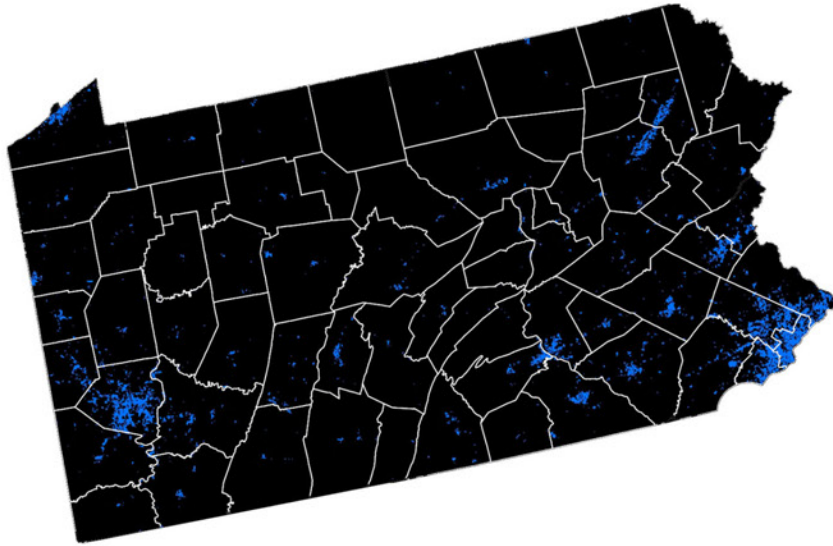
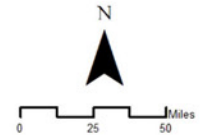


URBAN GROWTH VS. DEVELOPMENT SUITABILITY

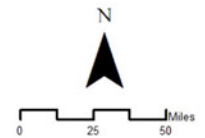
Search Suitable Lands for Pennsylvania Urban Growth



Legend

- basemap
- 1992 urban locations

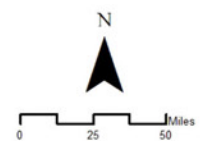
Pic 1. Maps of Urban Locations in 1992



Legend

- basemap
- 2001 urban locations

Pic 2. Maps of Urban Locations in 2001



Legend

- basemap
- urbanized locations (1992-2001)

Pic 3. Maps of Urbanized locations 1992-2001
The number of grid cells that were converted is 12418.

Table 1. Urban Land, Population Change and the Ratio by County

FID_1	STATE	COUNTY	NAME	pop_2000	pop_1990	pop_change	amount_urban_change	area_urban_change	ratio_urban_pop
0	42	049	Erie	293750	287786	5964.00	291	72749223.24	12198.06
1	42	015	Bradford	83154	76463	6691.00	90	22499759.76	3362.69
2	42	117	Tioga	53591	51930	1661.00	68	16999818.49	10234.69
3	42	105	Potter	26441	24743	1698.00	13	3249965.30	1914.00
4	42	083	McKean	60363	60010	353.00	53	13249858.53	37535.01
5	42	123	Warren	63964	58708	5256.00	63	15749831.83	2996.54
6	42	127	Wayne	86914	66846	20068.00	79	19749789.13	984.14
7	42	115	Susquehanna	60530	53528	7002.00	68	16999818.49	2427.85
8	42	039	Crawford	111719	106933	4786.00	194	48499482.16	10133.62
9	42	131	Wyoming	54443	49009	5434.00	48	11999871.87	2208.29
10	42	069	Lackawanna	244972	244913	59.00	223	55749404.75	944905.17
11	42	047	Elk	51694	49608	2086.00	40	9999893.23	4793.81
12	42	053	Forest	19301	14285	5016.00	13	3249965.30	647.92
13	42	121	Venango	84063	82208	1855.00	102	25499727.73	13746.48
14	42	023	Cameron	20623	13353	7270.00	3	749991.99	103.16
15	42	103	Pike	80014	49274	30740.00	130	32499652.99	1057.24
16	42	081	Lycoming	152052	140904	11148.00	188	46999498.17	4215.96
17	42	113	Sullivan	20698	16518	4180.00	11	2749970.64	657.89
18	42	085	Mercer	144514	140380	4134.00	258	64499311.32	15602.16
19	42	035	Clinton	60008	56125	3883.00	65	16249826.50	4184.86
20	42	031	Clarion	64406	64796	-390.00	76	18999797.13	-48717.43
21	42	079	Luzerne	362616	371975	-9359.00	296	73999209.89	-7906.74
22	42	065	Jefferson	69597	68679	918.00	91	22749757.09	24781.87
23	42	037	Columbia	99147	92573	6574.00	103	25749725.06	3916.90
24	42	033	Clearfield	114530	102981	11549.00	191	47749490.17	4134.51
25	42	027	Centre	171642	152474	19168.00	202	50499460.80	2634.57
26	42	089	Monroe	170047	119982	50065.00	416	103998889.57	2077.28
27	42	097	Northumberland	144797	144498	50065.00	99	24749735.74	494.35
28	42	019	Butler	220140	193661	26479.00	312	77999167.18	2945.70
29	42	093	Montour	36719	32462	4257.00	27	6749927.93	1585.61
30	42	005	Armstrong	117142	113010	4132.00	99	24749735.74	5989.77
31	42	119	Union	71752	63169	8583.00	64	15999829.17	1864.13
32	42	025	Carbon	103455	92643	10812.00	117	29249687.69	2705.30
33	42	073	Lawrence	114473	110888	3585.00	217	54249420.76	15132.33
34	42	095	Northampton	315951	289933	26018.00	284	70999241.92	2728.85
35	42	107	Schuylkill	189890	186610	3280.00	122	30499674.35	9298.68
36	42	063	Indiana	120421	120532	-111.00	88	21999765.10	-198196.08
37	42	109	Snyder	59828	55613	4215.00	63	15749831.83	3736.61
38	42	007	Beaver	213903	219407	-5504.00	333	83249111.13	-15125.20
39	42	087	Mifflin	69948	67641	2307.00	59	14749842.51	6393.52
40	42	077	Lehigh	383167	355317	27850.00	350	87499065.75	3141.80
41	42	061	Huntingdon	84365	75275	9090.00	44	10999882.55	1210.11
42	42	013	Blair	159809	157452	2357.00	170	42499546.22	18031.20
43	42	021	Cambria	188460	200643	-12183.00	185	46249506.18	-3796.23
44	42	067	Juniata	45552	40755	4797.00	24	5999935.94	1250.77
45	42	129	Westmoreland	468898	473872	-4974.00	403	100748924.28	-20255.11
46	42	011	Berks	440496	403583	36913.00	340	84999092.44	2302.69
47	42	003	Allegheny	1378735	1433858	-55123.00	1250	312496663.38	-5669.08
48	42	043	Dauphin	298414	289660	8754.00	324	80999135.15	9252.81
49	42	099	Perry	89418	87675	1743.00	57	14249847.85	8175.47
50	42	017	Bucks	685303	646510	38793.00	459	114748774.80	2957.98
51	42	075	Lebanon	153844	151136	2708.00	145	36249612.95	13386.12
52	42	125	Washington	250190	260626	-10436.00	279	69749255.27	-6683.52
53	42	091	Montgomery	899423	874661	24762.00	713	178248096.79	7198.45
54	42	041	Cumberland	267441	240912	26529.00	268	66999284.63	2525.51
55	42	009	Bedford	70703	68439	2264.00	66	16499823.83	7287.91
56	42	071	Lancaster	532091	480036	52055.00	398	99498937.62	1911.42
57	42	055	Franklin	154638	144153	10485.00	213	53249431.44	5078.63
58	42	111	Somerset	110317	102414	7903.00	86	21499770.44	2720.46
59	42	029	Chester	511566	457940	53626.00	333	83249111.13	1552.40
60	42	133	York	447120	389078	58042.00	256	63999316.66	1102.64
61	42	057	Fulton	27625	26692	933.00	39	9749895.90	10450.05
62	42	051	Fayette	194445	189955	4490.00	168	41999551.56	9354.02
63	42	101	Philadelphia	1582275	1651215	-68940.00	209	52249442.12	-757.90
64	42	001	Adams	130869	107680	23189.00	79	19749789.13	851.69
65	42	045	Delaware	595413	594716	697.00	234	58499375.39	83930.24
66	42	059	Greene	58651	56749	1902.00	55	13749853.19	7229.16

