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Exponential increase of urban sprawl in Montreal in the last 60 years

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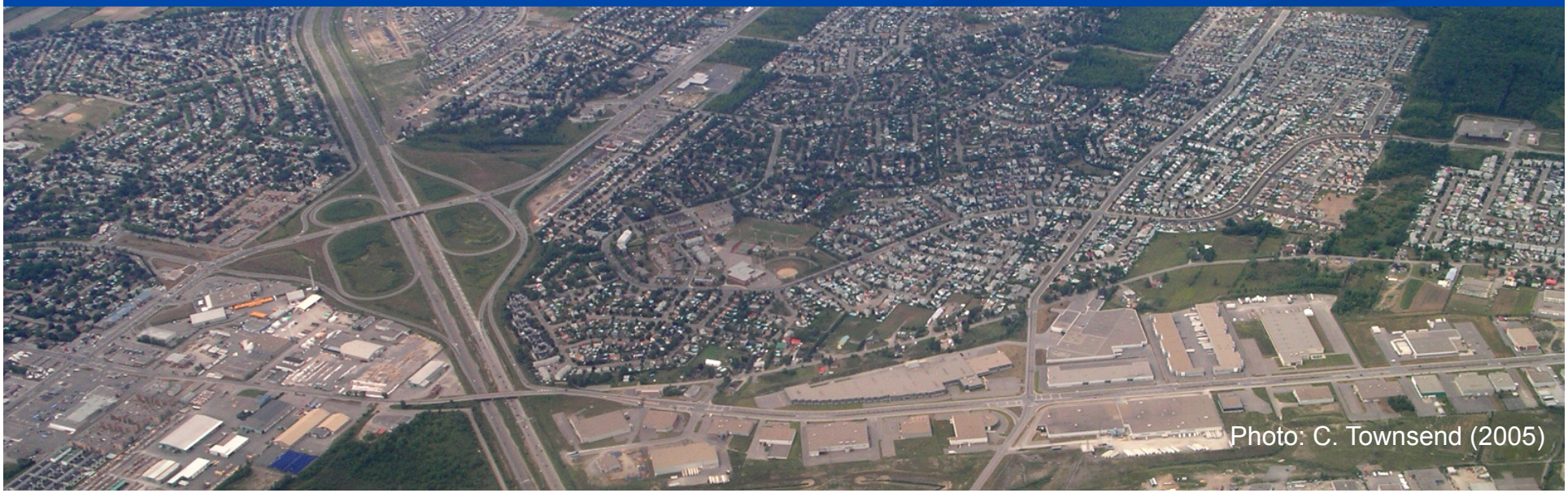

Photo: C. Townsend (2005)


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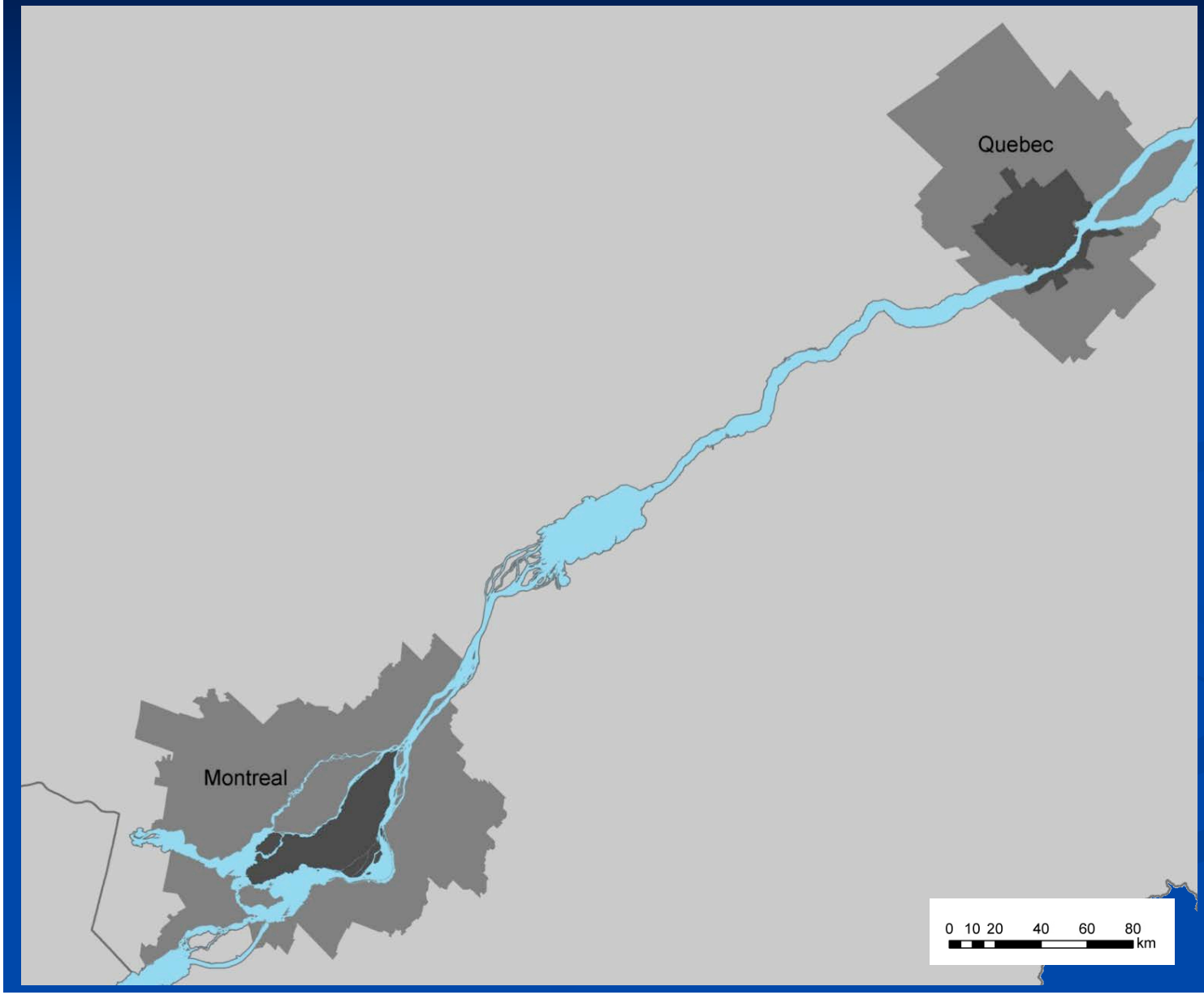
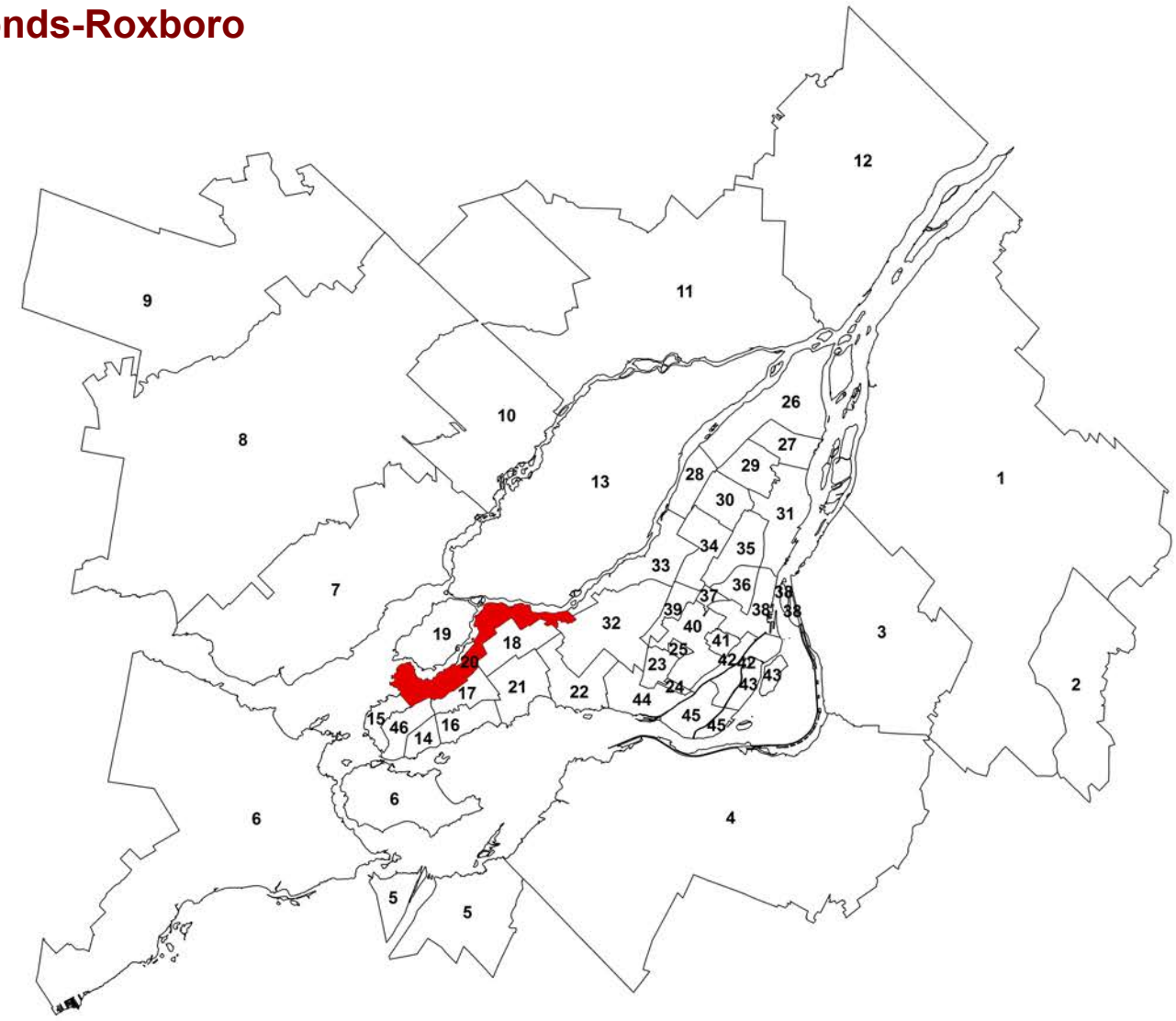
Urban sprawl in Montreal and Quebec City

Nazarnia et al. (2016)

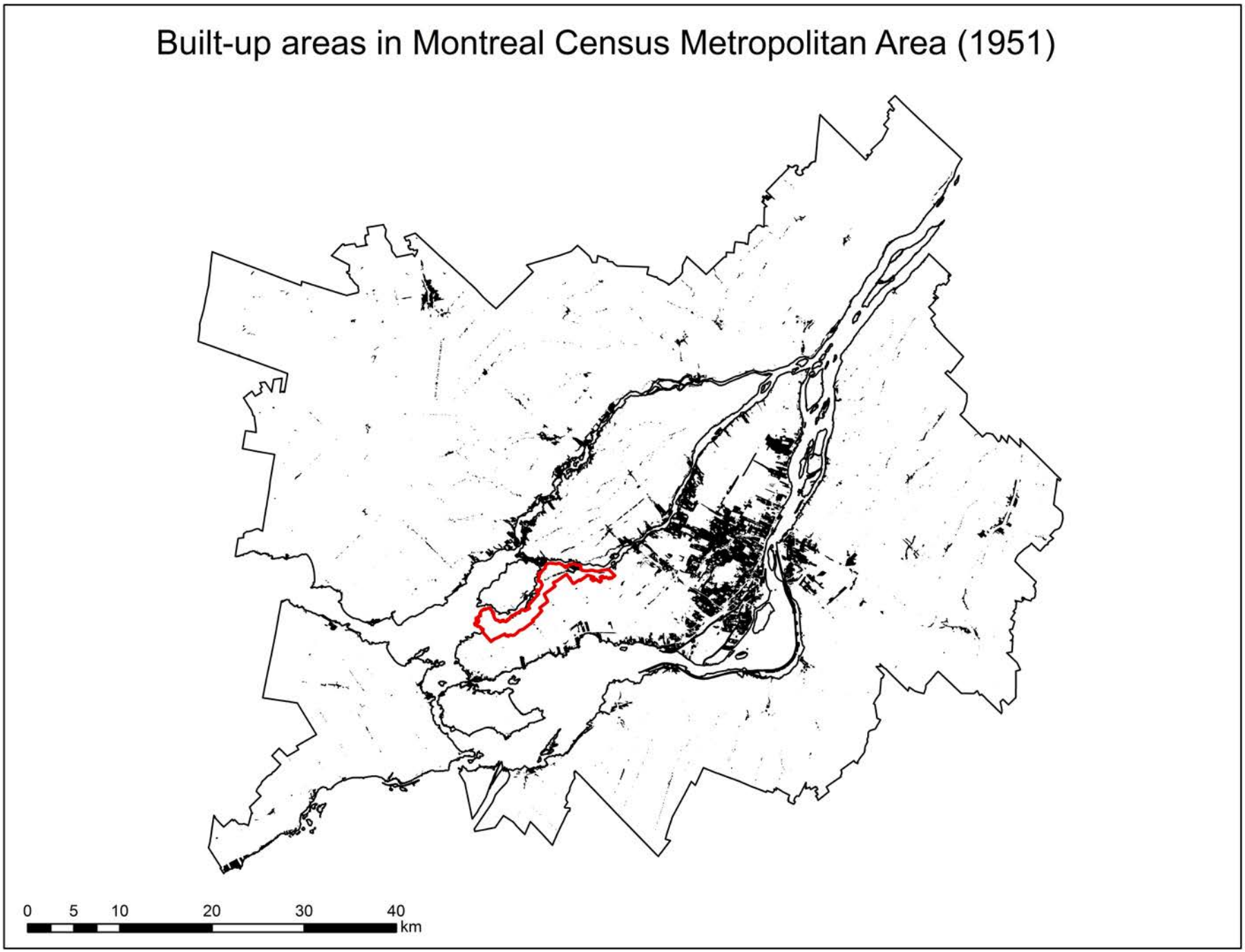


Nazarnia et al. (2016)

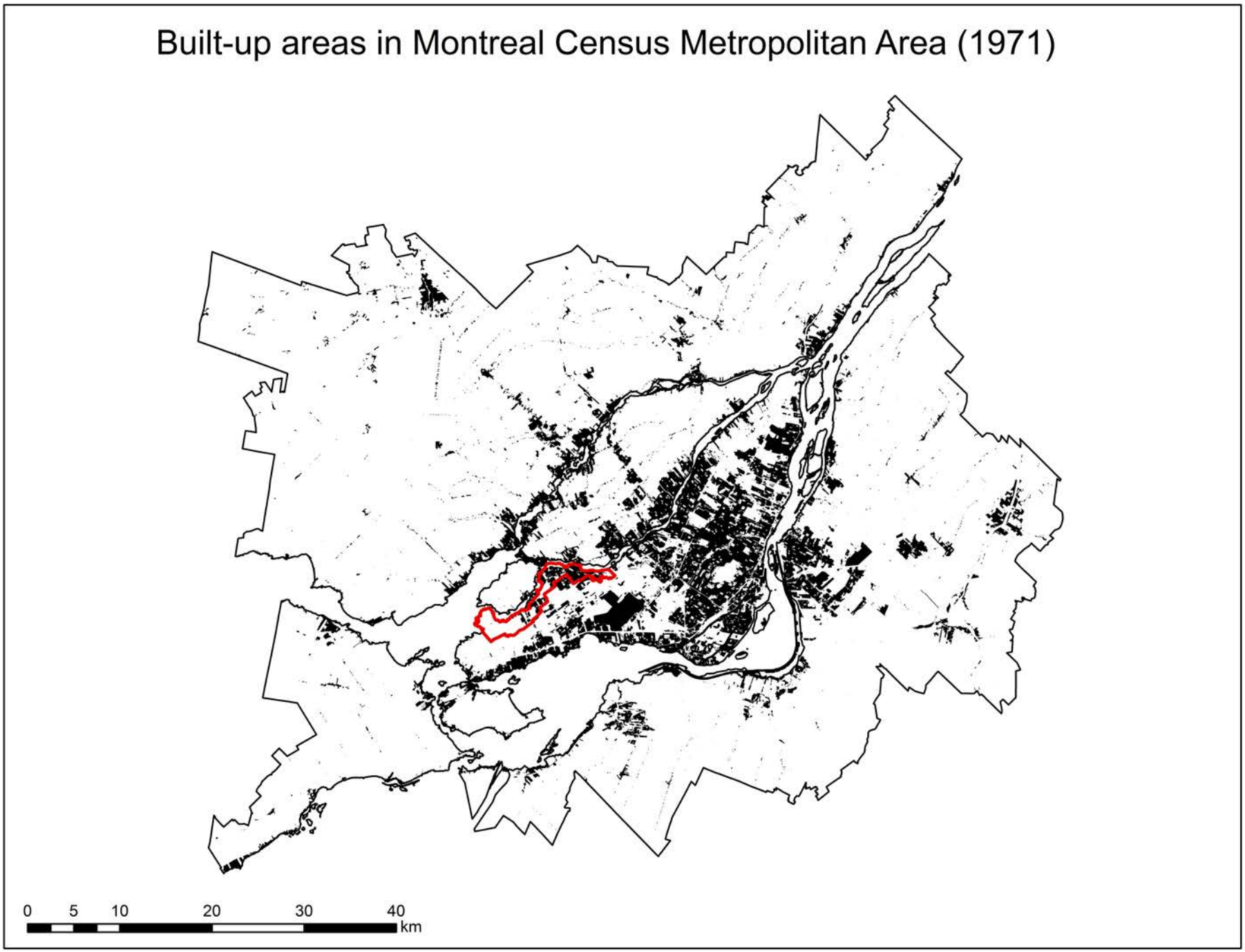
District:
Pierrefonds-Roxboro



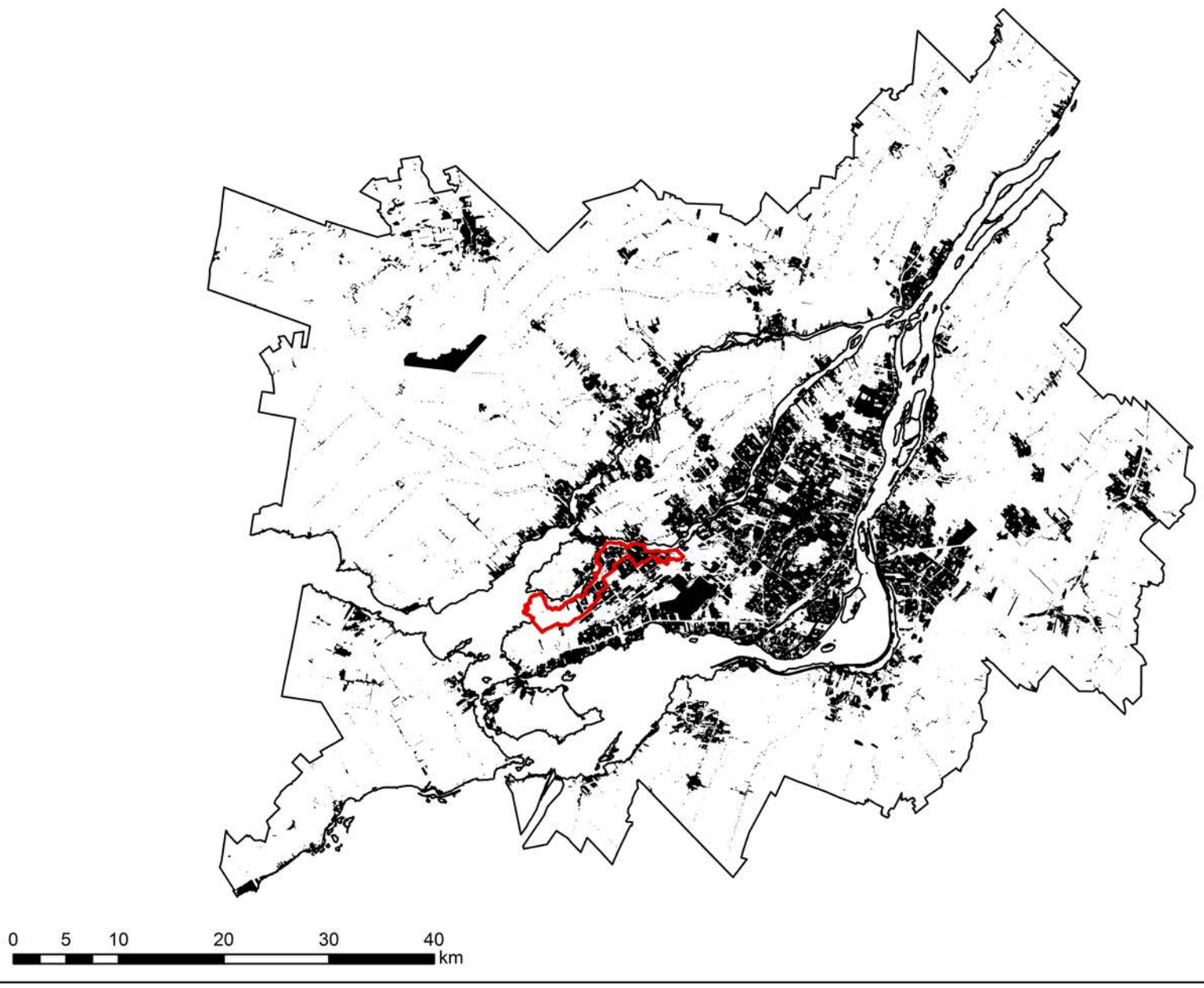
Built-up areas in Montreal Census Metropolitan Area (1951)



