

Assessment of Land Use Changes in Edmonton, Alberta, Canada Between 1966 and 1976: Urbanization

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Executive Summary:

Between 1966 and 1976 the city of Edmonton has experienced significant land use change in its landscape. Urban built areas observed a 181% increase in land use, reflected by an increase of 354 Kilometers squared in total area. The composition of urban areas in 1976 was found to be 38,9% diverted from previous croplands, and 13,5% from unimproved pasture and range land. Only 70% of urban areas fell within the urban built core area with edges of 100m, implying that 30% are in close proximity to potential harmful side effects of other land uses. This report brings forth the necessity to assess the potential consequences of land use types, such as mining, on urban areas. Although the landscape is found to be relatively diverse and even, it could be of interest to select zones where diversity is low to reduce the number of potential neighbors for urban developments, and therefore to reduce the probability of negative externalities impacting non-core area of urbanized locations. Finally, using spatial statistics it was found that the shape/size of croplands was also found to be vulnerable, and it could be in the city's power to protect those small croplands and farmlands to support the local economy, and ensure future urbanization developments do not eradicate such areas.

Introduction:

Between 1966 and 1976 the city of Edmonton in Alberta, Canada has experienced several land use changes in its landscape. The results and statistical description of such land use change will be analyzed below. The observed changes through maps, and data are what would be expected as the result of an expanding city; Urban built areas in the city of Edmonton has undergone an increase of 354 Kilometres² in total area in the period between 1966 and 1976. In fact, Edmonton, which is the capital of Alberta, experienced a population increase of 381,230 in 1966 to 461,559 in 1976, which means a 21% increase in the city's population¹. The following report will aim to assess the development of urbanization in the city's landscape, how that has impacted other land uses, most especially croplands, and will further look at the distribution of the landscape. Finally, this report, constructed for the city of Edmonton, will make some recommendations regarding the development of urban areas and on their relation to neighboring other land uses.

Data, Results, and Transition Matrices

To analyze land use changes, and urbanization developments in Edmonton between 1966 and 1976, Canadian Land Use Monitoring (CLUMP) datasets were downloaded from GeoGratis, one for each respective year. In order to assess land use changes, the data set was converted into 100m resolution rasters. By using ArcGis and Fragstats it was possible to extract spatial statistics regarding land use changes between 1966 and 1976 (Appendix A and B). It was also possible to map such changes into 3 separate maps (Appendix C) which easily portray the expansion of Edmonton's urban areas. In fact, Map 1 (Appendix C) represents effectively the overall land use changes experienced between 1966 and 1976. By integrating analyses and data from both ArcGis and Fragstats it was eventually possible to create a transition matrix which made it possible to see the evolution and conversion of different land use classes between 1966 and 1976.

The first pivot table/transition matrix (Table A in the Appendix A) represents how much percentage of the original land use in 1966 was converted into other land use types in 1976. For instance, table A tells us that 82% of Croplands from 1966 stayed croplands, while 7,5% of 1966 croplands were converted into Urban built area. 11% of non-productive woodland in 1966 became urban in 1976, and 21% of the land used for mines in 1966 was converted to urban built areas in 1976.

¹ "Population History." *City of Edmonton*, www.edmonton.ca/city_government/facts_figures/population-history.aspx.

Table B on the other hand illustrates, using percentages, the origin of the different land use types for each respective land use classes in 1976. For example, of the mines in 1976, only 23% were built on land that was used for mining in 1966. Most of the mining land in 1976, 63.3% was derived from land which was previously cropland. Table C represents the raw hectare values of land use transition uses across the two data sets.

As a matter of fact, Graph A in Appendix B is a visual representation of the data found in Table B. Indeed, it represents the composition of the different land uses in 1976 from land use in 1966. Out of the croplands in 1976, 89% was derived from croplands in 1966 and 7.5% was derived from Unimproved pasture and range land. Graph A further shows that Improved pasture and forage / Unproductive Land Rock / and Water areas have not experienced significant changes in their composition over time.

On the other hand, all other land use classes have undergone obvious land diversions and conversions since 1966 until 1976. Indeed, it is possible to see that most land developments have occurred and diverted land away from cropland usage, nonproductive woodland, productive woodland, and unimproved pasture and land range. However, even though most land use developments have built on croplands, it's total area of the landscape only decreases from 44% to 41% between 1976 to 1966; although croplands areas have been diverted away the city remains relatively farmer friendly while at the same time accommodating for urban developments.

Since we are interested in urbanization in Edmonton, Graph B is interesting as it portrays the breakdown of land used for urban built areas in 1976. 38,9% was derived from Croplands, 3,8% from non-productive croplands, 5% from productive woodland, 13,5% from unimproved pasture and range land, 0,9% from improved pasture and forage crops, 0,6% from mines, 0,4% from outdoor recreation and 35,6% of 1976 urban land was already urban in 1966. (A list of definitions of the 12 different land use classes can be found in Appendix A on page 12).

An environment subject to fast land use change

Indeed, land use changes within different classes have been quite significant between 1966 and 1976. Croplands have only decreased by 7% whilst horticulture has increased by 3161%. The percentage changes within each categories can be found in Table D in Appendix A. Nonproductive woodland decreased by 62%, yet productive woodland increased by 109% implying the probability that a significant part of non-productive woodland were mature enough to become productive in 1976. Indeed, this is confirmed by Table A, which shows that

from Non-productive woodland in 1966 51.6% were converted to productive woodland in 1976. Unproductive land rock decreased by 85%, overall and 60% of it became productive woodland. Outdoor recreation increased by 164%, and our area of interest relating to urbanization, urban built-up areas, increased by 181%.

