City of Saskatoon Ecological Footprint Report 2014

A report prepared for The City of Saskatoon

Community Services Department, Planning and Development Division

Corporate Performance Department, Environmental and Corporate Initiatives Division

Prepared by Anielski Management Inc.
(Jeff Wilson and Mark Anielski)

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City of Saskatoon
Ecological Footprint Report 2014

A report on the ecological footprint and other select household consumption indicators

Prepared for

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Executive Summary

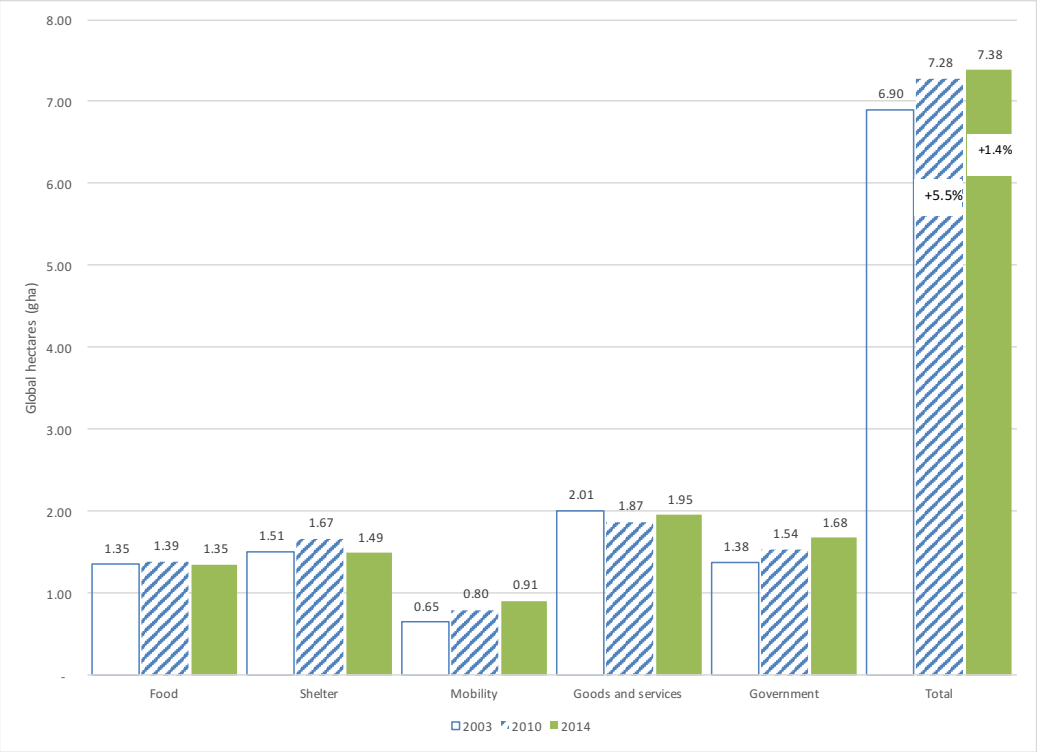
The City of Saskatoon has committed to reporting the ecological footprint as part of a larger indicator framework to track and measure progress towards sustainability and quality of life objectives. The ecological footprint is a sustainability accounting tool that measures the environmental impact of human consumption. Saskatoon's ecological footprint accounts for our population's consumption of food, transportation, housing, goods and services, and government services and expresses the findings in terms of the land area needed to support that level of consumption.

The ecological footprint inverts the traditional concept of 'carrying capacity' (the population a given region could support) and instead seeks to determine the total land area required, regardless of where that land is located, to sustain a given population. The ecological footprint is unique in that it accounts for the environmental impacts of consumption regardless of where the burden of that consumption falls in terms of production costs and pollution (Rees and Wackernagel, 1996). ***The Saskatoon ecological footprint, therefore, is the sum environmental impact of all Saskatoon residents' consumption no matter where in the world the environmental impact occurs***. The ecological footprint expresses results in global hectares. A global hectare is a standardized hectare to account for the fact that different land types and different land categories have different productivity or biocapacity potentials.

In 2014, the average per capita Saskatoon ecological footprint was 7.38 global hectares per person or a total area of 1.88 million global hectares of land. The ecological footprint total area for Saskatoon is 78 times larger than the geographic area of the City. Saskatoon's ecological footprint per person grew by 1.4% between 2010 and 2014 (Figure 1).

Three footprint components contributed to the overall increase: goods and services (+3.8%), government services (+8.8%) and transportation (+13.9%). Increases in these components were offset by a 10.9% decrease in the shelter component. The rise in the goods and services component and government services component reflect higher levels of household and government spending per person (in constant dollars). The rise in the transportation component reflects an increase in air travel and an increase in fuel consumption.

Figure 1: Saskatoon ecological footprint 2003, 2010, 2014 (summary)



The rise in ecological footprint between 2010 and 2014 coincided with a period of rapid economic development in Saskatoon as reflected in key socio-economic indicators. Gross domestic product (GDP) per person, household income, and household spending for example all increased by over 10% (Table 1).

Table 1: Key socio-economic indicators

	% change 2010 to 2014
GDP per person (Saskatoon CMA)	+ 11.6%
Employment (Saskatoon CMA)	+20.0%
Household median income	+ 12.7%
Household spending	+ 10.6%
Average home price	+17.7%
Population	+ 9.7%
Ecological Footprint per person	+1.4%

In comparison, the increase in the ecological footprint per person was considerably less than changes in other key socio-economic indicators. In addition to these indicators, two key ecological footprint components decreased, the shelter footprint (-11%) and the food footprint (- 3%).

The good news was reflected in other indicators of environmental performance as well (Table 2). For example, household electricity use, natural gas use, household waste going to landfill and greenhouse gas emissions (GHG) associated with public transit all decreased while public transit ridership increased.

Table 2: Environmental performance indicators (change 2010-2014)

	% change 2010 to 2014
Electricity use per household	- 9.1%
Natural gas use per household	-15.5%
Household waste to landfills	- 13.4%
Public transit GHG emissions	-6.7%
Public transit ridership	+ 0.2%

Overall, environmental performance by Saskatoon households in 2014 is summarized as follows:

Table 3: Household environmental performance indicators (summary)

Average Saskatoon Environmental Performance	
Ecological footprint per household	17.5 gha
Direct GHG emissions	17.3 tonnes of CO_2e
Shelter emissions	9.4 tonnes of CO_2e
Transportation emissions	9.4 tonnes of CO_2e
Water use	560 liters
Waste to landfills	771 kg
Waste diverted from landfills	338 kg

Introduction

The City of Saskatoon has committed to reporting the ecological footprint as part of a larger indicator framework to track and measure progress towards sustainability and quality of life objectives. Saskatoon's ecological footprint accounts for our population's consumption of food, transportation, housing, goods and services, and government services. The findings are converted to the total land area (global hectares) needed to support our population's consumption demands to make it easier to compare the impacts of different types of consumption.

This report updates Saskatoon's ecological footprint for the year 2014; the previous ecological footprint was calculated in year 2010. In addition to reporting an ecological footprint, the 2014 update reports a series of household consumption indicators. Expanding the suite of indicators offers a more complete understanding of household environmental impact and complements the ecological footprint as a broad measure of household sustainability. Further, it offers a more robust framework to track progress of sustainability efforts targeting households over time.