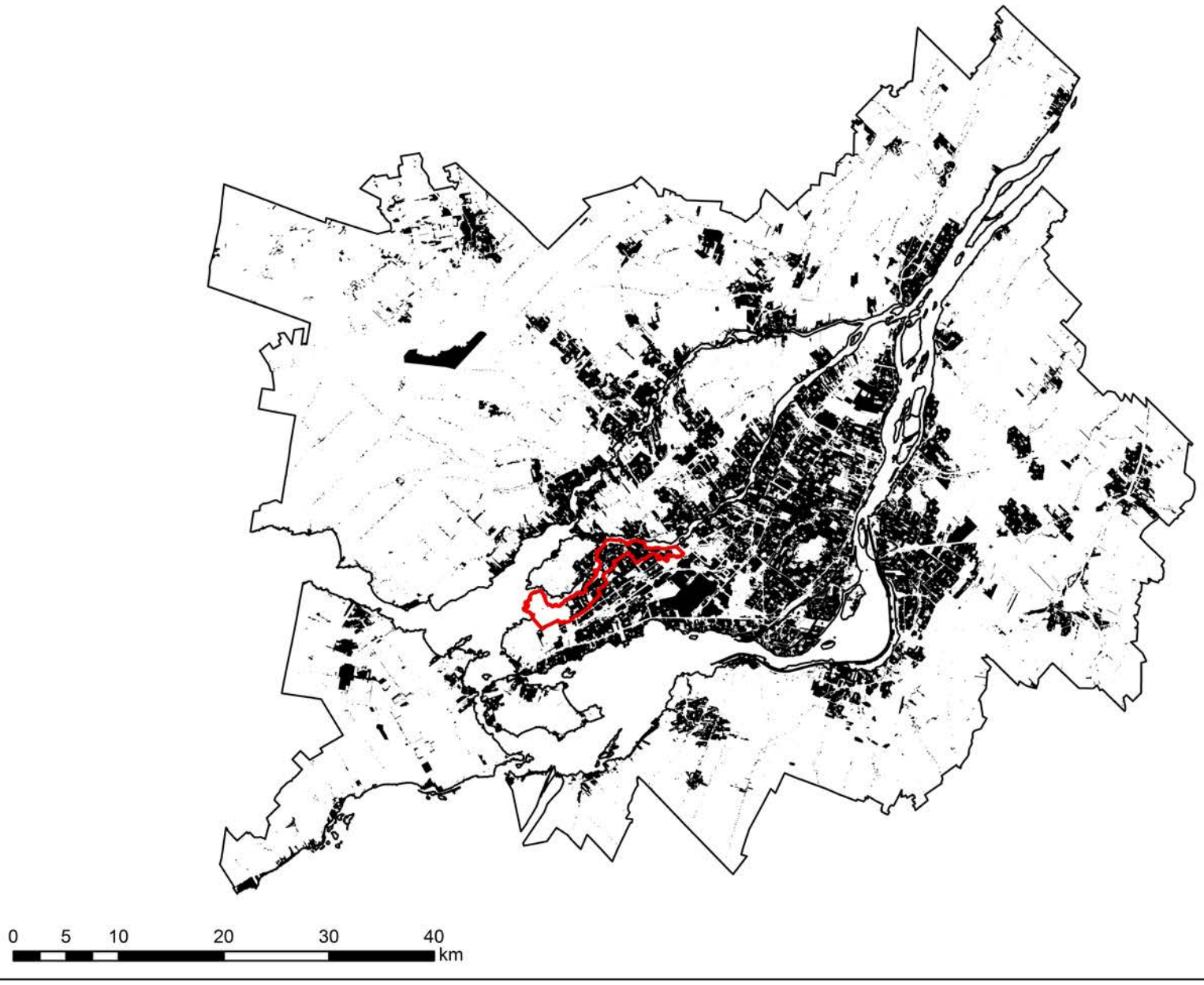
Built-up areas in Montreal Census Metropolitan Area (1971)



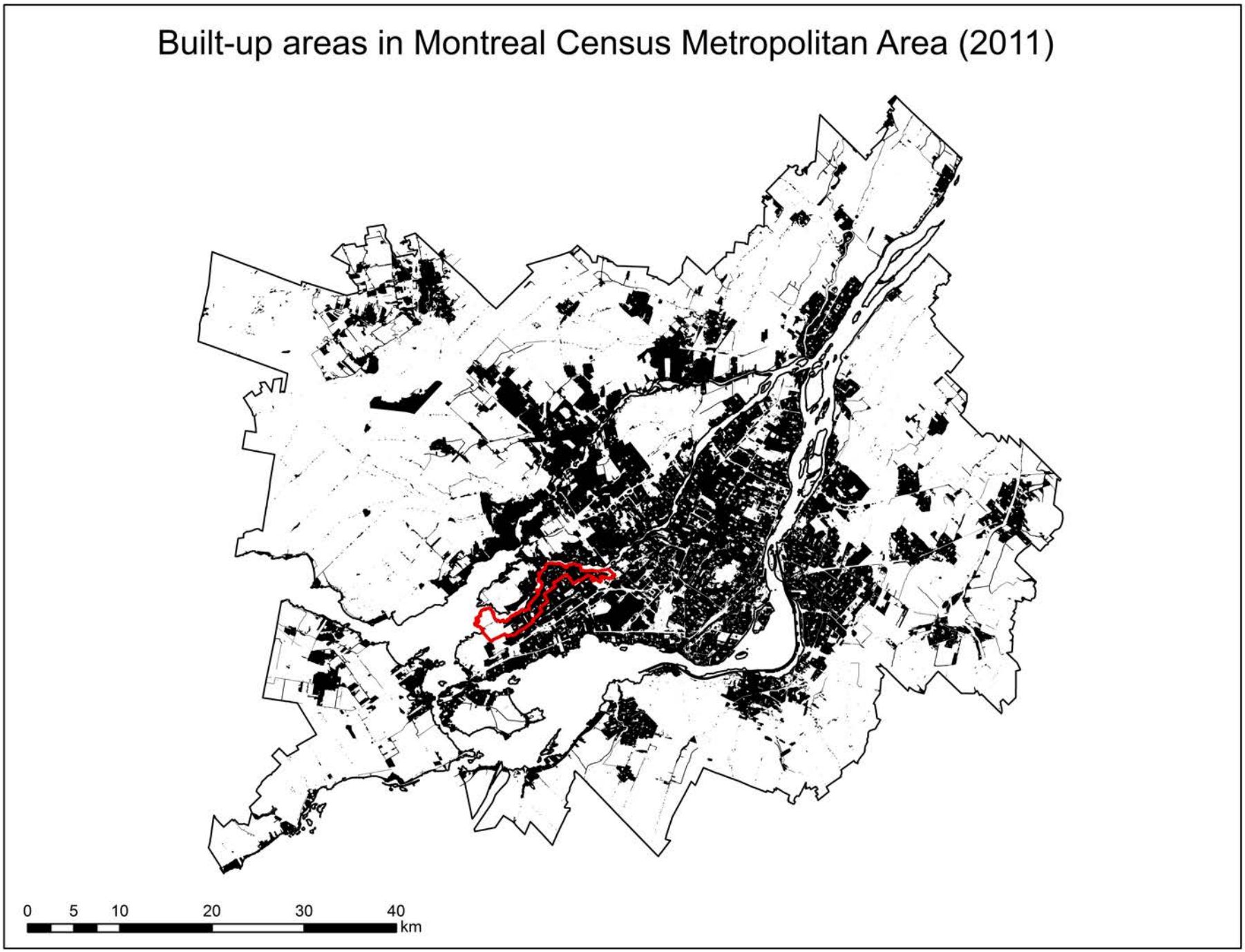
Built-up areas in Montreal Census Metropolitan Area (1986)



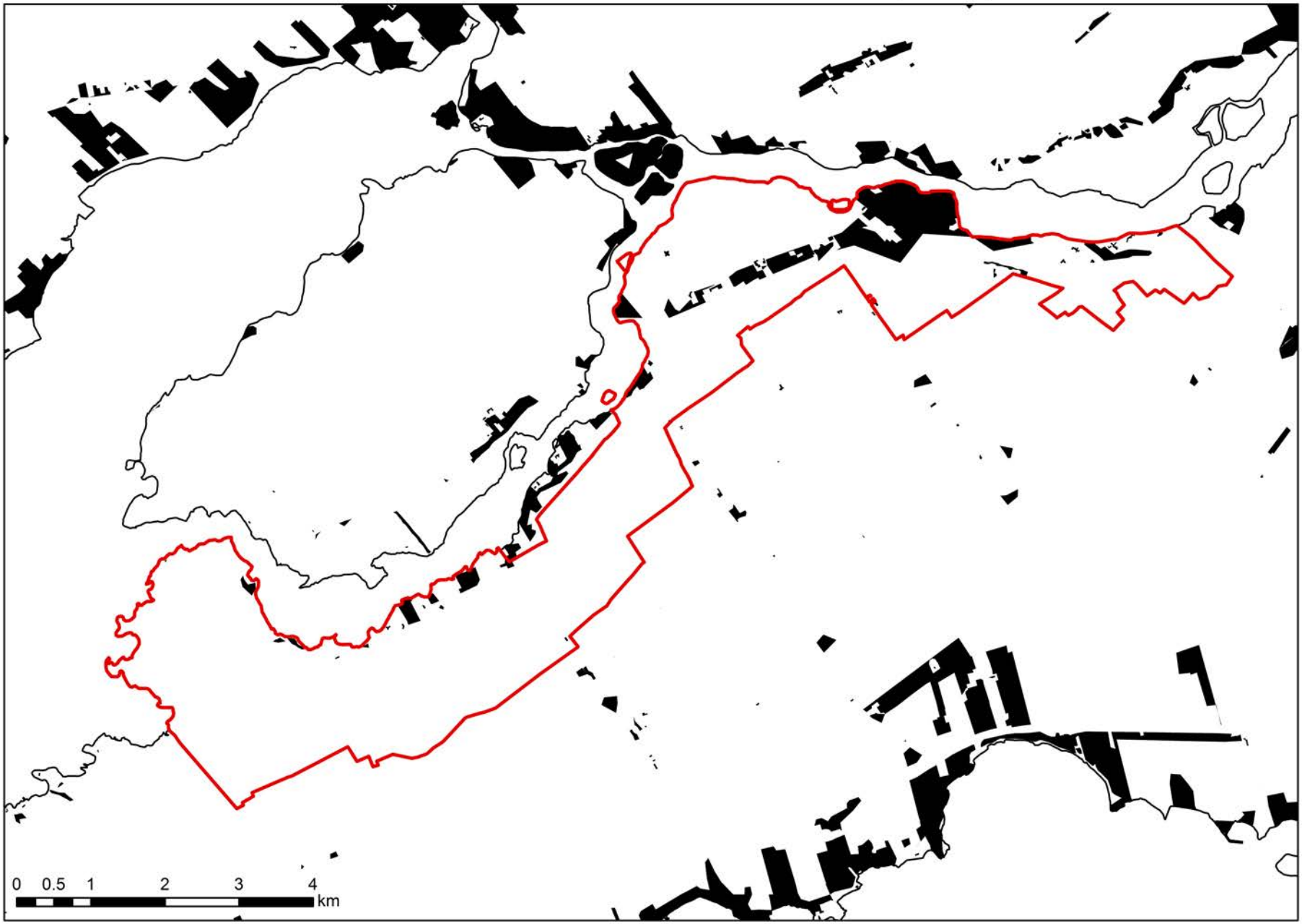
Built-up areas in Montreal Census Metropolitan Area (1996)



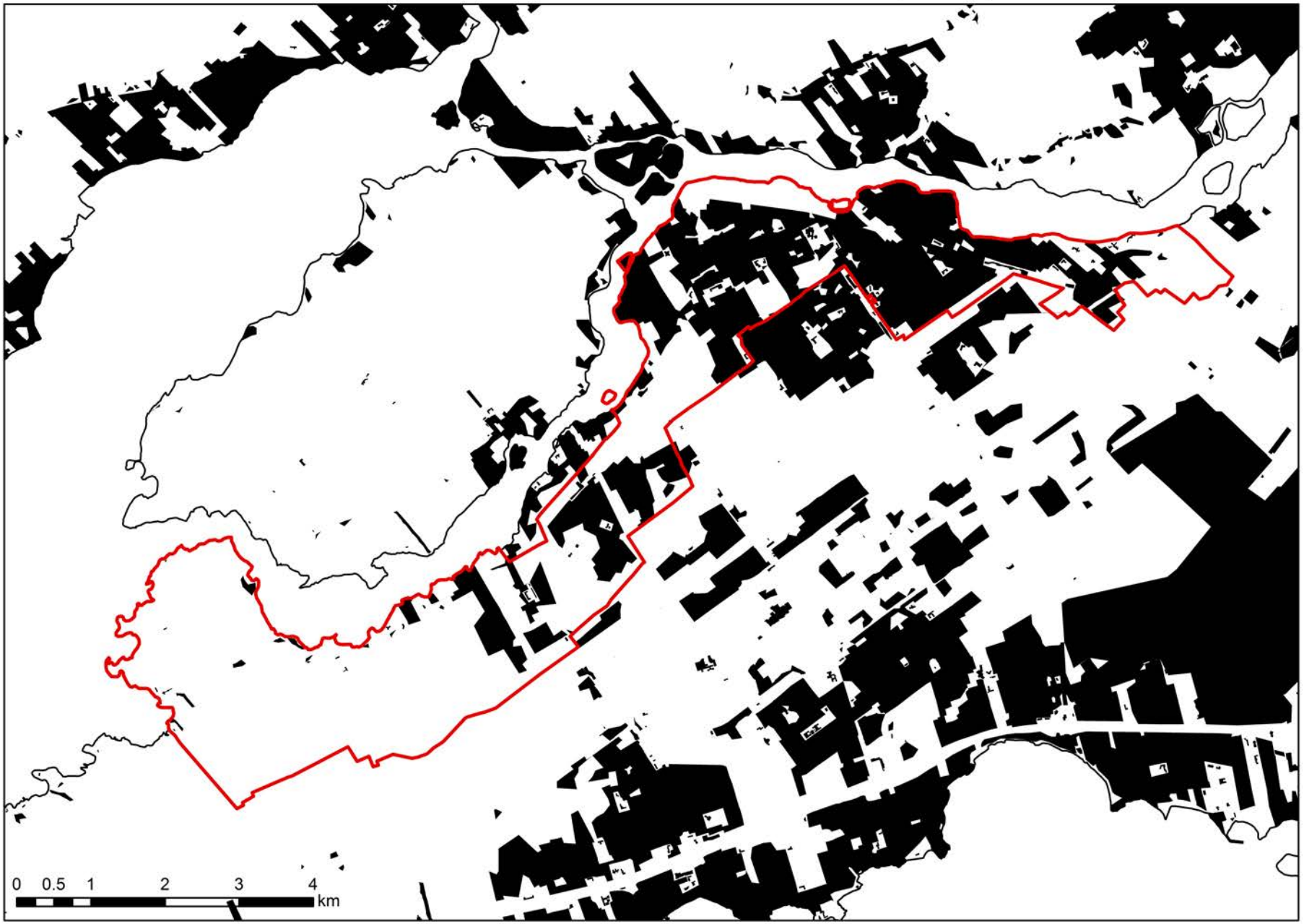
Built-up areas in Montreal Census Metropolitan Area (2011)



Built-up areas in Pierrefonds-Roxboro (1951)



Built-up areas in Pierrefonds-Roxboro (1971)

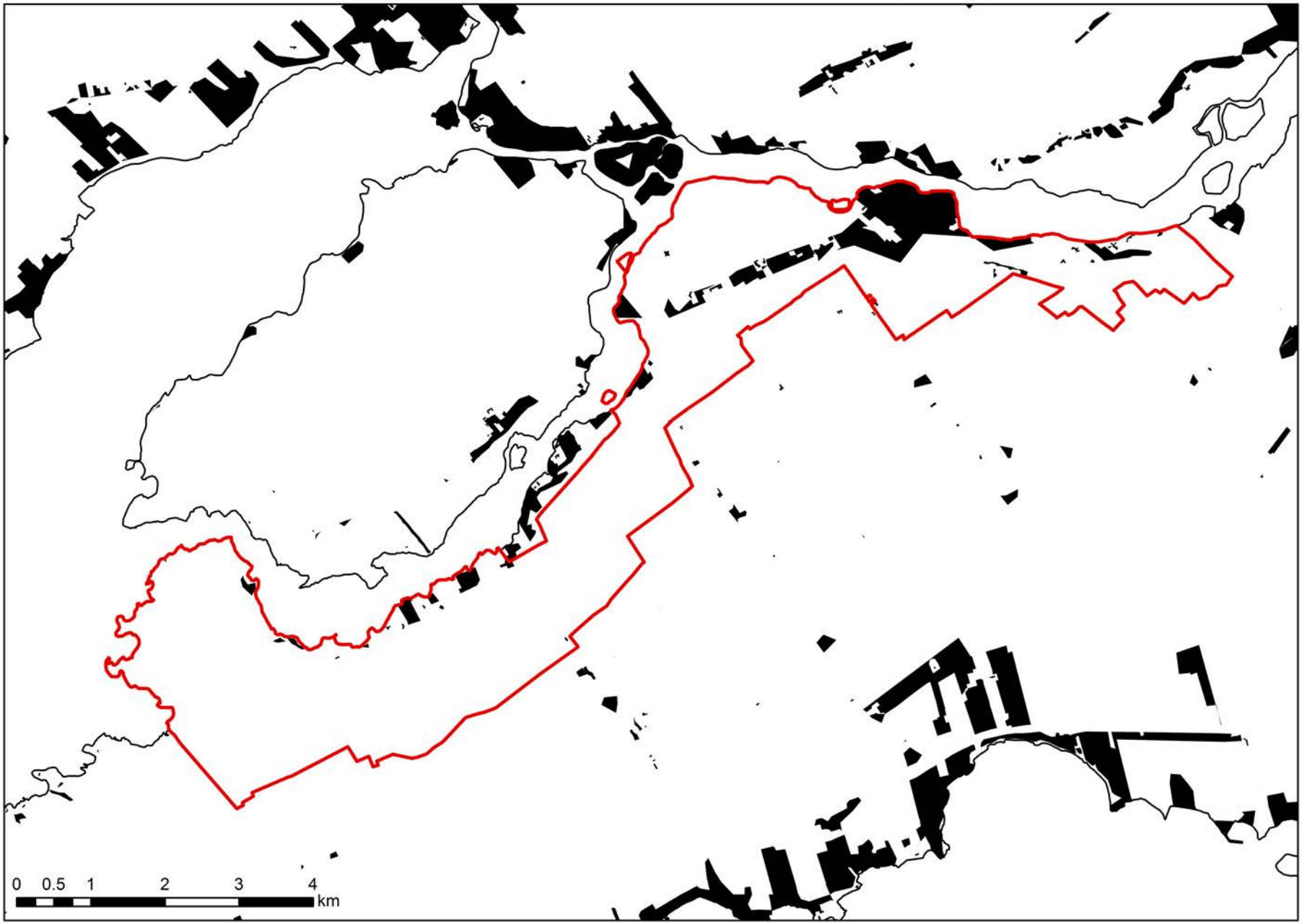


Built-up areas in Pierrefonds-Roxboro (1986)

Built-up areas in Pierrefonds-Roxboro (1996)

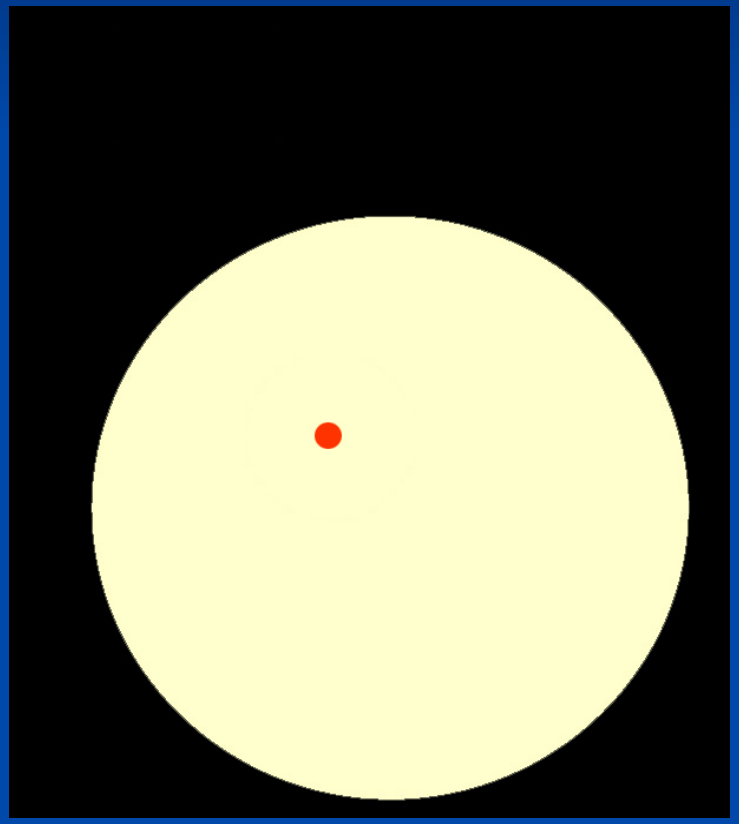
Built-up areas in Pierrefonds-Roxboro (2011)

Built-up areas in Pierrefonds-Roxboro (1951)