Focusing on Edmonton's Landscape and Urbanization using Spatial Statistics

Through the Fragstat analysis it was possible to derive spatial statistics about the overall landscape of study. By looking at Table E: the number of patches (NP) (Definitions in Appendix A Table H) increased from 7352 to 7736, which could possibly be due by an overall increase of the city's boundary. Total Edge decreased from 15 463 800 m to 15 002 600 m. A possible explanation for this decrease is the fact that through its developments, the process of urbanization has smoothed edges with neighboring other land usage, thus leading to lead points of contact between different land uses. Moreover, the decrease in total edges might as well imply that land use has been more organized amongst its users and that during the decade following 1966 more agreements and clearer delimitations have been decided among different stakeholders. Moreover, not only are land use division less abrupt but the landscape's distribution evenness has increased from 0,5699 to 0,6191 as indicated by the Shannon's Evenness Index (a measure of the landscape's. Shannon's Diversity Index also shows an increase in the diversity of patches across the landscape. This points out the fact that urbanization in Edmonton has had no bad impact on the diversity and evenness of land usage across the landscape, although its total area has increased from 3% of the landscape in 1966 to 8,5% of the landscape in 1976.

Table F looks at the spatial statistics for each land use class in the landscape. By looking at the Urban built areas class it is possible to observe that total areas for this land use class has increased; Consequently, number of patches for the class, total edges, and total core areas all have also increased as a result. In 1976, total core area for urban areas was 38268 hectares as opposed to a total area of 54,995 hectares. The core area was calculated by cutting 100m within the edges. This implies that in the shapes of urban area distribution across the landscape, 16 727 hectares are within 100m of proximity to other land usage, which is 30% of the total urban built area. Compared to 1966, where 15 708 hectares out of 19 596 hectares were core areas, and only 20% of urban areas were within 100m of neighboring classes, perhaps less preferable land uses classes? The expansion of the city has led to urban areas being increasingly built in areas which are in closer proximity to other land uses as mines represented in purple on Map 2 (Appendix C).

Impact on Croplands

Finally, another interesting point to highlight is the fact that although urbanization and other land use conversions have led to a decrease in Cropland's total percentage of the landscape – a decrease from 44% to 41% - its number of patches between 1966 and 1976 has increased from 579 to 709. This implies that although croplands have on overall decreased there are more smaller farms/croplands scattered around the landscape. For the cropland class 190,266 hectares out of 263,105 hectares are part of the core areas, which means that 28% of cropland is within 100m of neighbors.

Furthermore, in 1976, Cropland's Number of Patches of 709 increased to 928 of Disjunct Core Area: this implies that areas of croplands were shaped in such a way that cutting a 100m edge lead to the division of some patches. This is of importance when analyzing the process of urbanization in Edmonton as it shows the potential and vulnerability of some croplands to be converted into housing developments, or other urban developments. Their "thin" surface area makes it attractive land for urban development as they are easy to "cut" off. Map 3 shows how land use development has led to increase diversity in the landscape as well as the fact that such developments isolate some parts of croplands (hence more Number of Patches, and thus more vulnerable and prone to conversion areas of cropland from our perspective of urban development).

Recommendation

Through 1966 to 1976 the city of Edmonton seems to have developed its urban areas in such a way that has increased diversity and evenness across the landscape. Nevertheless, 30% of urban areas remain outside the core areas and are therefore susceptible to negative externalities from other neighboring land uses. It is critical for future urban developments to ideally be developed in areas where the diversity of neighborhood be reduced – yet like mentioned before the evenness and diversity of the landscape may pose problems when deciding on future urban developments. A recommendation could be to assess which land use classes has the less impact on urban areas. Moreover, the creation and establishment of regulations should be crucial in the areas around the core, and reducing the number of neighboring classes could be of interest – or avoiding certain land use types. In addition, the analysis has pointed out the vulnerability of small thin croplands. This could require the intervention of the city in the long run to protect these areas and support smaller farms; for instance, to ensure that urbanization developments do not have negative impacts on the local economy.

APPENDIX A - TABLES

Tables start on the following page.

Table A – Land Use Transition Matrix – Percentage of 1966 Land Use into 1976 Land Use

Percentage of 1966 Grand Total (%)	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swampmarsh or bog	Unimproved pasture and range land	Unproductive landrock	Urban built-up area	Water areas	Grand Total 1966 (Hectares)
Cropland	82,3	0,2	0,0	0,7	0,3	0,2	1,7	0,4	6,7		7,5		284295
Horticulture	34,8	52,2			4,3						8,7		23
Improved pasture and forage crops	1,0	0,0	94,4	0,1	0,3	0,1	0,8	0,2	2,2		1,0	0,0	46750
Mines quarries sand and gravel pits	4,3		0,1	42,6	3,8	5,4	9,1	0,2	13,4		21,1		1681
Non-productive woodland	12,6	0,0	0,1	0,3	8,5	2,3	51,6	0,5	13,3		10,9		19084
Outdoor recreation	0,2					85,4			0,3		14,1		1735
Productive woodland	14,9	0,0	0,1	0,4	1,4	2,1	63,8	0,3	7,3		9,7		28450
Swampmarsh or bog	17,7	0,0	0,1	0,1	7,8	1,0	12,9	28,2	26,1		6,1	0,1	11336
Unimproved pasture and range land	26,1	0,1	0,1	0,2	4,5	1,6	32,3	2,3	22,9		9,8	0,0	75896
Unproductive landrock	6,7				1,0	12,5	60,1		14,9		4,8		208
Urban built-up area	0,0		0,0	0,0			0,0		99,96				19596
Water areas												100	19861
Grand Total 1976 (Hectares)	263100	750	44358	3116	7316	4581	59431	6224	45150	31	54983	19875	508915

Table B – Land Use Transition Matrix – Composition of 1976 Land Use from 1966 Land Use

