ADVANCED IDENTIFICATION WETLAND INFRINGEMENT STUDY

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Abstract

Advanced Identification (ADID) wetlands are a special breed of wetlands. They are the ultimate offspring of the National Wetland Inventory (NWI), which was conducted, in the early eighties. In the late eighties the U.S. Environmental Protection Agency (EPA) and the U.S. Corps of Engineers (COE) designated certain wetlands in Lake County, IL. to possess special biological and hydrological functions. The question which I investigated was "are ADID wetlands in danger of losing these special designated functions?" The analysis procedures that were performed were new to Lake County. They involved utilizing land use and quarter section population data on a sub-watershed basis. This means that natural boundaries were used to perform analysis on political or straight boundaries. Later in the analysis phase this caused a problem but was soon remedied through routine analytical procedures.

The results of this study are meant to act as an indicator of which ADID wetlands might need to be analyzed more closely. Due to time restraints the analytical procedures could only be conducted to a certain point. Results indicated that the original estimated outcome was an undershoot. The final criteria consisted of a demand on land scale compared to the total amount of ADID acres in each sub-watershed. The demand on land scale is a function of three things: projected population for 2020, 1990 residential density, and available land for development. The total amount of ADID wetlands in each basin is a key factor when considering the above three functions. The less acres of ADID wetland in a sub-watershed and a higher demand scale indicated that the ADID wetlands in that sub-watershed would need to be studied in the near future. The ranking system also contemplated the fact that with higher predicted development in a sub-watershed, an increase in impervious surface would be proportional to increased runoff, polluted or not.

Introduction

This paper looks at the ADID wetlands of Lake County Illinois. Advanced Identification (ADID) is actually a process defined by the U.S. Army Corps of Engineers and the U.S. EPA. These two entities are authorized to, "identify in advance of specific permit requests, aquatic sites which will be considered as areas generally unsuitable for disposal of dredged or fill material." (Dreher et al. 1992) There are certain biological and hydrological functions that these wetlands perform. Each ADID, there are 203 of them, is numbered and has a name. More importantly, each of the wetlands are assigned biological values like special habitat and hydrological values like shoreline stabilization and toxicant retention. These wetlands serve not only their primary function but also serve some secondary processes, for example, heavy rain/floodwater retention, and aesthetics.

The nature of this project is not to say that the measurements made rank any specific wetlands that may be in danger, rather it is intended to highlight any potential wetlands that will be subject to degradation of their functions. It is also important to note that Lake County is a "wet" county, this means that it harbors well over 6 - 9 percent of the surface waters of the state. It was decided that the results from the work of this project will be addressed by a team of engineers at a later time. Although the idea of protecting the environment is not new to Lake County, the idea of using the sub-watershed coverage coupled with straight political boundaries is. These straight political boundaries include countywide coverages supplied by the Northern Illinois Planning Commission (NIPC), Lake County, and the U.S. EPA of which all play an important role in the ongoing study that has now begun. These coverages include current land use coverages (1990), current population data (1990), and projected population coverages (2020).

The literature used for this project was sparse; Lake County did not have any textual resources for this type of project. The main books read were *Wetland Resources of Illinois*: *An Analysis and Atlas, Advanced Identification (ADID) Study Lake County, Illinois: Final Report, and Classification of Wetlands and Deepwater Habitats of the United States*. These books proved to be useful in explaining the classification systems of the National Wetland Inventory (NWI), the Lake County Wetland Inventory (LCWI), and the ADID wetland program. The system used to classify these aqueous habitats is quite extensive and could be a whole other report in itself.

The methods of this procedure were primarily ARC/INFO and ArcView based. These two GIS systems were used to generate statistics from the relevant coverages. Basically, statistics were generated, which formed the foundations for my analysis.

The results from this project demonstrate that ADIDs within 13 of the 26 sub-watersheds in Lake County are in need of further study. According to the results from this study, by the year 2020, these ADID wetlands are likely to have their assigned functionality's threatened. It is very important that these ADID wetlands be studied further, especially because they are only protected under an advisory system and not a regulatory one. Knowing the type of people that work at Lake County, Illinois I know that more precise measurements will be made in the future.