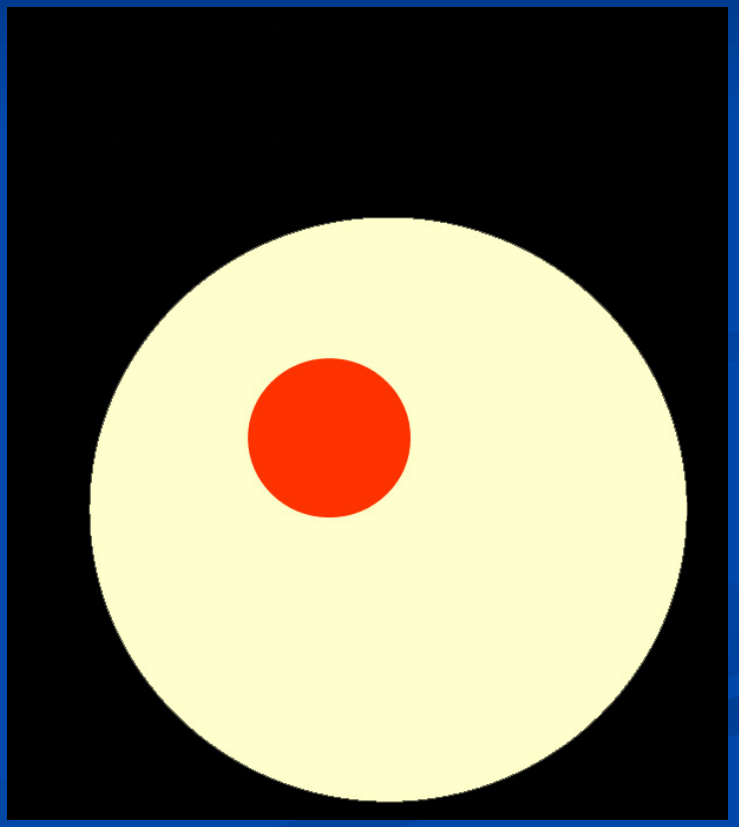


1. Amount of built-up area

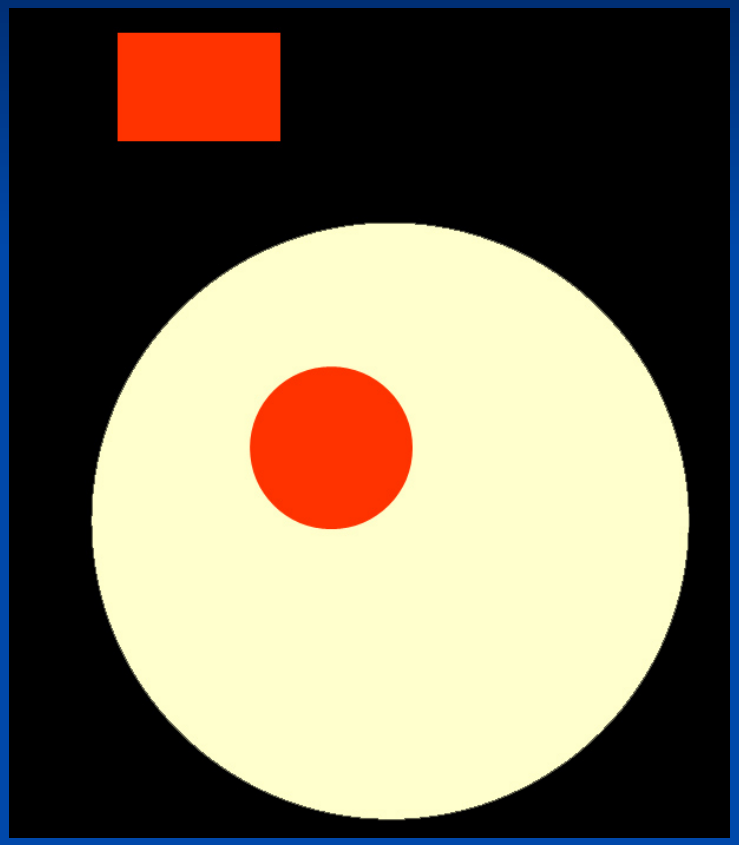
Low amount of built-up area



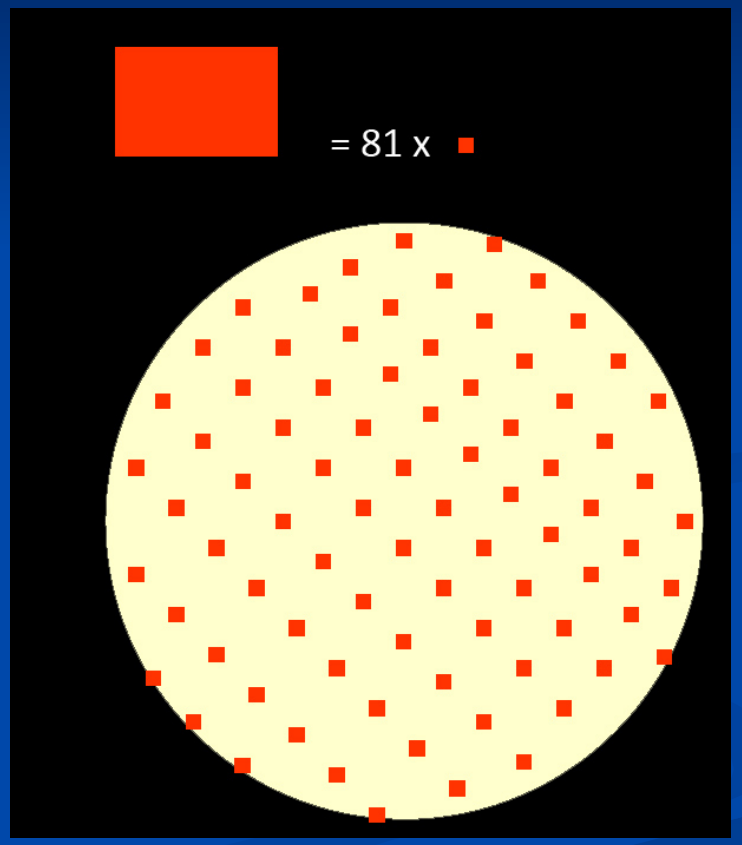
High amount of built-up area



2. Dispersion of built-up area



most compact → circle

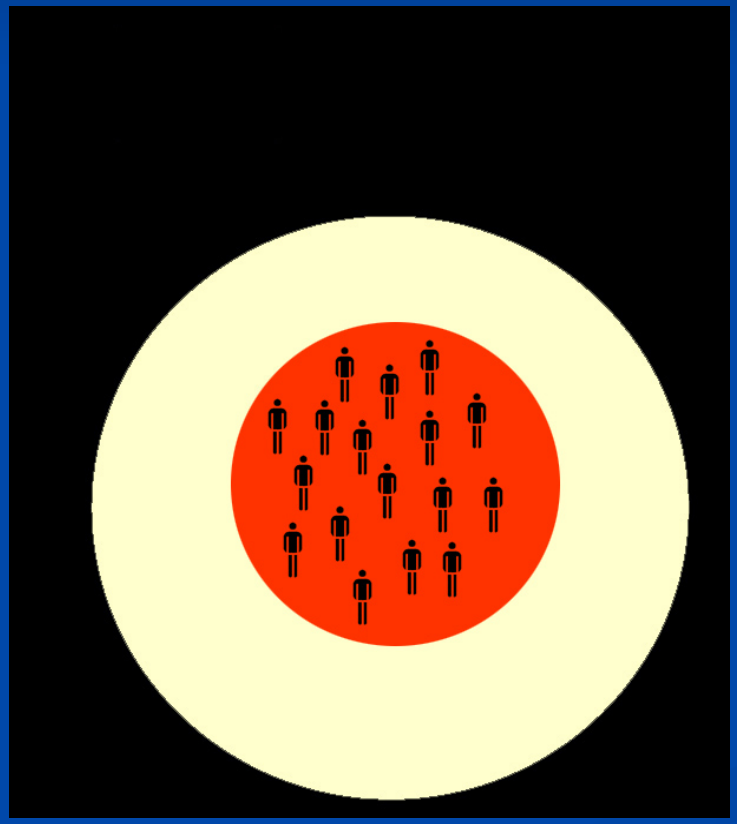


as far away from all other buildings a possible

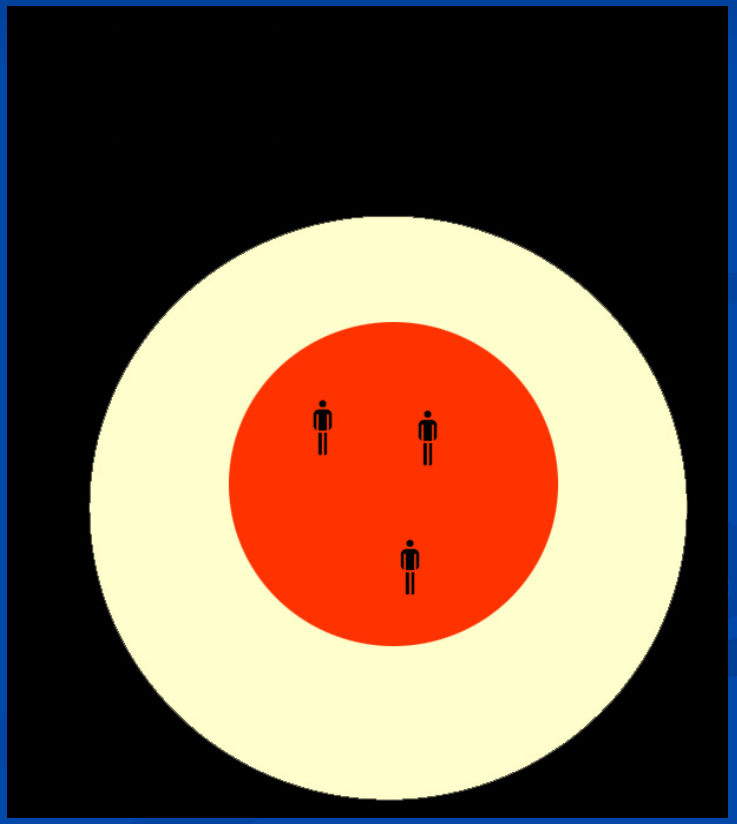
→ uniformly dispersed

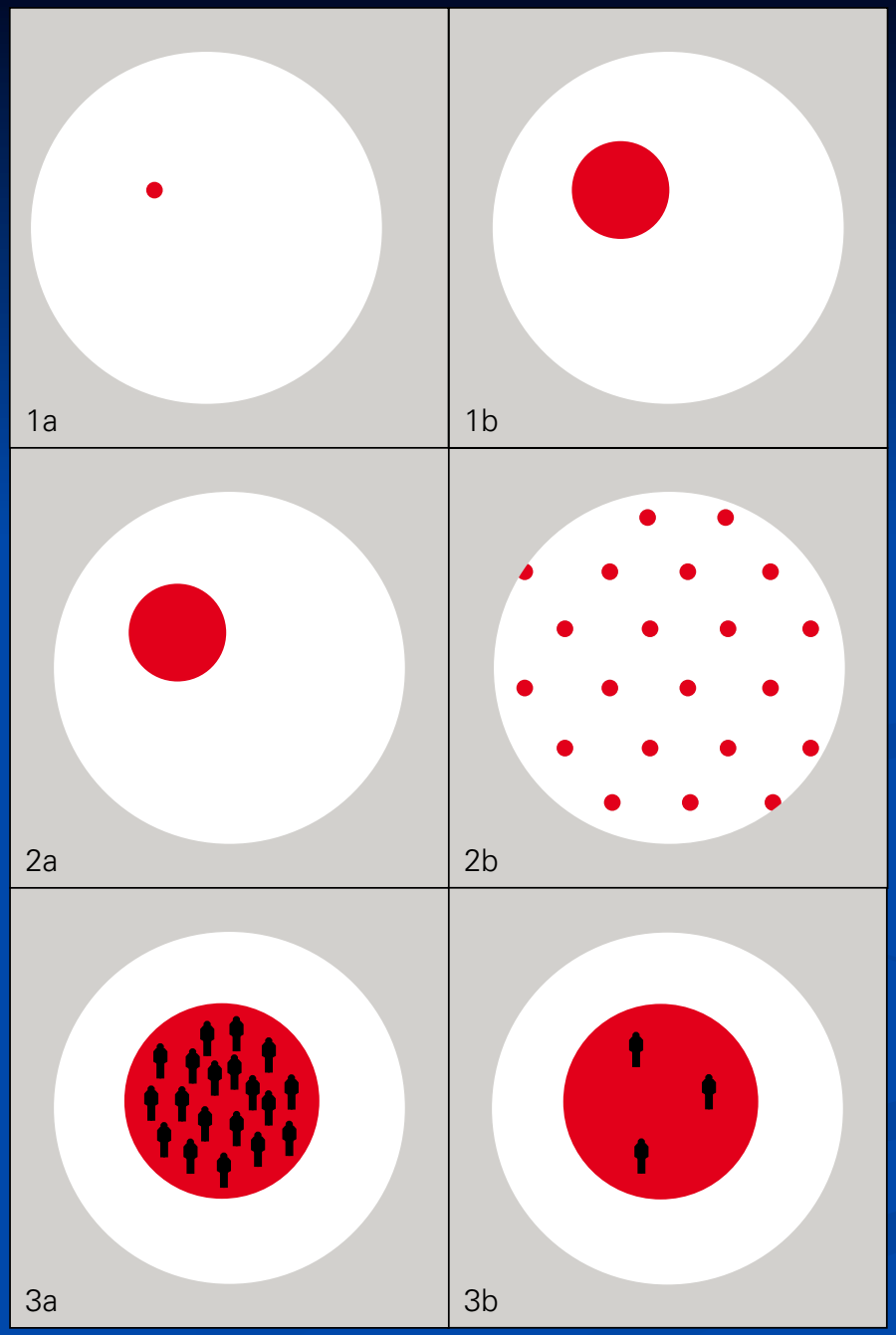
3. Land uptake per person

Low land-uptake per person



High land-uptake per person





Amount of built-up area

Dispersion of built-up area

Land uptake per person

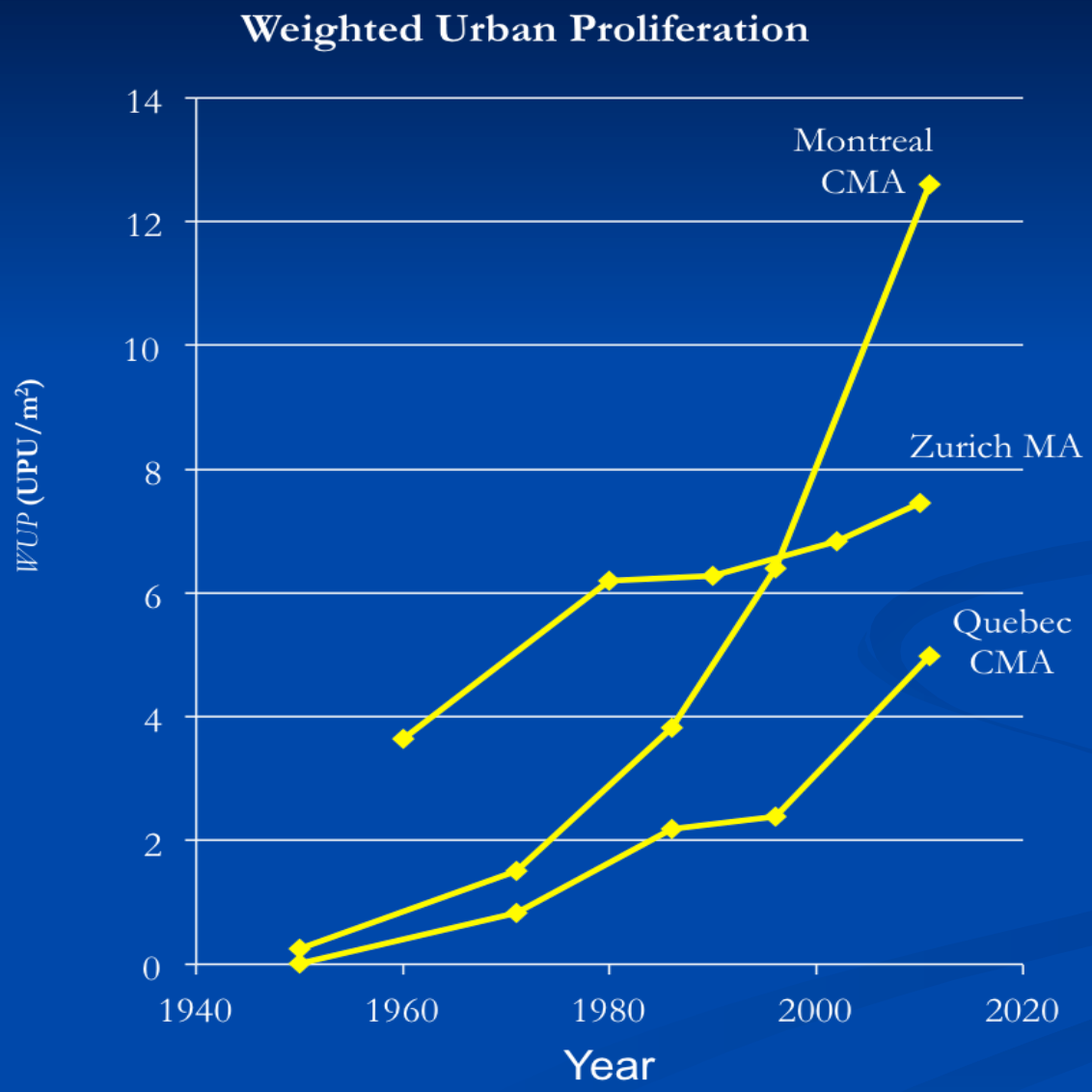
Jaeger and Schwick (2014)

Definition of “urban sprawl”

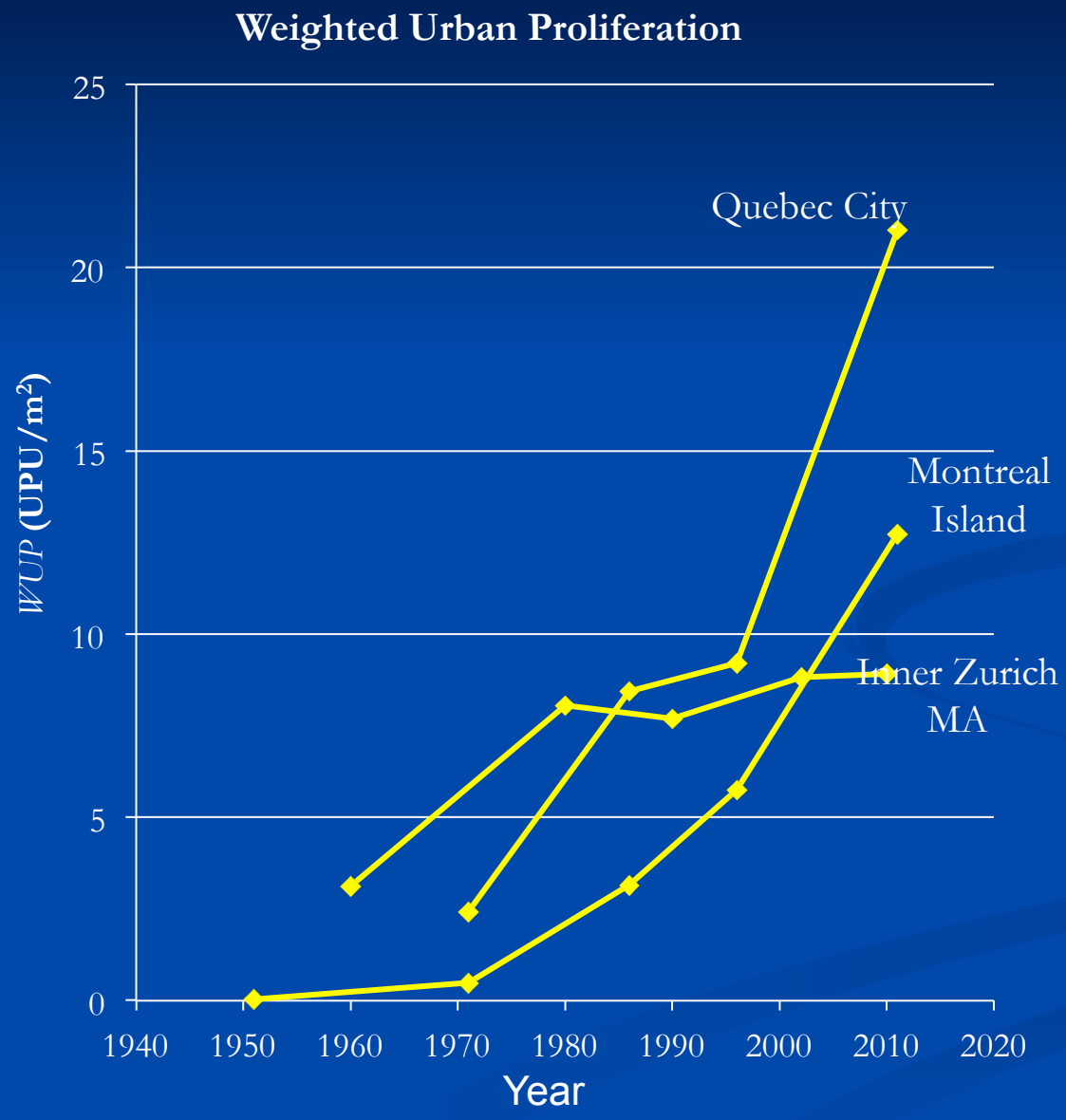
- can be visually perceived in a landscape:
  - a landscape is the more sprawled, the more it is permeated by buildings
- Degree of sprawl is higher when
  - more area is built up
  - the buildings are more dispersed in the landscape
  - the utilization intensity of built-up areas is lower
- Causes and consequences of sprawl are distinguished from sprawl itself

Jaeger und Bertiller (2006), Jaeger et al. (2010), Schwick et al. (2010), Jaeger and Schwick (2014)

Urban sprawl in Montreal CMA, Quebec CMA and Zurich MA

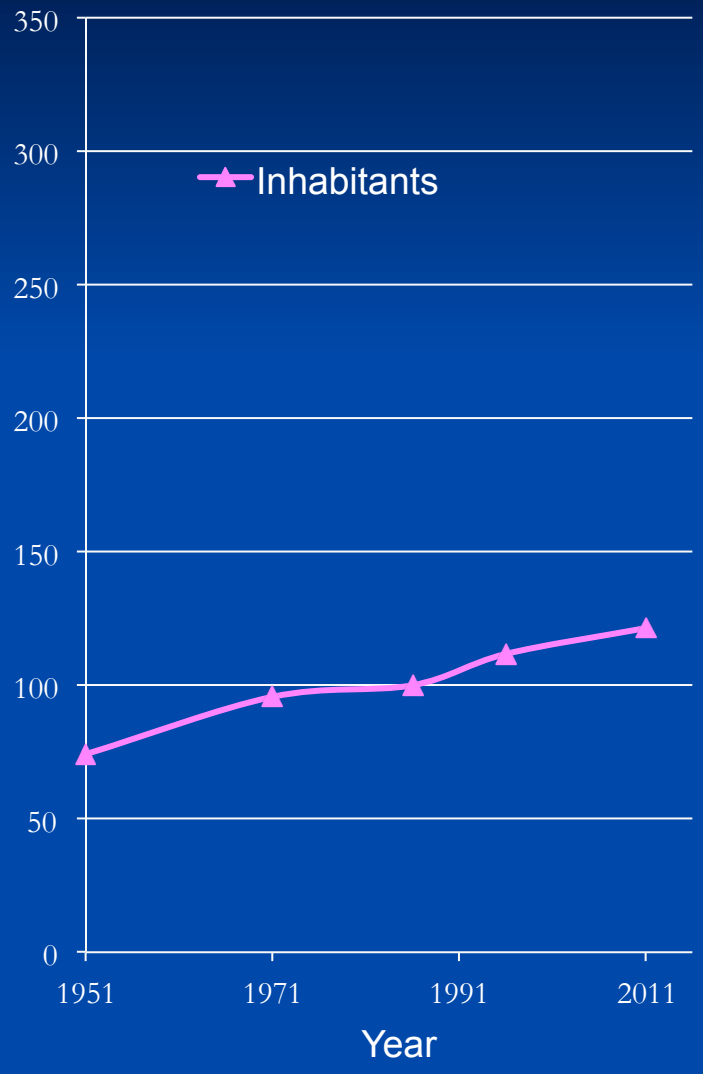


Urban sprawl metrics in the Island of Montreal, Quebec City and Inner Zurich Metropolitan Area