As can be seen from the table, most of the counties' population have grown from 1992 to 2001, the gray rows are those counties whose population have decreased.

The ratio of land conversion to population growth represent the efficiency of land utilization after land conversion. The higher the ratio, the more efficient the urban land conversion is (which means more people gather in urban areas).

Thus, Lackawanna's urban land conversion is most efficient, and Indiana's urban land conversion is most inefficient.

OBJECTID	NAME	ZONE_CODE	COUNT	AREA	SUM_gridcells	Sensitive_area
1	Erie	1	7400	1849980247.16	5949	1487234120.38
2	Bradford	2	10611	2652721676.03	9263	2315725274.34
3	Tioga	3	10401	260022236.58	9535	2383724548.29
4	Potter	4	9887	2471723608.60	9533	2383224553.63
5	McKean	5	8996	2248975986.95	8560	2139977150.85
6	Warren	6	8203	2050728103.71	7443	1860730132.45
7	Wayne	7	6854	1713481704.60	6412	1602982884.49
8	Susquehanna	8	7612	1902979681.27	6726	1681482046.34
9	Crawford	9	9486	2371474678.99	8124	2030978314.66
10	Wyoming	10	3702	925490118.24	3215	803741418.22
11	Lackawanna	11	4243	1060738674.15	3566	891490481.30
12	Elk	12	7606	1901479697.28	6931	1732731499.13
13	Forest	13	3948	986989461.59	3742	935490011.51
14	Venango	14	6242	1560483338.21	6085	1521233757.35
15	Cameron	15	3641	910240281.07	3538	884490556.04
16	Pike	16	5182	1295486167.67	4889	1222236949.83
17	Lycoming	17	11364	2840969666.04	10261	2565222610.39
18	Sullivan	18	4130	1032489975.78	3795	948739870.03
19	Mercer	19	6238	1559483348.89	5301	1325235850.08
20	Clinton	20	8217	2054228066.34	7863	1965729011.35
21	Clarion	21	5567	1391735139.99	5055	1263736506.72
22	Luzerne	22	8293	2073227863.47	7266	1816480604.92
23	Jefferson	23	6000	1499983984.18	5655	1413734905.15
24	Columbia	24	4470	1117488068.22	3887	971739624.46
25	Clearfield	25	10549	2637221841.52	9720	2429974054.47
26	Centre	26	10152	2537972901.24	9525	2381224574.99
27	Monroe	27	5652	1412984913.10	4872	1217986995.21
28	Northumberland	28	4370	1092488335.15	3862	965489691.19
29	Butler	29	7263	1815730612.85	6636	1658982286.57
30	Montour	30	1207	301746778.15	1067	266747151.87
31	Armstrong	31	6073	1518233789.32	5864	1465984347.27
32	Union	32	2903	725742251.01	2668	666992878.33
33	Carbon	33	3542	885490545.33	3315	828741151.29
34	Lawrence	34	3318	829491143.25	2816	703992483.27
35	Northampton	35	3453	863240782.90	2709	677242768.89
36	Schuylkill	36	7168	1791980866.44	6798	1699481854.15
37	Indiana	37	7630	1907479633.22	7303	1825730506.15
38	Snyder	38	3028	756991917.35	2698	674492798.25
39	Beaver	39	4057	1014239170.64	3532	882990572.06
40	Mifflin	40	3786	946489894.02	3577	894240451.94
41	Lehigh	41	3180	794991511.62	2256	563993978.08
42	Huntingdon	42	8125	2031228311.91	7828	1956979104.78
43	Blair	43	4825	1206237120.61	4464	1115988084.28
44	Cambria	44	6334	1583483092.64	5814	1453484480.73
45	Juniata	45	3601	900240387.84	3391	847740948.43
46	Westmoreland	46	9468	2366974727.04	8523	2130727249.62
47	Berks	47	7910	1977478885.81	6760	1689981955.58
48	Allegheny	48	6811	1702731819.38	4104	1025989045.22
49	Dauphin	49	5094	1273486402.57	4146	1036488933.11
50	Perry	50	5085	1271236426.59	4831	1207737104.65
51	Bucks	51	5679	1419734841.03	3788	946989888.72
52	Lebanon	52	3316	828991148.59	2901	725242256.38
53	Washington	53	7872	1967978987.25	7210	1802480754.40
54	Montgomery	54	4459	1114738097.58	2393	598243612.38
55	Cumberland	55	5038	1259486552.05	4139	1034738951.80
56	Bedford	56	9301	2325225172.81	8926	2231476173.89
57	Lancaster	57	8998	2249475981.61	7905	1976228899.24
58	Franklin	58	7063	1765731146.71	6259	1564733292.90
59	Somerset	59	9887	2471723608.60	9405	2351224895.30
60	Chester	60	6946	1736481459.02	5659	1414734894.47
61	York	61	8329	208227767.38	7020	1754981261.56
62	Fulton	62	4006	1001489306.77	3818	954489808.64
63	Fayette	63	7296	1823980524.77	6877	1719231643.27
64	Philadelphia	64	1308	326996508.55	286	71499236.58
65	Adams	65	4768	1191987272.76	4333	1083238433.95
66	Delaware	66	1735	433745368.76	870	217497677.72
67	Greene	67	5289	1322235882.06	5200	1299986119.68

