

Assessment of Land Use Change in Edmonton from 1966 to 1976

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Prepared for the Municipality of Edmonton

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Executive Summary

As Canadian cities and surrounding areas grow it is important to monitor change in land use type to proactively develop land zoning regulations to ensure efficient and responsible land use. From 1966 to 1976 the population of the City of Edmonton grew from 381,230 to 461,559 (City of Edmonton, 2018). This report shows that this growth came in the form of urban sprawl and rural urbanisation and that the primary land use change that enabled this growth was the conversion of cropland to urban built up areas. While urban built up areas increased from 19,596ha in 1966 to 54,995ha in 1976, the area of cropland decreased from 284,664ha to 263,105ha. Based on this, it is recommended that the City of Edmonton develop an urbanization projection plan to determine which land use types and areas are at risk of conversion to urban development in the future in order to help prepare for continued growth and to prevent further decline in cropland area.

Introduction

As pre-determined by the City of Edmonton, the purpose of this report is to analyze the urban sprawl and rural urbanisation in the study area and determine the most affected land use type from 1966 to 1976. By analyzing past urban sprawl and rural urbanisation changes, in this report can be used as a guide to continue to monitor land use change in an effort to be better equipped to plan for future land use zoning. The data presented in this report shows that cropland has been the land use type that has been converted most to urban built up areas. In a 2015 report looking at the Alberta-Calgary corridor, it was found that, “although Calgary and Edmonton had similar population growth rates, farmland conversion was much higher in Edmonton than in Calgary” (Qiu, Laliberté, Swallow, & Jeffrey, 2015). The authors cite the availability of prime farmland as the main catalyst for outward expansion of the city.

The analysis in this assessment was conducted by using Canada Land Use Monitoring (CLUMP) data from 1966 and 1976. The data was acquired from Geogratia. The study area is the urban area of Edmonton, Alberta and surrounding municipalities. Specific interest is on the urban core of the city of Edmonton and the west end of the study area. Two applications were used to analyze the land use data: Fragstats and ArcGIS (combined with excel). Fragstats was used to identify class level and landscape level metrics. Further analysis of the land use data was conducted through ArcGIS by combining 1966 and 1976 raster layers to create a database file that could be imported into Excel to create a transition matrix. Combined, these two data analysis techniques provide valuable statistical and visual representation of land use change in Edmonton from 1966 to 1976.

Results and Discussion

Table 1 summarizes the Fragstats class level metrics for each land use type in 1966 and 1976. As this table shows, the land use type that increased most in total area was urban built-up areas as this land use type expanded from a total area of 19,596ha in 1966 to 54,995ha in 1976. The land use type with the largest decrease in total area was cropland, with a decrease of 284,664ha in 1966 to 263,105ha in 1976. Yet, as Table 1 shows, although the total area of cropland has decreased more than any other land use type, cropland still accounted for a

greater percentage of the total landscape (or study area) than any other land use type as cropland accounted for 40.86% of the total landscape in 1976. This drop in total area of cropland represents a 3.32% decrease of total landscape coverage from 44.18% in 1966 to 40.86% in 1976. While the percent of landscape dropped for cropland it almost tripled for urban built up areas as the percent of this land use type in the landscape increased from 3.04% to 8.54%. This suggests that a good portion of the cropland in 1966 became urban built up areas by 1976. As the maps attached show, a larger portion of this land use change occurred around the downtown core of Edmonton as urban sprawl saw the city expand outward and therefore converted cropland to urban development. The transition matrix (Table 4) shows that 7.52% of the 1966 cropland was converted to urban built up areas by 1976. This 7.52% conversion from cropland to urban built up areas represents a larger cropland conversion than from cropland to any other land use type (e.g. only 1.69% of cropland was converted to productive woodland).