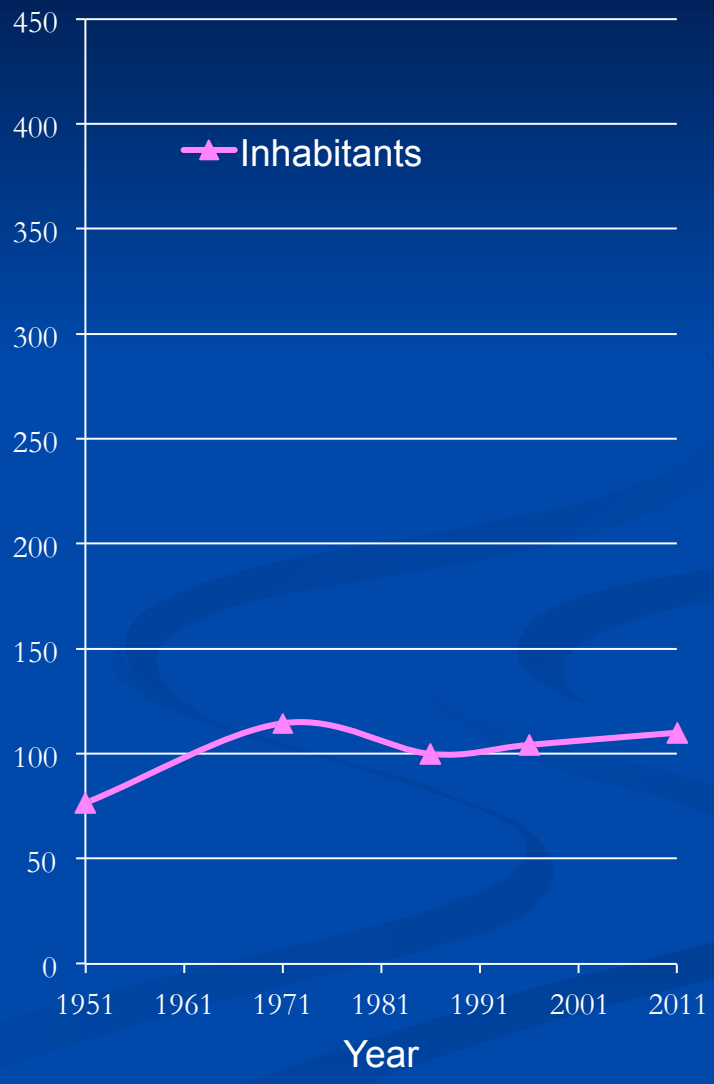


Increase of urban sprawl, built-up areas and inhabitants

1986: 100%



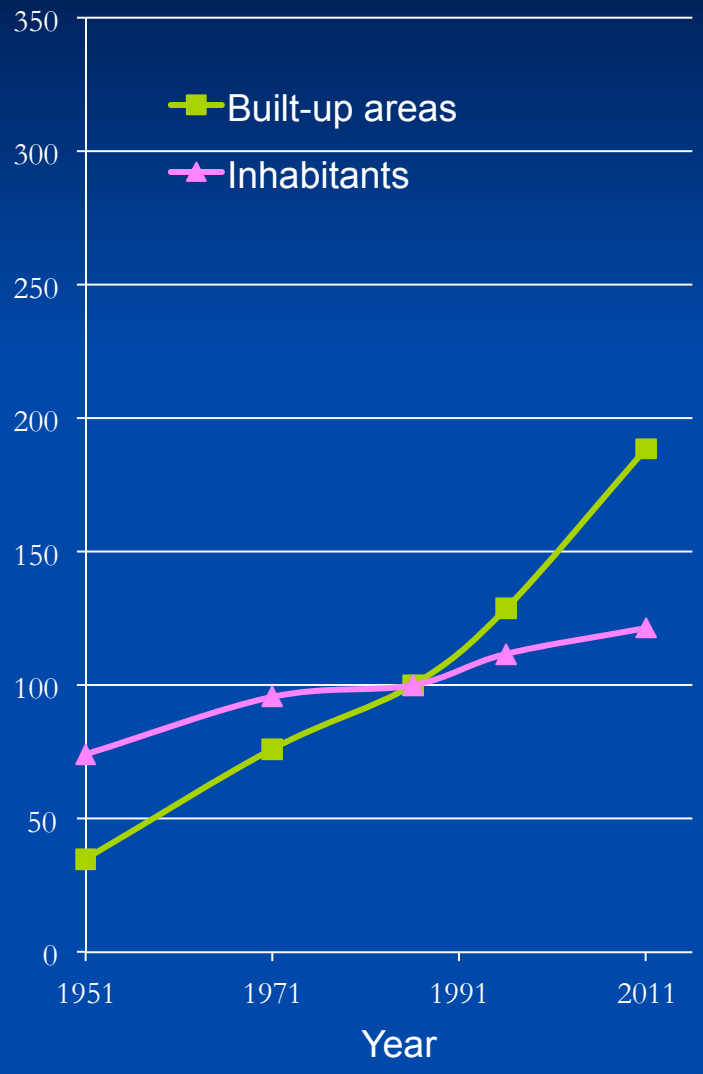
Montreal CMA



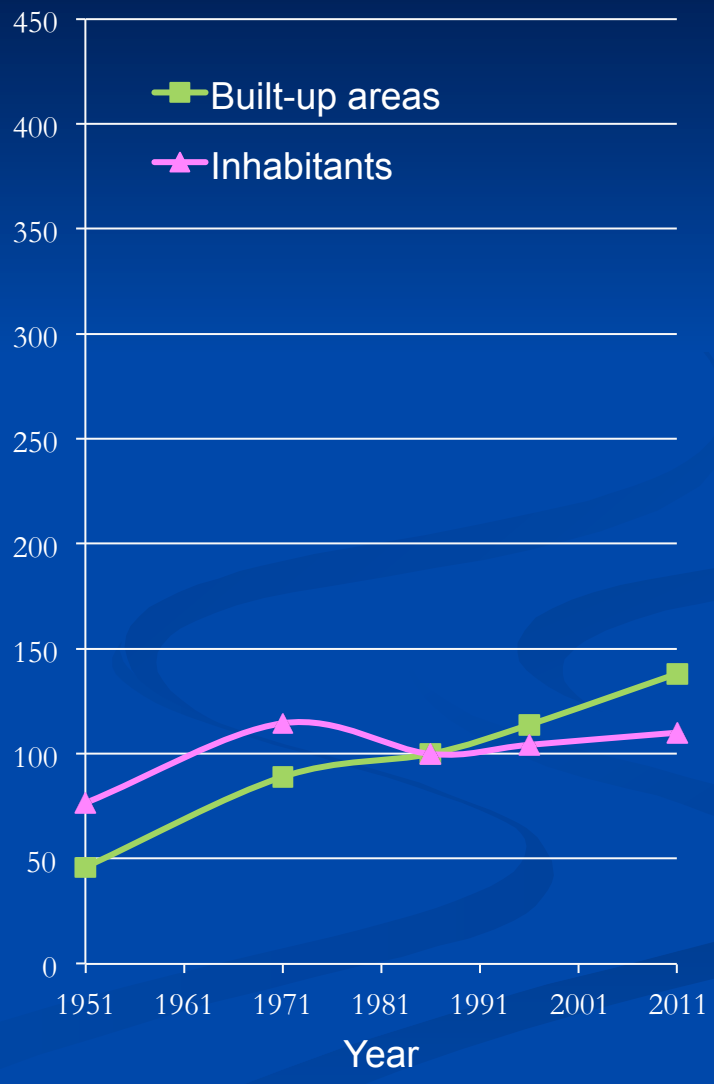
Island of Montreal

Increase of urban sprawl, built-up areas and inhabitants

1986: 100%



Montreal CMA



Island of Montreal

Increase of urban sprawl, built-up areas and inhabitants

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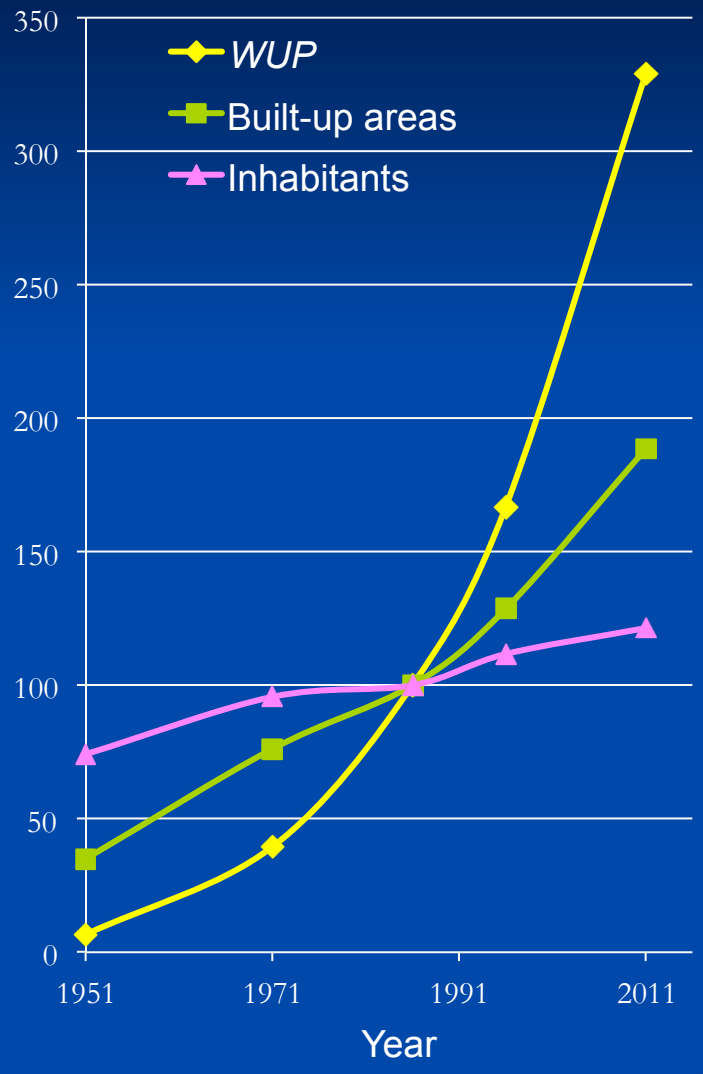
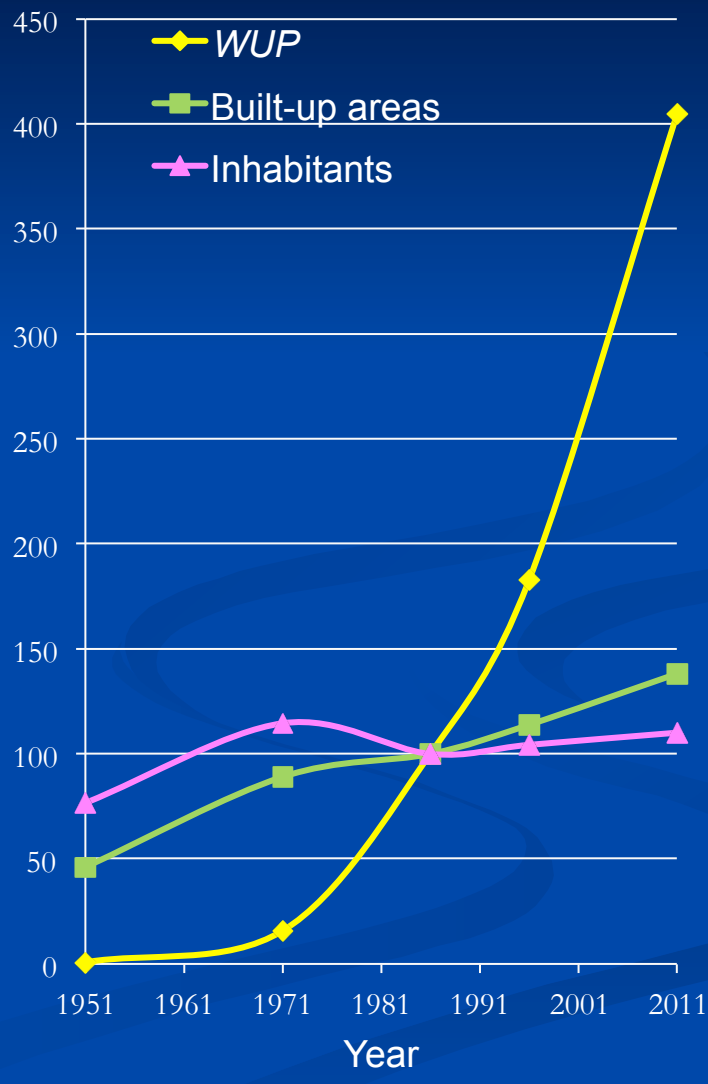
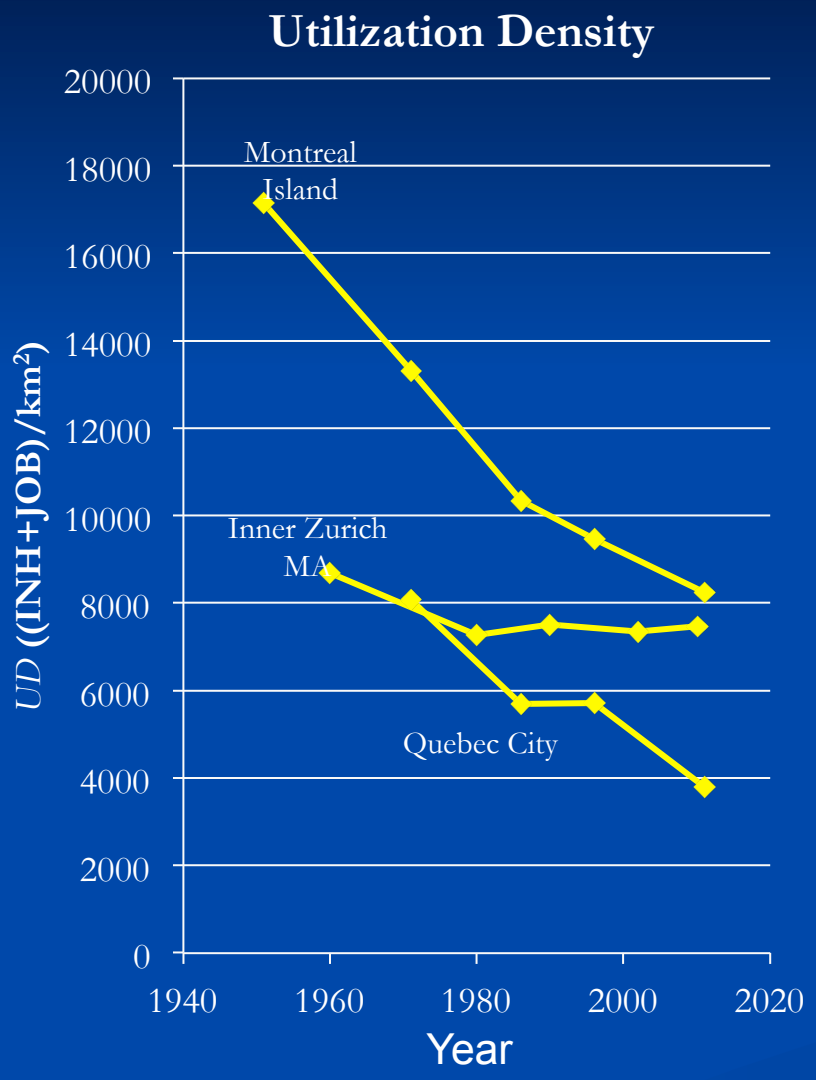


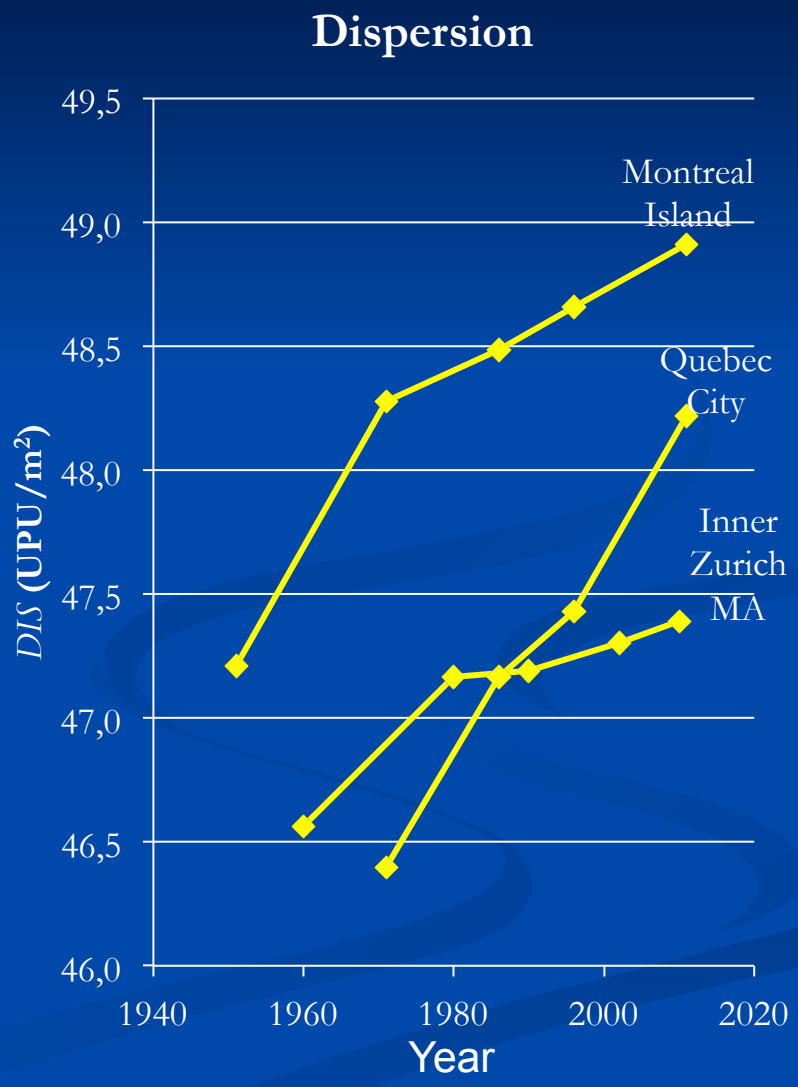
Montreal CMA



Island of Montreal

Urban sprawl metrics (Island of Montreal, Quebec City and Inner Zurich Metropolitan Area)





Findings

- Urban sprawl on the island of Montreal has increased 29-fold between 1971 and 2011
  - exponentially

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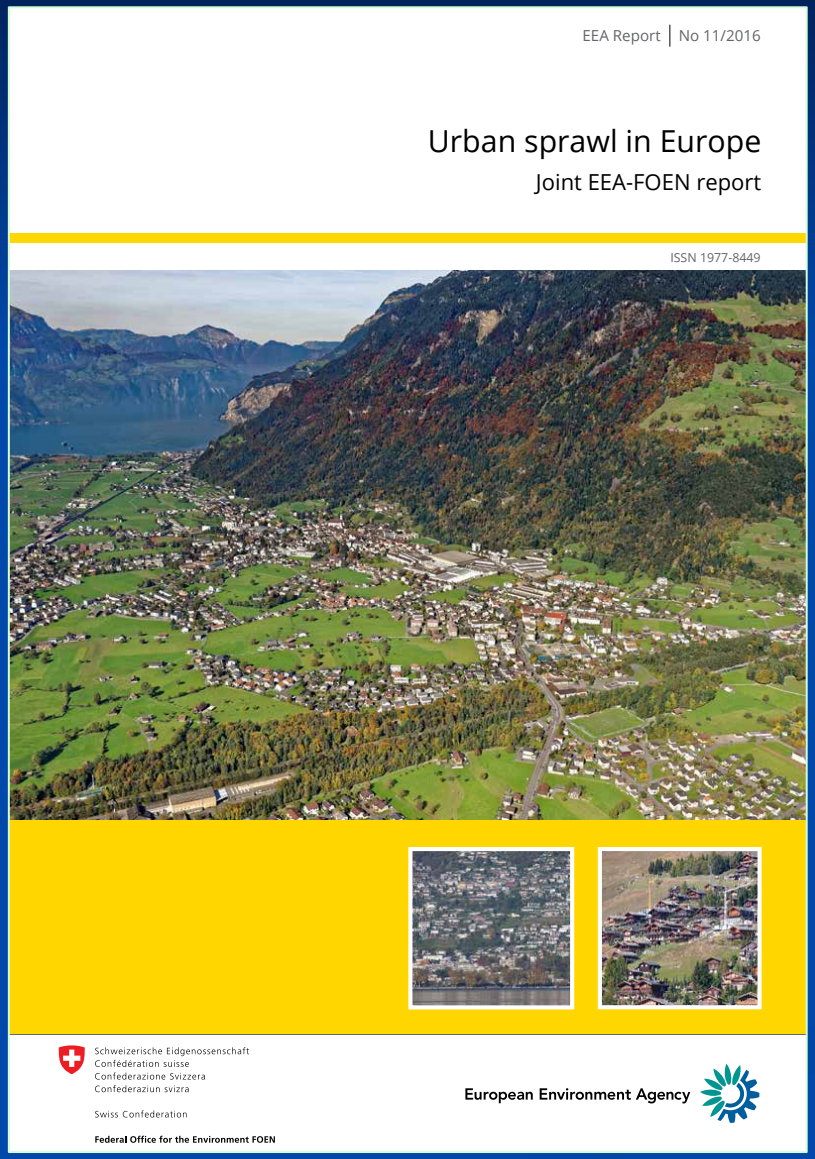
- Urban sprawl on the island of Montreal has increased 29-fold between 1971 and 2011
  - exponentially
- Urban sprawl in Montreal has never before increased as fast as it has increased in the last 20 years and is increasing **today**
- Urban sprawl in Montreal appears to be out of control.