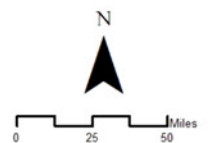
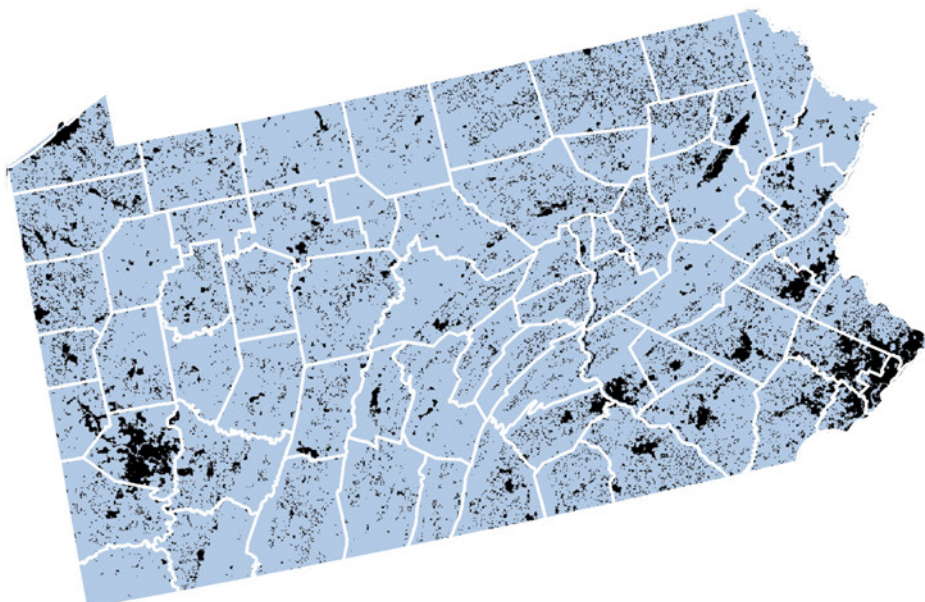
Table 2.
1992 Sensitive Lands by County

This table shows the amount of sensitive lands by county in 1992. It can be seen that the Lycoming county has the most sensitive lands, It also has the largest area.

After raster calculation and re-classification of the four layers, I got a new map of 1992 sensitive lands (Pic 4).

The value 1 means that this area is one of the four types of land: water, farm, pasture or forest. The value 0 means that this area is none of the following four type.

Pic 4. 1992 Sensitive Lands



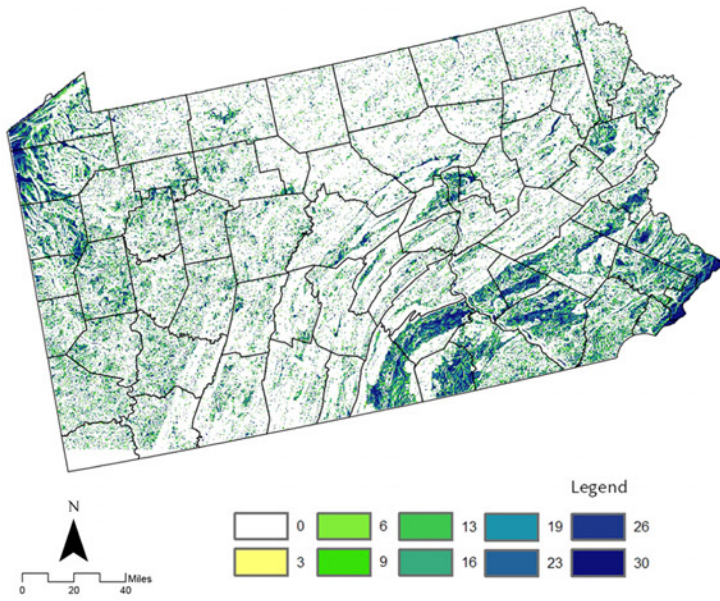
Legend

- 0 None-sensitive areas
- 1 Sensitive areas

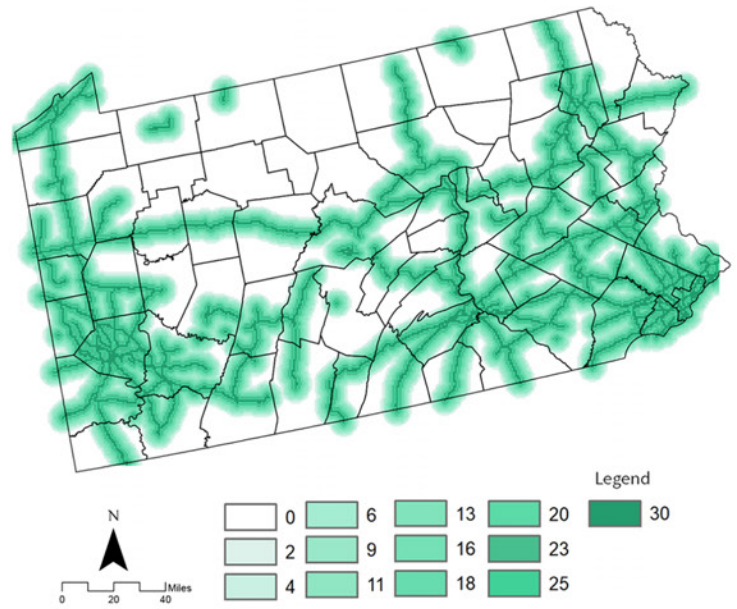
Table 3. Urbanized Sensitive Land by County