Study Area

The study area for this project was Lake County, Illinois which lies in the furthest northeastern corner of Illinois (Fig 1.). Upon closer inspection of figure 1 you will notice the study area is bordered on the East Side by LakeMichigan, on the West Side by Mchenry County, to the south by

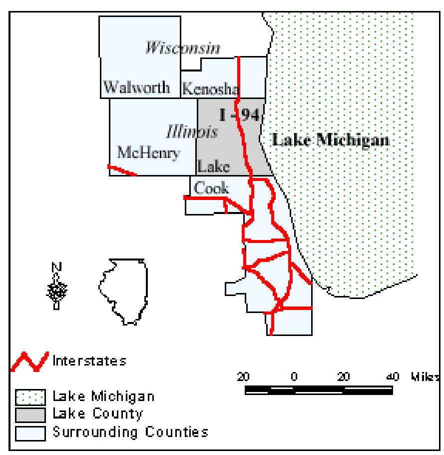

Figure 1. Lake County's position in the state of Illinois.

Cook County, and to the north by Wisconsin. Lake County is 23.56 miles from North to South and at its widest width

22.65 miles from West to East and is 535 square miles.

There are four watersheds in the county and they are the Fox, Lake Michigan, Desplains, and the Chicago watersheds. Within the four watersheds there are 26 sub-watersheds, they are numbered from one to twenty-six. Aside from being a "wet" county, it is also experiencing urban growth as well. This is a phenomenon known as urban sprawl. It is for this reason that this study was deemed useful and practical.

Methods and Materials

Step One

The first process that was performed was to acquire all of the proper coverages and databases. These coverages included the drainage, LCWI, ADID, land use, forests preserves, parks, population/forecast, and flood hazard data sets. The population/forecast coverage was from NIPC and dealt with current population data and some forecasted population data. A new file was created and the above mentioned coverages were copied. This was a sub-watershed study so it seemed logical that the statistics be performed on a sub-watershed basis. I decided to SPLIT the 26 sub-watershed into their separate constituents and then INTERSECT the different coverages with each of the 26 splits. I first conducted a dry run and used only one of the splits. The first split coverage was called split_00, the LCWI coverage and the split_00 coverages were intersected to a coverage called int_00. In arcedit the coverage int_00 was drawn and the table was checked to be sure that all necessary items were in place. After the test INTERSECT coverage was checked it was decided that the process would be adequate to complete the construction of the database. Once started, all 26 of the splits were used to perform intersections on all of the coverages mentioned above. For example, split_1 was used to intersect with the ADID, LCWI, flood hazard, forests, and parks coverages. The population/forecast and land use coverages presented slight modifications in the process and will be mentioned in the following sections. From performing 26 intersections on each of these different coverages there was a tremendous amount of data that needed to be sorted through.

Once the intersections were completed statistics needed to be compiled. The table for LCWI, ADID, forests preserves, flood hazard areas, parks, land use, and forecast coverages had the same column headings for each area. The first column heading was basin#, these were numbered from one to twenty-six. The next was the basin acreage, next was the number of acres for each feature in each sub-watershed. The percent of basin coverage and percent of county total for each feature was the last column headings.

The acreage of the sub-watershed was calculated by dividing the square footage of the sub-watershed by 43,560 ft^2. Total acreage of each feature was calculated by reselecting out the universal polygon and adding up the square footage of that feature in the sub-watershed and dividing by 43,560 ft^2. For percentage of basin coverage, I took the total feature acreage and divided it by the total number of acres in the sub-basin. Percentage of county total was acquired by dividing the feature acreage by the total county acreage of the feature. All of these fields were calculated manually except for the acreage of each feature in each of the sub-watersheds which was done in INFO.

Step One:

a. Land use

The land use coverage was a cumbersome one that needed to be simplified. For example, 1100 stood for residential land use and under that heading there were several sub-sections, commercial was 1200, also with several sub-sections (Table 1.).