Household consumption indicators reported in 2014 update include:

- Ecological footprint
- Ecological footprint by consumption category (food, shelter, goods and services, transportation, government services)
- Direct greenhouse gas emissions – shelter (electricity and natural gas)
- Direct greenhouse gas emissions – transportation (personal transportation, transit)
- Residential waste (landfill, recycling, compost)
- Residential water use

The selected suite of indicators offers community leaders, policy makers and city planners useful information to help develop sustainability strategies targeting the household sector. Further, the findings can be used to raise awareness and educate citizens about the sustainability impacts of lifestyle choices and inspire and promote dialogue to encourage household behaviour change.

The Average Saskatoon Household
Environmental Performance

- Ecological footprint: 17.5 gha
- Direct GHG: 17.3 tonnes of CO_2e
  - *Shelter - 9.4 tonnes of CO_2e*
  - *Transportation - 7.9 tonnes of CO_2e*
- Water use: 560 liters
- Waste to landfills: 771 kg
- Waste diverted from landfills: 338 kg

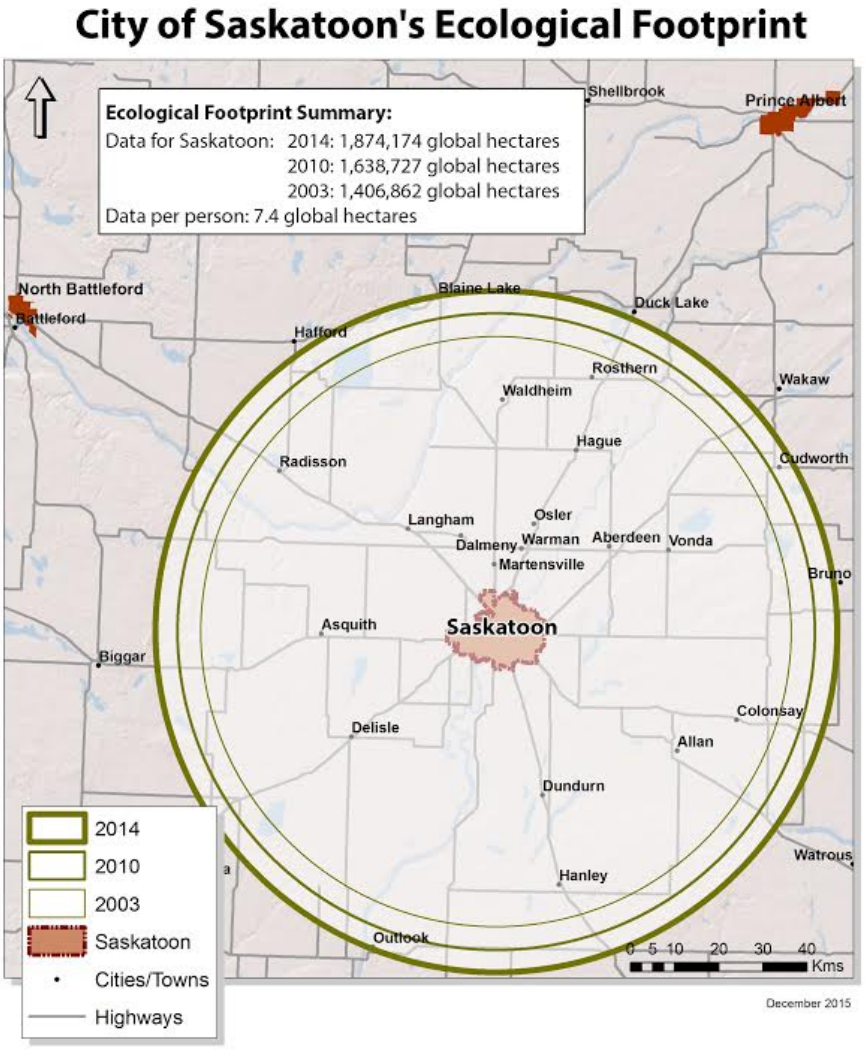
While the focus of the report is to update the 2010 ecological footprint, time series data points are presented for the additional indicators as well. Household consumption indicators are discussed in terms of broader progress toward reducing household environmental impacts.

Saskatoon Ecological Footprint

The average Saskatoon household used 17.5 global hectares (43.2 acres) of land in 2014 which is the equivalent of 27% of a quarter section of farm land.

The average ecological footprint of a Saskatoon resident in 2014 was 7.4 global hectares per person (gha/person) or 17.5 gha per household. In terms of total area, the city's ecological footprint of Saskatoon's 107,424 households far exceeds its geographic area. Saskatoon's total ecological footprint occupied almost 1.9 million global hectares. This is more than 78 times larger than the city's total land area (23,637 hectares). Figure 2 depicts how Saskatoon's ecological footprint has grown between 2003 and 2014 in relation to City boundaries.

Figure 2: Saskatoon's ecological footprint



The Saskatoon ecological footprint is able to exceed the political boundaries of the city as it is a measure of total household consumption of Saskatoon residents. The indicator accounts for the consumption of materials and energy of a given population regardless of where the extraction, production, and manufacturing occur. In fact, the majority of Saskatoon's ecological footprint falls outside its borders. Because of trade the impacts associated with resource extraction, food production, manufacturing and distribution, for example, do not necessarily occur within Saskatoon, Saskatchewan or Canada for that matter. As an indicator, the ecological footprint accounts for the impacts of consumption regardless of where in the world they take place.

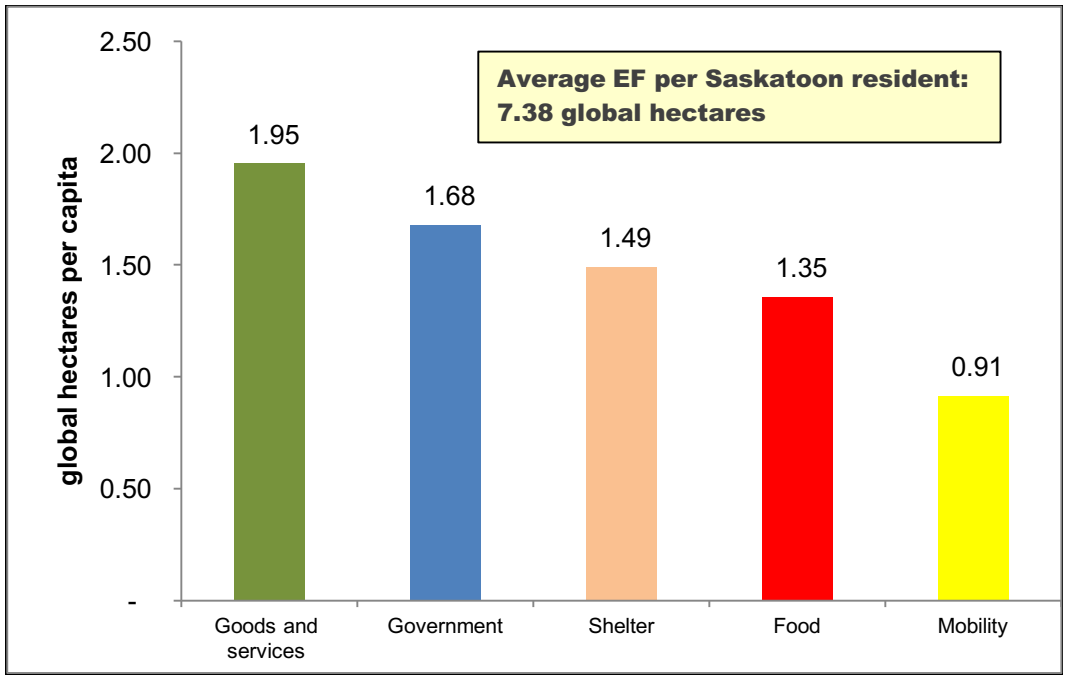
Global Sustainability Perspective

Similar to other Canadian cities, Saskatoon's ecological footprint remains substantially higher than the global sustainability threshold of 1.7 hectares per capita (Living Planet Report, 2014). The global sustainability threshold is determined by taking the total amount of bioproductive space in the world and dividing it by the total population. Assuming an equal distribution of bioproductive space among the global population, Saskatoon residents, on average, are using over four times more than their 1.7 hectare share of the global bioproductive space.