OBJECTID	NAME	ZONE_CODE	COUNT_total	AREA_total	GridCells_sensitive_urbanized	Area_sensitive_urbanized
1	Erie	1	7400	1849980247.16	92	22999754.43
2	Bradford	2	10611	2652721676.03	57	14249847.85
3	Tioga	3	10401	2600222236.58	46	11499877.21
4	Potter	4	9887	2471723608.60	12	2999967.97
5	McKean	5	8996	2248975986.95	34	8499909.24
6	Warren	6	8203	2050728103.71	44	10999882.55
7	Wayne	7	6854	1713481704.60	51	12749863.87
8	Susquehanna	8	7612	1902979681.27	37	9249901.24
9	Crawford	9	9486	2371474678.99	90	22499759.76
10	Wyoming	10	3702	925490118.24	23	5749938.61
11	Lackawanna	11	4243	1060738674.15	63	15749831.83
12	Elk	12	7606	1901479697.28	23	5749938.61
13	Forest	13	3948	986989461.59	8	1999978.65
14	Venango	14	6242	1560483338.21	62	15499834.50
15	Cameron	15	3641	910240281.07	3	749991.99
16	Pike	16	5182	1295486167.67	62	15499834.50
17	Lycoming	17	11364	2840969666.04	58	14499845.18
18	Sullivan	18	4130	1032488975.78	9	2249975.98
19	Mercer	19	6238	1559483348.89	94	23499749.09
20	Clinton	20	8217	2054228066.34	36	8999903.91
21	Clarion	21	5567	1391735139.99	46	11499877.21
22	Luzerne	22	8293	2073227863.47	97	24249741.08
23	Jefferson	23	6000	1499983984.18	62	15499834.50
24	Columbia	24	4470	1117488068.22	46	11499877.21
25	Clearfield	25	10549	2637221841.52	123	30749671.68
26	Centre	26	10152	2537972901.24	99	24749735.74
27	Monroe	27	5652	1412984913.10	142	35499620.96
28	Northumberland	28	4370	1092488335.15	41	10249890.56
29	Butler	29	7263	1815730612.85	125	31249666.34
30	Montour	30	1207	301746778.15	18	4499951.95
31	Armstrong	31	6073	1518233789.32	56	13999850.52
32	Union	32	2903	725742251.01	27	6749927.93
33	Carbon	33	3542	885490545.33	61	15249837.17
34	Lawrence	34	3318	829491143.25	101	25249730.40
35	Northampton	35	3453	863240782.90	65	16249826.50
36	Schuylkill	36	7168	1791980866.44	90	22499759.76
37	Indiana	37	7630	1907479633.22	51	12749863.87
38	Snyder	38	3028	756991917.35	35	8749906.57
39	Beaver	39	4057	1014239170.64	118	29499685.02
40	Mifflin	40	3786	946489894.02	33	8249911.91
41	Lehigh	41	3180	794991511.62	75	18749799.80
42	Huntingdon	42	8125	2031228311.91	37	9249901.24
43	Blair	43	4825	1206237120.61	81	20249783.79
44	Cambria	44	6334	1583483092.64	87	21749767.77
45	Juniata	45	3601	900240387.84	15	3749959.96
46	Westmoreland	46	9468	2366974727.04	173	43249538.21
47	Berks	47	7910	1977478885.81	113	28249698.37
48	Allegheny	48	6811	1702731819.38	286	71499236.58
49	Dauphin	49	5094	1273486402.57	95	23749746.42
50	Perry	50	5085	1271236426.59	50	12499866.54
51	Bucks	51	5679	1419734841.03	93	23249751.76
52	Lebanon	52	3316	828991148.59	59	14749842.51
53	Washington	53	7872	1967978987.25	134	33499642.31
54	Montgomery	54	4459	1114738097.58	131	32749650.32
55	Cumberland	55	5038	1259486552.05	72	17999807.81
56	Bedford	56	9301	232525172.81	52	12999861.20
57	Lancaster	57	8998	2249475981.61	149	37249602.28
58	Franklin	58	7063	1765731146.71	71	17749810.48
59	Somerset	59	9887	2471723608.60	67	16749821.16
60	Chester	60	6946	1736481459.02	93	23249751.76
61	York	61	8329	2082227767.38	91	22749757.09
62	Fulton	62	4006	1001489306.77	28	6999925.26
63	Fayette	63	7296	1823980524.77	88	21999765.10
64	Philadelphia	64	1308	326996508.55	41	10249890.56
65	Adams	65	4768	1191987272.76	32	7999914.58
66	Delaware	66	1735	433745368.76	81	20249783.79
67	Greene	67	5289	1322235882.06	35	8749906.57

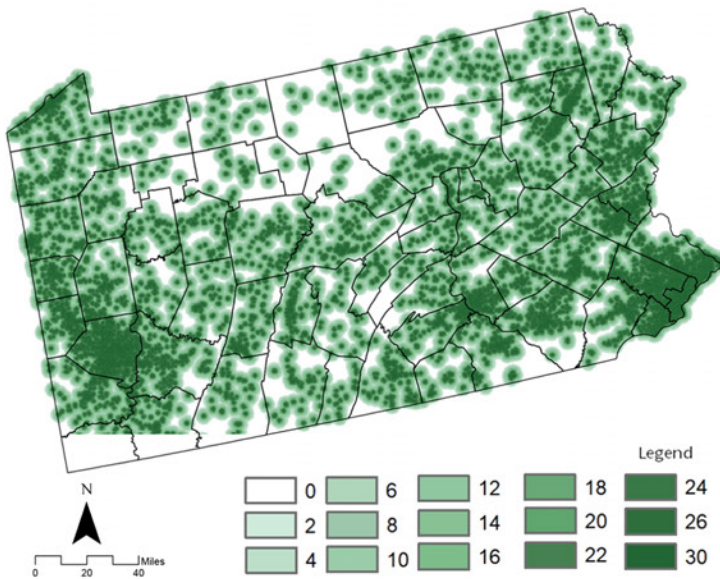
The table shows the sensitive lands that were urbanized by county. When the number of sensitive urbanized gridcells get higher, the recent urban growth is more threatening to sensitive lands in 1992. It can be seen that the Allegheny's urban growth was most threatening to sensitive lands.



