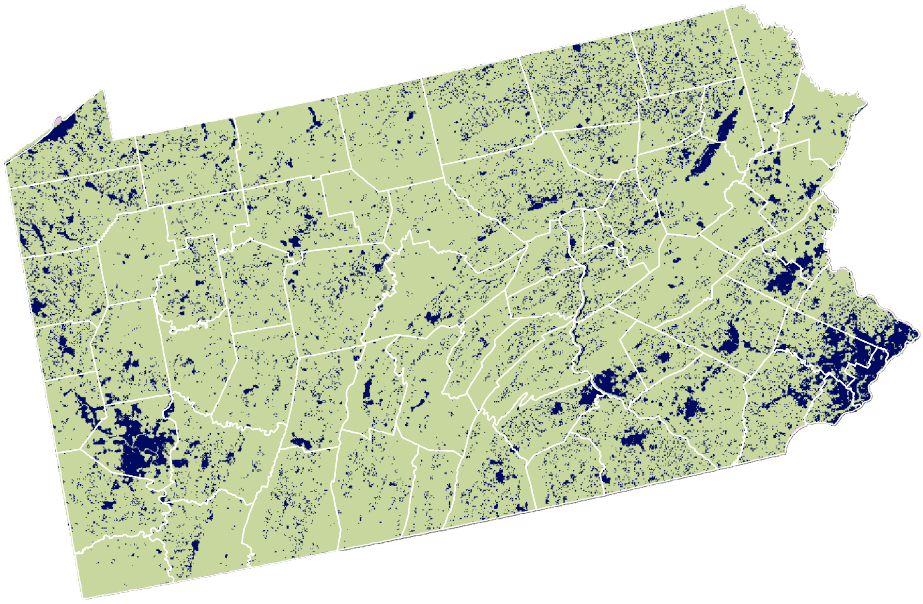
The ratio of net land conversion to population growth is important because it allows us to compare the speed of urban growth in relation to population growth. In general, the smaller the ratio, the more efficient the conversion. This is because a smaller ratio reflects that the population per unit of land is more dense. In Pennsylvania, the most efficient county is Wayne.

The rows highlighted in red indicate counties that actually lost population over the years. The urban land is inefficient for these counties because urban land increased while population density decreased.

The rows highlighted in yellow indicate counties that had zero net urban growth. In such cases, the ratio of land to population has no meaning.

3. Environmental Conditions

Pennsylvania Sensitive Lands 1992



From the table one can tell that the counties with the most sensitive land area are Lycoming, Clearfield, and Tioga; the counties with the least sensitive land area are Philadelphia, Delaware, and Montour. The larger cities tend to have less sensitive lands.

Sensitive Lands By County

NAME	Sensitive Area (cell count)	Sensitive Area (km2)
TOTAL	368913	92227.27
Lycoming	10256	2563.97
Clearfield	9724	2430.97
Tioga	9538	2384.47
Centre	9527	2381.72
Potter	9514	2378.47
Somerset	9416	2353.97
Bradford	9260	2314.98
Bedford	8941	2235.23
McKean	8560	2139.98
Westmoreland	8522	2130.48
Crawford	8120	2029.98
Lancaster	7921	1980.23
Clinton	7859	1964.73
Huntingdon	7846	1961.48
Warren	7446	1861.48
Indiana	7296	1823.98
Luzerne	7264	1815.98
Washington	7213	1803.23
York	7029	1757.23
Elk	6933	1733.23
Fayette	6895	1723.73
Schuylkill	6777	1694.23
Berks	6765	1691.23
Susquehanna	6718	1679.48
Butler	6637	1659.23
Wayne	6432	1607.98
Franklin	6292	1572.98
Venango	6096	1523.98
Erie	5929	1482.23
Armstrong	5856	1463.98
Cambria	5822	1455.48
Chester	5695	1423.73
Jefferson	5660	1414.98
Mercer	5297	1324.24
Greene	5211	1302.74
Clarion	5052	1262.99
Pike	4905	1226.24
Monroe	4861	1215.24
Perry	4823	1205.74
Blair	4453	1113.24
Adams	4355	1088.74
Dauphin	4153	1038.24
Cumberland	4147	1036.74
Allegheny	4096	1023.99
Columbia	3890	972.49
Northumberland	3849	962.24
Fulton	3831	957.74
Bucks	3815	953.74
Sullivan	3802	950.49
Forest	3735	933.74
Mifflin	3576	893.99
Lackawanna	3569	892.24
Cameron	3539	884.74
Beaver	3537	884.24
Juniata	3391	847.74
Carbon	3309	827.24
Wyoming	3214	803.49
Lebanon	2898	724.49
Lawrence	2812	702.99
Northampton	2725	681.24
Snyder	2702	675.49
Union	2684	670.99
Montgomery	2406	601.49
Lehigh	2265	566.24
Montour	1066	266.50
Delaware	899	224.75
Philadelphia	287	71.75