Percentage of 1976 Grand Total (%)	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swampmarsh or bog	Unimproved pasture and range land	Unproductive landrock	Urban built-up area	Water areas	Grand Total 1966 (Hectares)
Cropland	89,0	84,5	0,1	63,6	10,2	13,5	8,1	17,2	41,9		38,9		284295
Horticulture	0,0	1,6				0,0					0,0		23
Improved pasture and forage crops	0,2	0,9	99,5	1,9	1,8	0,9	0,6	1,2	2,2		0,9	0,0	46750
Mines quarries sand and gravel pits	0,0		0,0	23,0	0,9	2,0	0,3	0,0	0,5		0,6		1681
Non-productive woodland	0,9	1,2	0,0	1,6	22,2	9,6	16,6	1,4	5,6		3,8		19084
Outdoor recreation	0,0					32,4			0,0		0,4		1735
Productive woodland	1,6	1,6	0,1	3,6	5,6	12,9	30,5	1,2	4,6		5,0		28450
Swampmarsh or bog	0,8	0,5	0,0	0,3	12,1	2,6	2,5	51,3	6,5		1,2		11336
Unimproved pasture and range land	7,5	9,6	0,2	6,0	47,2	25,7	41,3	27,7	38,6		13,5		75896
Unproductive landrock	0,0				0,0	0,0	0,2			100,0	0,0		208
Urban built-up area	0,0		0,0	0,0			0,0				35,6		19596
Water areas												99,9	
Grand Total 1976 (Hectares)	263100	750	44358	3116	7316	4581	59431	6224	45150	31	54983	19875	508915

Table C – Raw Data of Transition Matrix – Land Use 1966 vs. 1976

Sum of COUNT (Hectares)	Cropland	Horticulture	Improved pasture and forage crops	Mines quarries sand and gravel pits	Non-productive woodland	Outdoor recreation	Productive woodland	Swampmarsh or bog	Unimproved pasture and range land	Unproductive landrock	Urban built-up area	Water areas	Grand Total 1966 (Hectares)
Cropland	234099	634	57	1981	747	617	4803	1068	18916		21373		284295
Horticulture	8	12				1					2		23
Improved pasture and forage crops	459	7	44133	59	131	43	359	74	1006		477	2	46750
Mines quarries sand and gravel pits	73		2	716	64	90	153	3	226		354		1681
Non-productive woodland	2398	9	10	51	1627	438	9851	87	2542		2071		19084
Outdoor recreation	3					1482			5		245		1735
Productive woodland	4245	12	32	112	409	589	18140	76	2084		2751		28450
Swampmarsh or bog	2003	4	14	8	886	118	1458	3193	2956		687		11336
Unimproved pasture and range land	19794	72	108	188	3450	1177	24541	1723	17415		7425		75896
Unproductive landrock	14				2	26	125			31	10		208
Urban built-up area	4		2	1			1				19588		19596
Water areas												19861	
Grand Total 1976 (Hectares)	263100	750	44358	3116	7316	4581	59431	6224	45150	31	54983	19875	508915

Table D – Percentage Change in Total Hectares for each Land Use between 1966 and 1976

Percentage change in number of hectares for each land use between 1966 and 1976:

Cropland	- 7 %	Swamp marsh or bog	-45 %
Horticulture	+ 3161 %	Unimproved pasture and range land	-41 %
Mines quarries sand and gravel pits	+ 85 %	Unproductive land rock	-85 %
Non-productive woodland	- 62 %	Urban built-up area	+ 181 %
Outdoor recreation	+ 164 %	Water areas	0 %
Productive woodland	+ 109 %		

Table E – Landscape Metrics 1966 vs. 1976 Total Land Use in Edmonton

Landscape metrics									
Number of Patches (NP)		Patch Density (PD) (Number per 100 hectares)		Total Edge (TE) (Metres)		Shannon's Diversity Index		Shannon's Evenness Index	
1966	1976	1966	1976	1966	1976	1966	1976	1966	1976
7352	7736	1,141	1,201	15463800	15002600	1,416	1,5383	0,5699	0,6191

Table F – Spatial Statistics for Land Use Classes in Edmonton 1966 vs. 1976

	Total Area (CA) (hectares)		Percentage of landscape (PLAND)		Number of patches (NP)		Total Edge (TE) meters		Coefficient of Variation of Patch Area (AREA_CV)		Shape Index - Mean (SHAPE_MIN)		Total Core Area (TCA) (Hectares)		Core Area percent of landscape (CPLAND)		Number of Disjunct Core Areas (NDCA)	
	1966	1976	1966	1976	1966	1976	1966	1976	1966	1977	1966	1976	1966	1976	1966	1976	1966	1976
Water areas	19861	19875	3,08	3,0866	337	340	930100	934600	599,7003	602,0022	1,3198	1,3189	13003	13003	2,0	2,0	238	238
Cropland	284664	263105	44,18	40,8601	579	709	11119000	9334000	1498,1967	1121,912	1,6392	1,5205	196305	190266	30,5	2,0	1349	928
Unimproved pasture and range land	75934	45154	11,79	7,0124	2597	1715	8103500	4675200	525,5473	281,4969	1,4701	1,405	24261	15687	3,8	29,5	1922	1183
Improved pasture and forage crops	46750	44358	7,26	6,8888	2132	2170	5302700	5258100	186,3394	169,2857	1,3557	1,3403	11720	10710	1,8	2,4	1547	1489
Productive woodland	28450	59439	4,42	9,2308	843	1718	2750700	5879400	263,1711	414,5431	1,4933	1,4841	10701	22774	1,7	1,7	670	1291
Non-productive woodland	19086	7316	2,96	1,1362	517	403	1718500	864800	339,773	219,4666	1,5178	1,374	7816	2236	1,2	3,5	413	203
Mines	1681	3116	0,26	0,4839	99	84	197600	262100	154,1402	342,119	1,2398	1,3176	508	1405	0,1	0,3	47	61
Urban built-up areas	19596	54995	3,04	8,5407	133	417	548800	2339800	604,8148	703,7032	1,2798	1,4787	15708	38268	2,4	0,2	88	384
Outdoor recreation	1735	4582	0,27	0,7116	80	126	202100	368600	132,3644	249,2571	1,3764	1,3274	563	2152	0,1	5,9	47	79
Horticulture	23	750	0,00	0,1165	5	44	4200	77400	89,7381	131,8307	1,0286	1,1377	0	255	0,0	0,3	0	22
Unproductive land - sand	36	18	0,01	0,0028	16	6	10100	4800	83,887	81,6497	1,1083	1,1667	0	0	0,0	0,0	0	0
Unproductive land - rock	208	31	0,03	0,0048	14	4	40300	6400	65,4976	136,0587	1,7833	1,2955	5	0	0,0	0,0	2	0