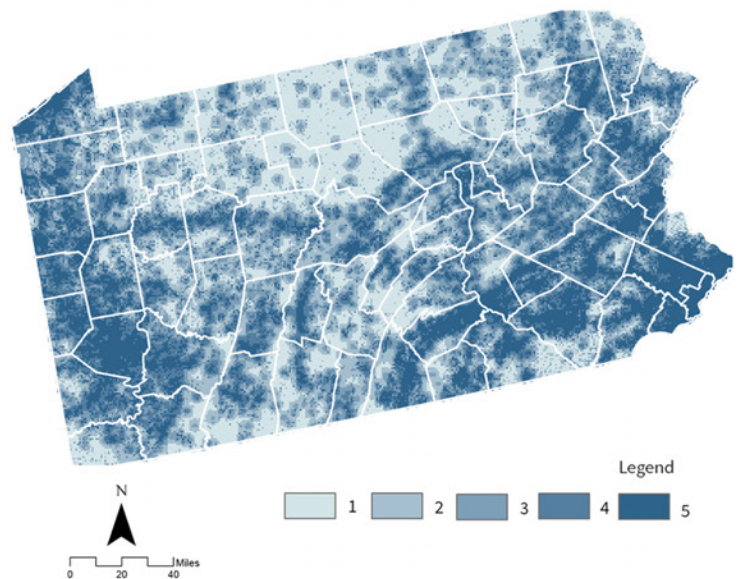
Pic 5. Slope Index Map (less than 2 degrees)



Pic 6. 4-Lane Highways Index Map (within 10 km)



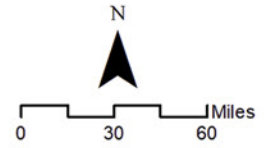
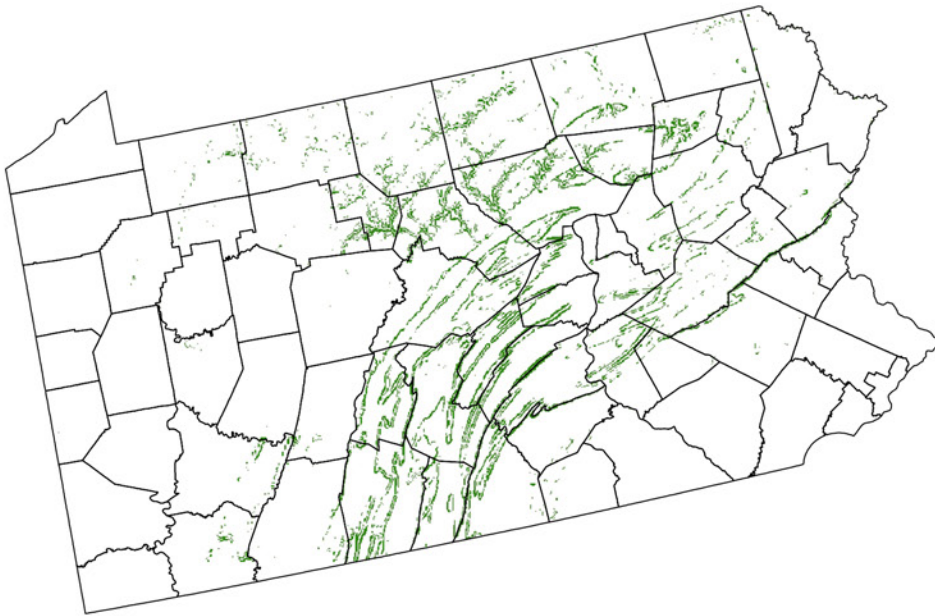
Pic 7. Existing Urban Development Index Map (within 6km)



Pic 8. Future Urbanization Index Map

After applying euclidean distance tools, I used the quantile method to divide the feature into 30 categories respectively, and screened out the areas that met the requirements ,then I assigned values (0-30) according to the distance between the areas and the target (highway,urban ,ets).

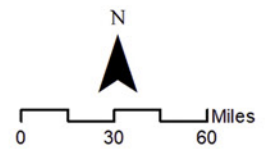
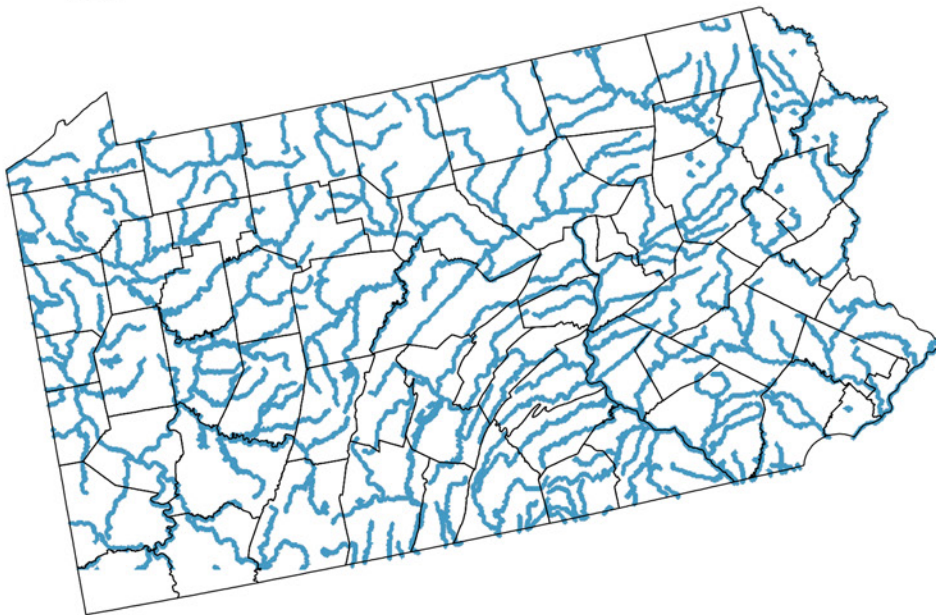
Finally , I used the raster calculator to get the Future Urbanization Index Map.