The total core area (calculated with a depth-of-edge distance of 100m) increased more for the urban built up areas land use type than any other land use type. From 1966 to 1976, the total core area for urban built up areas increased from 15,708ha to 38,268ha and the core area percent of landscape increased from 2.43% to 5.94% (Table 1). This suggests that urban sprawl around the downtown core of Edmonton accounted for a substantial amount of growth in the size of the urban built up areas as can also be seen in the 'Edmonton land use change from 1966 to 1976' map attached. While a large portion of the conversion to urban built up areas occurred around the downtown core, analysis of the west end of the study area along with analysis of the number of patches (shown in Table 1) shows that urban areas appeared in suburban areas outside of the downtown core. Comparison of the 'Edmonton land use in 1966' and the 'Edmonton land use in 1976' maps (attached) shows the introduction of urban patches from 1966 to 1976 in the west end of the study area. Along with this, Table 1 shows that from 1966 to 1976, the number of urban built up area patches increased from 133 to 417. This suggests that rural areas urbanized, and urban sprawl occurred simultaneously from 1966 to 1976. This combination of urbanisation of the rural and urban sprawl were what allowed the population of the City of Edmonton to increase from 381,230 in 1966 to 461,559 in 1976 (City

of Edmonton, 2018). And, as has been seen, this expansion, through land conversion to urban built up areas, has largely been at the expense of cropland. While the number of urban patches has increased, Table 1 shows that the number of cropland patches has also increased – from 579 in 1966 to 709 in 1976. This suggests that cropland has become fragmented and a main cause of this fragmentation is likely the conversion of cropland to urban built up areas, especially in areas outside of the downtown core.

Table 2 summarizes the Fragstats landscape level metrics in 1966 and 1976. Landscape level metrics provide a summary of the entire study area (or landscape). Table 2 shows that the total number of patches for the entire study area decreased from 8496 in 1966 to 8287 in 1976. Therefore, although the number of urban patches increased, and the fragmentation of cropland increased (as per Table 1 analysis above), over-all the land use became more divided from 1966 to 1976. As Table 1 shows, this over-all decrease in number of patches is a result of the decrease in the number of patches of the following land use types: unimproved pasture and range land (-879 patches), improved pasture and forage crops (-417 patches), productive woodland (-440 patches) and swamp, marsh or bog (-593 patches). Table 2 also includes values for the Shannon's diversity index and the Shannon's evenness index. As the Shannon's diversity index became larger, and the Shannon's evenness index grew closer to 1 from 1966 to 1976, it can be concluded that the data became more evenly distributed from 1966 to 1976.

Recommendations

Based on the findings in this report, it is recommended that the City of Edmonton conduct an urbanization projection plan to determine which land use types are at risk of conversion to urban development in the future in order to help prepare for continued growth and future land use zoning regulations. By conducting further data analysis of past trends in land use change and predicting future trends, regulation that ensures the most efficient use of urban land can be pro-actively developed. Special priority should be put on minimizing cropland fragmentation as Edmonton is host to a finite reserve of class 1 soil (Zhang, Guindon, & Sun, 2010) that should be zoned for crop growth and protected against urban development.

References

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Table 1: Class level metrics for land use in Edmonton – 1966 versus 1976

Year	Total Area (hectares)		Percentage of Landscape (%)		Number of Patches		Total Edge (km)		CV of Patch Area		Shape Index		Total Core Area (hectares)		Core Area Percent of Landscape		Number of Disjunct Core Areas	
	1966	1976	1966	1976	1966	1976	1966	1976	1966	1976	1966	1976	1966	1976	1966	1976	1966	1976
Water areas	19861	19875	3.083	3.087	337	340	1001	1004	599.7	602.0	1.32	1.32	13003	13003	2.0181	2.0194	238	238
Cropland	284664	263105	44.181	40.860	579	709	11817	9697	1498.2	1121.9	1.64	1.52	196305	190266	30.467	29.5482	1349	928
Unimproved pasture and range land	75934	59439	11.785	9.231	2597	1718	8727	6029	525.5	414.5	1.47	1.48	24261	22773	3.7654	3.5366	1922	1290
Improved pasture and forage crops	46750	45154	7.256	7.012	2132	1715	5503	4866	186.3	281.5	1.36	1.41	11720	15687	1.819	2.4362	1547	1183
Productive woodland	28450	7316	4.416	1.136	843	403	2872	906	263.2	219.5	1.49	1.37	10701	2236	1.6608	0.3472	670	203
Swamp marsh or bog	11340	6228	1.760	0.967	1144	551	1867	927	218.2	197.2	1.28	1.26	1951	1375	0.3028	0.2135	365	219
Non-productive woodland	19086	44358	2.962	6.889	517	2170	1861	5328	339.8	169.3	1.52	1.34	7816	10710	1.2131	1.6633	413	1489
Mines quarries sand pits	1681	3116	0.261	0.484	99	84	199	262	154.1	342.1	1.24	1.32	508	1405	0.0788	0.2182	47	61
Urban built-up area	19596	54995	3.041	8.541	133	417	555	2373	604.8	703.7	1.28	1.48	15708	38268	2.4379	5.943	88	384
Outdoor recreation	1735	750	0.269	0.117	80	44	204	78	132.4	131.8	1.38	1.14	563	255	0.0874	0.0396	47	22
Horticulture	23	4582	0.004	0.712	5	126	4	379	89.7	249.3	1.03	1.33	0	2152	0	0.3342	0	79
Unproductive land sand	36	18	0.006	0.003	16	6	11	5	83.9	81.6	1.11	1.17	0	0	0	0	0	0
Unproductive land rock	208	31	0.032	0.005	14	4	40	6	65.5	136.1	1.78	1.30	5	0	0.0008	0	2	0