Table G – Description and Codes of Land Use Data from GeoGratis

B	Urban built-up area	Built-up area. Land occupied by cities, towns, and villages, or by isolated units away from settlements such as manufacturing plants, rail yards, and military camps. Parks and other open spaces within built-up areas are also included.
E	Mines, quarries, sand and gravel pits	Mines, quarries, sand and gravel pits, open excavations. Land used in the past or present for the extraction of earth materials.
O	Outdoor recreation	Outdoor recreation - Land used for private or public outdoor recreational purposes. Some examples are: golf courses, parks, beaches, summer cottage areas, game preserves and historic sites.
H	Horticulture	Horticulture, poultry and fur operations. Land used for intensive cultivation of vegetables and small fruits, includes market gardens, nurseries, flower and bulb farms and sod farms. Large scale commercial fur and poultry farms are also included because of their specialized agricultural nature.
G	Orchards and vineyards	Orchards and vineyards. Land used for the production of tree fruits, hops and grapes.
A	Cropland	Cropland - Land used for annual field crops such as grain, oilseeds, sugar beets, tobacco, potatoes, field vegetables and canning crops. Associated fallow, and land being cleared for field crops are also included.
P	Improved pasture and forage crops	Improved pasture and forage crops.- Land used for improved pasture or for the production of hay and other cultivated fodder crops, including land being cleared for these purposes.
K	Unimproved pasture and range land	Rough grazing and range land. Areas of natural grasslands, sedges, herbaceous plants and abandoned farmland whether used for grazing or not. Bushes and trees may cover up to 25% of the area. Intermittently wet hay lands (sloughs or meadows) are included as long as the land is utilized. Within some grassy, open woodlands, bushes and trees may exceed 25% cover if the area is actively grazed and no other use dominates.
T	Productive woodland	Productive woodland. Wooded land with trees having over 25% canopy cover and being over 20 feet in height approximately. Artificially restocked areas, or plantations are included regardless of age. Much cut-over and burned-over land is included.
U	Non-productive woodland	Non-productive woodland. Land covered by scrub growth.
M	Swamp, marsh or bog	Swamp, marsh, or bog. Open wetlands except those which frequently dry up or show evidence of grazing or hay cutting.
S	Unproductive land - sand	Sand, sand bars, sand flats, dunes and beaches -Unproductive unconsolidated land which does not support vegetation.
L	Unproductive land - rock	Rock and other unvegetated surfaces - rock barrens, badlands, alkaline flats, gravel bars, eroded river banks, mine dumps. Unproductive land which does not support vegetation.
8	Unmapped areas	Unmapped areas
Z	Water areas	Additional code added during data integration for water areas based on the CLI shoreline maps.

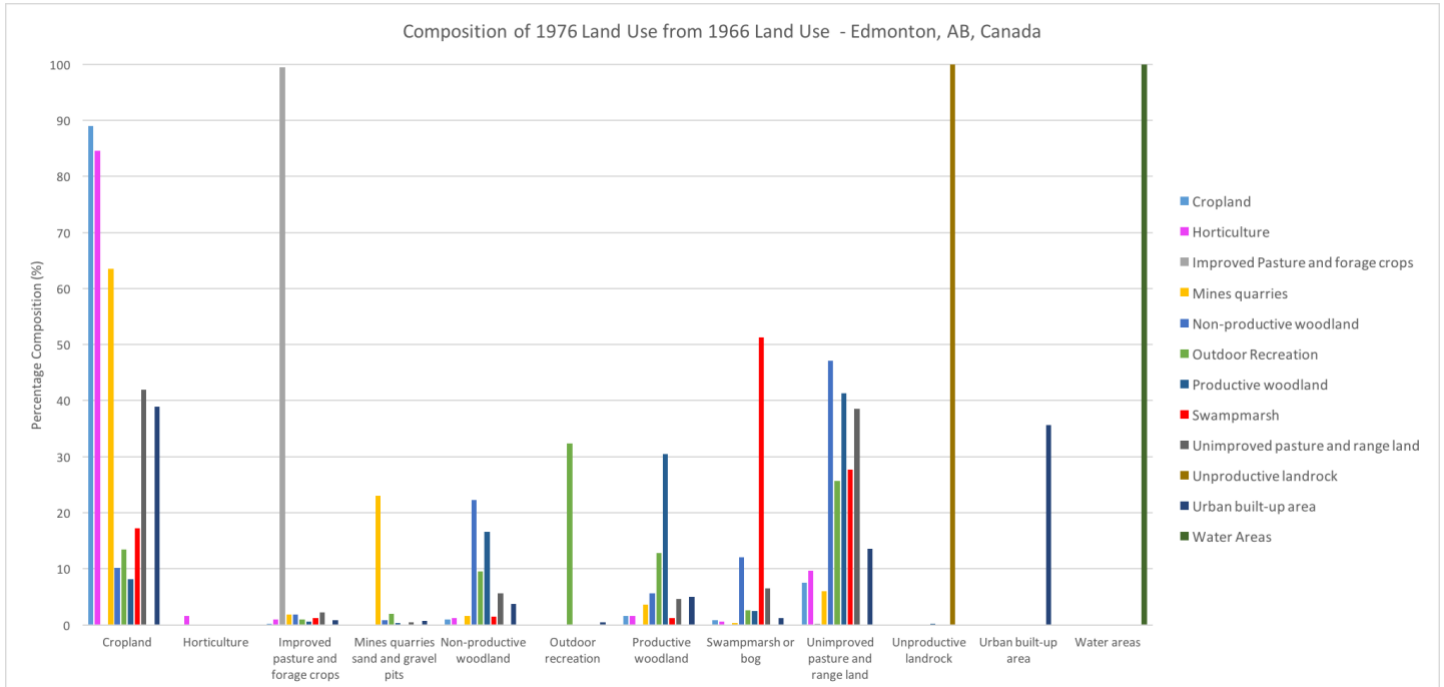
Table H – Description of Class and Landscape Metrics