Legend

- 0 (hillsides with slopes less than 15 degrees)
- 1 (hillsides with slopes of 15 degrees or more)

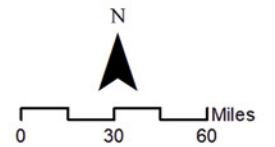
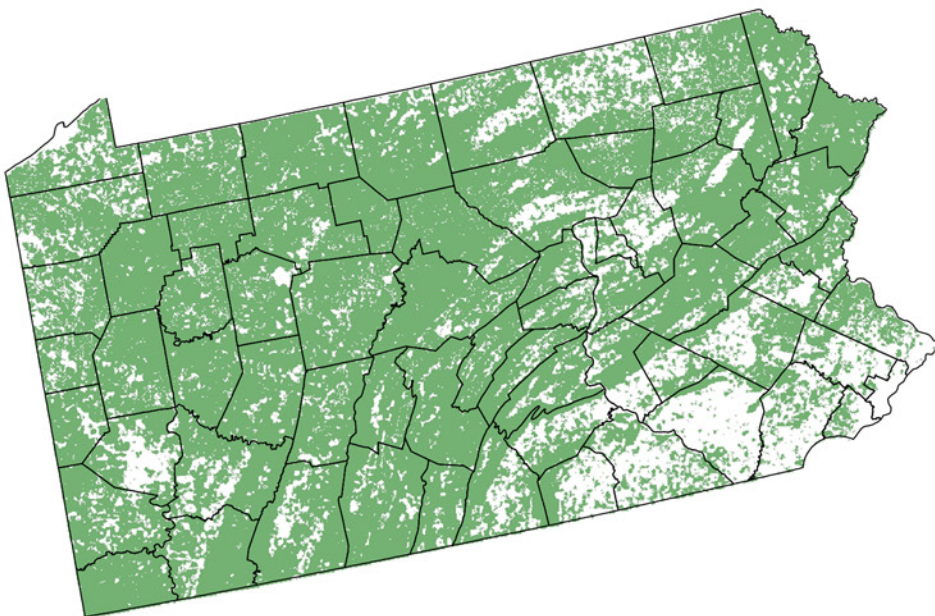
Pic 8. Slope Index Map (more than 15 degrees)



Legend

- 0 (1km of rivers away)
- 1 (within 1km of rivers)

Pic 9. River Index Map (within 1 km)

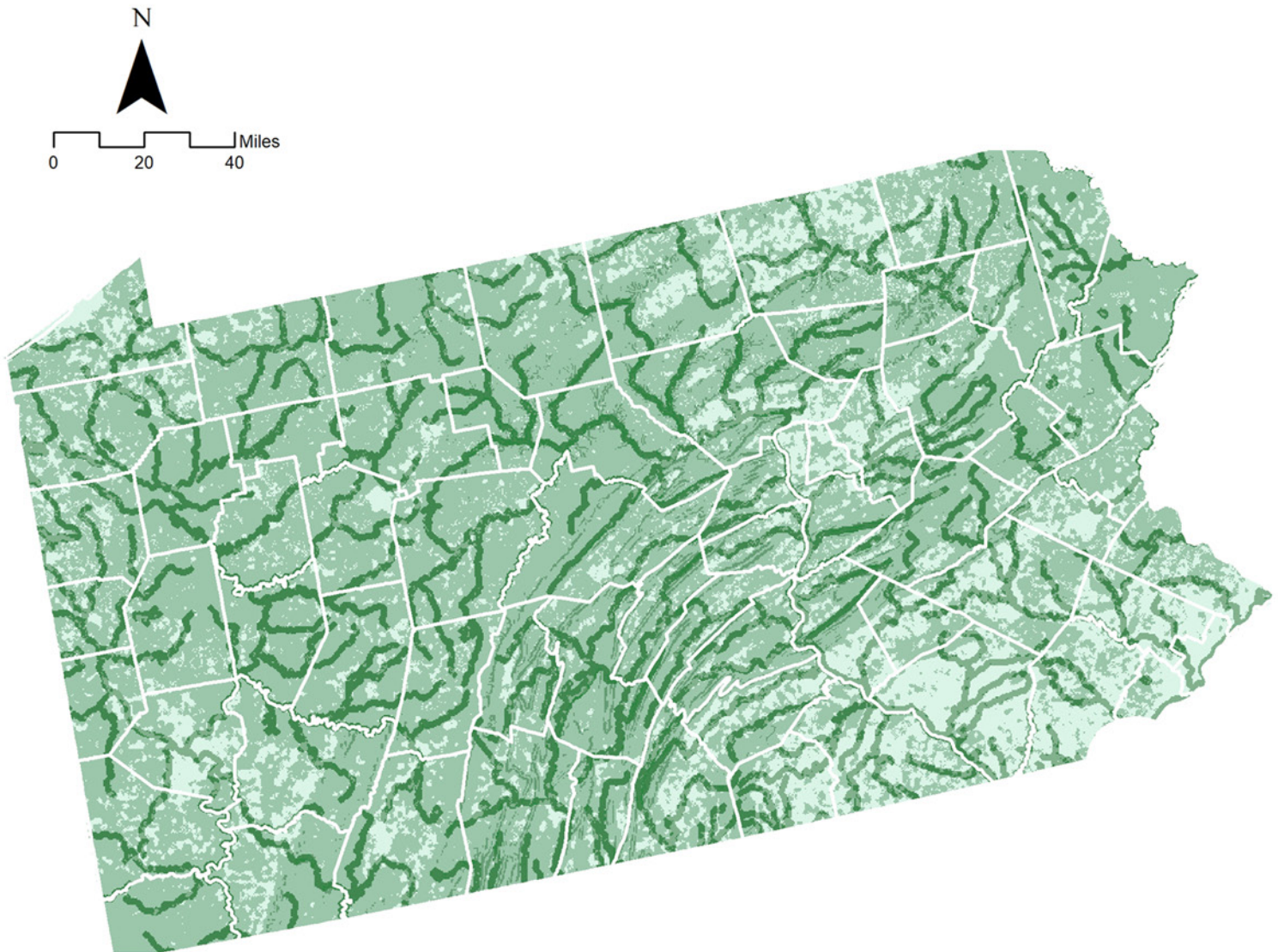


Legend

- 0 (not in active farm and forest use)
- 1 (in active farm and forest use)

Pic 10. Existing farm and Forest Index Map

Pic 11. Environmental Sensitive Index Map

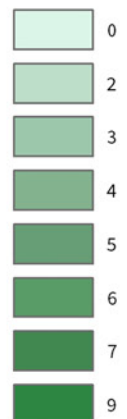


Finally, I give proximity to river proximity a weight of 4, existing farm and forest a weight of 3, and slope a weight of 2 to measure the environment sensitivity.