Ecological footprint by consumption category

The Saskatoon ecological footprint can be broken down by consumption category (Figures 3, 4). Consumption categories include food, shelter, personal transportation, goods and services, and government.

Figure 3: Saskatoon ecological footprint by consumption category



The consumption of goods and services makes up 26% of the total ecological footprint, the largest of the footprint categories (Figure 4). The goods and services component has contributed most to the increase in ecological footprint since the year 2003 (Table 4) increasing 29% between 2003 and 2014. Since 2010, the goods and services component has increased by 4%. The goods and services category accounts for all the stuff we buy and the services we use other than those directly related to food, housing and transportation. These include recreation expenditures, entertainment, computer equipment, education supplies, legal and financial services, gambling, tobacco and alcohol products, insurance, pension fund contributions and charitable giving. Expenditure data are from the Statistics Canada Survey of Household Spending. To compare results between years, expenditures are adjusted by the Consumer Price Index to ensure constant dollars. The increase in this component of the footprint correlates with the rise in household incomes and wealth in Saskatoon.

Government services makes up 23% of the total ecological footprint. Government services would include such things as roads, schools, health care, garbage collection, and snow removal. The government services component of the footprint is estimated based on government expenditures from City and Provincial accounts. To compare results between years, government expenditures are adjusted by the Consumer Price Index to ensure constant dollars. Similar to the goods and services component, the strong economy between 2003 and 2014 has contributed to the 21% rise in the government services component of the ecological footprint; the government services footprint increased by 9% between 2010 and 2014.

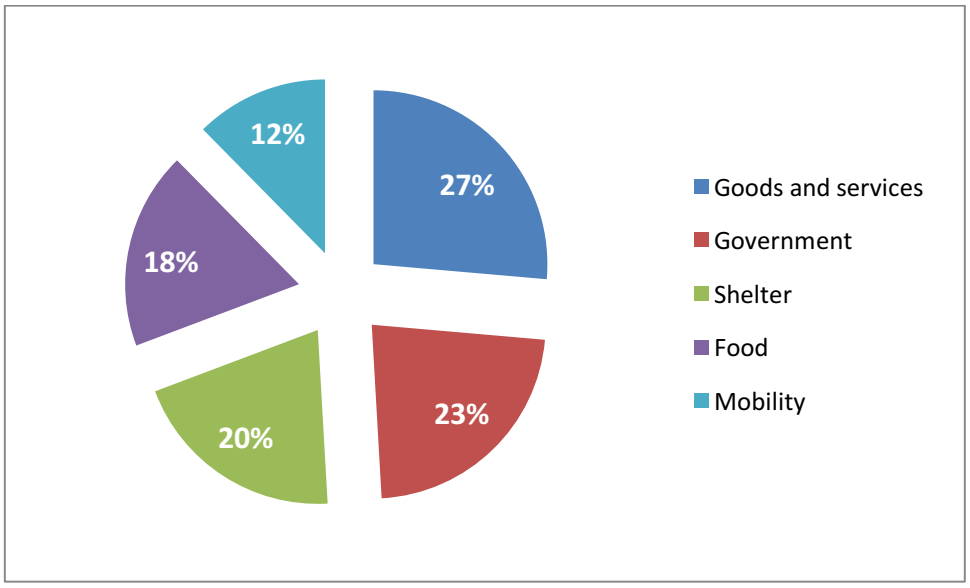
Shelter, which includes household energy consumption as well as the materials and energy used to maintain the shelter, makes up 20% of the total ecological footprint. The shelter footprint component has been steadily declining since 2003 falling by 26%. Between 2010 and 2014 the shelter footprint fell by 11%. The steady decline in the shelter footprint category has played a critical role in offsetting increases in the other footprint categories such as transportation and household goods and services. The energy component is calculated directly using electricity data and natural gas data provided by the City of Saskatoon from the utility companies. The non-energy component of the shelter footprint is based on household square footage data provided by the City of Saskatoon.

The food category makes up 18% of the ecological footprint and includes the impacts from the production phase through to consumption. The food footprint has been mostly unchanged since 2003. The food footprint is based on expenditures on food from the Survey of Household Spending. To compare results between years, food expenditures are adjusted by the Consumer Price Index to ensure constant dollars.

Personal transportation accounts for 12% of the ecological footprint. The transportation footprint has increased by 14% between 2010 and 2014. Since 2003 it has increased by 40%. The category accounts for private vehicle use, public transit, air travel and rail travel. Private vehicle use contributes most to the respective category (54%) followed by air travel (40%). The transportation footprint is estimated based on a combination of expenditure data from the Survey of Household Spending and fuel

consumption provided by the City of Saskatoon. For a description of consumption categories, ecological footprint calculation approach and source references, see Appendix A.

Figure 4: Saskatoon ecological footprint by component



Historical Comparisons, 2003, 2010, 2014

Saskatoon's ecological footprint per person increased by 0.10 gha between 2010 and 2014 (Tables 4, 5 and Figure 5). Three categories increased: government services (0.14 gha/ person), transportation (0.11 gha/person), and goods and services (0.08 gha/person). The food component (0.04 gha/ person) and shelter components (0.18 gha/person) decreased. Since the initial Saskatoon ecological footprint estimate for 2003, Saskatoon's ecological footprint per person has increased by 7% (Wilson and Anielski, 2004).

Table 4: Saskatoon ecological footprint - 2003, 2010, 2014

EF (gha/person)	Goods and services	Food	Shelter	Transportation	Govt.	Total
Saskatoon (2014)	1.95	1.35	1.49	0.91	1.68	**7.38**
Saskatoon (2010)	1.87	1.39	1.67	0.80	1.54	**7.28**
Saskatoon (2003)	1.51	1.35	2.01	0.65	1.38	**6.90**