Class Metrics	
Total Area (TA)	TA equals the total area (m ²) of the landscape, divided by 10,000 (to convert to hectares). TA excludes the area of any background patches within the landscape.
Percentage of Landscape (PLAND)	%LAND equals the sum of the areas (m ²) of all patches of the corresponding patch type, divided by total landscape area (m ²), multiplied by 100 (to convert to a percentage); in other words, %LAND equals the percentage the landscape comprised of the corresponding patch type. Note that %LAND is equivalent to LSIM at the patch level.
Number of Patches (NP)	NP equals the number of patches in the landscape. Note, NP does not include any background patches within the landscape or patches in the landscape border.
Total Edge (TE)	TE equals the sum of the lengths (m) of all edge segments in the landscape. If a landscape border is present, TE includes landscape boundary segments representing true edge only (i.e., contrast weight > 0). If a landscape border is absent, TE includes a user-specified proportion of the landscape boundary. Regardless of whether a landscape border is present or not, TE includes a user-specified proportion of background edge.
Coefficient of Variation of Patch Area (AREA_CV)	CACV2 equals the standard deviation in the size of disjunct core areas (CASD2) divided by the mean size of disjunct core areas (MCA2) of the corresponding patch type, multiplied by 100 (to convert to percent); that is, the variability in core area relative to the mean core area. Note, this is the population coefficient of variation, not the sample coefficient of variation, and that CACV2 represents the variation in size of disjunct core areas, not patch core areas, as in CACV1.
Shape Index - Mean (SHAPE_MN)	SHAPE equals patch perimeter (m) divided by the square root of patch area (m ²), adjusted by a constant to adjust for a circular standard (vector) or square standard (raster).
Total Core Area (TCA)	TCA equals the sum of the core areas of each patch (m ²), divided by 10,000 (to convert to hectares).
Core Area percent of landscape (CPLAND)	C%LAND equals the sum of the core areas of each patch (m ²) of the corresponding patch type, divided by total landscape area (m ²), multiplied by 100 (to convert to a percentage); in other words, C%LAND equals the percentage the landscape comprised of core area of the corresponding patch type.
Number of Disjunct Core Areas (NDCA)	Equals the sum of number of disjunct core areas contained within each patch of the corresponding patch type, divided by total landscape area, multiplied by 10,000 and 100 (to convert to 100 hectares).

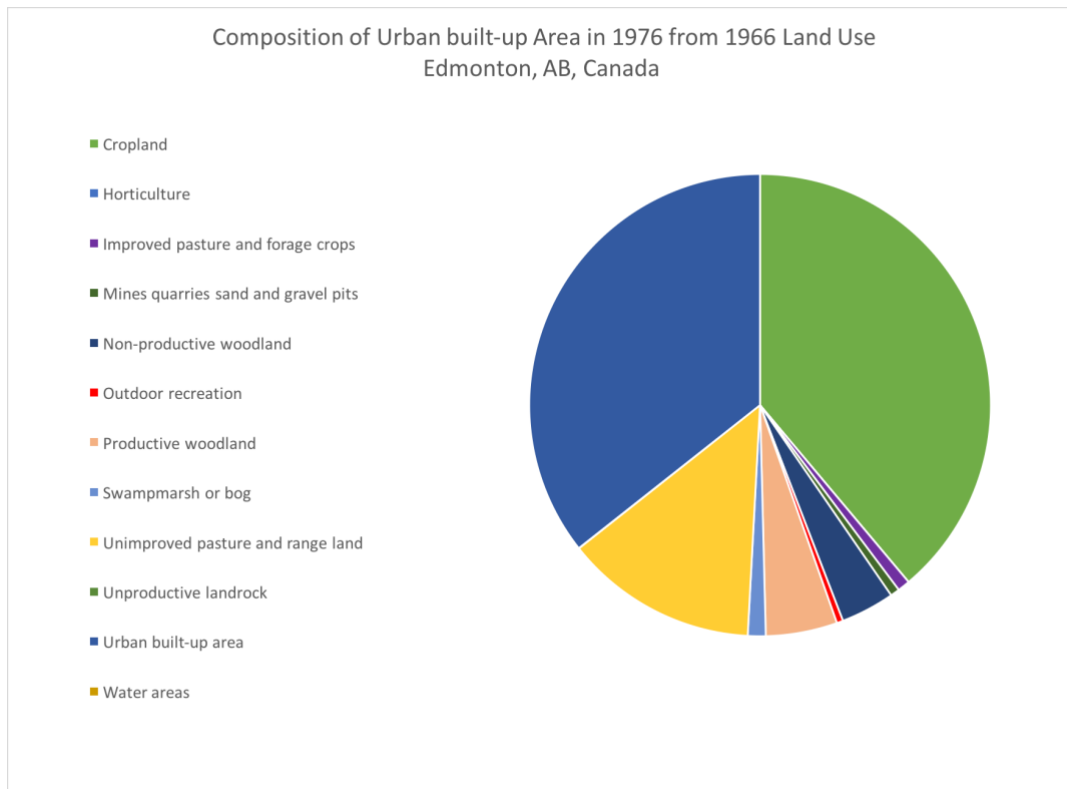
Landscape metrics	
Number of Patches (NP)	NP equals the number of patches of the corresponding patch type (class).
Patch Density (PD)	PD equals the number of patches of the corresponding patch type (NP) divided by total landscape area, multiplied by 10,000 and 100 (to convert to 100 hectares).
Total Edge (TE)	TE equals the sum of the lengths (m) of all edge segments involving the corresponding patch type. If a landscape border is present, TE includes landscape boundary.
Shannon's Diversity Index (SHDI)	Shannon's diversity index is a popular measure of diversity in community ecology, applied here to landscapes. Shannon's index is somewhat more sensitive to rare patch types than Simpson's diversity index. SHDI = 0 when the landscape contains only 1 patch (i.e., no diversity).
Shannon's Evenness Index (SHEI)	The Shannon evenness index, abbreviated as SEI, provides information on area composition and richness. SHEI equals minus the sum, across all patch types, of the proportional abundance of each patch type multiplied by that proportion, divided by the logarithm of the number of patch types. In other words, the observed Shannon's Diversity Index divided by the maximum Shannon's Diversity Index for that number of patch types.