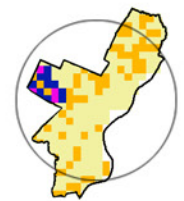
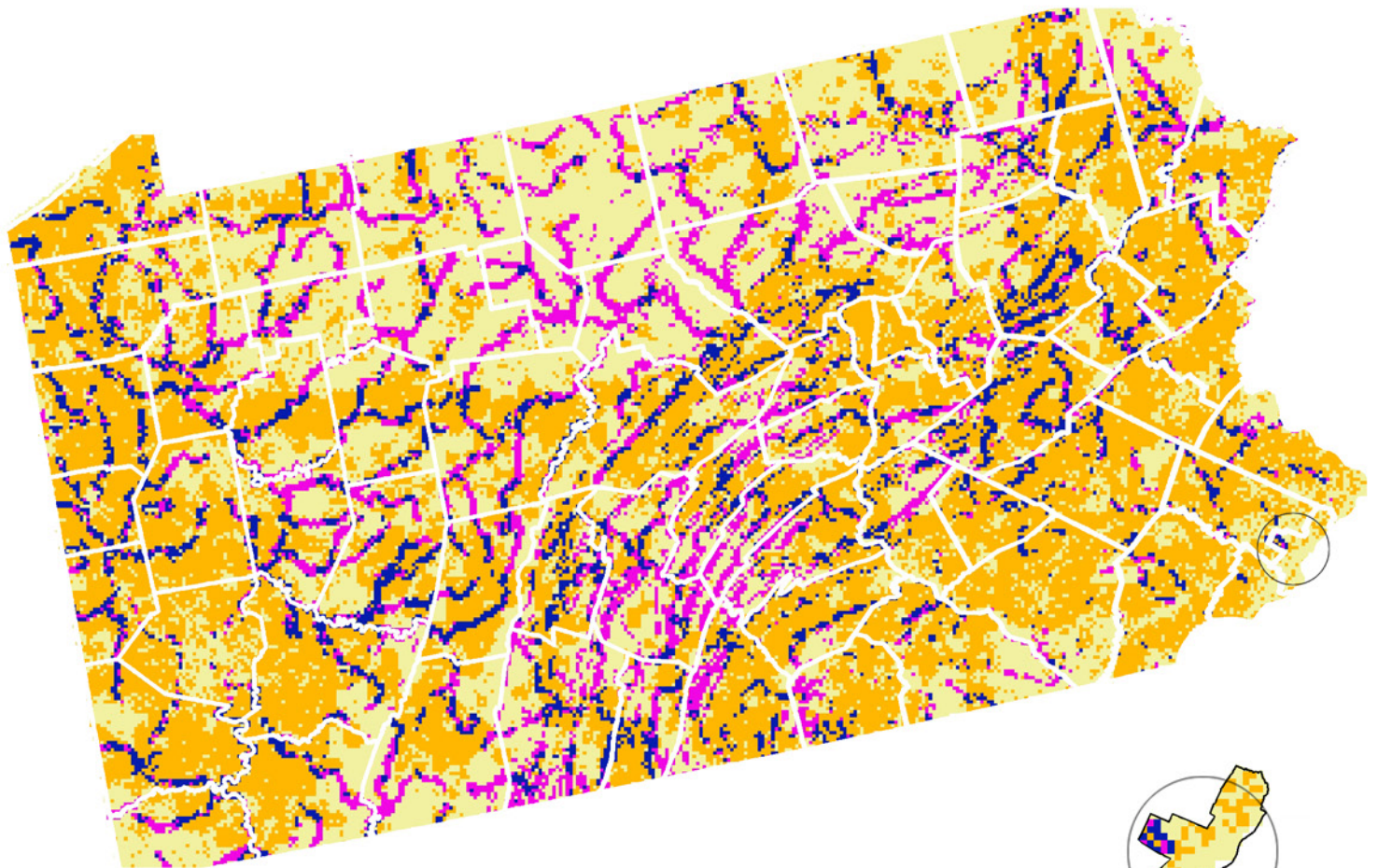
The environment sensitivity refers to the ecological system's sensitivity to the interference of natural and human activities in the region, that is, the probability of ecological environmental problems when the ecological system encounters the interference.

I give the highest weight in river proximity, because river is one of the most important living conditions for creature, when the river is destroyed, the ecological environment is most likely to be severely damaged. The existing farm and forest ranked the second, because they are home to many animals. The slope has the least weight of 2. Then I do this in raster calculator, and get the following environmental sensitivity index map. The higher the value, the higher the environmental sensitivity.