Table 2: Landscape level metrics for land use in Edmonton – 1966 versus 1976

Year	Number of Patches	Patch Density	Total Edge (km)	Shannon's Diversity Index	Shannon's Evenness Index
1966	8496	1.319	17331	1.4914	0.5814
1976	8287	1.287	15929	1.5855	0.6182

Table 3: Description of class and landscape level metrics used in analysis (descriptions from Fragstats documentation)

Total Area	the total area (hectares) of the landscape
Percentage of Landscape	the sum of the areas (m ²) of all patches of the corresponding 2 patch type, divided by total landscape area (m ²), multiplied by 100 (to convert to a 2 percentage)
Coefficient of Variation	the standard deviation divided by the mean, multiplied by 100 to convert to a percentage
CV of Patch Area	coefficient of variation for the patch area
Shape Index	corrects for the size problem of the perimeter-area ratio index by adjusting for a square standard and, as a result, is the simplest and perhaps most straightforward measure of shape complexity
Total Core Area	the same as core area at the patch level, but here core area is aggregated over all patches of the corresponding patch type.
Core Area Percent of Landscape	the same as core area at the patch level, but here core area is aggregated over all patches of the corresponding patch type and computed as a percentage of the total landscape area
Disjunct Core Areas	a spatially contiguous (and therefore distinct) core area. Depending on the size and shape of the patch and the specified depth-of-edge distance(s), a single patch may actually contain several disjunct core areas.
Number of Patches	the sum of the number of distinct bodies of a single land use type
Total Edge	the sum of the lengths (km) of all edge segments involving the corresponding patch type
Patch Density	expresses number of disjunct core areas on a per unit area basis that facilitates comparisons among landscapes of varying size
Shannon's Diversity Index	minus the sum, across all patch types, of the proportional abundance of each patch type multiplied by that proportion - Shannon's diversity index is a popular measure of diversity in community ecology, applied here to landscapes
Shannon's Evenness Index	the observed Shannon's Diversity Index divided by the maximum Shannon's Diversity Index for that number of patch types - Shannon's evenness index is expressed such that an even distribution of area among patch types results in maximum evenness (as such, evenness is the complement of dominance)