Many effects of urban sprawl



European Environment Agency (2016)

Table 1.2 Environmental, economic and social effects of urban sprawl and/or urban growth

Theme	Consequences of urban sprawl	Sources (examples)
Environmental impacts		
Land cover	Land uptake for buildings and related infrastructure facilities, and loss of farmland	Camagni et al., 2002; Pauleit et al., 2005; Eigenbrod et al., 2011; Wilson and Chakraborty, 2013
	Removal and alteration of vegetation over larger areas	Pauleit et al., 2005
	Soil compaction, sealing of soil surfaces, loss of ecological soil functions, loss of water permeability, reduction of groundwater regeneration and reduced evapotranspiration, desertification	Ewing, 1994; Scalenghe and Marsan, 2009; Siedentop and Fina, 2010; Barbero-Sierra et al., 2013
Geomorphology	Local alterations to geomorphology (e.g. cuts, stabilisation of slopes) over larger areas	Rivas et al., 2006
Local climate	A change in microclimate conditions as a result of the urban heat island effect, which leads to reduced vegetation cover, reduced albedo, warming of surface temperature and increased variability in temperature	Taha, 1997; Zhou et al., 2004; Stone et al., 2010
	A modification of humidity conditions, for example reduced evapotranspiration, as a result of vegetation removal and soil sealing; a lower moisture content in the air because of higher solar radiation; stagnant moisture as a result of soil compaction; and increased variability in moisture	Taha, 1997
	Climatic thresholds and the modification of wind conditions as a result of the removal of vegetation and the construction of buildings	Song, 2005; Stone et al., 2010
Energy and climate change	Higher energy consumption and higher greenhouse gas emissions per person	Kenworthy et al., 1999; Borrego et al., 2006; Duffy, 2009; Waitt and Harada, 2012; Jones and Kammen, 2014
	Reduced carbon dioxide uptake as a result of the removal of vegetation, such as forest and grassland, over large areas	Hutyra et al., 2011
	A reduction in the capacity of the soil to act as a carbon sink	Lal, 2003
Air pollution, noise and light	Higher air pollution per capita as a result of vehicle exhausts, fertilising substances, dust, particles, road salt, oil, fuel and other substances which cause air and water pollution, and eutrophication	Borrego et al., 2006; Rich and Loncore, 2006; Navara and Nelson, 2007; Tu et al., 2007; Bart, 2010;
	Higher noise pollution (causing insomnia and other effects on health)	Slabbekoorn and Peet, 2003; Moudon, 2009
	Higher light pollution, modification of light conditions and other visual stimuli	Bennie et al., 2014

Table 1.2 Environmental, economic and social effects of urban sprawl and/or urban growth (cont.)

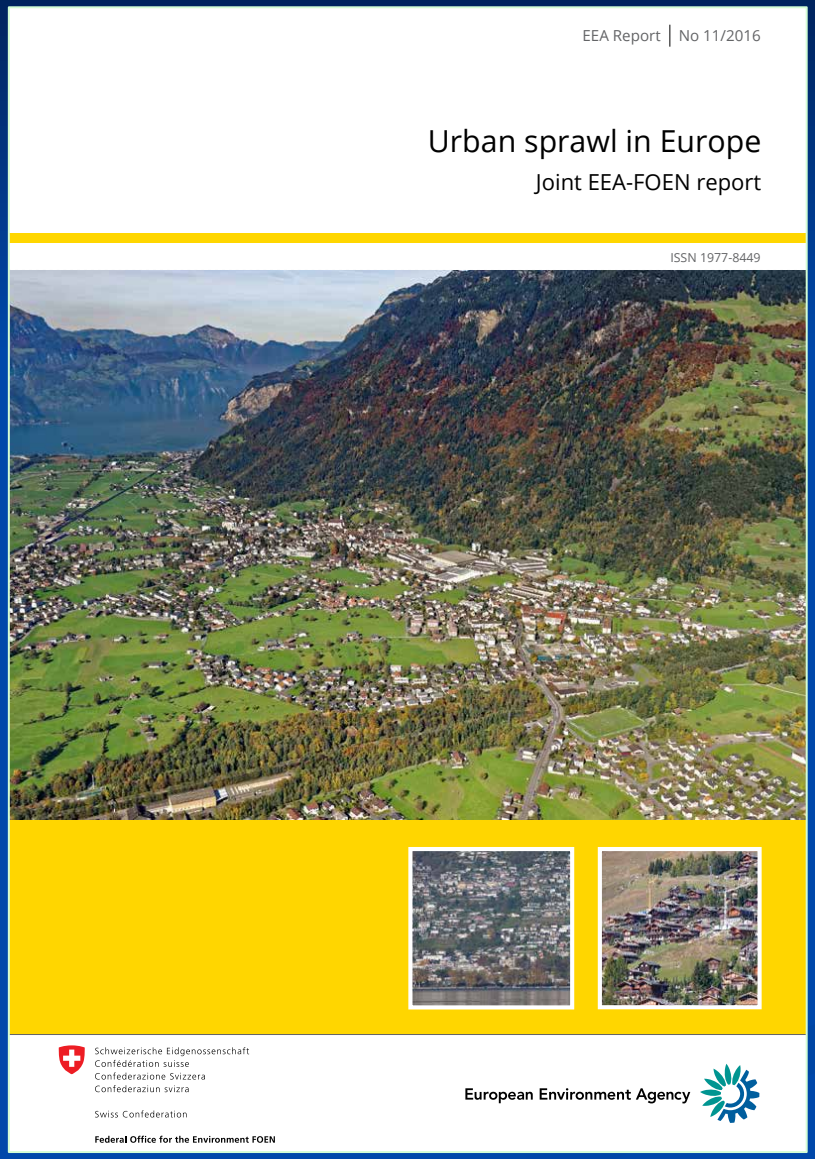
Theme	Consequences of urban sprawl	Sources (examples)
	The decoupling of material cycles of waste treatment (i.e. longer distances for waste transport and treatment counterbalance the positive effects of material recycling)	EEA, 2006b
Water	Hydrological alterations of watersheds as a result of the reduction of the quantity and quality of groundwater, and the lifting or lowering of the groundwater table	Jat et al., 2008; Wilson and Chakraborty, 2013
	Modification of surface water courses	Feyen and Dankers, 2009; Haase, 2009
	Water pollution, such as the pollution of rainwater by tire abrasion, dust and heavy metals, which washes into rivers	Tu et al., 2007
	A higher risk of leakages per capita (there will be more leakages as the network of pipes increases)	Pauliuk et al., 2014
	Drainage, faster removal of water and increased risk of flooding (e.g. because of sealed surfaces)	Haase, 2009; Wilson and Chakraborty, 2013
	Diminished hydrological dynamics of wetlands around sprawled cities	EEA, 2006b
	Increased water consumption per capita	March and Saurí, 2010
	Competition between agricultural irrigation and water use by city dwellers (e.g. in dry summers)	EEA, 2006b
Flora and fauna	The loss of habitats for native species; sometimes creation of new habitats with special conditions	Alberti, 2005
	The loss of soil biodiversity	Turbé et al., 2010
	The reduction of habitat areas below the required minimum, the loss of species and the loss of biodiversity	Alberti, 2005
	Habitat alteration and higher disturbance rates	EEA, 2006b
	Higher numbers of invasive species and the spread of invasive species as a result of changes in climatic conditions	Nobis et al., 2009; Scalenghe and Marsan, 2009; Shochat et al., 2010
	The reduced resilience of ecosystems	Scalenghe and Marsan, 2009; Shochat et al., 2010
	The impoverishment or alteration of species' communities	McKinney, 2006, 2008; Raupp et al., 2010
	The modification of food webs as a result of altered food availability	Faeth et al., 2005
	The increased fragmentation of the landscape: barrier effect, habitat fragmentation, disruption of migration pathways, impediment of dispersal, increased road mortality of wildlife, isolation of populations, degradation of ecological networks and loss of existing green infrastructure	Alberti, 2005; EEA, 2006b; EEA and FOEN, 2011a
	Genetic isolation and increased inbreeding, and disruption of metapopulation dynamics	Alberti, 2005; EEA, 2006b
	A restriction of the re-colonisation of empty patches of habitat	McKinney, 2008
Landscape scenery	Visual stimuli and noise	Slabbekoorn and Peet, 2003; Moudon, 2009; Bennie et al., 2014
	The increasing penetration of the landscape by built-up areas	Pauleit et al., 2005
	Landscapes can be read and interpreted less because of visual breaks caused by the contrasts between nature and technology	Ewald and Klaus, 2009
	Changes in the character and identity of the landscape	Ewald and Klaus, 2009; Marull et al., 2010; Müller et al., 2010
	The increased exploitation of river beds and the expansion of quarries for construction materials	EEA, 2006b
Land use	Loss of agricultural land and highly fertile soils (non-renewable resources)	Wilson and Chakraborty, 2013
	The uptake of agricultural land leads to the intensification of agricultural production elsewhere and encourages mass production	Peña et al., 2007; Eigenbrod et al., 2011
	The reduced recreational quality of natural and semi-natural areas	White et al., 2013
	Conflicts with other land-use interests because of a decrease in the availability of land for agriculture, renewable energy supply and industrial purposes; higher pressure on protected areas; and conflicts with conservation management because of light and noise pollution and recreational activities	Haber, 2007

European Environment Agency (2016)

Table 1.2 Environmental, economic and social effects of urban sprawl and/or urban growth (cont.)

Theme	Consequences of urban sprawl	Sources (examples)
Economic impacts		
	Higher costs for transport associated with commuting for households	Camagni et al., 2002; Bento et al., 2005; Travisi et al., 2010
	A higher demand for transport, increased car use and a higher cost for public transport infrastructure	Ewing, 1997; Kenworthy et al., 1999
	Higher costs associated with traffic congestion and the extension of urban infrastructure in newly developed regions	Hortas-Rico and Solé-Ollé, 2010; Klug and Hayashi, 2012; Cinyabuguma and McConnell, 2013
	Higher costs as a result of higher energy consumption per person	Kenworthy et al., 1999
	Higher public service costs and higher expenditure for construction and maintenance of infrastructure per capita (roads, electricity, water provision pipes, wastewater collection pipes, municipal garbage collection, snow removal, etc.)	Ewing, 1997; Kenworthy et al., 1999; Pauliuk et al., 2014
	Higher material use for construction per housing unit	Roy et al., 2015
	A reduction in food production and self-sufficiency, and a higher dependence on imported food	Haber, 2007; Wilson and Chakraborty, 2013
	An increased demand for raw materials, such as concrete, the expansion of quarries and the over-extraction of gravel from river beds	EEA, 2006b
	Changes in the distribution of populations relative to the locations of ecosystem service supplies, which can reduce the per capita supply and increase the costs of service provision	Eigenbrod et al., 2011
	The degradation or loss of various ecosystem services, and higher costs for their substitution or restoration by technology	Cumming et al., 2014
	Environmentally degraded urban areas are less attractive to new investors and their highly qualified employees	EEA, 2006b
	Economic losses in touristic areas in which the landscape scenery has been degraded	EEA, 2006b
Social impacts and quality of life		
	Desired place to live for many people because low-density housing offers more privacy and larger garden areas than densely built-up parts of cities	Bruegmann, 2005
	A higher proportion of single households, which leads to a more resource-intensive living style	Dura-Guimera, 2003; Howley, 2009
	A greater segregation of residential development based on income	Thurston and Yezer, 1994; Power, 2001; Brade et al., 2009; Cassiers and Kesteloot, 2012
	Longer commuting times and a reduction in social interaction	Putnam, 2000
	Respiratory problems (e.g. asthma) as a result of more air pollution	Frumkin et al., 2004
	Insomnia and other effects on health as a result of higher noise pollution and the heat island effect	Frumkin et al., 2004
	Increased obesity, stress and decreased physical activity	Costal et al., 1988; Ewing et al., 2003; Garden and Jalaludin, 2009
	Reduced human benefits from groundwater and conflicts as a result of competition for groundwater	EEA, 2006b

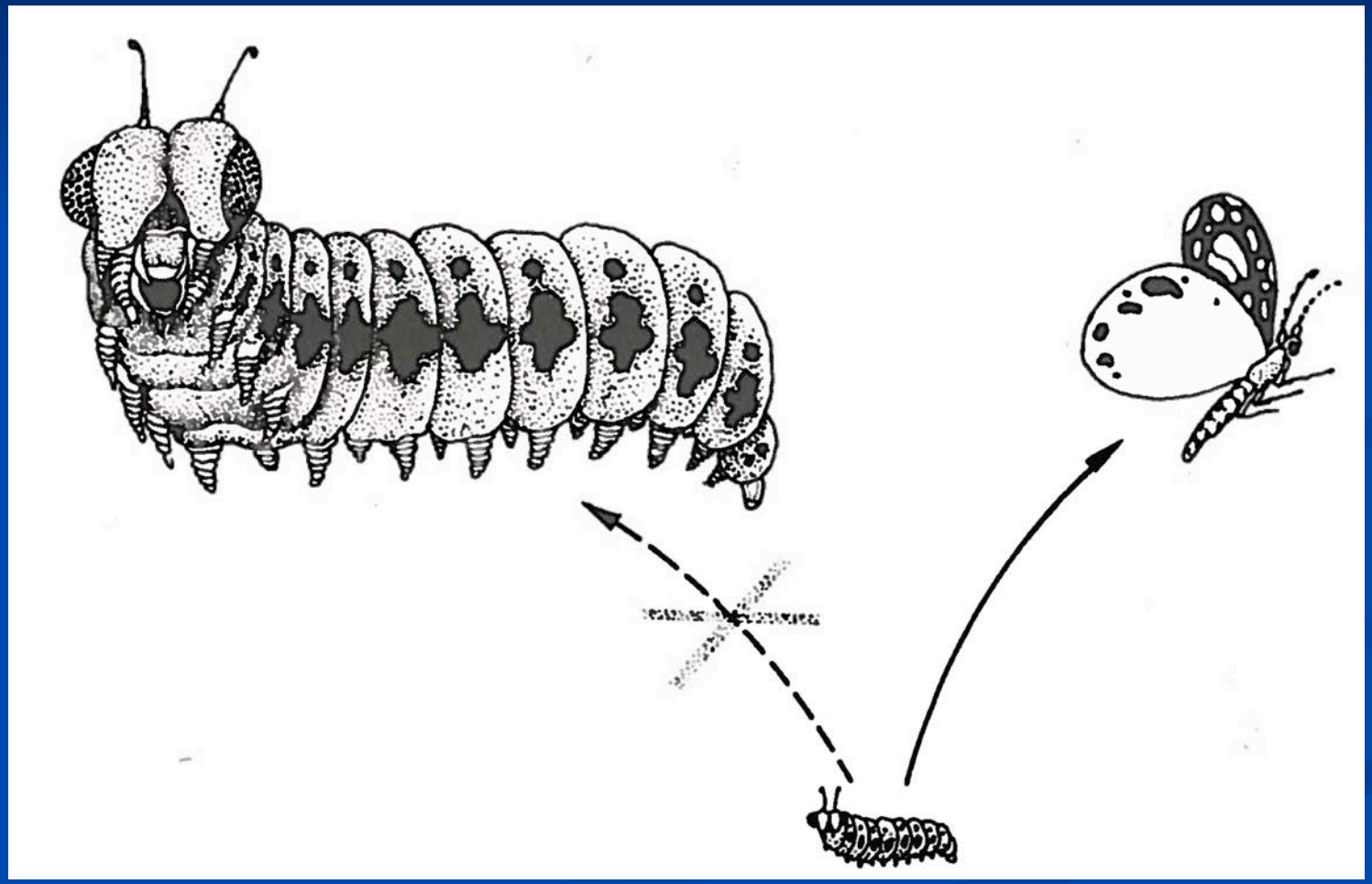
Many effects of urban sprawl



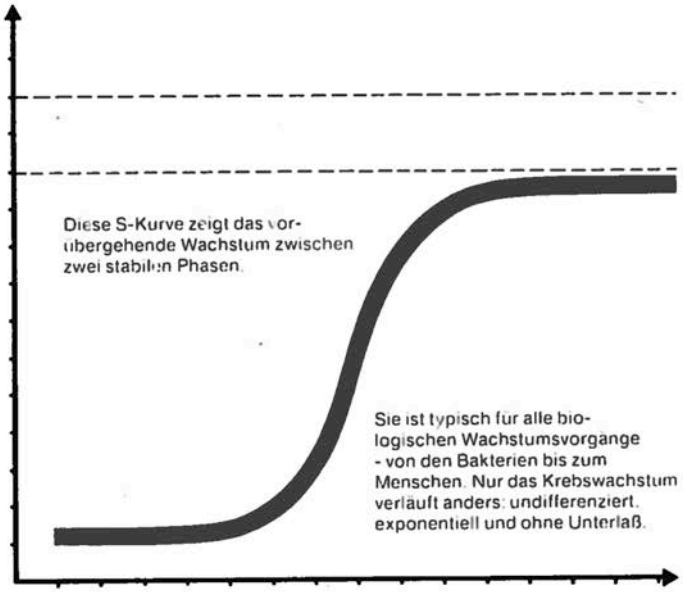
Available at
www.eea.europa.eu/publications/
urban-sprawl-in-europe

European Environment Agency (2016)

How much growth is sustainable?



Logistic growth – not unlimited growth

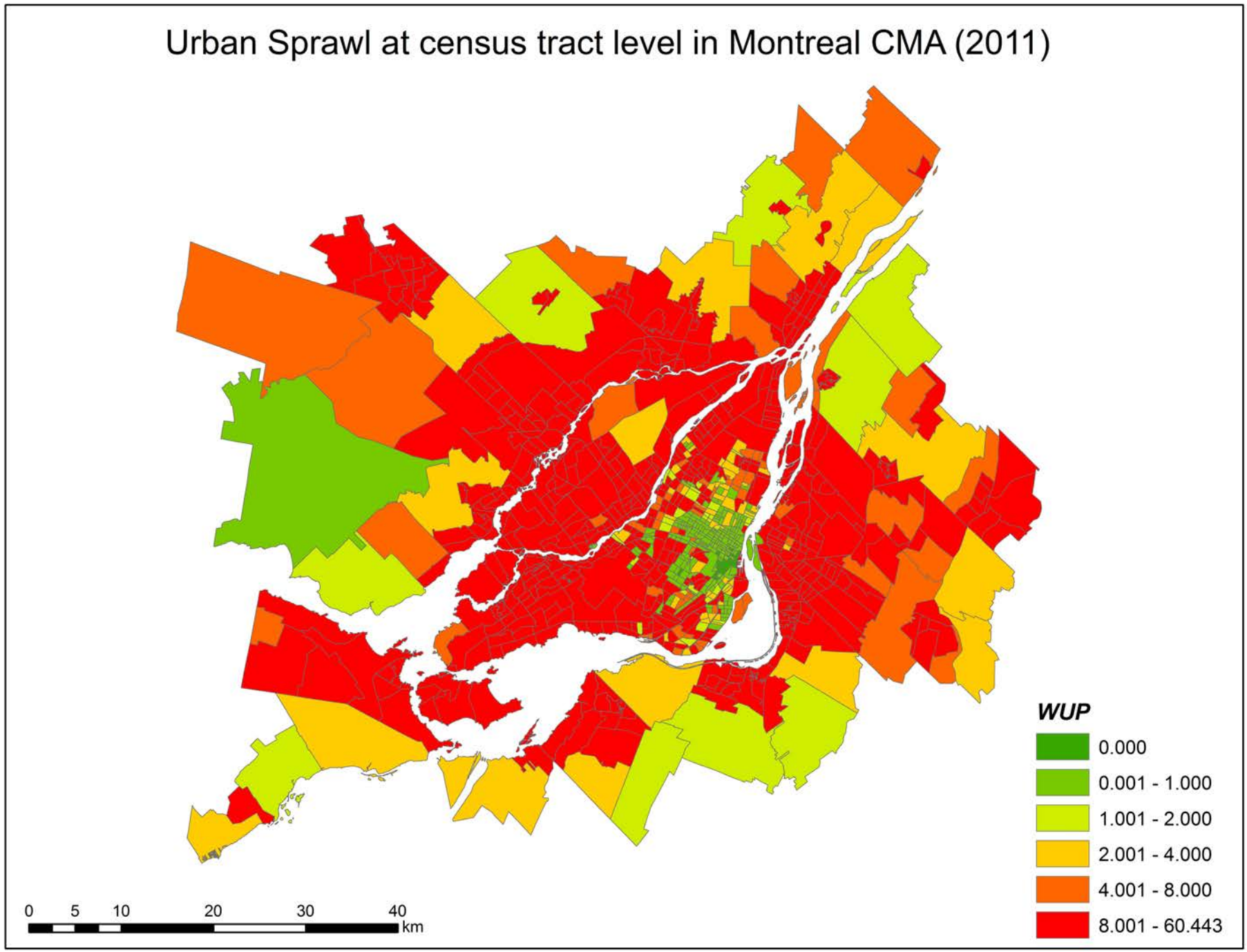


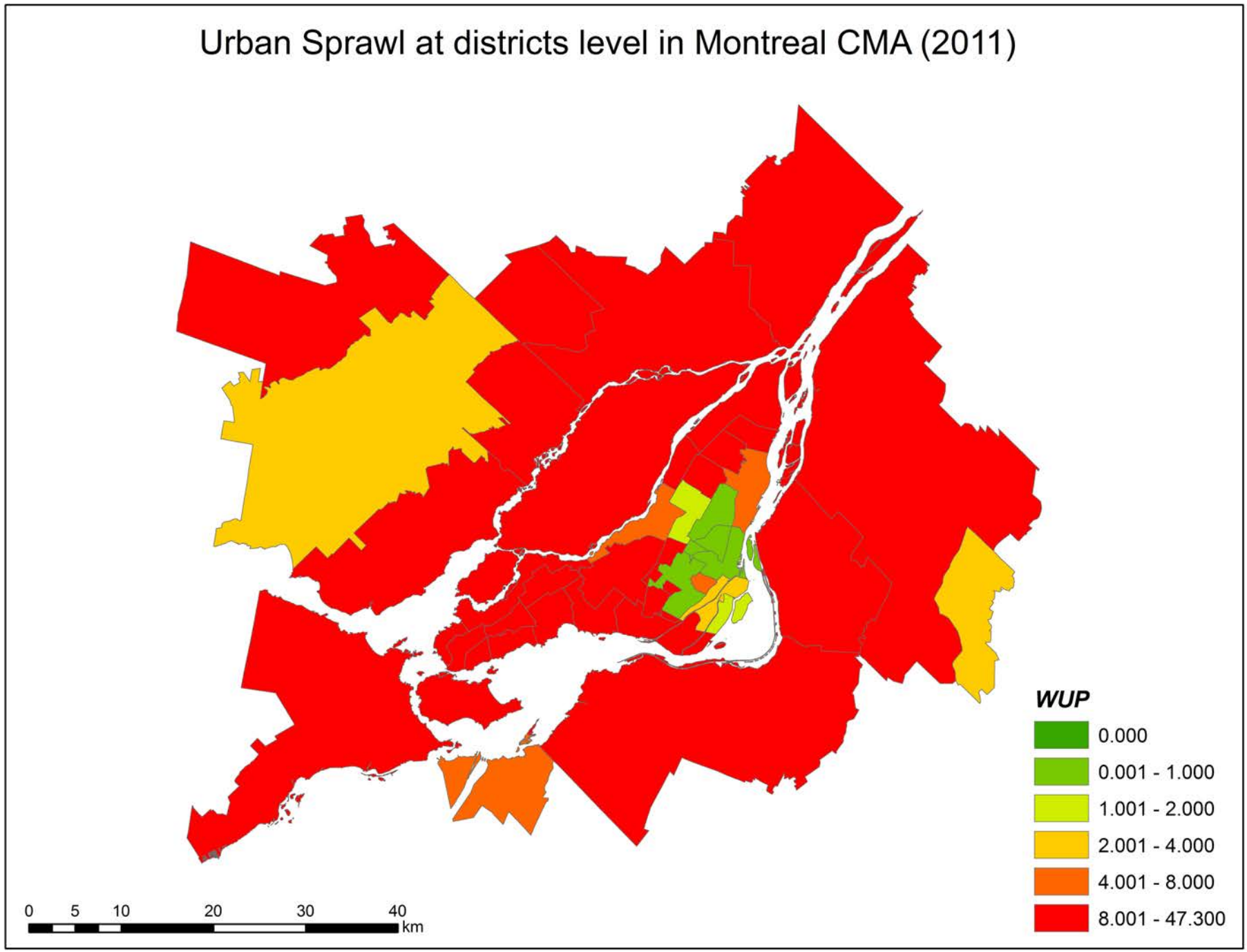
Das Prinzip des organischen Wachstums: Seine Besonderheit ist, daß es nur vorübergehend auftritt und den nächsten Wachstumsstopp schon in sich trägt – zum Beispiel beim menschlichen Organismus,

Die Kurve zeigt das vorübergehende Wachstum zwischen zwei stabilen Phasen. Sie ist typisch für alle biologischen Wachstumsvorgänge.