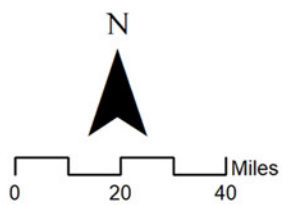
Legend







Pic 12. Urban Growth vs. Development Suitability Map

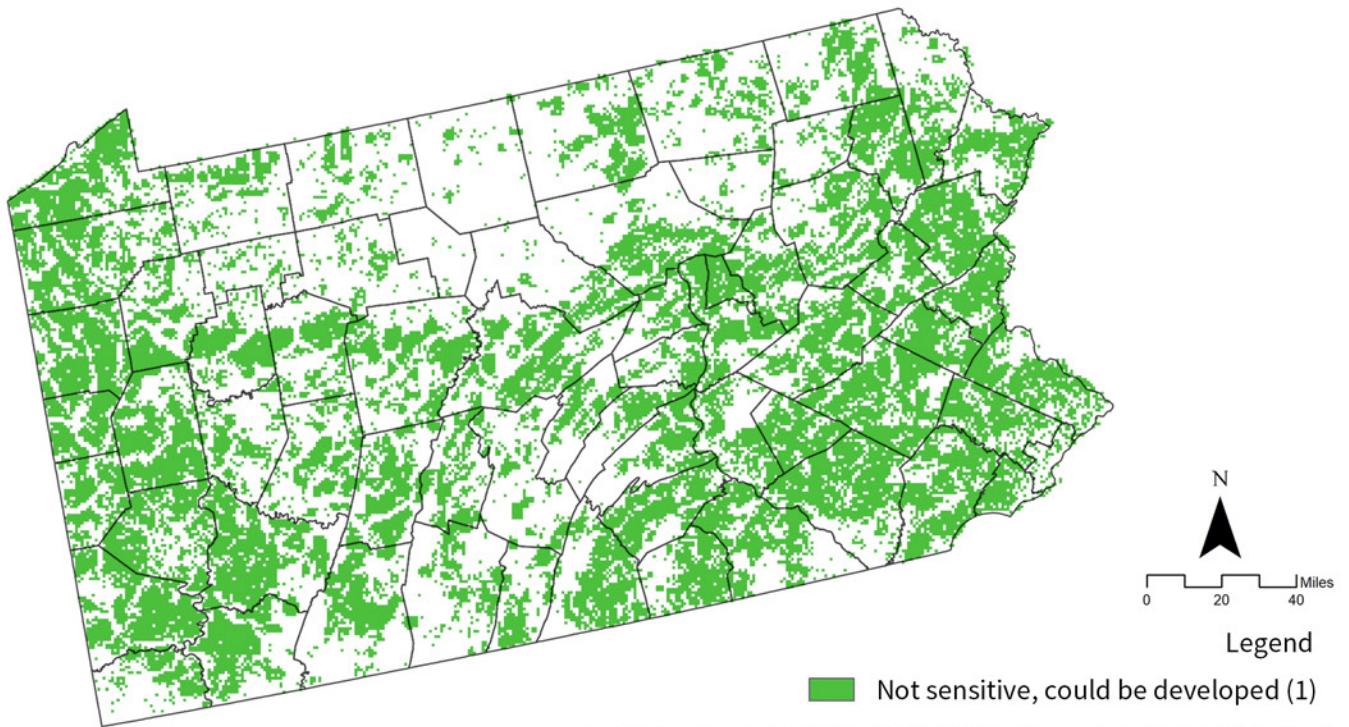


Philadelphia County

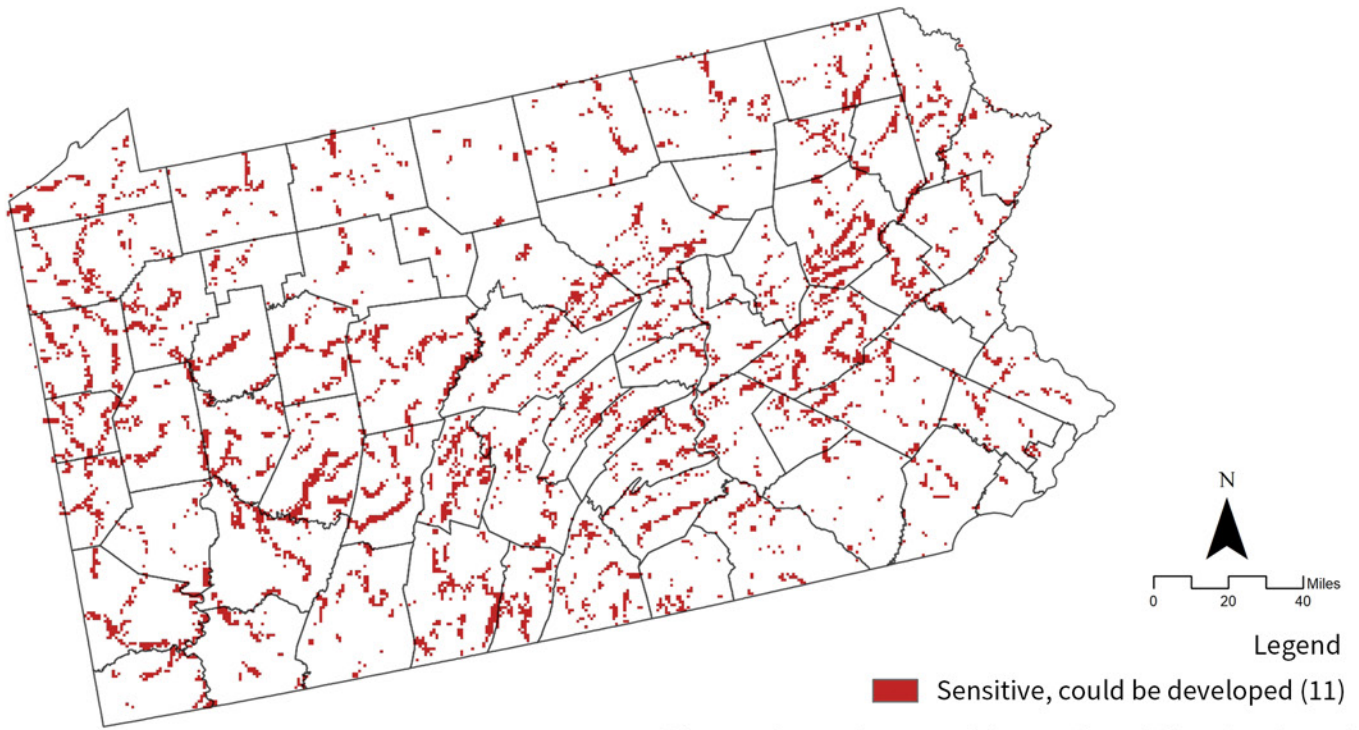


Legend

-  Areas not environmentally sensitive AND might not be developed
-  Areas that are not sensitive AND might be developed
-  Areas that are environmentally sensitive AND might not be developed
-  Areas that are sensitive AND might be developed



Pic 13. Areas that not sensitive and could be developed



Pic 14. Areas that sensitive and could be developed

As can be seen from the pictures above, Philadelphia county's future urban development has a tendency to continue to expand outward toward the county's boundary (Except towards the east). However, due to the high ecological sensitivity in the west of Philadelphia, the development in the west may cause some damage to the ecological environment. Thus, I would recommend the development in the south or north.