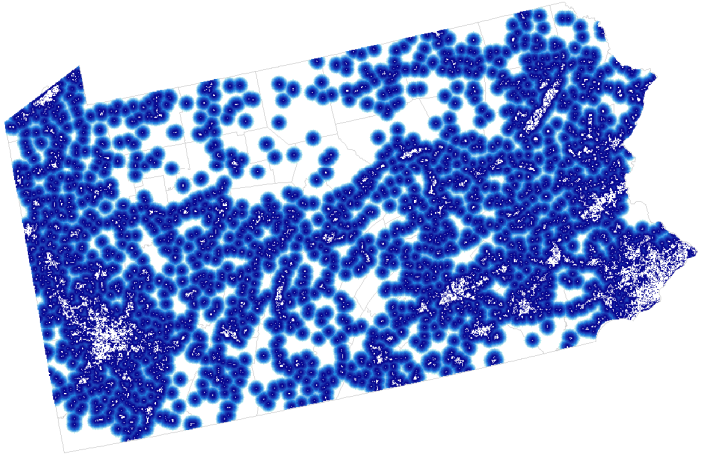
4. Pennsylvania Urban Growth Affecting Sensitive Lands

NAME	Urban Growth on Sensitive Lands (cell count)	Urban Growth on Sensitive Lands (km2)
Allegheny	285	71.25
Westmoreland	178	44.50
Lancaster	149	37.25
Monroe	141	35.25
Washington	132	33.00
Montgomery	132	33.00
Butler	124	31.00
Clearfield	123	30.75
Beaver	118	29.50
Berks	113	28.25
Lawrence	100	25.00
Centre	99	24.75
Dauphin	97	24.25
Mercer	94	23.50
Luzerne	94	23.50
Bucks	94	23.50
Erie	92	23.00
Crawford	92	23.00
Schuylkill	92	23.00
York	91	22.75
Fayette	91	22.75
Chester	89	22.25
Cambria	88	22.00
Delaware	83	20.75
Blair	82	20.50
Lehigh	73	18.25
Cumberland	72	18.00
Franklin	71	17.75
Somerset	67	16.75
Northampton	66	16.50
Lackawanna	64	16.00
Pike	64	16.00
Venango	62	15.50
Jefferson	62	15.50
Carbon	61	15.25
Lebanon	59	14.75
Lycoming	58	14.50
Bradford	57	14.25
Armstrong	55	13.75
Wayne	51	12.75
Bedford	51	12.75
Indiana	50	12.50
Perry	48	12.00
Tioga	46	11.50
Columbia	46	11.50
Clarion	45	11.25
Warren	44	11.00
Northumberland	44	11.00
Philadelphia	42	10.50
Huntingdon	37	9.25
Susquehanna	36	9.00
Clinton	36	9.00
McKean	34	8.50
Greene	34	8.50
Snyder	33	8.25
Mifflin	33	8.25
Adams	32	8.00
Fulton	28	7.00
Union	25	6.25
Wyoming	23	5.75
Elk	23	5.75
Montour	18	4.50
Juniata	16	4.00
Potter	12	3.00
Sullivan	9	2.25
Forest	8	2.00
Cameron	3	0.75

The top five counties with the most sensitive lands being threatened by urban growth are highlighted in red: Allegheny, Westmoreland, Lancaster, Monroe, Washington, and Montgomery.