APPENDIX B - GRAPHS

Graph A – Composition of 1976 Land Use from 1966 Land Use



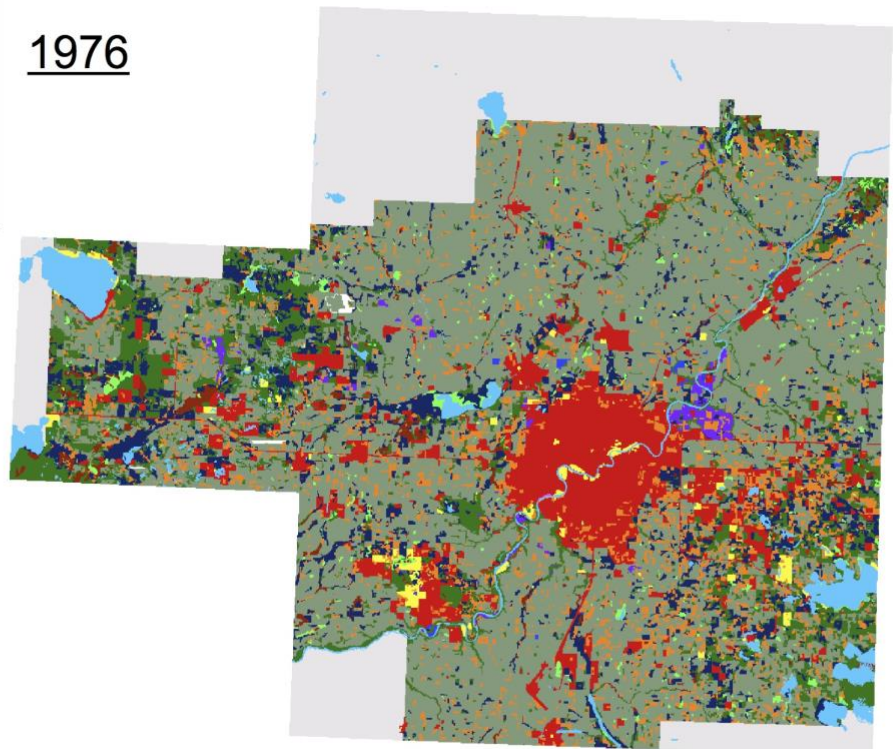
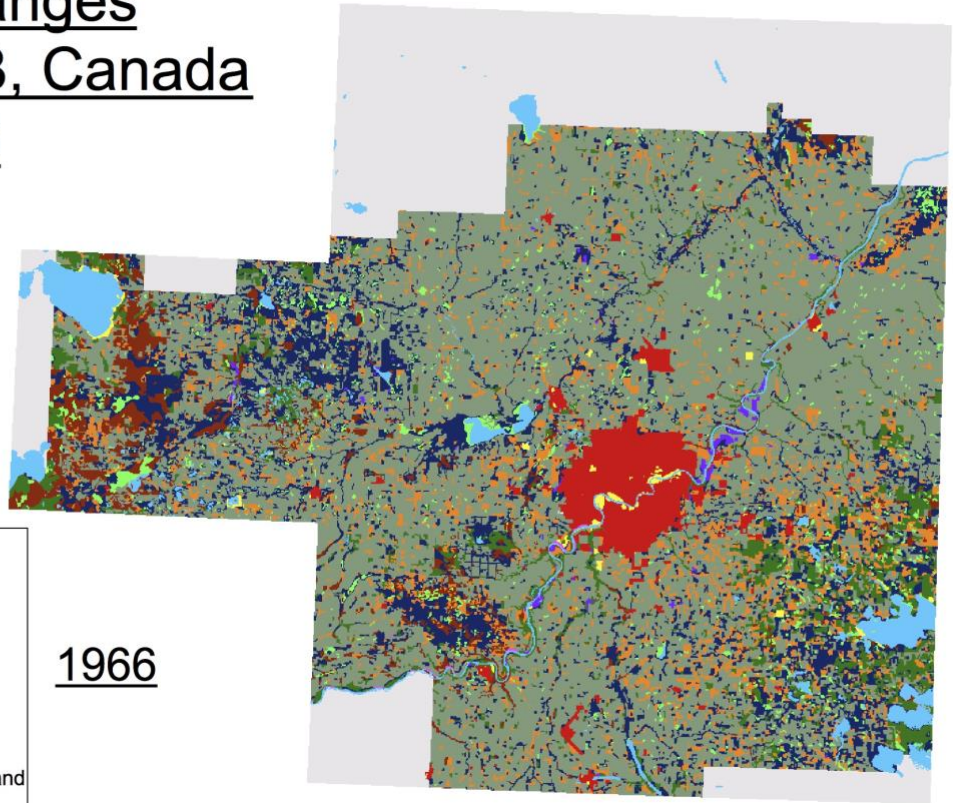
Graph B – Composition of Urban Built Areas in 1976 from 1966 Land Use

