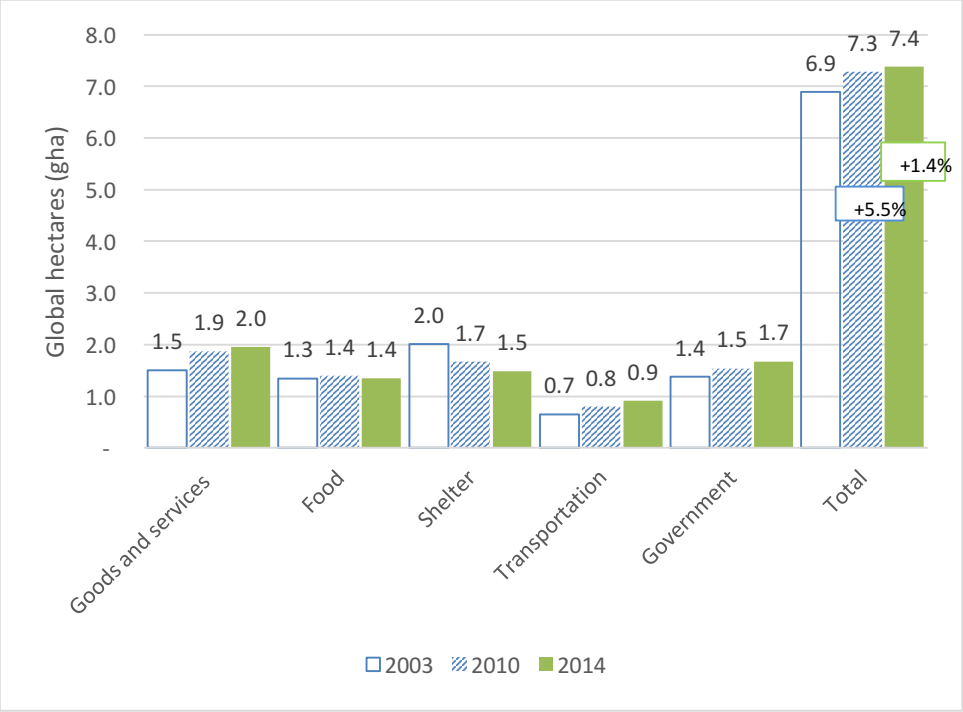
Table 5 shows the percentage changes in the ecological footprint components by consumption category between 2010 and 2014 and between 2003 and 2014. Since 2003, in percentage terms, the transportation category has increased the most (+40%). In terms of overall impact, however, the good and services category has risen the most (0.44 gha/person).

Table 5: Ecological footprint per capita – percentage change

	2010-2014		2003-2014	
Goods and services	+	4%	+	29%
Food	-	3%		unchanged
Shelter	-	11%	-	26%
Transportation	+	14%	+	40%
Government	+	9%	+	21%
Ecological footprint	+	1%	+	7%

Between 2010 and 2014, the transportation (+14%), government services (+9%) and goods and services (+4%) components contributed to the rise in ecological footprint. A decrease in the shelter component by 11% helped offset the increases in terms of total ecological footprint. Similar to the 2010-2014 period, the rise in the transportation, goods and services and government services components largely explain the 7% increase in ecological footprint per person between 2003 and 2014. In terms of total contribution to the footprint, transportation represents 12% whereas the goods and services component represents 27%. The shelter component (which includes household energy use) has declined substantially (down 26%) while the food component has remained relatively unchanged since 2003. Figure 5 compares the Saskatoon ecological footprint by component for the years 2003, 2010 and 2014.

Figure 5: Saskatoon ecological footprint 2003, 2010, 2014



Ecological footprint comparisons – total footprint

In terms of total land area, Saskatoon's ecological footprint has increased by 34% since 2003, from 1,406,862 global hectares (3,474,948 acres) in 2003 to 1,878,174 global hectares (4,641,069 acres) in 2014 (Table 3). To put this growth into context, the net growth of 471,312 global hectares (1,164,637 acres) in total ecological footprint area since 2003 is the equivalent of 691 Saskatchewan farms (which average 1,688 acres per farm). Over the same period, Saskatoon's population grew by 24.9% from 203,893 in 2003 to 254,569 in 2014. The rise in Saskatoon's total ecological footprint reflects an increase in population size (+25%) and an increase in ecological footprint per person (+7%).

Table 6: Saskatoon, total ecological footprint area (2003, 2010, 2014)

EF (Global hectares)	Goods and services	Food	Shelter	Transportation	Govt.	Total
Saskatoon (2014)	495,456	344,866	378,799	232,440	426,613	1,878,174
Saskatoon (2010)	422,008	313,485	375,979	180,410	346,844	1,638,727
Saskatoon (2003)	307,408	274,936	409,975	133,340	280,923	1,406,581

Consumption in relation to biocapacity

Saskatoon's total ecological footprint area is 1.9 million hectares (4.6 million acres), the equivalent of 2,750 average sized farms in Saskatchewan (1,688 acres average farm size). The consumption demands of Saskatoon households alone dramatically exceed the available biocapacity in the region. Populations are able to exceed local biocapacity by importing goods and services from other regions of the country and the world.[1] Taking a regional lens, however, offers a more relevant context given that cities by their very nature depend on resources from outside their borders. If we assume a regional context to be a 100 mile radius[2] around the city, the region has an available biocapacity of 8.8 million hectares or roughly 40 hectares per Saskatoon citizen (Table 7 and Figure 6 map showing biocapacity by land type). Given the large amount of cropland and relative small population (254,569 in 2014) of Saskatoon and surrounding area, the region, in theory, has sufficient biocapacity to support the population. With a total ecological footprint area of 1,878,174 hectares in 2014, Saskatoon's households would require 21% of a 100-mile radius of available biocapacity.

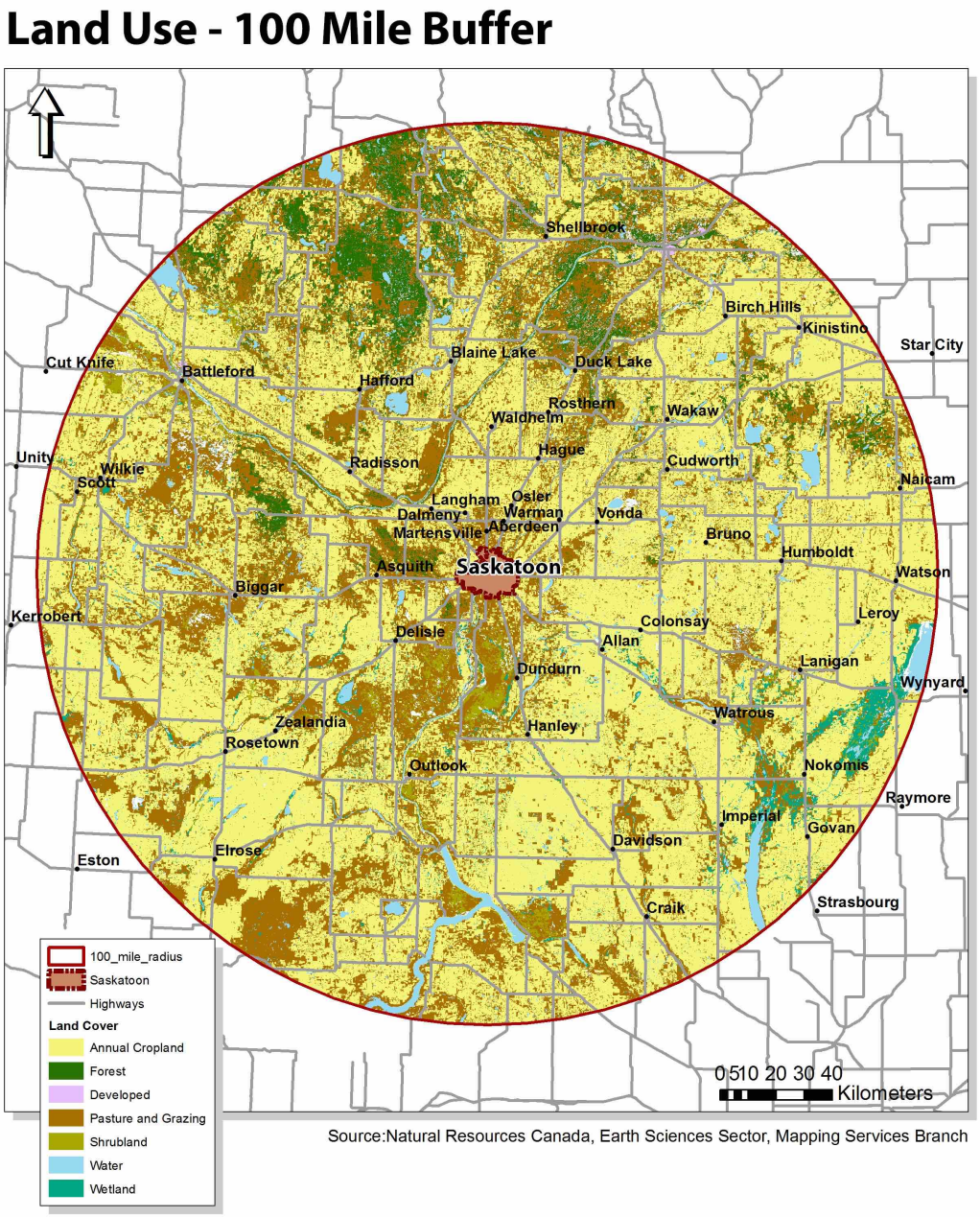
[1] In a global economy, the impact of consumption falls not just in your own backyard but all over the planet. The ecological footprint is a useful indicator because it aggregates the impact of consumption and attributes it to consumer.