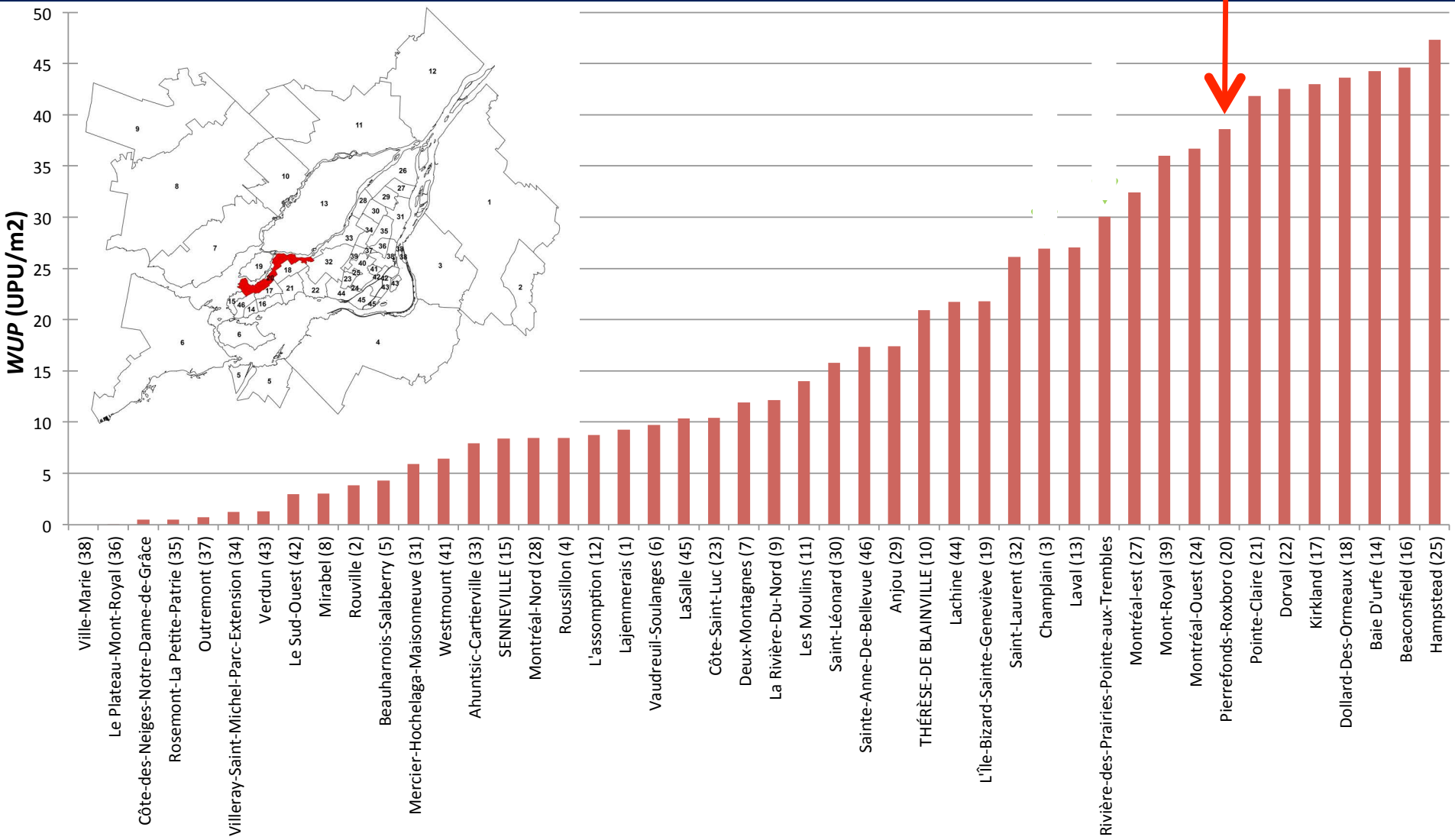
“He who wants to act responsibly needs to know what he does. He needs to be able to see the potential consequences of his actions. (...) An enlightened reason would be a reason that recognizes its own possibilities and limitations. It would be a reason that does not do everything that one can do, but has recognized that only such an acting is sensible that sees its own consequences within our given limitations, and can only in this way become responsible acting.”

Georg Picht (1967)

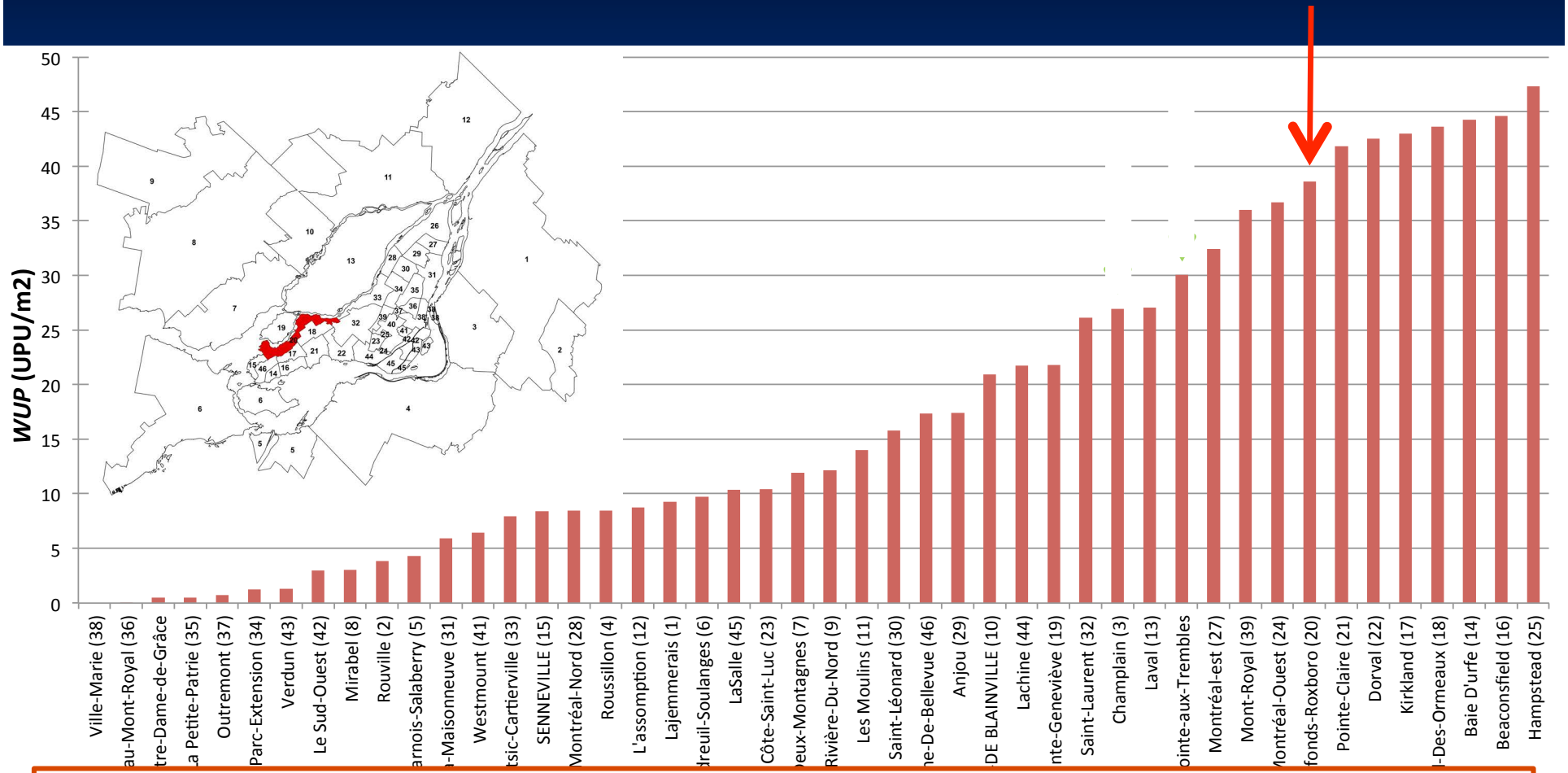

Urban Sprawl at census tract level in Montreal CMA (2011)
WUP
0.000
0.001 - 1.000
1.001 - 2.000
2.001 - 4.000
4.001 - 8.000
8.001 - 60.443
0 5 10 20 30 40
km


Urban Sprawl at districts level in Montreal CMA (2011)
WUP
0.000
0.001 - 1.000
1.001 - 2.000
2.001 - 4.000
4.001 - 8.000
8.001 - 47.300
0 5 10 20 30 40
km

Urban sprawl in the Montreal CMA at district level (2011)



Urban sprawl in the Montreal CMA at district level (2011)



The proposed development would very likely increase urban sprawl significantly.

en Suisse: La gestion durable du paysage fait partie de la Constitution fédérale suisse depuis 1999.

« L'étalement urbain et la destruction des terres agricoles sont des problèmes non résolus de l'aménagement du territoire. »

Citation de Doris **Leuthard**,
Présidente de la Confédération

et de

Corinne **Casanova**
Chancelière de la Confédération

en 2010

11 measures to limit urban sprawl:
Use land sparingly

- Keeping settlement areas within existing boundaries
- Halting dispersed expansion of settlements
- Proper protection of open countryside
- Protect sprawl-sensitive areas
- Settlement restriction
- Respect for the directive only to build in the designated zones
- Limiting the extent of designated building zones
- Large-scale cooperative planning
- Setting targets, limits and benchmarks for sprawl
- Long-term settlement planning based on guiding principles for landscape management
- Measures related to landscape fragmentation
  - By-passes closer to town
  - Bundling of transport routes
  - Demolition of transport routes that are no longer essential

11 measures to limit urban sprawl:
Use land sparingly

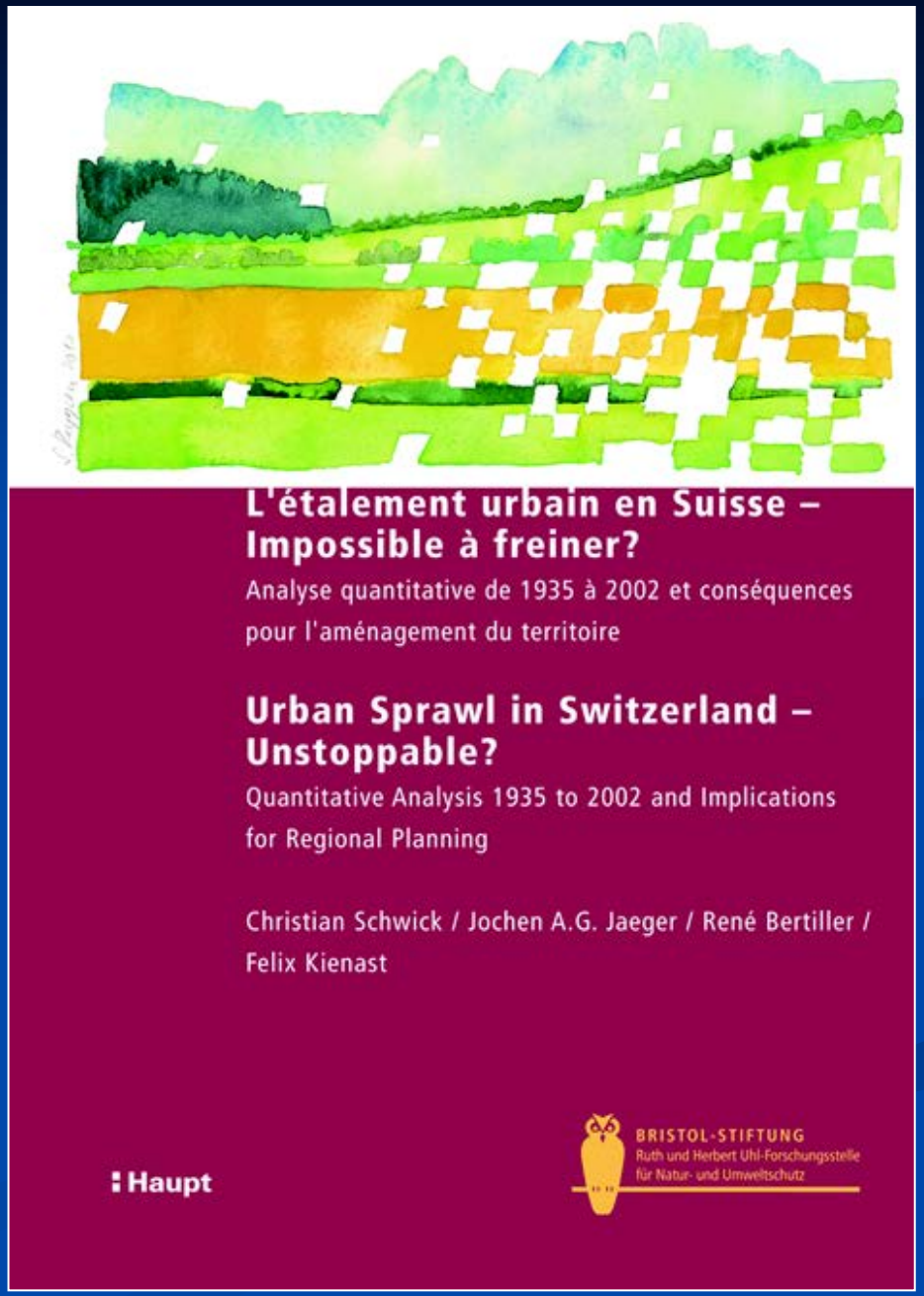
- Keeping settlement areas within existing boundaries

Establish quantitative limits to curtail urban sprawl

Establish a set of suitable indicators for controlling urban sprawl in the future

"Reduction of land uptake per inhabitant and concentration of existing settlement areas without extending the borders of each settlement" (Schwick et al. 2012)

Analysis of urban sprawl in Switzerland:



Schwick et al. (2012)

BANQUE
ALTERNATIVE
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Communiqué de presse du 18 juin 2012

La Banque Alternative Suisse engage la lutte contre le mitage

La Banque Alternative Suisse (BAS) est la première banque en Suisse à mesurer les atteintes au paysage des projets de construction qu'elle finance. Elle exclut l'octroi d'un crédit hypothécaire aux projets induisant un degré de mitage élevé.

En Suisse, près d'un mètre carré de sol est urbanisé chaque seconde. Des études récentes montrent qu'entre 2002 et 2010, la superficie des zones d'habitat a augmenté en Suisse de quelque 170 kilomètres carrés. La Banque Alternative Suisse a développé un instrument pour mesurer les atteintes au paysage des projets de construction qu'elle finance. Lorsque ceux-ci induisent un degré de mitage élevé, l'octroi d'un crédit hypothécaire est refusé.

Immeubles durables, un enjeu majeur pour la BAS

Le financement d'immeubles apportant une plus-value écologique et sociale représente un

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Immeubles durables, un enjeu majeur pour la BAS
Le financement d'immeubles apportant une plus-value écologique et sociale représente un enjeu majeur pour la BAS. En tant que banque centrée sur l'éthique, elle se concentre, entre autres, sur l'octroi de crédits à des projets qui favorisent la densification des constructions en zones urbaines ou la reconversion de bâtiments industriels. « La BAS joue ainsi, depuis longtemps déjà, un rôle important dans la lutte contre le mitage. Avec ce nouvel instrument de mesure, la BAS franchit une étape supplémentaire et ajoute à ses outils d'évaluation de la durabilité immobilière un composant novateur », indique Martin Rohner, président de la direction de la BAS.

Un instrument de mesure complet
La BAS a développé l'instrument en collaboration avec Christian Schwick du bureau d'experts-géographes Schwick+Spichtig. Le calcul du degré de mitage prend en compte trois facteurs : la pénétration urbaine, la dispersion des surfaces bâties et la densité de population et d'emplois. « C'est la réunion de ces trois paramètres dans une même formule qui est fondamentalement novatrice », explique Christian Schwick. La BAS recourt à cet instrument depuis le 1er juin 2012 dans le cadre d'études préliminaires destinées à déterminer l'opportunité d'un financement immobilier.

La BAS assume ses responsabilités de banque
« Nous sommes persuadés qu'il existe encore en Suisse de nombreuses régions à forte concentration urbaine qui pourraient être mieux exploitées pour répondre au besoin en habitats attrayants ou en surfaces commerciales bien équipées », estime Martin Rohner. L'instrument incite à mieux utiliser ces surfaces. La BAS montre de quelle manière une banque peut assumer ses responsabilités en matière de mitage.

www.abs.ch

Pour toute information supplémentaire et demande d'interview
Dominique Roten, responsable de la région romande,
Tél. 021 319 91 01, Courriel: dominique.roten@bas.ch

Simon Rindlisbacher, Marketing et Communication
Tél. 062 206 16 93, Courriel: medien@abs.ch

La BAS : écologique, sociale et transparente depuis plus de 22 ans
Fondée en 1990, la Banque Alternative Suisse SA est en mains de 4'400 actionnaires. Son bilan dépasse le milliard de francs. Les 27'000 clientes et clients de la BAS savent où va leur argent : la BAS publie la liste de tous les crédits qu'elle a octroyés et elle n'investit que dans des projets et entreprises durables. Pour cela, elle refuse de maximiser le profit, donnant la priorité à ses valeurs sociales, écologiques et éthiques. Huit secteurs de crédit d'encouragement bénéficient de conditions avantageuses, financées par la renonciation volontaire de clientes et clients à leurs intérêts. Sur cette base éthique, la BAS propose toute la gamme des services habituels d'une banque de placement, d'épargne et de crédit.

Ce communiqué de presse est également publié en allemand sur www.bas.ch.

- Switzerland: Notice pour le praticien
  - PDF disponible à www.wsl.ch/etalementurbain

- Proposal:
  - write such a paper about Montreal
  - new data for 2016/17
    - financial support?

Notice pour le praticien

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http://www.wsl.ch/publications

47
Octobre
2011

Mesurer et éviter l'étalement urbain

Christian Schwick, Jochen Jaeger et Felix Kienast

En Suisse, l'étalement urbain augmente à une vitesse effrayante. Il a plus que doublé depuis 1950 et ses conséquences à long terme sont alarmantes. Une nouvelle méthode pour le mesurer confère aux planificateurs et aux politiciens un instrument susceptible de donner aux discussions une note plus objective, d'évaluer les scénarios de planification, de définir les objectifs pour l'avenir et de vérifier le succès des mesures qui visent à la réduire.

Consommation de paysage vertigineuse en Suisse

La croissance des surfaces bâties et des voies de communication, le remembrement rural et l'agriculture intensive ont provoqué un changement radical des paysages en Europe au cours des cinquante dernières années. À maints endroits, le paysage d'autrefois ne se reconnaît quasiment plus (Ewald et Klaus 2009; Fig. 1).