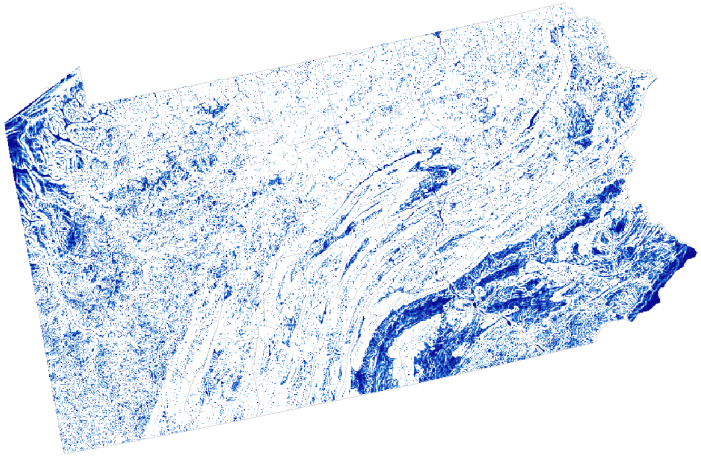
5. Finding Suitable Sites for Future Urbanization

Note that the intersection rather than the union of the three factors is taken since these restrictions should be all met in order to find the suitable areas for urbanization.



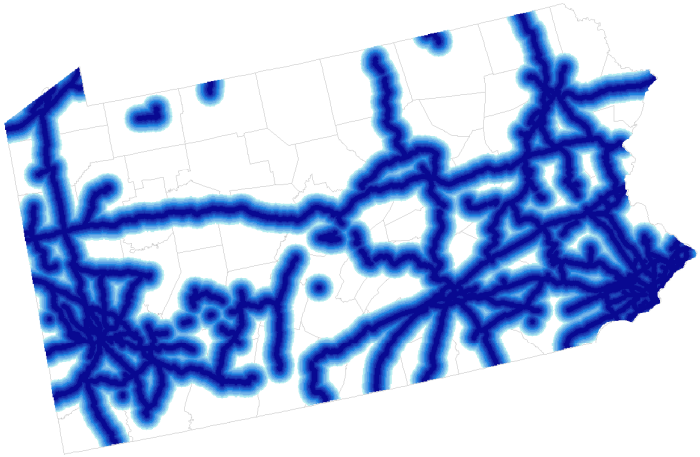
Sites within 6 km Distance to Existing Urban Development (Scale 1-59)

+



Sites with Slope Less Than 2 Degrees (Scale 1-59)

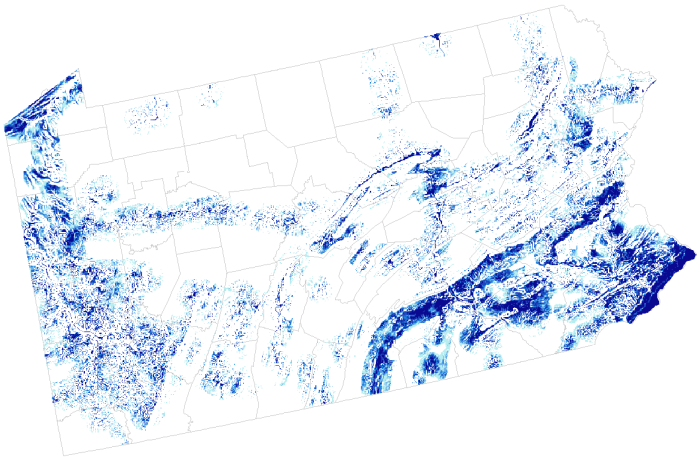
+



Sites within 10 km Distance to Highways (Scale 1-59)

1 - 7.4 (Least Suitable)
7.5 - 13.9
14 - 20.3
20.4 - 26.8
26.9 - 33.2
33.3 - 39.7
39.8 - 46.1
46.2 - 52.6
52.7 - 59 (Most Suitable)