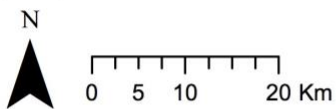
APPENDIX C - MAPS

Map 1 – Land Use Changes, Edmonton, AB, Canada, 1966 vs. 1976

Land Use Changes Edmonton, AB, Canada 1966 vs. 1976



Land Use	
	Unmapped areas
	Cropland
	Urban Built Area
	Mines
	Horticulture
	Unimproved pasture and range land
	Unproductive land - rock
	Swamp, marsh, or bog
	Outdoor Recreation
	Improved pasture and forage crops
	Unproductive land - sand
	Productive woodland
	Non-productive woodland
	Water

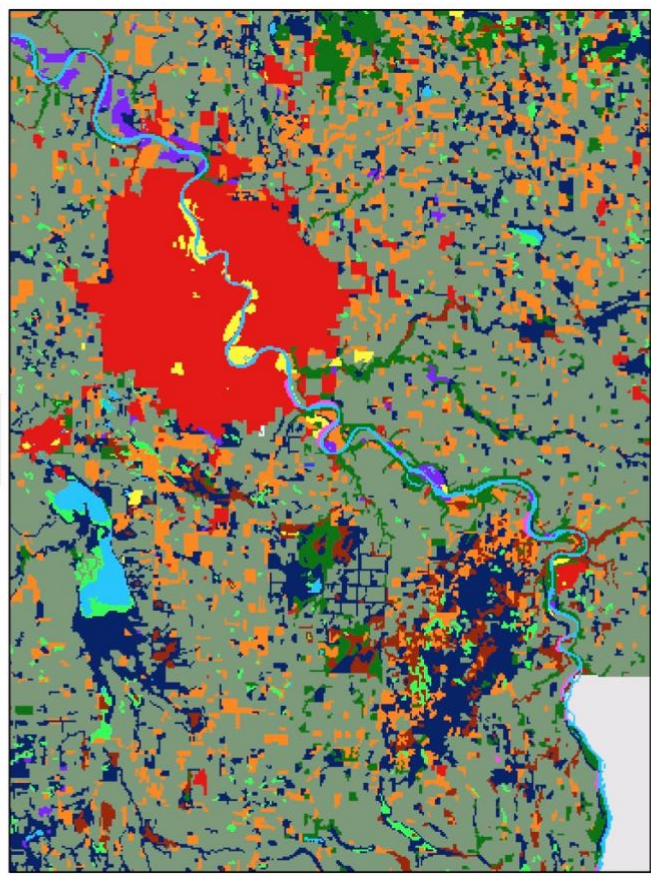


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January 2018
Data: GeoGratis
Raster resolution: 100m
Coordinate System: NAD 1927 UTM Zone 12N
Projection: Transverse Mercator

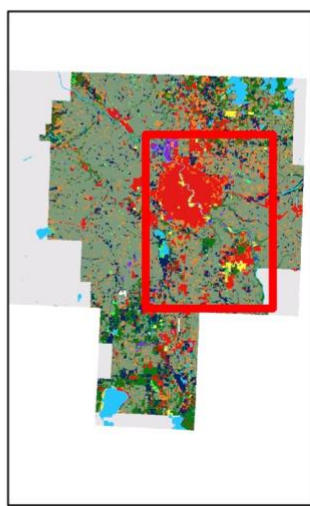
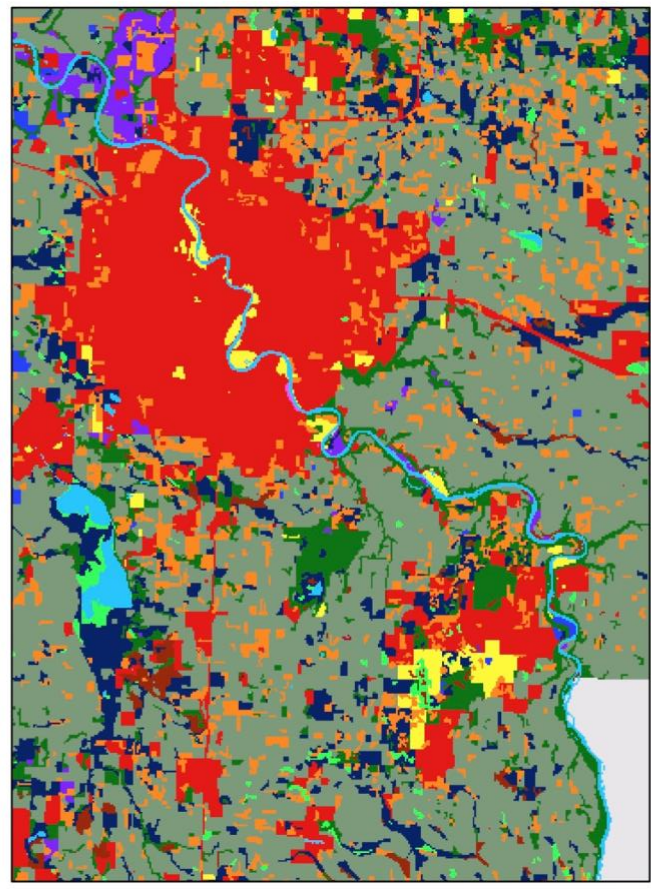
MAP 2 – Urbanization in Edmonton, AB, Canada, 1966 vs. 1976