En 1955, dans un mince opuscule rouge intitulé «achtung: die Schweiz» («attention: la Suisse»), Lucius Burckhard, Max Frisch et Markus Kutter mettaient déjà en garde contre la croissance incontrôlée du paysage urbain. Ils proposaient alors de respecter la limitation des surfaces comme défi à se donner et de bien considérer les conséquences à long terme. La loi sur l'aménagement du territoire (LAT) de 1979 prescrit une utilisation mesurée du sol en vue d'éviter le mitage. L'étalement du milieu bâti doit donc être limité. En renforçant le rôle des zones à bâtir, la LAT a permis, au cours des trente dernières années, un recul marqué de la construction de nouveaux bâtiments en dehors de ces zones. Toutefois, depuis lors, la surface bâtie et à bâtir n'a pas cessé de croître de façon considérable en Suisse. Avec les conséquences suivantes: perte de terres agricoles, d'habitats pour la faune sauvage et de biodiversité, dissémination d'espèces de plantes invasives, grandes distances spatiales entre l'habitat, le travail et les loisirs, de même que formation de cités-dortoirs.

Un problème majeur est l'utilisation souvent faible des surfaces bâties (Fig. 2). Ce phénomène a des répercussions économiques, écologiques et sociales négatives, notamment à cause des coûts élevés de viabilisation et de services (voirie, eau, électricité, collecte de déchets), d'une plus

Fig. 1. L'étalement urbain gagne également les vallées alpines. Vue depuis la Cima della Trosa en direction du Centovalli. (Photo: Die Geographen schwick+spichtig, 2011)

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Accelerated urban sprawl in Montreal, Quebec City, and Zurich: Investigating the differences using time series 1951–2011

Naghmeh Nazarnia[a], Christian Schwick[b,c], Jochen A.G. Jaeger[a,*]

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Utilization density (*UD*)
Weighted urban proliferation (*WUP*)

ABSTRACT

Increasing awareness of the negative effects of urban sprawl has made sprawl a topic of great debate. However, higher efforts are needed to protect forests, agricultural lands, and other open spaces from urban sprawl. This study compares patterns of accelerated increase in sprawl in the Montreal and Quebec Census Metropolitan Areas in Canada with the Zurich metropolitan area in Switzerland between 1951 and 2011. We applied the recent metrics of urban permeation (*UP*) and weighted urban proliferation (*WUP*) to measure urban sprawl. Urban sprawl has accelerated continuously in Montreal and Quebec since 1951. Here, the fastest increases in sprawl have been observed in the last 25 years, whereas in Zurich the strongest acceleration was in the 1960s. Urban sprawl has increased exponentially in Montreal since 1951. On the Island of Montreal, the degree of urban sprawl (*WUP*) increased 26-fold from 0.49 UPU/m^2 in 1971 to 12.74 UPU/m^2 in 2011, while in Quebec City it increased 9-fold from 2.41 UPU/m^2 to 21.02 UPU/m^2 from 1971 to 2011. In contrast, the level of sprawl (*WUP*) in the Inner Zurich metropolitan area increased almost 3-fold from 3.12 UPU/m^2 in 1960 to 8.91 UPU/m^2 in 2010, i.e., it was higher before 1980, but then was surpassed by Montreal and Quebec City. The strongest increases in land uptake per person were observed in Quebec City and on the Island of Montreal, while it increased only slightly in Zurich. Two major reasons for this striking difference in sprawl dynamics are Switzerland's stronger planning legislation since 1979 and a much higher level of public transportation availability in Zurich. The comparative analysis of urban sprawl presented in this study can greatly help land-use planners critically assess projected plans and control urban sprawl and its negative consequences. The *WUP* method can also be used to establish targets and limits to urban sprawl and to evaluate the effectiveness of measures to control sprawl.

1. Introduction

More than half of the world's human population has been living in urban areas since about 2008 as a consequence of population growth and a movement of people from rural to urban areas (UNFPA, 2007). For example, while only 50% of Americans lived in cities in 1950, 80% lived in metropolitan areas by the 1990s (Putnam, 2000). In many cases, this has resulted in urban sprawl, in particular in North America where low-density suburban development and automobile dependency have been prevalent, but also in many other places all over the world for similar reasons (Irwin and Bockstael, 2002; Batisani and Yarnal, 2011; Hennig et al., 2015).

1.1. Causes and consequences of urban sprawl

Many factors contribute to the particular pattern of urban development known as urban sprawl, e.g., consumer preferences for inexpensive lots, single-family detached housing, and for living in green low-density neighbourhoods, and the wish for second homes. Telecommunication improvements and low gasoline prices have made human choices of dwelling locations more independent of their distances from central facilities (Ewing, 1997). Unorganized patterns of growth have resulted from planning activities without

Abbreviations: CMA, Census Metropolitan Area; CMM, Communauté Métropolitaine de Montréal; *DIS*, dispersion; FSO, Federal Statistical Office of Switzerland; *LUP*, land uptake per person; MA, metropolitan area; NTDB, National Topographic Database; PMAD, Plan Métropolitain d'Aménagement et de Développement; RCM, regional county municipalities; TLM, topographic landscape model; TOD, transit-oriented development; *UD*, utilization density; *UP*, urban permeation; URSMEC, URban Sprawl MEtrics Calculation (tool); *WUP*, weighted urban proliferation.

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E-mail addresses: naghmeh.nazarnia@concordia.ca (N. Nazarnia), christian.schwick@wsl.ch (C. Schwick), jochen.jaeger@concordia.ca (J.A.G. Jaeger).

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1470-160X/

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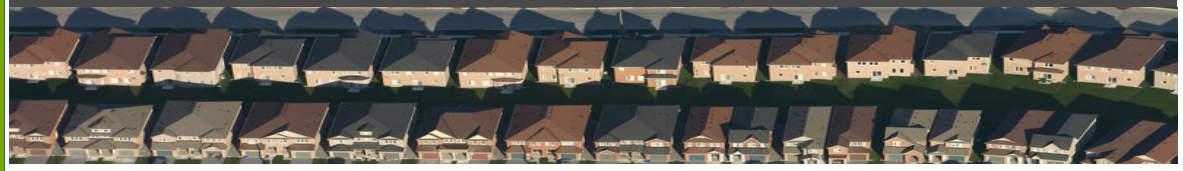
Acceleration of urban sprawl in Montreal during the last 60 years and the need for a change

by
Naghmeh Nazarnia and Jochen A.G. Jaeger

Department
of
Geography, Planning and Environment

Concordia University

November, 2014



Nazarnia et al. (2016)

Many consequences of urban sprawl

ENVIRNOMENTAL IMPACTS	
Energy	• Less land available for renewable energy supplies and industrial purposes • Higher energy consumption (e.g. due to dispersed character of sprawled areas)
Food	• Less land available for food production • Reduced quality of agricultural products (e.g. due to soil contamination or over fertilization)
Land	• Land consumption and soil sealing • Landscape fragmentation • Loss of agricultural lands due to conversion into higher built-up areas
Climate	• Modification of temperature conditions (e.g. heat island effect, heating up of roads) • Modification of wind conditions (e.g. due to aisles in forests in fragmented areas)
Flora and fauna	• Loss of valuable ecosystems for different kinds of animals • Death of animals caused by road mortality • Change in animal movement behavior due to changes in the land use
Water	• Negative impact on hydrological systems (e.g pollution by oil and fuel) • Loss of permeability of soil for water
Pollutions	• Higher noise pollution (e.g. the noise produced by vehicles and rapid growth in transport volumes) • Urban air pollution (e.g. air pollution due to higher dependency on cars and higher use of fuel and oil)
Landscape scenery	• Change in look of landscape (e.g. penetration of the landscape by posts and wires) • Change of landscape character due to its less recreational character in sprawled areas
ECONOMICAL IMPACTS	
Costs	•Higher public service costs (e.g. higher public transport costs) • Increase in personal transportation costs due to long commutes
SOCIAL IMPACTS	
Human being	• Negative health effects, such as obesity • Increase in traffic and traffic-related fatalities • Higher mental health problems (e.g. higher level of stress) • Lack of physical activity (e.g. due to higher automobile dependency)

Many consequences of urban sprawl

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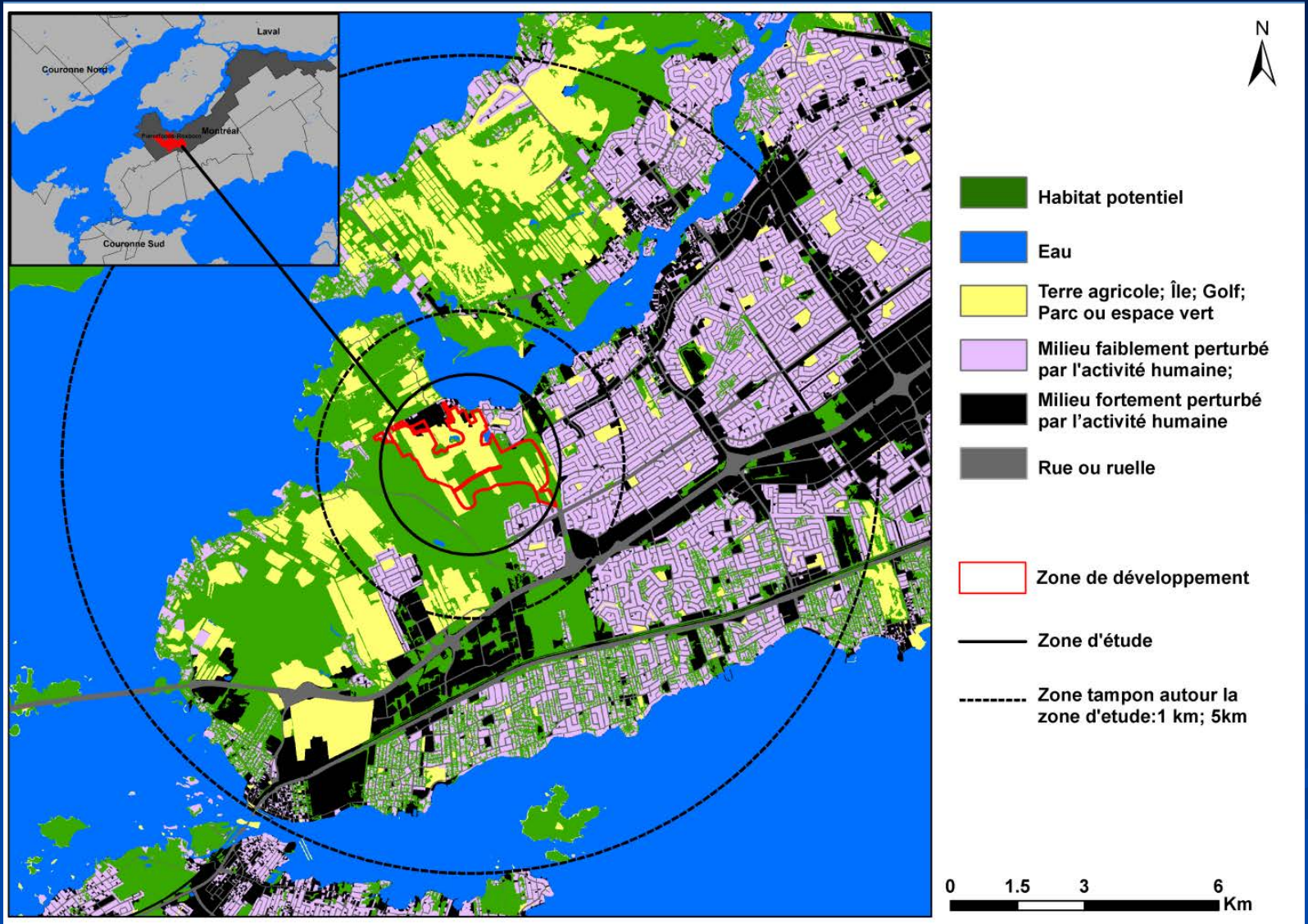
Example


Laval
Couronne Nord
Montréal
Couronne Sud
N
Habitat potentiel
Eau
Terre agricole; Île; Golf; Parc ou espace vert
Milieu faiblement perturbé par l'activité humaine;
Milieu fortement perturbé par l'activité humaine
Rue ou ruelle
Zone de développement
Zone d'étude
Zone tampon autour la zone d'etude:1 km; 5km
0
1.5
3
6
Km

Example

Évaluation écologique de l'ouest du territoire de Pierrefonds-Roxboro

Rapport d'étape

Février 2016

The impacts of the Cap Nature real estate project (Pierrefonds West) on ecological connectivity

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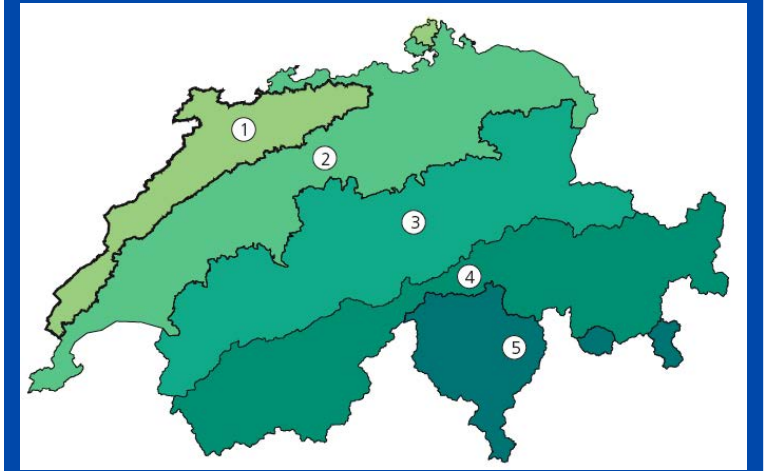
Definition of "urban sprawl"?

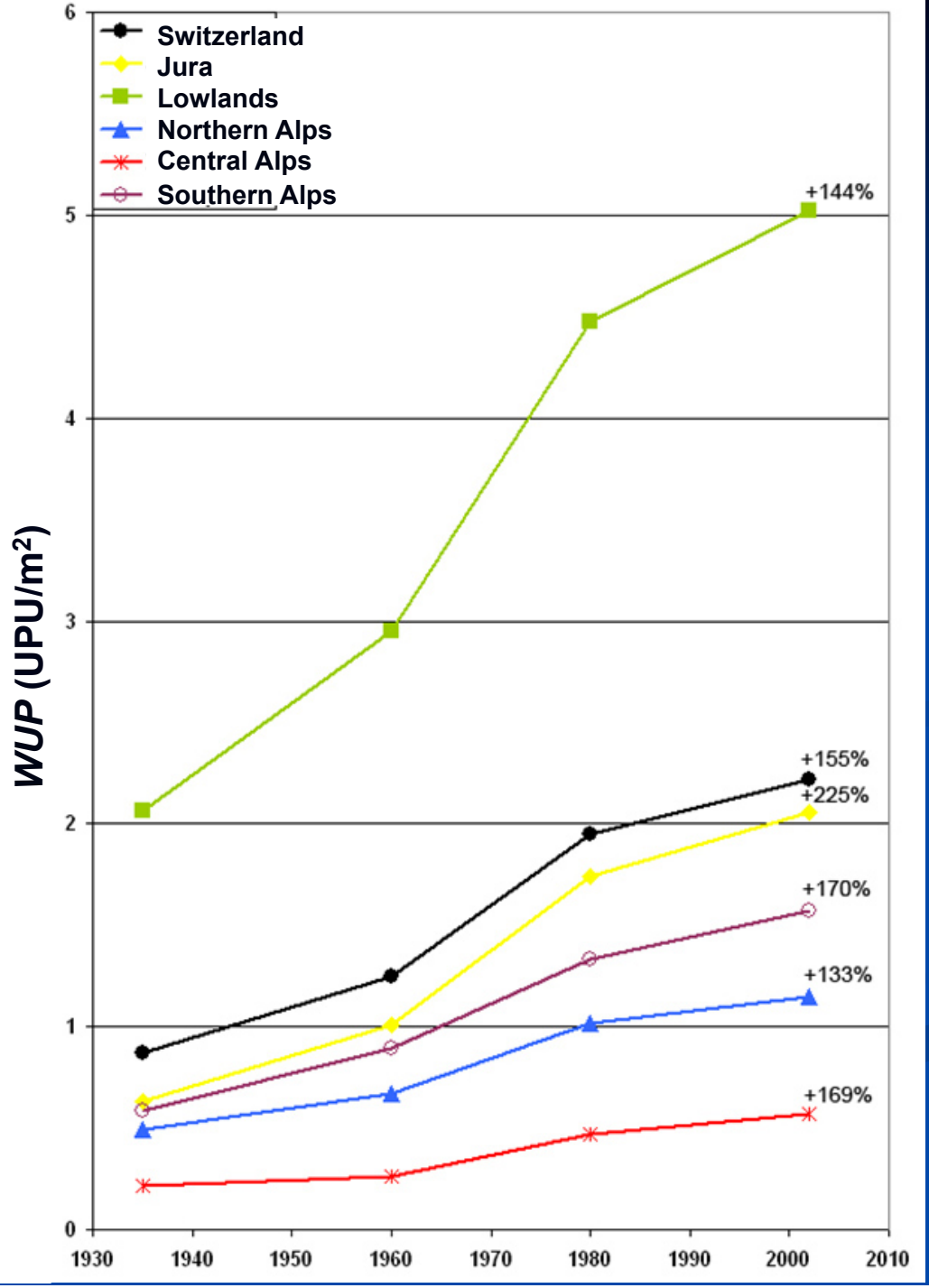
Definition	Source
Sprawl = "on the one hand, the spilling over of urban-type buildings into the suburban and agrarian areas, and on the other hand, the disorganized growth of sporadic beginnings of settlements in agrarian regions (separate farms, houses of farm workers, secondary occupation settlements) as well as in early industrialized or commercially permeated areas where ironworks, foundries and mines served as starting points of such sprawlings. In addition, the term is also applied to the unsystematic positioning of (weekend) houses and groups of houses that are only temporarily occupied outside of closed settlement areas." German original: Zersiedelung = "einerseits das Ausufern städtischer Bebauung in den vorstädtischen und agrarischen Raum hinein, andererseits das ungeregelte Wachstum sporadischer Siedlungsansätze sowohl in Agrargebieten (Einzelhöfe, Landarbeiterwohnungen, Nebenerwerbssiedlungen) wie auch in früh industrialisierten oder gewerblich durchsetzten Räumen, wo Eisenhämmer, Hütten und Bergwerke als Ansatzpunkte derartiger Zersiedelungen dienten. Schliesslich wird der Begriff auch angewendet auf die planlose Ansetzung von nur zeitweilig bewohnten (Wochenend-)Häusern und Häusergruppen ausserhalb geschlossener Siedlungsräume."	Akademie für Raumforschung und Landesplanung (1970: 3863)
Sprawl = "process of the spilling-over of settlement areas and of excessive use of the open landscape by unsystematic, mostly weakly condensed extensions of settlement areas in the fringes of urban agglomerations." German original: Zersiedelung = "Prozeß des Ausuferns der Siedlungsflächen und der übermäßigen Inanspruchnahme der freien Landschaft durch konzeptionslose, meist gering verdichtete Siedlungsflächenerweiterungen in den Randbereichen von Verdichtungsräumen."	Ermer et al. (1994: 119)
Sprawl identified as the combination of three characteristics = "(1) leapfrog or scattered development; (2) commercial strip development; and (3) large expanses of low-density or single-use developments—as well as by such indicators as low accessibility and lack of functional open space".	Ewing (1997: 32)
"Sprawl: the unchecked growth of settlements, taking effect in the area. The danger of sprawl in a landscape is particularly high in the fringe of the large cities, not only through expansive residential building activities, but also through economic institutions that are extensive in area (industrial businesses, airports, etc.). In recent time, sprawl particularly threatens attractive nearby recreational areas through increased building of weekend houses." German original: "Zersied(e)lung: das unkontrollierte, flächenhaft wirkende Wachstum von Siedlungen. Die Gefahr einer Z. der Landschaft besteht vor allem am Rande der grossen Städte, und zwar nicht allein durch eine ausgedehnte Wohnüberbauung, sondern auch durch flächenextensive Wirtschaftseinrichtungen (Industriebetriebe, Flughäfen usw.). Die Z. bedroht in jüngerer Zeit durch einen verstärkten Wochenendhausbau besonders reizvolle Naherholungsgebiete."	Leser and Huber-Fröhli (1997)
Sprawl = "low-density development beyond the edge of service and employment, which separates where people live from where they shop, work, recreate and educate—thus requiring cars to move between zones".	Sierra Club (1999: 1)
Sprawl = "a particular type of suburban development characterized by very low-density settlements, both residential and non-residential; dominance of movement by use of private automobiles, unlimited outward expansion of new subdivisions and leap-frog development of these subdivisions; and segregation of land uses by activity".	USHUD (1999: 33)
"Sprawl is to be understood as the disturbance or destruction of the landscape and of ecosystems by spill-over development of settlements outside of closed built-up areas." German original: "Unter Zersiedelung ist die Beeinträchtigung oder Zerstörung der Landschaft und von Ökosystemen durch ausufernde Siedlungsentwicklung ausserhalb geschlossener Ortschaften zu verstehen."	ARL & VLP (1999: 106)
"Sprawl, is an unplanned, unsystematic, area-intensive outward growth mainly of city-type settlements into the rural space and is a consequence of progressive urbanization. The wish for living in green places, for weekend houses, quickly accessible shopping centers, cheap industrial areas, and transportation infrastructure occupies much space, and if there are no conditions posed by regional planning and environmental protection, then construction will happen at places where it is cheapest. In this way, open spaces, recreational areas, and ecological compensation areas are lost, become dissected or downsized and loose their ecological and socio-economic functions." German original: "Zersiedlung, ist ein ungeplantes, konzeptloses, flächenintensives Hinauswachsen vor allem von städtischen Siedlungen in den ländlichen Raum und ist eine Folge der fortschreitenden Verstädterung und Urbanisierung. Das Bedürfnis nach Wohnen im Grünen, nach Wochenendhäuschen, schnell erreichbaren Einkaufszentren, billigen Industriegebieten und Verkehrsbauten benötigt viel Platz, und ohne Auflagen der Raumplanung und des Umweltschutzes wird dort gebaut, wo es am billigsten ist. Freiflächen, Erholungsgebiete und ökologische Ausgleichsflächen gehen dadurch verloren, werden zerschnitten oder verkleinert und verlieren ihre ökologische, wie auch sozioökonomische Funktionalität."	Landscape Gesellschaft für Geo-Kommunikation (2000–2002: 469)
Sprawl = "the process in which the spread of development across the landscape far outpaces population growth. The landscape sprawl creates has four dimensions: a population that is widely dispersed in low-density development; rigidly separated homes, shops, and workplaces; a network of roads marked by huge blocks and poor access; and a lack of well-defined, thriving activity centers, such as downtowns and town centers. Most of the other features usually associated with sprawl – the lack of transportation choices, relative uniformity of housing options or the difficulty of walking – are a result of these conditions."	Ewing et al. (2002)