Table 1. This table represents the Commercial and Services land use classified by NIPC.

1200. Commercial and Services
  1210. Shopping Malls (open and enclosed) (10 acre minimum size applicable only in suburbs.)
  1220. Business Park (Office Campus/Research Park.)
  1230. Single Structure Office
  1240. Urban Mix (City of Chicago characterized by storefronts built to sidewalk.)
    1241. Urban Mix (City of Chicago.)
    1242. Urban Mix (City of Chicago Strip Malls.)
    1243. Urban Mix (Suburban.)
  1250. Cultural, Entertainment.
  1260. Hotel/Motel.

All of the primary headings for the land use classifications and their simplification letters were 1100 Residential (A), 1130 Multi-Family(B),1200 Commercial (C), 1300 Institutional (D), 1400 Industrial and warehouseing and Wholesale trade (E), 1500 Transportation, Communication, and Utilities (F), 2000 Agricultural Land (G), 3000 Open Space (H), 4000 Private and Vacant and Wetlands (I), and finally 5000 Water (J).

What I did, for example, was to reselect for all of the sub-sections under 1200 and add the item group to them. Then that was calculated to equal the letter c. That way I had the county wide coverage for commercial land use simplified to a letter. This was a handy way of performing analysis on the land use data because I did not have to perform an operation on each of the subsets. Once I had the scheme figured out I needed to write an AML that would carry this task out. The AML structure is as follows:

```
&set .cover [response 'Enter the coverage to group' null]
&if  %.cover% = null
&do
  &type No coverage was entered
  &call end
&end
Tables
Sel %.cover% .pat
Resel landuse = '1110' ect.
Move a to group a
Asel  ect..........
```

To calculate the acreage for each of the simplifications I added up the square footage for each type and divided by 43, 560 ft^2 (Table 2.)

The land use simplification letter I is missing from this table because those were areas that consisted of developable, vacant land that was deemed developable by the methods of this study. These calculations were utilized at a later stage.

Step One:

b. Population/forecast

The population coverage presented a problem that had to be fixed before the coverage could be intersected with the sub-watershed splits. The problem was that the population coverage was in quarter sections which meant that the quarter sections had straight boundaries. The sub-watersheds had natural boundaries that did not mesh at all with the quarter section boundaries. This does not mean that I

Table 2. This table shows each of the land use simplifications and their acreage for each sub-basin.

BASIN	A_ACR	B_ACR	C_ACR	D_ACR	E_ACR	F_ACR	G_ACR	H_ACR	J_ACR
1	5006	97	483	97	508	34	1882	3478	5678
2	2379	22	367	235	208	13	2764	137	1118
3	1072	6	347	69	380	27	1480	17	347
4	4348	99	457	233	1015	189	9817	971	1054
5	1034	15	137	30	272	34	1885	70	1038
6	818	5	53	12	241	16	3852	0	227
7	2304	13	237	78	105	26	876	1129	616
8	3061	11	54	2	49	33	975	602	567
9	8687	28	374	350	641	118	2176	1558	704
10	1709	32	26	190	393	14	7674	351	775
11	3065	67	641	304	349	155	8350	436	1016
12	1212	0	15	6	2	334	3012	24	4
13	7529	259	1239	458	1031	881	9722	3726	837
14	2017	15	257	559	415	108	2554	529	254
15	8352	196	876	526	1550	185	5585	1585	857
16	4234	27	703	234	393	102	1319	2277	291
17	5000	61	343	94	142	27	986	666	177
18	1645	79	113	57	702	82	411	272	39
19	1813	32	220	86	113	206	1474	1157	5
20	4409	45	485	286	450	1040	372	3384	165
21	3908	218	816	541	195	319	0	701	25
22	842	26	84	1264	85	28	47	175	3
23	4454	37	357	1038	0	54	20	262	0
24	5129	185	1166	811	468	517	630	2630	48
25	4702	18	326	347	712	304	1967	939	192
26	2975	25	481	230	74	226	366	402	71

could not intersect the split coverages, they would have intersected fine. The problem was that the population coverage was in a polygon format, which means that when a sub-watershed boundary did not fully encompass a quarter section the population would split and the total population for that sub-watershed would effectively be doubled (Figure 2.).