[2] A 100 mile radius was selected for illustration purposes and has no scientific basis.

Table 7: Available biocapacity within a 100 mile radius of Saskatoon

Land type	Biocapacity (hectares)
Cropland	5,628,411
Grazing land	2,391,659
Mixed wood	139,787
Forest	294,580
Water	216,832
Wetland	142,815
Total	**8,814,083**

Figure 6: Biocapacity within 100 miles of Saskatoon



Household Consumption Indicators

The ecological footprint is presented alongside a series of household consumption indicators in the context of understanding the broader environmental impacts of households. Indicators focus on three aspects of household consumption: direct greenhouse gas emissions, residential waste and water use.

Direct greenhouse gas emissions

Our analysis focused exclusively on direct GHG emissions associated with the household sector (shelter and transportation). Direct GHG emissions refer to Scope 1 and Scope 2 emissions as defined by the World Resources Institute (WRI). Related to shelter, we report emissions for electricity consumption and natural gas consumption for home heating. We do not include other forms of home heating sources such as wood or oil. The focus is exclusively direct GHG emissions. We did not include indirect GHG emissions associated with energy production, distribution and trade, electricity and heating infrastructure, construction and maintenance, and operation of energy services. Our analysis also did not include the indirect emissions associated with physical shelter, such as construction, maintenance, and waste removal. For transportation, we report emissions for personal vehicle use and transit only. We did not include GHG emissions associated with air travel, rail or other forms of travel. We did not include the indirect emissions associated with transportation energy production, distribution and trade, emissions related to the manufacture, maintenance and disposal of private vehicles, as well as their transportation infrastructure, construction and maintenance, and operation of the transport business. Table 8 reports direct greenhouse gas emissions attributed to the average Saskatoon household.

Table 8: Direct greenhouse gas emission – households (tonnes of CO_2e/household)

Shelter - electricity	Shelter - natural gas	Personal transportation – vehicle use	Personal transportation – transit	Direct GHG emissions
4.24	5.16	7.83	0.05	**17.28**

Shelter

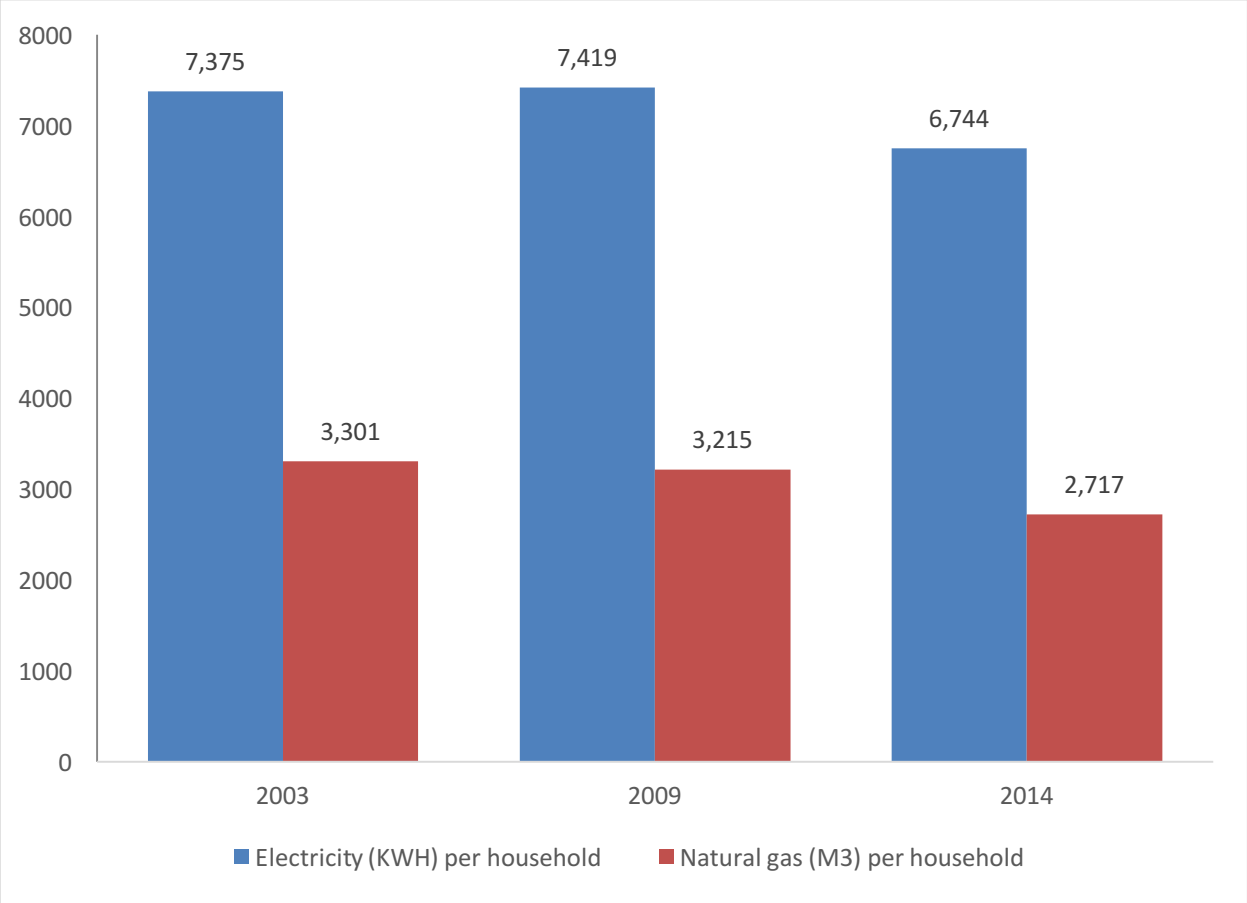
Electricity and natural gas consumption data were converted to GHG emissions using the conversion factors provided by the City of Saskatoon (2015a). In 2014, emissions attributed to household electricity use and home heating (natural gas only) totaled 9.4 tonnes of CO_2e per household. Energy consumption affiliated with Saskatoon homes (0.97 gha/person) in 2014 accounted for 13.2% of the total ecological footprint. Approximately 55% of that amount can be attributed to natural gas use for space heating and 45% for electricity use.