=



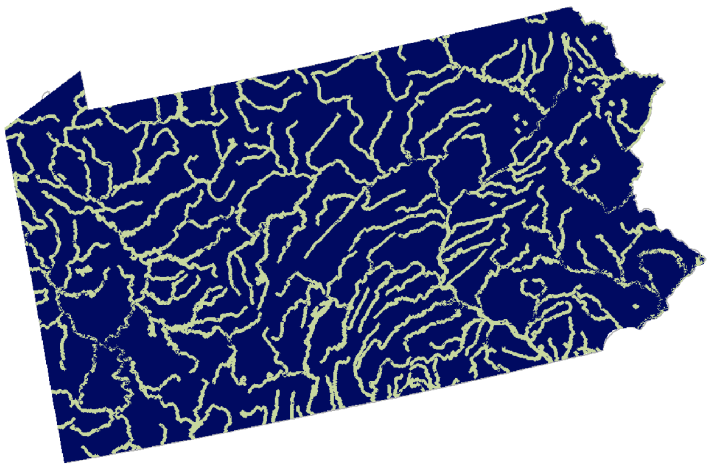
Future Urbanization Index Map (Scale 1-5)

1 (Least Suitable)
2
3
4
5 (Most Suitable)

0 30 60 120
Kilometers

N

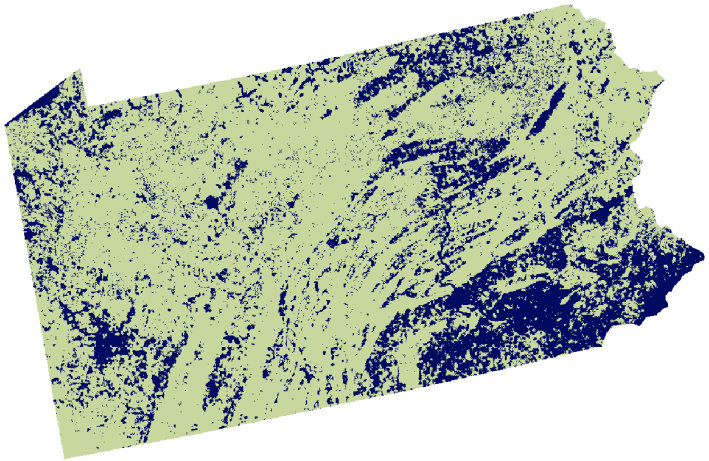
6. Finding Sensitive Sites to Avoid



Undeveloped Sites Within 1km of Rivers

Factor Weight = 5

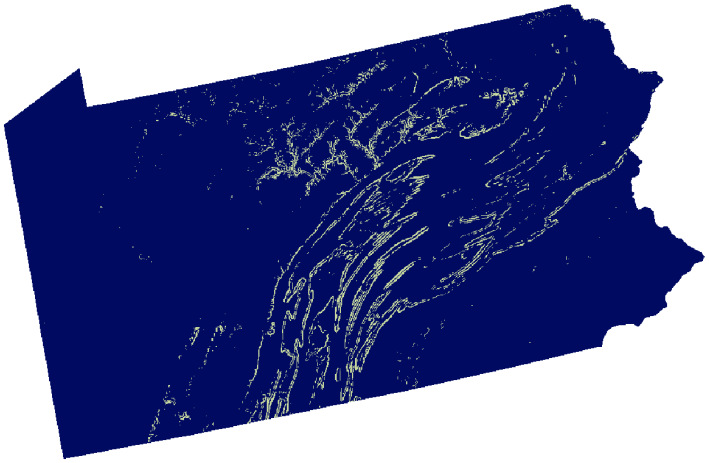
+



Active Farm and Forest Use

Factor Weight = 4

+



Hill Sides with Slopes 15 Degrees or More

Factor Weight = 2