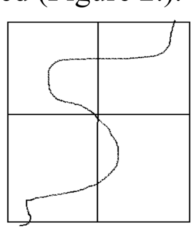

Figure 2. This figure represents how a sub-basin boundary intersects quarter sections.

I pondered on this predicament for a long time and decided that I would "put" the polygons into a point coverage. This way, when the sub-watersheds intersected the quarter sections the centroids for each of the population quarter sections would fall on whatever side of the boundary they were on. This worked great until I went into INFO and did a reselect on any sub-watersheds that had a population of zero. After some careful analysis I found that there were some quarter sections that had their centroids in Lake Michigan. When the county was surveyed, if a quarter section did not end at the county's east boundary, a new quarter section was started and sometimes extended almost a mile out in the lake. This was easily remedied by going into arcedit and drawing the sub-watersheds as a backcover and then drawing the point population coverage over it. I moved the points over to the landward side of the sub-watershed coverage and re-intersected those splits with the point population coverage. Once this was done all of the sub-watersheds on the lake side had the proper population numbers.

Step two:
Calculations

Most of the calculations that were performed during this part of the project utilized data from the population/forecast coverage. Once these numbers were obtained then it was possible to draw some conclusions from all of this data and to begin to determine which ADIDs will be in need of further study.

The first calculation that I made was to find the population density by basin in the year 1990. This proved to be useful because it could then be used to figure out different densities for future occurrences. The equation that was used involved dividing the population of 1990, which was provided by NIPC, by the total basin acres:

Population 1990 / total basin acres i.e Basin #2 20,098/ 20, 911 = .9611 people / acre.

The next calculation that was performed was to find the residential density on a sub-basin basis for the year 1990. This involved dividing the population for 1990 by the residential acres for the basin. To find the residential acres for each basin two items were added to the NIPC info table, lu_a and lu_b. The group lu_a consisted of codes for single family homes, farmhouses, and mobile home parks and trailer courts. The group lu_b consisted of codes for multi-family areas such as subdivisions. The acreage for each of these was added together and added as a new item to the info table. The equation is as follows:

Population for 1990 / residential acres i.e. Basin #2 20, 098/5103 = 3.983 people per acre.

Thirdly the population density by basin for the year 2020 was calculated and this involved the population by basin for 2020 divided by the total basin acres. The population for the two years, 1990 and 2020, came form the NIPC coverage. The equation for this is as follows:

Population 2020 / total basin acres i.e. 31,024 / 20, 911 = 1.486 people /acre.

The final major calculation that was performed was a pinnacle one. This involved finding all of the land in each basin that was not available for development. The base coverage that was used as a foundation for this was the land use for 1990 coverage. There were five coverages that were unioned to the land use coverage and they were the LCWI, parks, flood hazard, forest preserve, and the sub-watershed coveages. The specific ADID coverage was not added into this procedure because the ADIDs are contained within the LCWI coverage. Once the last coverage was formed from the union process a reselect was performed on land use classes greater than 5000 and less than 3220. This process acquired which land was available for development by leaving the vacant land behind. Land use class of 5000 and over are water classes and 3220 and below are lands that are already industrially and commercially zoned. The only classes that were left were those that were available for development on a residential scale, industrial scale, or commercial scale. These classes were 4000 through 4300. There was still a problem because according to NIPC there were still areas that I considered not suitable for development. These areas included state parks, flood hazard zones, forest preserves, LCWI types NW and ". The type NW and " for LCWI included forested areas that were found to be in the middle of the LCWI wetlands, not a suitable place for development. To remedy this problem, a reselect was performed within the original land use coverages to find all of the areas available for development. Five items were reselected from this huge coverage, by huge I mean that the table had over 14,000 records in it, I am glad to say that INFO cut this process down to a matter of minutes. The five items that were selected were parks_1# < 2, flood_1# < 2, forests# < 2, type = nw or type ". Once all of these items were reselected an item was added called code was calculated to one so this process would not have to be repeated. All of the items that had a code = 1 now represented land that was suitable for development. A frequency was then run in ARC and the first item that was entered was code and the second item was basin. This gave me a table (table 3.) which listed each of the basins and how many acres of developable land was in each.