Table 9: Shelter energy use (gha/person) for electricity and natural gas, 2014

Electricity	Natural gas	Shelter - energy
0.44	0.53	0.97

Figure 6 shows that electricity use per household decreased from 7,375 kwh per customer in 2003 to 6,744 kwh per customer in 2014; an 8.5% decrease. The decrease between 2009 and 2014 was 9.1%. Natural gas use per customer decreased by 17.7% between 2003 and 2014 from 3,301 m^3 per household in 2003 to 2,717 m^3 per household in 2014. Between 2009 and 2014 natural gas use per household declined 15.5%. These household energy use decreases indicate that Saskatoon households have become more energy efficient reducing total energy consumption and thus their respective direct greenhouse gas emissions footprint.

Figure 7: Saskatoon energy use, 2003, 2009, 2014



Personal transportation

In 2014, direct GHG emissions associated with personal transportation use (personal vehicle use and transit use) totaled 7.87 tonnes of CO_2e per household (Table 8). Personal vehicle use (7.83 tonnes of CO_2e) accounts for over 98% of GHG emissions associated with personal transportation, while transit use accounts for less than 2% (0.04).

Personal vehicle use

Greenhouse gas emissions associated with personal vehicle use are based on liters of gasoline consumed per vehicle from the Canada Vehicle Use Study for Saskatoon (Transport Canada, 2015). The per vehicle value is multiplied by the number of registered vehicles to determine a total value for the city (City of Saskatoon, 2015b). Liters of gasoline are converted to GHG emissions using the conversion factors provided by the City of Saskatoon (2015a). As the Canada Vehicle Use Study estimated fuel use using on-board technology as opposed to a recall survey, historical comparisons are not possible. Fuel use data based on litres sold in Saskatoon is available (Kent Group Ltd., 2015). The totals, however, do not distinguish between commercial use and private use. Between 2010 and 2014, GHG emissions based on total litres of fuel sold in Saskatoon increased by 11%.

Transit use

Greenhouse gas emissions associated with transit use are from the City of Saskatoon's Environmental Leadership Report (2014). Public transit ridership has increased by only 0.2% between 2009 and 2014. However, between 2009-2013 transit ridership increased 13.9% from 11,579,606 rides in 2009 to 13,188,586 in 2013 reaching 53.4 trips per capita in 2013.[3] Unfortunately, in 2014 ridership fell sharply by 12.1% to 11,596,982 or only 45.6 rides per capita. On a positive note, total GHG emissions associated with transit use[4] declined 6.7% between 2009 and 2014 reaching 10,881 tonnes of CO_2e in 2014 or an average of 0.043 tonnes of CO_2e per person.

Household waste

Household waste refers to the direct waste generated by the residential sector. Household waste offers a proxy for household material consumption and throughput. Figure 8 shows trends in total residential/household waste produced, which includes waste to landfills and waste diverted from

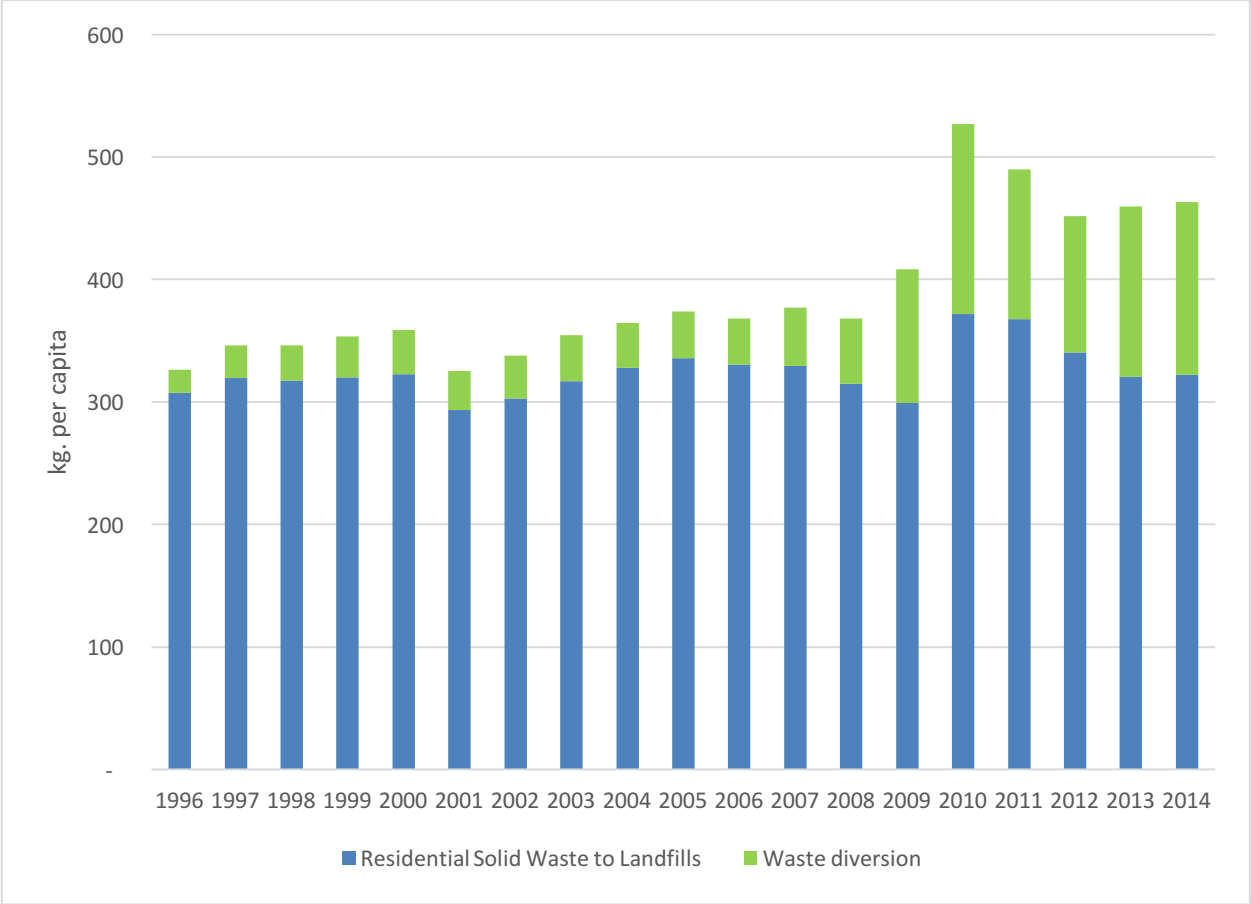
[3] City of Saskatoon, Transit. Figures reported from *Our Environment: The City of Saskatoon's 2014 Environmental Leadership Report.*

[4] Greenhouse gas emissions are estimated by the City of Saskatoon Transit using fuel data.

landfills through recycling between 1996-2014. The total residential waste per capita (including waste recycled) remained relatively steady from 1996 to 2008 then jumped in 2010 to a peak of 527 kg per person and since moderated at 463 kg per person in 2014. Between 2010-2014 household waste to landfills decreased by 13.4% while waste diverted from the landfill through recycling declined marginally by 9.0% from the peak waste diversion volumes achieved in 2010 (155 kg/ person).