Urbanization - Land Use Changes between 1966 and 1976 - Edmonton, AB, Canada

1966



1976



Land Use

- Unmapped areas
- Cropland
- Urban Built Area
- Mines
- Horticulture
- Unimproved pasture and range land
- Unproductive land - rock

- Swamp, marsh, or bog
- Outdoor Recreation
- Improved pasture and forage crops
- Unproductive land - sand
- Productive woodland
- Non-productive woodland
- Water

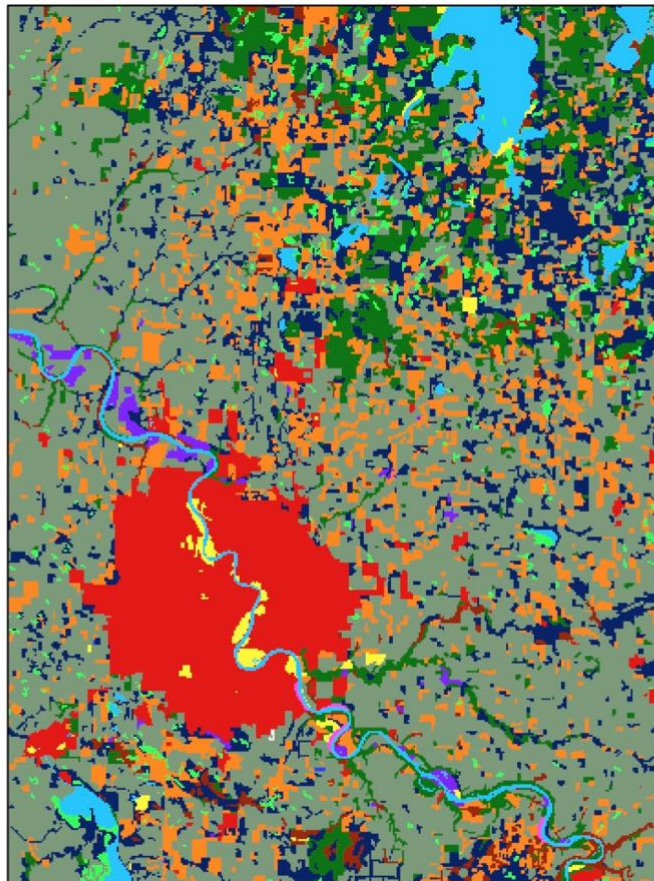


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 Data: GeoGratis
 Raster resolution: 100m
 Coordinate System: NAD1927 UTM Zone 12
 Projection: Transverse Mercator

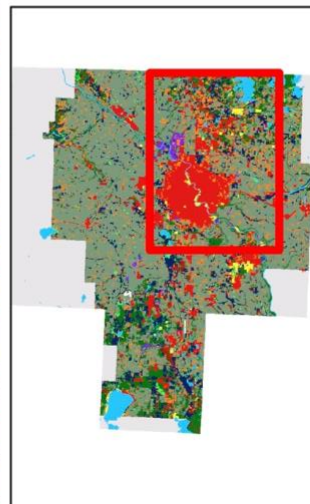
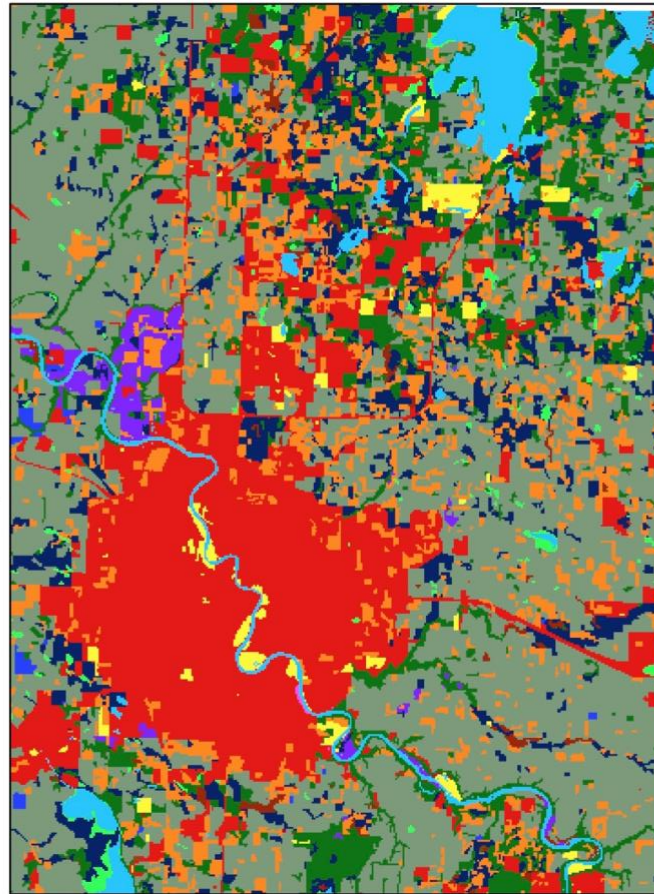
MAP 2 – Land Use Changes in Edmonton, AB, Canada, 1966 vs. 1976

Land Use Changes between 1966 and 1976 - Edmonton, AB, Canada








1966




1976



Land Use

-  Unmapped areas
-  Cropland
-  Urban Built Area
-  Mines
-  Horticulture
-  Unimproved pasture and range land
-  Unproductive land - rock

-  Swamp, marsh, or bog
-  Outdoor Recreation
-  Improved pasture and forage crops
-  Unproductive land - sand
-  Productive woodland
-  Non-productive woodland
-  Water



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 Coordinate System: NAD1927 UTM Zone 12
 Projection: Transverse Mercator