Table 3. This table shows the amount of developable acres in each sub-basin.

BASIN_	DEV._ACRES
1	1068.203324
2	934.637030
3	886.472515
4	3608.001539
5	595.747317
6	787.783342
7	630.236319
8	458.940419
9	1409.619110
10	1383.257548
11	3300.223776
12	408.100013
13	4949.756931
14	654.275684
15	3168.454854
16	1232.547353
17	792.401146
18	436.711678
19	353.434149
20	809.360379
21	596.563139
22	132.636662
23	93.396720
24	1622.779955
25	1473.534400
26	492.823327

These numbers provided the last elements of an equation to find the demand on land. It's output units were ratios and a number less than one indicated that there will be more land available for development than there will be demand for it. A number equal to one indicates that the demand for land and the amount of land will meet head on and completely balance out. If a number was greater than one there would be a greater demand on land than there will be land available. The equation is as follows: the 2020 population / 1990 residential density = the desired 2020 acreage / the amount of available land from table three = the ratio demand on land variable. For example,

31,024 / 3.398 = 9130 / 1068 = 8.54

What this equation says is that for this sub-basin there will be a 8.54 higher demand for land than there will be available.

Now the demand scale was ready to be used with other collected data. In ArcView using the Spatial Analyst extension the ADID coverage was merged with the sub-watershed coverage which depicted the demand scale. Once this was done a query was built for a demand scale greater than 4.41 and ADID acres contained within the sub-basin less than 890.

Results/Discussion

As you have seen there is a lot of work that went into this project. The methods involved seemed to produce results that are accurate and helped to generate a better understanding of what might happen to the ADID wetlands by the year 2020. The demand on land coverage (Figure 3), did not produce any results that were one or below

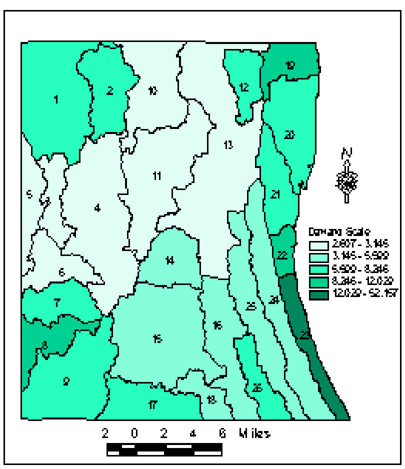

Figure 3. This figure represents the demand on land scale for Lake County.

The lowest demand was 2.607 and the highest ratio was 52.167. It is important to keep in mind that these numbers are reflections of what might happen in the year 2020 correlated with 1990 data given the question, "are the ADID wetlands in Lake County, Illinois going to lose their assigned functionality in the future?" After the query was built and converted into a shapefile there were thirteen of the 26 sub-watersheds that contained ADIDs that may be threatened by the year 2020 (Figure 4.).

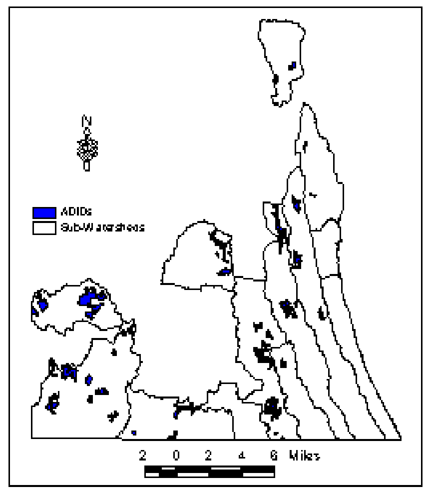

Figure 4. This figure shows the thirteen sub-watersheds which contain ADIDs that may be threatened by the year 2020.