In 2014, the total waste produced by households was 463 kg per person which included waste to landfills (322 kg/person) and waste diverted from landfill through recycling (141 kg/person). The good news is that residential waste to landfills grew by only 1.5% from 2003 to 2014, while the volume diverted from landfills grew by 278.4%. The bad news is that the total amount of waste produced (including recycled waste) by households remains higher than it was in the late 1990s in spite of recycling efforts.

Figure 8: Saskatoon residential waste and waste diversion, 1996-2014



Residential water use

Households on average used 560 liters of water or an average of 234 liters of water per household member in the year 2014. Residential water use refers to direct water use only and does not include the indirect water use associated with food production, production of goods and services or any other upstream water use. It also does not include water consumed outside the home; for example, in the workplace, school or other commercial or institutional establishments.

National and International Ecological Footprint Comparisons

From a global perspective, the 2014 Saskatoon ecological footprint of 7.4 gha per person remains substantially larger than the global average ecological footprint of 2.7 gha per person and greater than the global available biocapacity of 1.8 gha per person. Saskatoon's ecological footprint in 2014 is 5.3% larger than Canada's ecological footprint (last estimated in 2007) at 7.0 gha per person. Comparing the Saskatoon ecological footprint in 2014 with other benchmark countries (Table 10) shows that Saskatoon would rank 7th largest in the world, however, smaller than Edmonton's ecological footprint of 7.7 gha per person (2012 estimates). Saskatoon's ecological footprint is larger than Nordic countries like Sweden, Finland and Norway who have similar climates.

Table 10: Countries with the largest ecological footprints (based on 2007 data other than Edmonton which is 2010 data)

Largest ecological footprints by Nation	Ecological footprint per person	GDP per capita (PPP)	Ave. Annual Temperature °C
United Arab Emirates (#1)	10.7	$66,300	26.8
Qatar (#2)	10.5	$137,200	26.8
Denmark (#3)	8.3	$44,600	7.5
Belgium (#4)	8.0	$43,100	9.0
United States (#5)	8.0	$54,400	11.6
Estonia (#6)	7.9	$27,900	5.5
Edmonton (2012)	7.7	$62,832	2.6
Saskatoon (2014)	**7.4**	**$53,461**	**3.3**
Canada (#7)	**7.0**	**$45,000**	3.6
Australia (#8)	6.8	$46,600	17.3
Iceland (#9)	6.5	$44,000	4.6
Kuwait (#10)	6.3	$70,700	24.7
Finland (#13)	6.2	$40.700	2.7
Sweden (#14)	5.9	$46,200	4.7
Norway (#18)	5.6	$67,200	4.3
World	**2.7**		

Sources:

1. Global Footprint Network, 2010, based on 2007 data http://www.footprintnetwork.org/images/uploads/Ecological_Footprint_Atlas_2010.pdf.
2. Edmonton's Ecological Footprint 2014 (Anielski Management Inc. May 2014).
3. GDP per capita figures in PPP per capita are 2014 estimates from World Fact Book https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html.
4. Average World Temperatures are from Weatherbase http://www.weatherbase.com/weather/countryall.php3.
5. Saskatoon GDP per capita (PPP) is estimated based on conversion of C$65,915 per capita in 2014, converted to US dollars ($59,681/capita) and then to PPP using a conversion ratio of 1.1163.
6. Edmonton GDP per capita (PPP) is from Brookings Institute, Global Metro Monitor.

It is sometimes argued that it is unrealistic for Canada or regions within Canada to attain a dramatically smaller footprint. The assumption is that Canadians would have to give up their high quality of life, security, or that geography and climate make it impossible for Canada to have a substantially lower footprint. There is evidence, however, to suggest that other countries are able to enjoy high quality of lives, experience happiness, and be financially well off on smaller ecological footprints. Similarly, there are countries with cold climates, resource based economies, and similar values that have ecological footprints much smaller than Saskatoon and Canada.

Canada's cold climate is often cited as a reason explaining our relatively large ecological footprint. Compared with Nordic benchmark countries, Saskatoon's ecological footprint is 33% greater than Norway, 25% larger than Sweden and 20% larger than Finland.

In terms of Western countries with the largest economies, if we compare the ecological footprints of the G8 nations (G7 + Russia), with the exception of the United States and Canada, the remaining countries have ecological footprints around a third less than the value of Saskatoon's ecological footprint.

Conclusion

The City of Saskatoon's average ecological footprint per person increased by 1.4% between 2010 and 2014. The overall increase is consistent with a rise in household incomes, household spending and GDP growth. A rise in the goods and services, transportation, and government services components explain the higher ecological footprint. On a positive note, an 11% decrease in the shelter footprint offset the increases in the respective categories. The decline in a period of rapid economic development provides an example of where technology changes, rising household awareness and progressive policy decisions have made a positive impact. The good news was reflected in other indicators of household environmental performance as well. For example, household electricity use, natural gas use, household waste going to landfill and greenhouse gas emissions (GHG) associated with public transit all decreased.

Substantial reductions in Saskatoon's ecological footprint will take time and are a key component of a long-term sustainability vision. An important take away for community leaders, planners and policy makers is that large-scale footprint reductions require rethinking urban form, infrastructure, and

entrenched consumption and production patterns. While past decisions regarding major infrastructure and production systems lock a community into consumption patterns, current decisions can foster a lower impact future (Rees, 1999). Government policies, investments, and programs can support opportunities for households to lighten their ecological footprint and reduce household environmental impacts.

References

Anielski Management Inc. 2014. Edmonton's Ecological Footprint 2014. Prepared for the City of Edmonton, May, 2014

Anielski Management Inc. 2011. Saskatoon Ecological Footprint Analysis. Prepared for the City of Saskatoon, February 17, 2011

Chambers, N., Simmons. C., and M. Wackernagel. 2000. Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability. Earthscan Publishers, p. 31.

City of Saskatoon. 2014. Our Environment, The City of Saskatoon's 2014 Environmental Leadership Report. Saskatoon, SK.

City of Saskatoon. 2015a. Greenhouse gas emissions conversion factors. Personal communication. Provided by Matthew Regier. November, 2015.

City of Saskatoon, 2015b. Vehicle Registrations, City of Saskatoon. Personal communication. Provided by Bill Holden. November, 2015. Ewing B., A. Reed, A. Galli, J. Kitzes, and M. Wackernagel. 2010. Calculation Methodology for the National Footprint Accounts, 2010 Edition. Oakland: Global Footprint Network.

Global Footprint Network. 2008. Canadian Land Use Matrix.

Global Footprint Network, 2009. Ecological Footprint Standards 2009. Oakland: Global Footprint Network. Available at www.footprintstandards.org.

Global Footprint Network. 2010. National Footprint Accounts, 2008 Edition. Oakland: Global Footprint Network.

Ipsos Reid. 2014. 2013 Household Travel Survey. City of Saskatoon Infrastructure Services Department. March 25, 2014.

Kent Group Ltd. 2015. Gasoline & Diesel, Total Industry, City of Saskatoon (2010, 2014). Personal communication. Provided by Matthew Regier. November, 2015.

Rees, W. 1999. The built environment and the ecosphere: a global perspective. Building research and information, 27, 206–220.

Rees, W. and M. Wackernagel. 1996. Our Ecological Footprint: Reducing Human Impact On The Earth. New Society Publishers, Gabriola Island, BC.