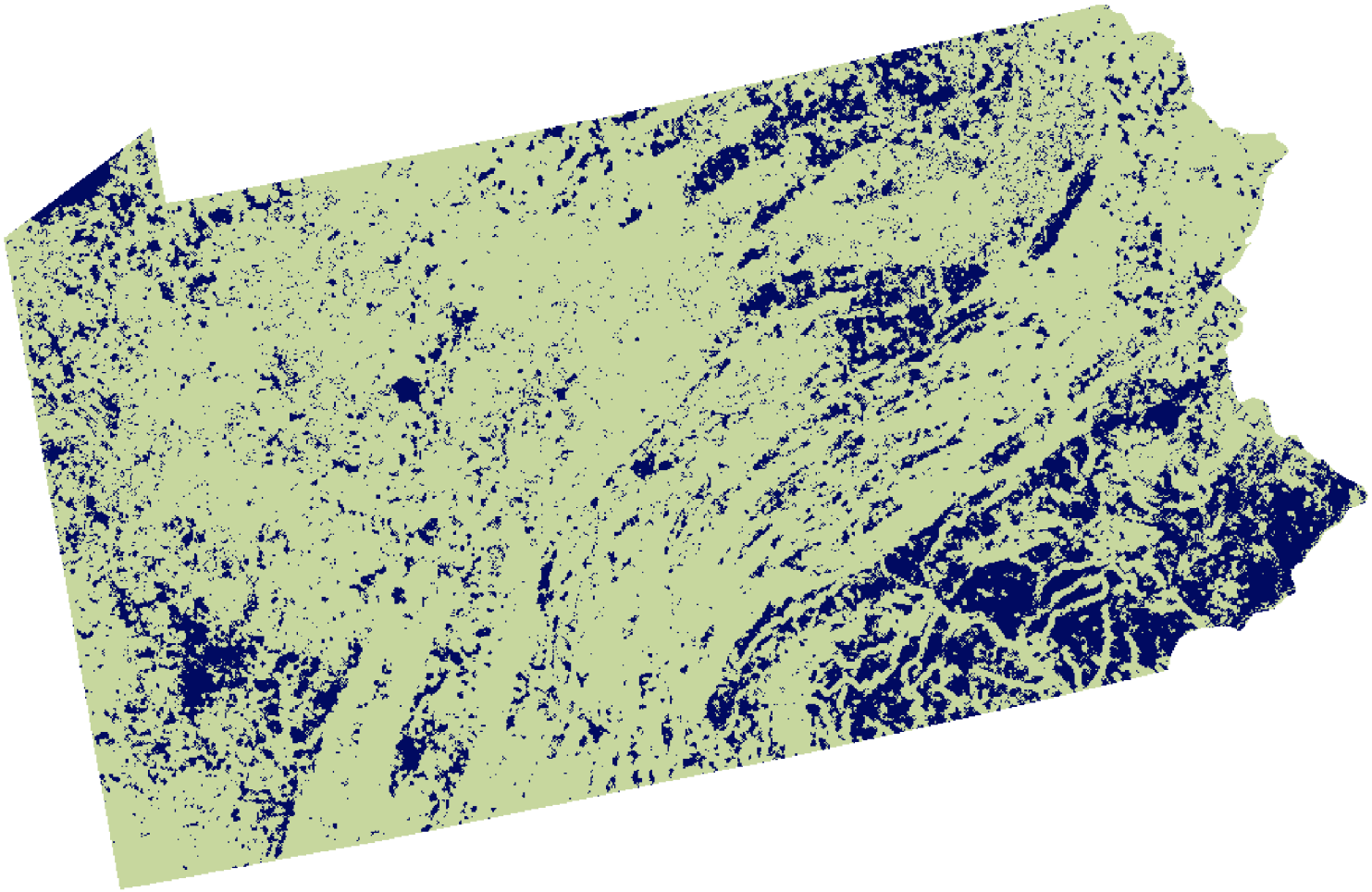
0 Unsensitive Lands

1 Sensitive Lands

0 30 60 120 Kilometers

N

7. Finding Sensitive Sites to Avoid - Continued

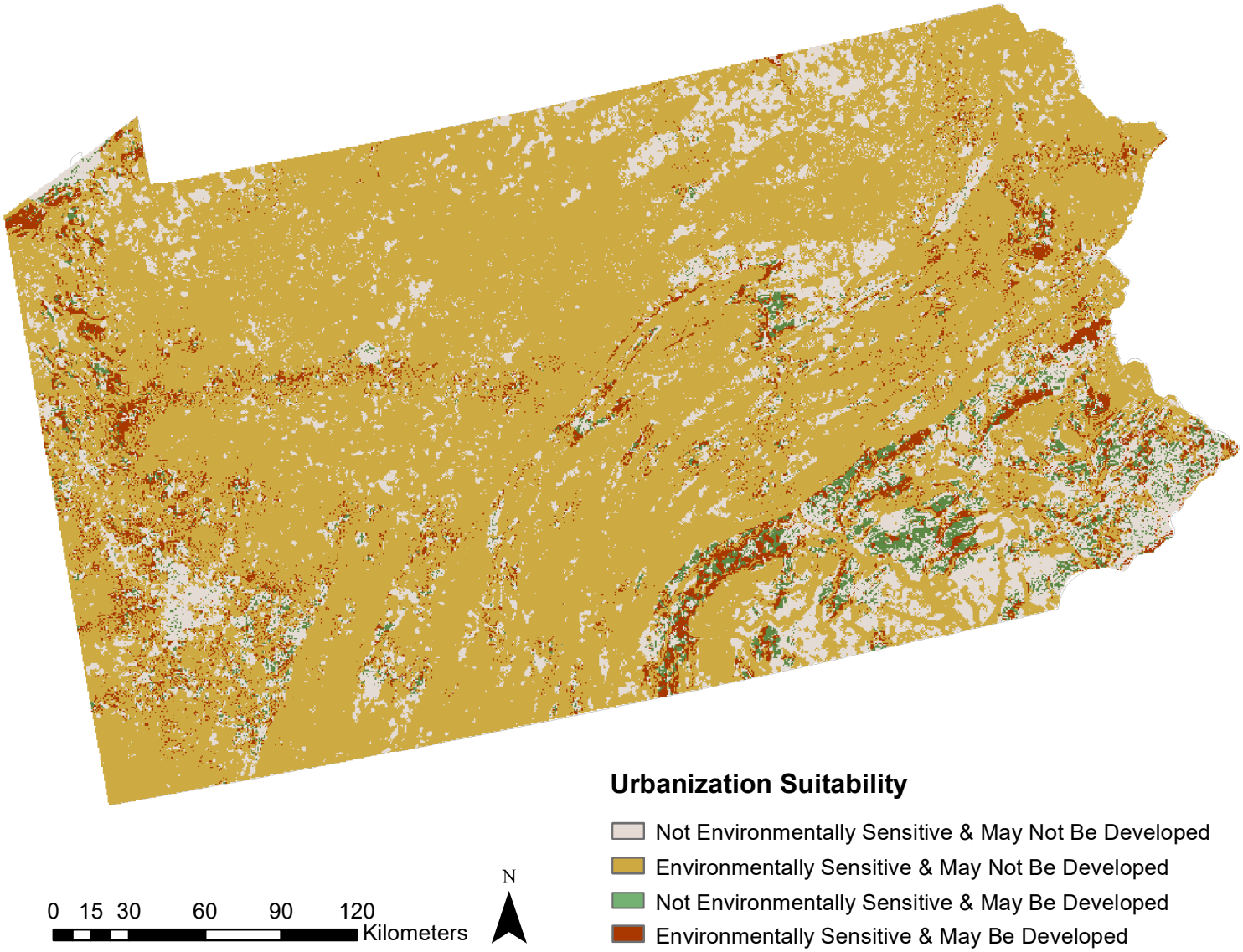


I have assigned the river proximity with the most weight (5) because I believe the water quality is greatly influenced by urban development and water quality is important for both the life qualities of people as well as the vegetations and other living species. In order to create a strong and resilient environment, area close to water should be treated as the most sensitive lands.

I have assigned the farm and forest lands with a weight of 4 because vegetations help balance the negative effects of urbanizations on the environment, such as air pollution.

I have assigned the slope factor a weight of 2 because even though these areas are less accessible to people and thus are less sensitive to urbanization.