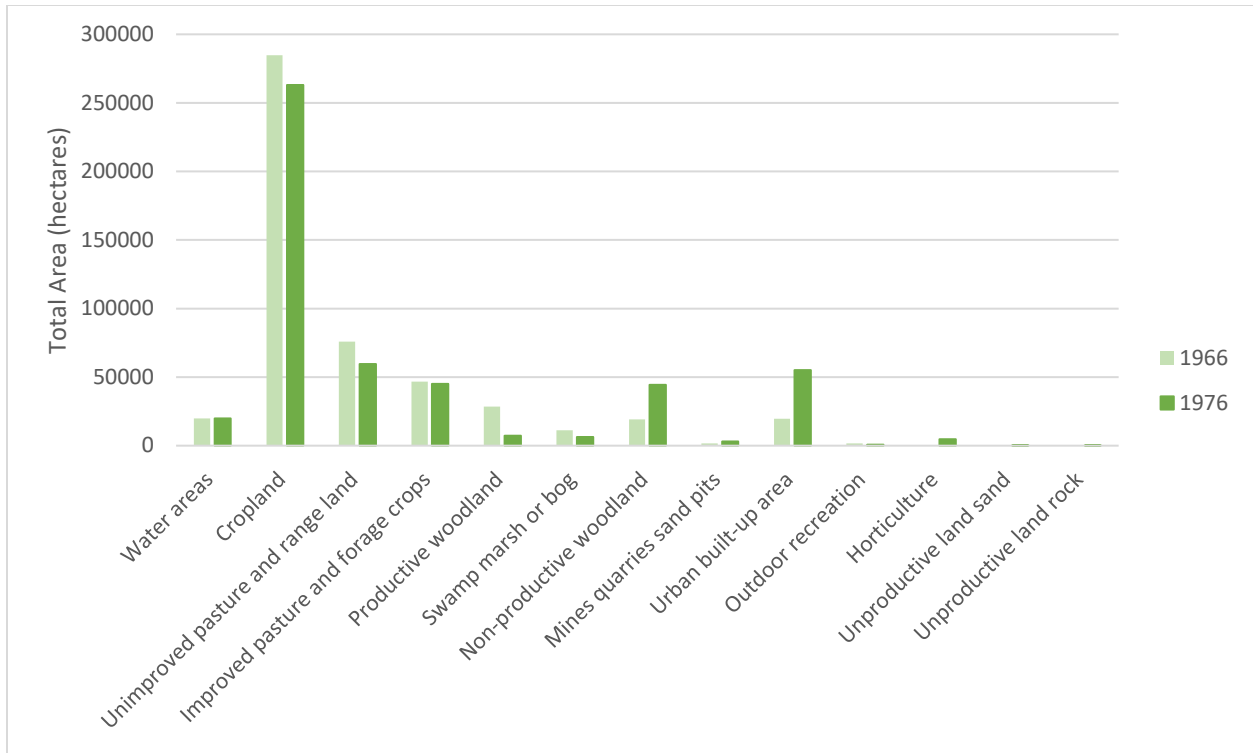


Figure 1: Total area of each land use type in Edmonton for 1966 and 1976

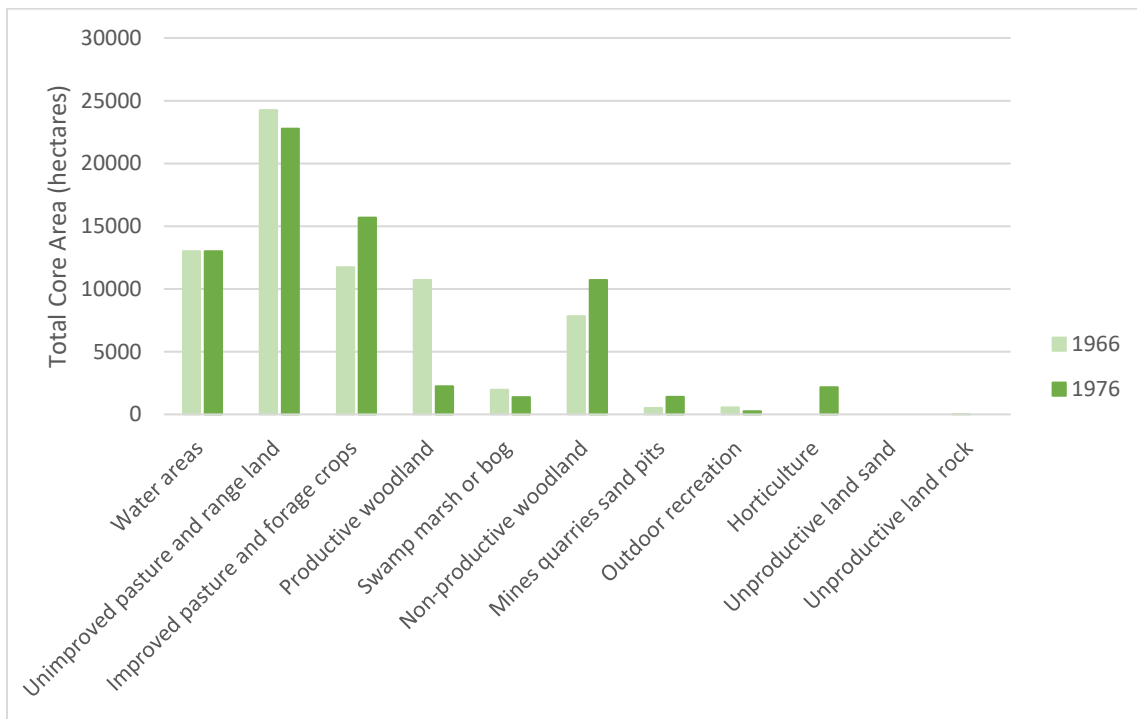


Figure 2: Total core areas for each land use type in Edmonton for 1966 and 1976 (excluding cropland and urban built-up areas)