Terefe, B. 2010. Greenhouse Gas Emissions from Private Vehicles in Canada, 1990 to 2007. Statistics Canada. Environment Accounts and Statistics Analytical and Technical Paper Series. Catalogue no. 16-001-M, no. 12. ISBN 978-1-100-14958-5.

Transport Canada. 2015. Canada Vehicle Use Study 2014. Ottawa, ON.

Wilson, J., and M. Anielski. 2004. Ecological Footprint of 18 Canadian Municipalities. Ottawa, ON. Prepared for the Federation of Canadian Municipalities.

Wilson, J. and J. Grant. 2009. Calculating Ecological Footprints at the municipal level: what is a reasonable approach for Canada? *Local Environment*. 14 (10):963-979.

Wilson, J., P. Tyedmers, and J. Grant. 2013. Measuring environmental impact at the neighbourhood level. *Journal of Environmental Planning and Management*. 56, 42-60.

Appendix A – Methodological Background

Background

The ecological footprint is an accounting tool that measures the environmental impact of human consumption. The tool accounts for a populations' consumption of food, transportation, housing, goods and services and expresses the findings in terms of the land area needed to support that populations' consumption demands. The ecological footprint inverts the traditional concept of 'carrying capacity ' (the population a given region could support) and instead seeks to determine the total land area required, regardless of where that land is located, to sustain a given population. The ecological footprint is unique in that it accounts for the environmental impacts of consumption regardless of where the burden of that consumption falls in terms of production costs and pollution (Rees and Wackernagel, 1996).

The Saskatoon ecological footprint, therefore, is the sum environmental impact of all Saskatoon residents' consumption no matter where in the world the environmental impact occurs.

The ecological footprint tool makes it possible to estimate the area of land needed to support the consumption demands of Saskatoon residents. In more technical terms, the ecological footprint provides a snapshot in time and the trajectory over time of how much nature, expressed in a common unit of bioproductive space, is used exclusively for producing all the resources (food, energy, materials) a given population consumes and absorbing the CO_2e emissions they produce, using prevailing technologies (Chambers et al. 2000). In essence, the ecological footprint is an accounting tool to measure the impact of human activity on the planet. At the macro level, if the human footprint exceeds the productive capacity of the biosphere then consumption patterns are clearly not sustainable. The ecological footprint directly acknowledges that there are limits constraining the function of ecological systems and services and assesses where we are in relation to those limits.

Ecological Footprint Metaphor

The metaphor of the ecological footprint conveys very clearly that we have a finite amount of ecological productivity or natural capital to support human activity. More so, the metaphor evokes some very powerful messages. If we only have so much space and I over-consume, how does that impact ecological sustainability? What does that mean for future generations? What does that mean for other people living on the planet now? Does overconsumption in one region necessitate poverty elsewhere?

While the ecological footprint is an indicator of sustainable consumption, important factors other than consumption habits influence the ecological footprint. These include population size, technology, and gains or losses in eco-efficiency. For example, new technologies such as zero-emission vehicles, or a reduction in population are factors which could lower Saskatoon's overall ecological footprint.

Global hectares

The ecological footprint expresses results in global hectares. A global hectare is a standardized unit to account for the fact that different land types and different land categories have different productivity or biocapacity potentials. A common unit allows for the meaningful summation of different land types and categories and also allows for meaningful comparisons of footprint results between regions and countries. Land types are adjusted, reflecting the fact that land types (for example, agriculture land) have different productivity potentials depending on the region. Productivity potential can vary both within a country and across countries. The productivity potential of the different land categories are also converted to global hectares so the different land categories can be summed into a total ecological footprint value. For example, cropland in the ecological footprint methodology is considered to be more productive than pasture land. The land category conversion factors are based on global scientific data and updated by the Global Footprint Network (Ewing et al., 2010).[5]

Calculation methodology

The 2014 Saskatoon ecological footprint update adopts a top-down/ bottom-up approach to estimate the ecological footprint. The portion of the ecological footprint associated with direct household energy use and personal transportation is calculated directly based on data specific to the City of Saskatoon. The remaining footprint categories are estimated following the sub-national ecological footprint calculation proposed by Wilson and Grant as a consistent calculation strategy for Canadian communities (2009). The approach adjusts the Canadian National Accounts developed by the Global Footprint Network (2010) using the consumption expenditure model developed to assess the ecological footprint of Canadian municipalities by Wilson and Anielski (2004) and refined by Wilson and Grant (2009) and Wilson, Tyedmers and Grant (2013). The sub-national footprint calculation strategy estimates ecological footprint categories based on proxies for the major consumption categories of the ecological footprint: food, shelter, mobility, goods, services, and government. The respective categories are described here. For detailed calculations, please refer to The Saskatoon Ecological Footprint Calculation Spreadsheets. The spreadsheet file is available upon request.

Consumption categories

Goods and services

The goods and services category is adjusted using household expenditure data on goods and services from the Statistics Canada Survey on Household Spending. Expenditure data is adjusted by the Consumer Price Index to ensure constant dollars. Expenditures on goods and services as reported in the Survey of Household Spending include: household operation, household furnishing and equipment,

[5] The Global Footprint Network (GFN) is the global authority on the ecological footprint. GFN coordinated the development of and maintains the ecological footprint calculation and reporting standards. In addition, GFN reports the National Ecological Footprint Accounts annually. Their website, www.globalfootprintnetwork.org, is an excellent clearinghouse for ecological footprint information.

clothing, health care, personal care, recreation, reading materials and other printed matter, education, tobacco products and alcoholic beverages, games of chance (net), miscellaneous expenditures.

Shelter – energy

The shelter energy footprint refers to the direct energy demands associated with electricity consumption and home heating. Electricity and natural gas consumption data were converted to greenhouse gas (GHG) emissions using conversion factors provided the City of Saskatoon (2015a). Greenhouse gas emissions were converted to global hectares using the footprint intensity of carbon conversion factor from the Global Footprint Network calculation standard (2009). Historic city level electricity and natural gas consumption data were provided by the City of Saskatoon.

Shelter – non energy

The non-energy component of the shelter footprint refers to the construction, maintenance, and other material inputs to support shelter. To adjust the shelter-non energy component we compare the dwelling space occupied per person by dividing the number of rooms per dwelling by the number of household members. Rooms per dwelling data are from the Statistics Canada Census.

Transportation

The portion of the transportation footprint attributed to private transportation was updated based on expenditure on gasoline and other fuels. Prices were adjusted using the Consumer Price Index for gasoline to ensure constant dollars. Greenhouse gas emissions associated with transit were provided directly by the City of Saskatoon. Greenhouse gas emissions were converted to global hectares using the Global Footprint Network standard conversion factor (GFN 2009). Emissions associated with air travel were adjusted based on expenditure on airlines from the Survey of Household Spending. Prices were adjusted using the Consumer Price Index for airplane to ensure constant dollars. The ecological footprint associated with rail is assumed to be consistent with that of Canada.

Food

To adjust the food footprint we use expenditure on food as a proxy of food consumption. Food expenditure data is adjusted by the Consumer Price Index to ensure constant dollars.

Government

To adjust the government component of the ecological footprint we use expenditure on municipal and provincial government services as a proxy. Federal government expenditures would be consistent across the country. While government expenditures may vary by region within a province and a city, government services such as roads, schools, health care, garbage collection, and snow removal serve all citizens of the city.