8. Combine All Factors

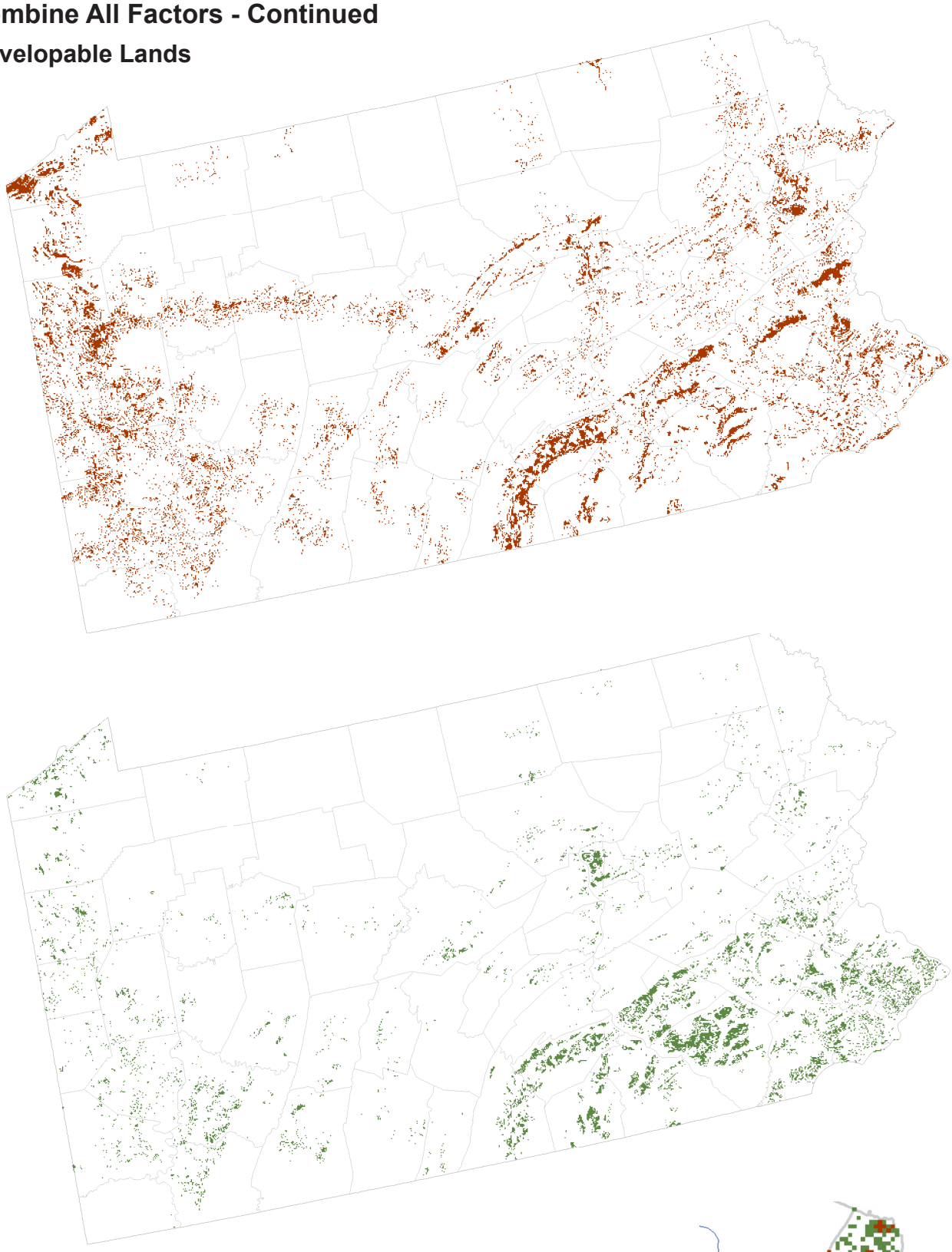


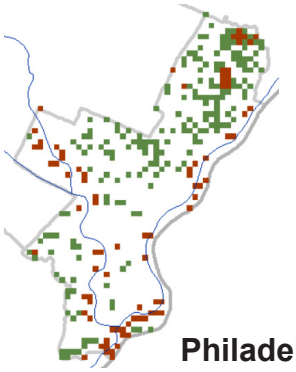
The combined map demonstrates the areas classified as developable/ undevelopable and environmentally sensitive/insensitive. One can tell that the environmentally sensitive areas are mostly along rivers and mountainous areas. The existing urban fabric really influence the areas that have developing potential, since we have defined that the proximity to highways and existing urban area are important factors. The resulting developable areas are mostly on the west and east ends of PA as well as along highways.

About the Philadelphia County (on the next page):
The developable but environment sensitive areas are mostly areas along the rivers, where the lands are covered by vegetation and reserved for the protection of the water bodies. The developable and environment insensitive areas cluster around the northern side of Philadelphia as well as on the edge of southern Philadelphia. This makes sense since these areas are suburbs of Philadelphia that are developable.

9. Combine All Factors - Continued

Developable Lands





Philadelphia County

Environmentally Sensitive

Not Environmentally Sensitive

0 15 30 60 90 120

Kilometers

N