It is now evident that future study will need to be conducted on the ADIDs in these thirteen sub-watersheds. When studied more closely there does not seem to be any direct relationship between the number of acres in each sub-watershed compared to the number of ADID wetlands (Figures 5 & 6.)
When looking at the graph that depicts the demand on land scale there still does not seem to be any correlation between the

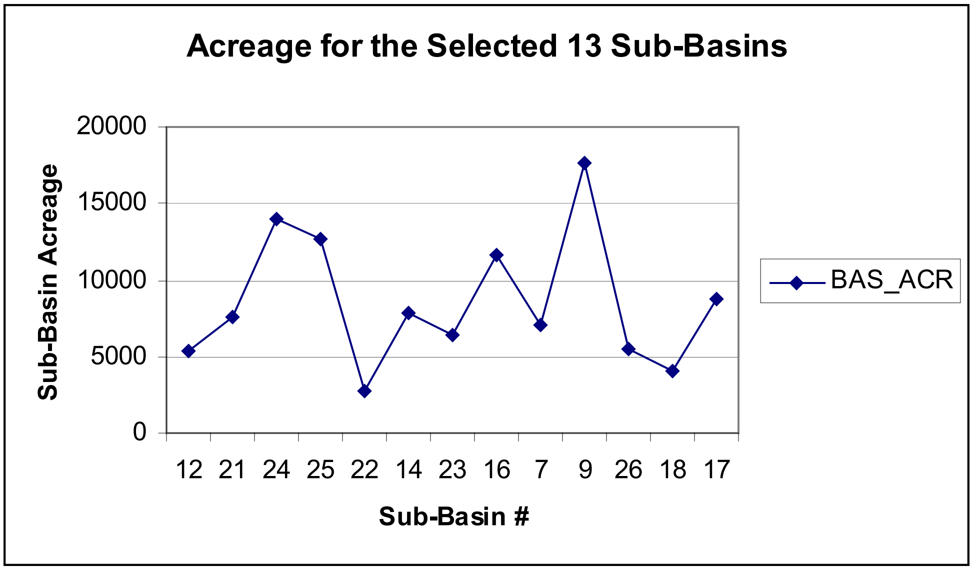

Figure 5. This graph displays the acreage for each of the selected 13 sub-watersheds.

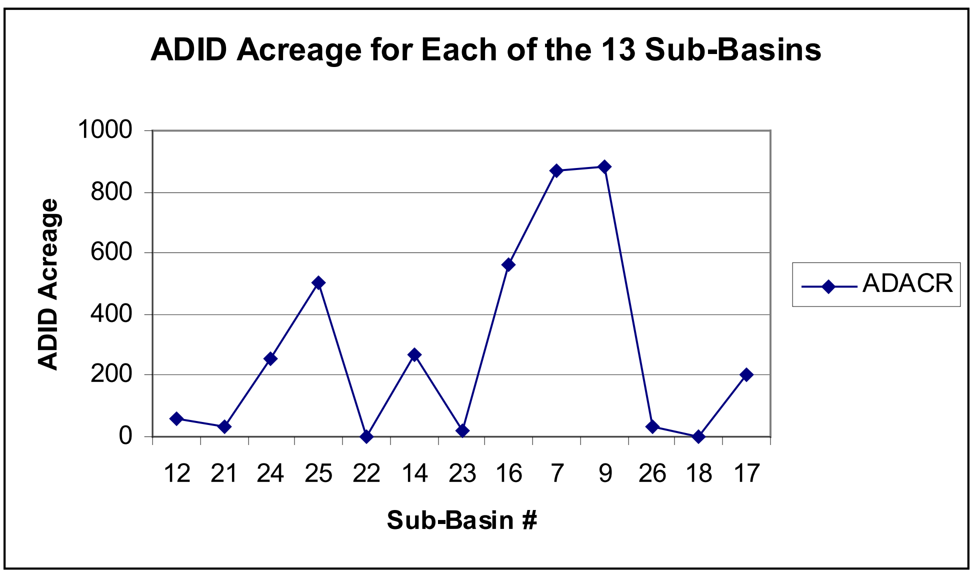

Figure 6. This graph displays the acreage of ADID's in each of the 13 selected sub-basins.