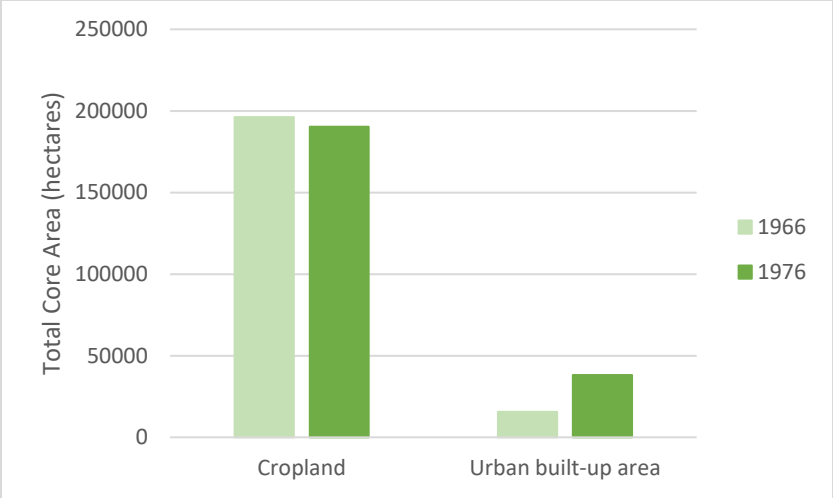


Figure 3: Total core areas for cropland and urban built up areas in Edmonton for 1966 and 1976

Table 4: Transition matrix for land uses changes in Edmonton from 1966 to 1976

1966 \ 1976	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swamp	Unimproved pasture and range land	Unproductive land - rock	Urban built-up area	Water	Grand Total
Cropland	82.34%	0.22%	0.02%	0.70%	0.26%	0.22%	1.69%	0.38%	6.65%		7.52%		100.00%
Horticulture	34.78%	52.17%				4.35%					8.70%		100.00%
Improved pasture and forage crops	0.98%	0.01%	94.40%	0.13%	0.28%	0.09%	0.77%	0.16%	2.15%		1.02%		100.00%
Mines quarries sand and gravel pits	4.34%		0.12%	42.59%	3.81%	5.35%	9.10%	0.18%	13.44%		21.06%		100.00%
Non-productive woodland	12.57%	0.05%	0.05%	0.27%	8.53%	2.30%	51.62%	0.46%	13.32%		10.85%		100.00%
Outdoor recreation	0.17%					85.42%			0.29%		14.12%		100.00%
Productive woodland	14.92%	0.04%	0.11%	0.39%	1.44%	2.07%	63.76%	0.27%	7.33%		9.67%		100.00%
Swamp	17.67%	0.04%	0.12%	0.07%	7.82%	1.04%	12.86%	28.17%	26.08%		6.06%	0.08%	100.00%
Unimproved pasture and range land	26.08%	0.09%	0.14%	0.25%	4.55%	1.55%	32.34%	2.27%	22.95%		9.78%		100.00%
Unproductive land - rock	6.73%				0.96%	12.50%	60.10%			14.90%	4.81%		100.00%
Urban built-up area	0.02%		0.01%	0.01%			0.01%				99.96%		100.00%
Water areas												100.00%	100.00%
Grand Total	51.70%	0.15%	8.72%	0.61%	1.44%	0.90%	11.68%	1.22%	8.87%	0.01%	10.80%	3.91%	100.00%

Table 5: Percent change of land use type in Edmonton from 1966 to 1976

Land use type	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swamp	Unimproved pasture and range land	Unproductive land - rock	Urban built-up area	Water areas
Percent change	92.55%	3260.87%	94.88%	185.37%	38.34%	264.03%	208.90%	54.90%	59.49%	14.90%	280.58%	100.07%