demand on land (Figure 7.) vs. the amount of ADID in each sub-watershed or the actual acreage of the sub-watersheds. From figures 5 and 6 you can see that there is no real correlation between the amount of ADID acres and the size of the sub-watershed. When the information from figure 7 is analyzed with these two it is evident that there is also no correlation between the amount of ADID acreage and the acreage of the sub-watersheds and the demand on land by the year 2020. Now when graphically comparing the amount of developable land that will be available by 2020 (figure 8.) you will notice that sub-watershed 23, the one with the highest demand on land rating, has almost no acres that will be available for development.

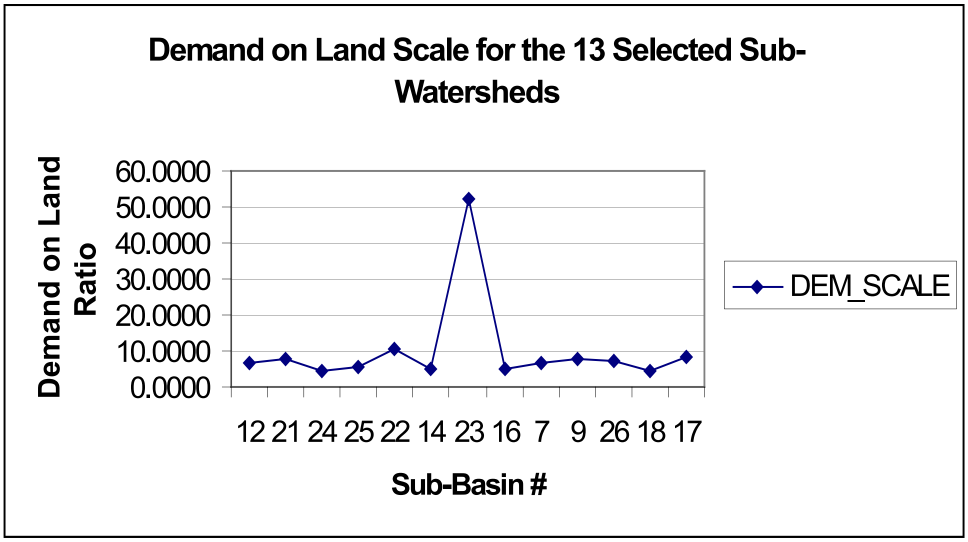

Figure 7. This graph displays the demand on land scale that was calculated above for the 13 selected sub-basins.

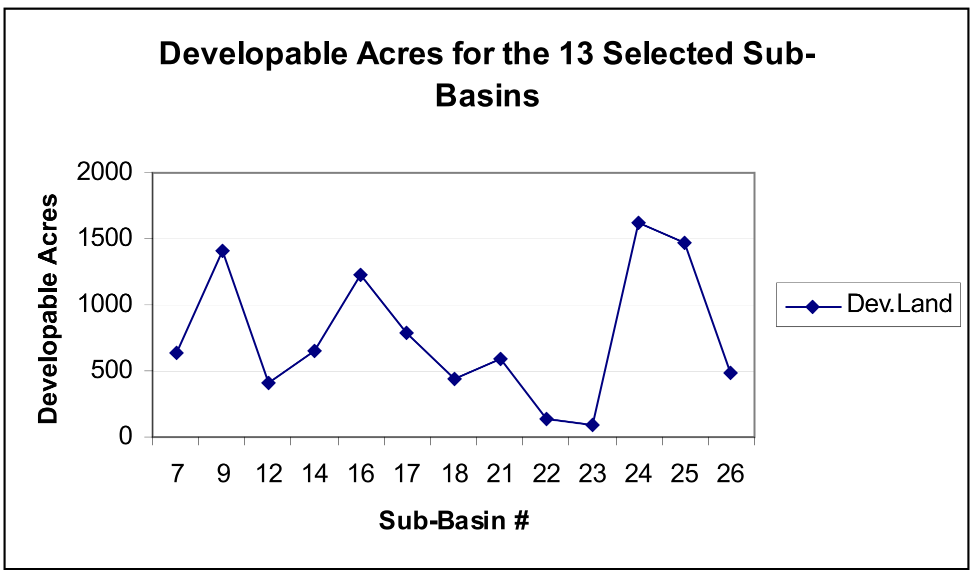

Figure 8. This graph displays the amount of developable land left for the year 2020 for each of the 13 selected sub-basins.

The total basin density for sub-basin 23 will be 4.88 people per acre, this is not a really big increase from the 1990 data that states the density was 4.56 people per acre. Personally I know this area well enough to realize that most of the infrastructure stack people and businesses from the ground up. I suspect that the high demand on land scale comes from the high number that it already had, but fortunately there are zero ADID wetlands in this sub-basin so the numbers for this sub-watershed will not be studied any further. It is easy to get the impression from looking at table 3 and figure 8 that there is not a lot of land that will be available for development by the year 2020.
From viewing all of the graphs above I was not able to draw any visual correlation between them. In SPSS I was able to draw

statistical correlations between the amount of developable land and the population in each sub-watershed (Table 4.), using the Pearson two tailed correlation test.

Table 4. This table shows the correlations between the population in each sub-watershed to the population for the years 1970 through 2020 for each sub-watershed.

	Correlation	Significant @
Pop_70		
Avail_land	0.095	0.757
Pop_80		
Avail_land	0.244	0.422
Pop_90		
Avail_land	0.31	0.302
Pop_20		
Avail_land	0.38	0.2

Looking at these correlations I found that the general trend is for the correlation to move towards one as the years go on. As the population grows then the amount of developable acres will shrink. This is the correlation that is being drawn in this situation.

There are some very important assumptions that had to be made in order for this project to function as it did. The first assumption that was made was that zoning will remain the same over the years. Thirty years is a long time to assume that it will remain the same but I had no reason to indicate that it would change. Given this information I arrived at the numbers in table 2. Commercial and industrial development could not be predicted, this is why it was factored into the amount of developable land per sub-basin calculations. I also assumed that with the increase in development, there would be an increase in impervious surface, and an increase in impervious surface is proportional to polluted runoff. Most of the land use in the county is residential thus residential was assumed to chew up most of the landscape in each sub-watershed.

The population data that were provided from NIPC are the best available. NIPC itself makes certain assumptions during its own study methodologies. The zoning and comp plans do not mean that events will occur, it states that if development occurs, the present zoning wants it to occur in a certain manner.

The demand scale calculated was performed from zoning of today, features like sewage, traffic, and education are all areas that are considered in this, keep in mind that these features may change and thus affect the development of the future.

Conclusion

This study was derived to try to find a way that would highlight any of the ADID wetlands in Lake County, Illinois that may be threatened by the year 2020. The year 2020 was decided upon because that is how far my data sources would allow me to proceed. These data sources were used because they were determined to be the most reliable and accurate. Remember that there are certain assumptions that were made during the analysis procedures, for example, zoning will remain the same for the next thirty years, I had no other reason or data verification to prove otherwise. I am sure that there are certain aspects of the zoning that will change but those changes could not be addressed. The point of this project was not to make precise measurements on the wetlands themselves, it was to find any wetlands that may become threatened in the future. This project found that there are 13 sub-watersheds that contain ADIDs that should be studied in the future.

Recommendations for further study would be to create a pilot study for the analysis of an individual wetland. This would mean more detailed aerial photointerpretation and the inclusion of more detailed coverages like 2 ft. contour data for a sub-watershed. Coverages like this would allow for runoff coefficients to be calculated and would look at increased density as it is proportional to polluted runoff.

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