Jaeger et al. (2010a)

Results for Switzerland



UPU/m^2 = urban permeation units per square meter of landscape



L'ENVIRONNEMENT SUISSE
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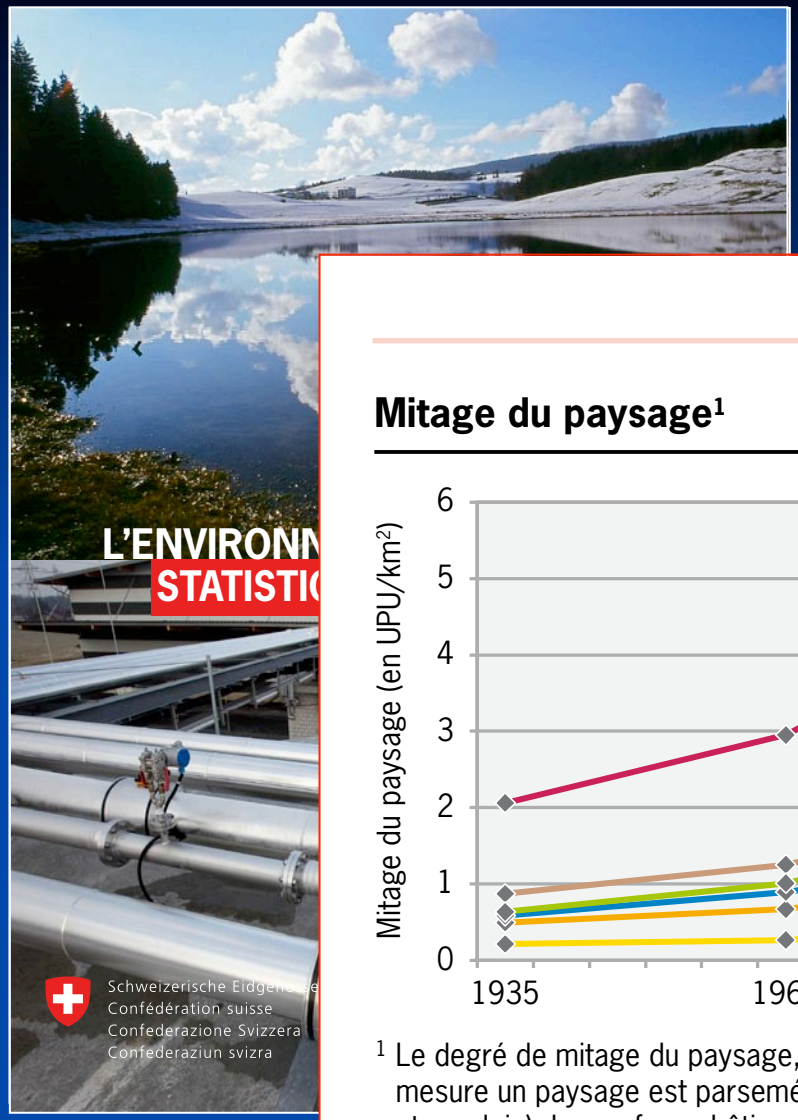
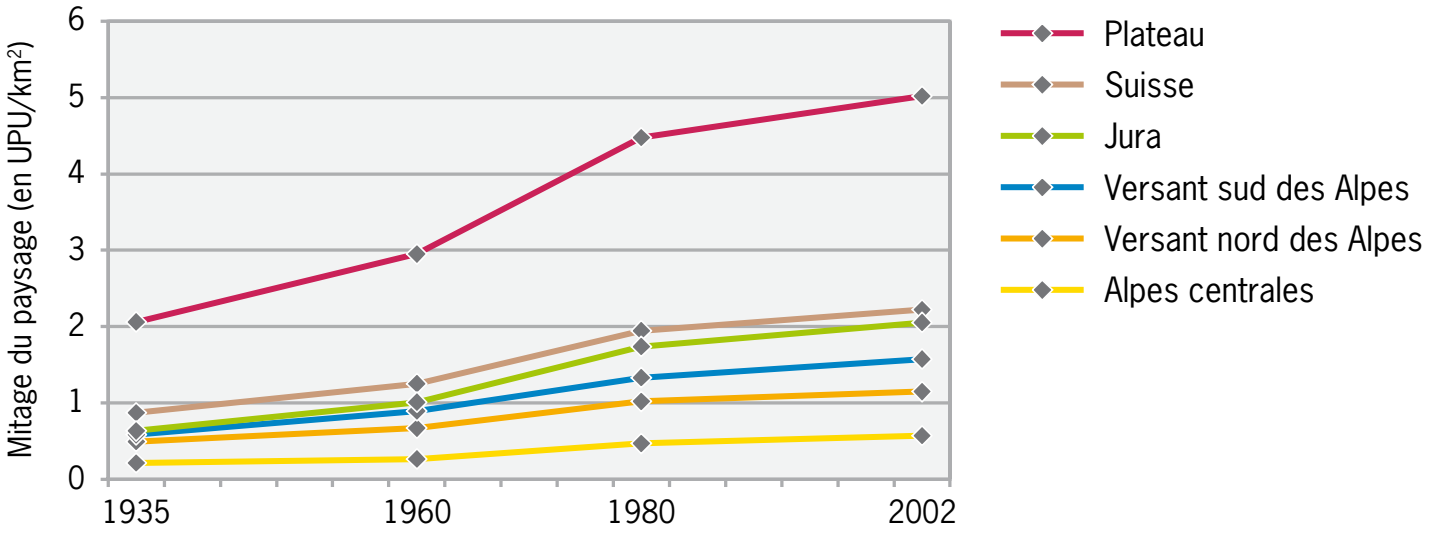
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Office fédéral de la statistique OFS

Office fédéral de l'environnement OFEV



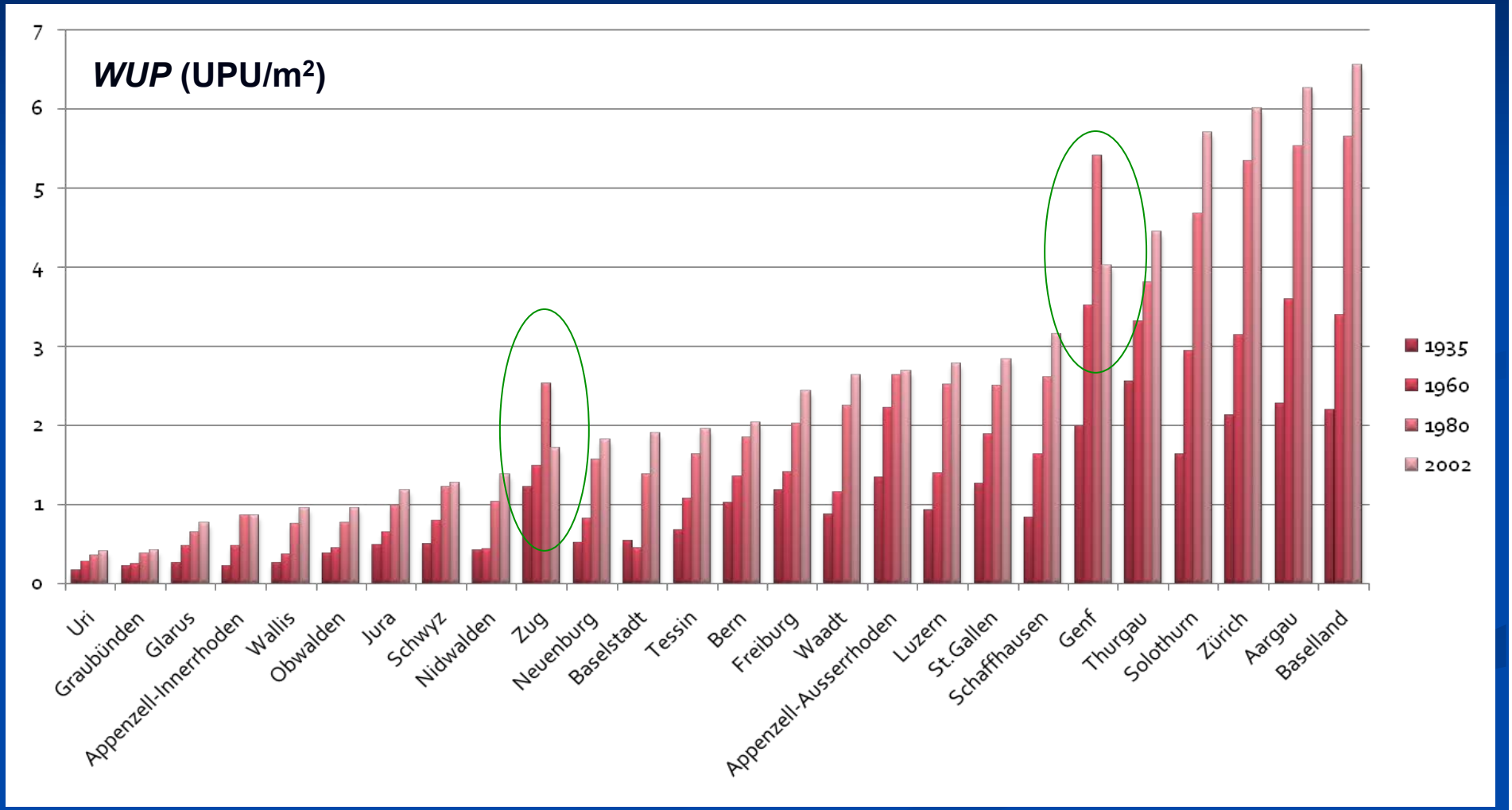
Mitage du paysage[1]



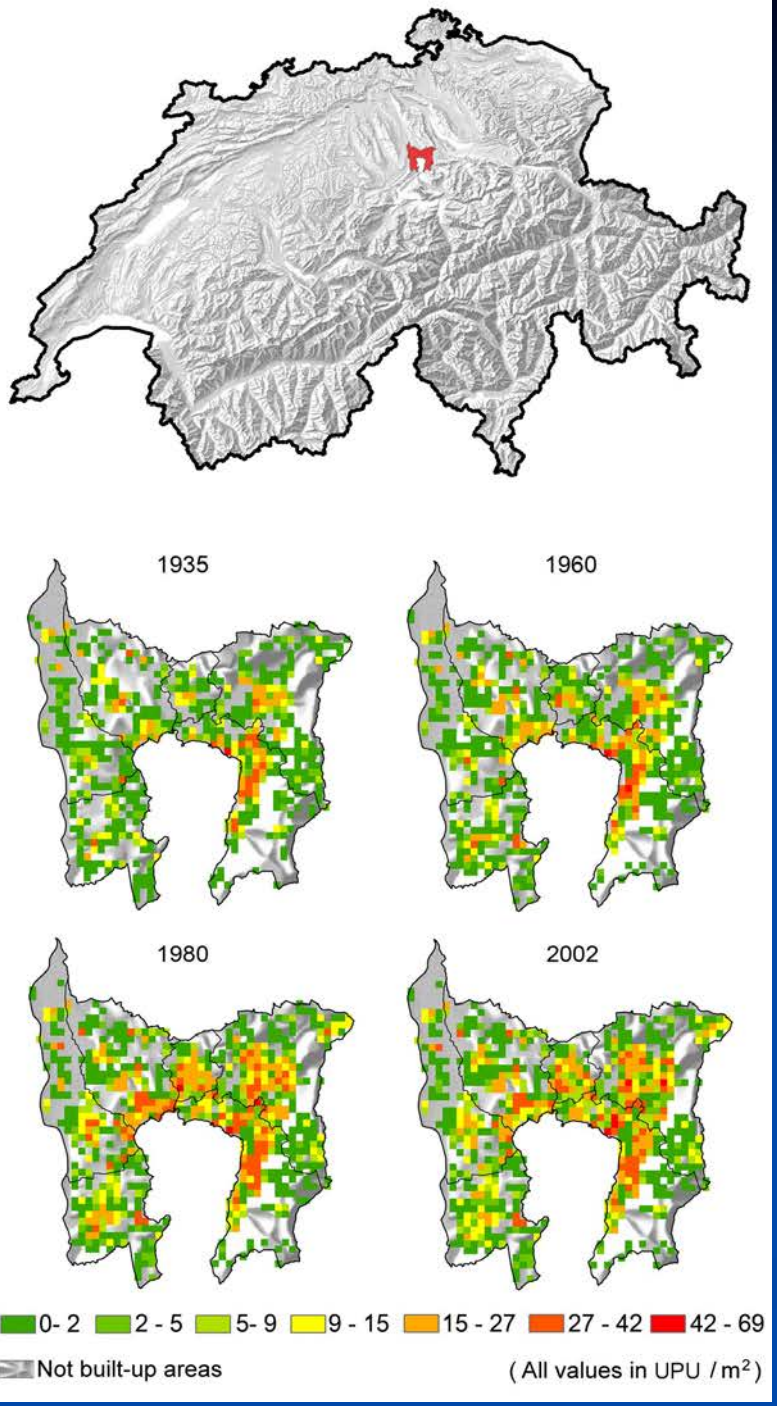
[1] Le degré de mitage du paysage, exprimé en «unités de pénétration urbaine (UPU) par km²», indique dans quelle mesure un paysage est parsemé de bâtiments. Nouvellement, la densité d'utilisation (nombre d'habitants et emplois) des surfaces bâties est prise en compte. Plus il y a de surfaces bâties, plus les bâtiments sont dispersés et plus la densité d'utilisation est faible, plus la pénétration urbaine est élevée.

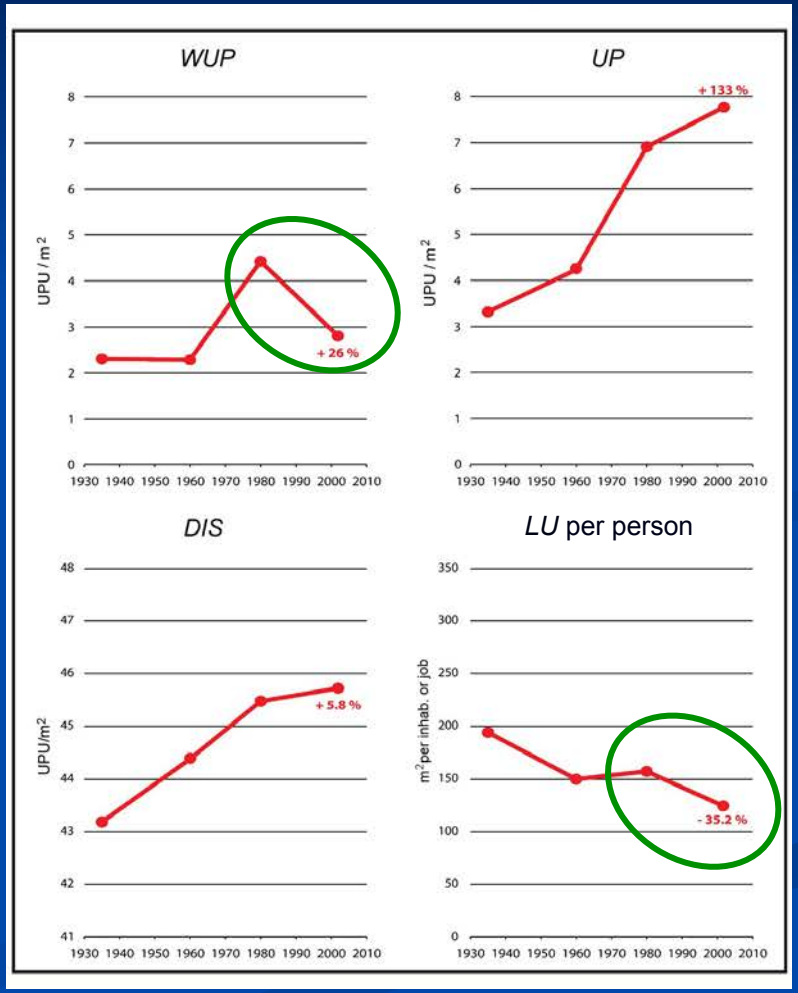
Source: «Landschaftszersiedelung Schweiz», PNR 54 (J. Jaeger, C. Schwick, R. Bertiller), 2008.

Results: Cantons



A positive example: Zug





Examples of application of the method

- National environmental and regional monitoring
  - MONET = Monitoring for sustainable development
  - LABES = Monitoring of landscape quality
- Scenarios: In what landscape do we want to live in the future?
- in the designation of building zones

Examples of solutions to other common-pool problems in Switzerland

- Limitation of the density of cows on Alpine pastures through Alpine cooperatives to avoid overgrazing (before 1291)
- Total protection of the forest areas (since 1888)
- Limits to air pollution (since 1983)
- Water pollution law (since 1991)

Conclusions

- Further sprawl appears to be avoidable ***if***...
  - ... we learn to better understand the *Tragedy of the Commons* for the landscape
  - ... we finally take this problem seriously
  - ... we create sensible regulations and incentives
    - establish quantitative limits to sprawl
- Learn from experiences from other countries
  - e.g., get banks involved in not financing urban sprawl

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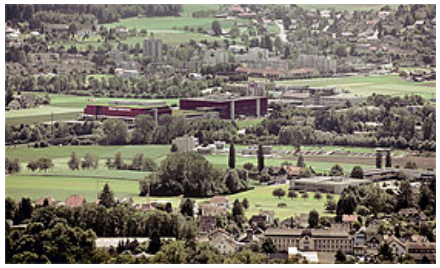
etalementurbain

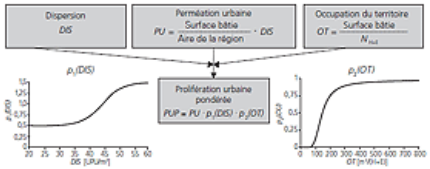
Mesurer et éviter l'étalement urbain

L'étalement urbain est aujourd'hui un problème largement reconnu et figure au coeur du débat politique actuel (Révision de la loi sur l'aménagement du territoire, Initiative pour le paysage)



Comment mesurer le degré de mitage de ce paysage? Vue depuis le Säli-Schlössli près d'Olten en direction d'Aarburg/Rothrist. (Photo: Klaus Ewald, 1999)

Les tendances actuelles du développement de l'urbanisation en Suisse vont à l'encontre de l'objectif d'un développement territorial durable. Afin de limiter l'étalement urbain, des prescriptions légales claires s'avèrent indispensables comme cadre de référence fiable. Il serait ainsi possible d'instaurer une sécurité juridique, de mettre un terme à la concurrence entre des communes qui se disputent emplois, contribuables et habitants, et de favoriser de meilleures coopérations dans l'optique d'un développement durable.



Rapport entre les paramètres de l'étalement urbain (agrandir)

Prolifération urbaine pondérée

Jusqu'à présent, les définitions de l'étalement urbain étaient trop imprécises pour servir de base à sa mesure. Un projet dans le cadre du Programme national de recherche 54 est venu remédier à ce manque. Ainsi les critères mesurables suivants: taille de la surface bâtie, dispersion et utilisation de celle-ci viennent compléter l'évaluation intuitive. L'impact sur le mitage de toute modification de l'urbanisation peut, sur la base de cette définition, être analysé dès la phase de planification.

La nouvelle méthode pour mesurer la prolifération urbaine pondérée confère aux planificateurs et aux politiciens un instrument susceptible de définir les objectifs pour l'avenir et de vérifier le succès des mesures qui visent à le réduire.

Pour en savoir plus

- La Notice pour le praticien du *WSL Mesurer et éviter l'étalement urbain* explique avec clarté l'étalement du paysage en Suisse, les nouvelles méthodes pour le quantifier, ainsi que les mesures qui en découlent pour endiguer ce phénomène.
- L'étalement urbain en Suisse - Impossible à freiner? Analyse quantitative de 1935 à 2002 et conséquences pour l'aménagement du territoire. Urban Sprawl in Switzerland - Unstoppable? Quantitative Analysis 1935 to 2002 and Implications for Regional Planning. Zurich, Bristol-Stiftung; Berne, Stuttgart, Vienna, Haupt. 216 p. 4 maps. Flyer/Commander

Thank you so much for your attention!

Thank you also to:

- Swiss Research Institute WSL
- Swiss Federal Office for the Environment (FOEN)
- European Environment Agency
- Swiss National Science Foundation
- Bristol Foundation (Liechtenstein), et al.

New project:

Controlling urban sprawl in Switzerland: Specific measures and setting of targets

Schwick, Jaeger, Hersperger, Kienast (2013-2016)

- Part A. Measuring urban sprawl
  - Proposal of limits to sprawl from a scientific perspective
- Part B. Obstacles and potential for the implementation of measures and targets
- Part C. Instruments and legal regulations for limiting urban sprawl

CanVec

Table A1
Entities from the CanVec dataset that were used for the delineation of urban areas (BS: building and structures, LX: places of interest, IC: industrial and commercial areas, EN: energy, TR: transportation).

Entity	Entity description	Theme	Name (point)	Name (surface)
Building	Arena	BS	2010009 0	2010009 2
Building	Other	BS	2010009 0	2010009 2
Building	Community centre	BS	2010009 0	2010009 2
Building	Highway service centre	BS	2010009 0	2010009 2
Building	Medical centre	BS	2010009 0	2010009 2
Building	Sportsplex	BS	2010009 0	2010009 2
Building	Gas and oil facilities building	BS		2010009 2
Building	Parliament building	BS	2010009 0	2010009 2
Building	Educational building	BS	2010009 0	2010009 2
Building	Penal building	BS	2010009 0	2010009 2
Building	Industrial building	BS		2010009 2
Building	Religious building	BS	2010009 0	2010009 2
Building	Railway station	BS	2010009 0	2010009 2
Building	Hospital	BS	2010009 0	2010009 2
Building	City hall	BS	2010009 0	2010009 2
Building	Unknown	BS	2010009 0	2010009 2
Building	Armoury	BS	2010009 0	2010009 2
Building	Courthouse	BS	2010009 0	2010009 2
Building	Customs post	BS	2010009 0	2010009 2
Building	Police station	BS	2010009 0	2010009 2
Building	Fire station	BS	2010009 0	2010009 2
Building	Electric power station	BS	2010009 0	2010009 2
Building	Municipal hall	BS	2010009 0	2010009 2
Building	Satellite-tracking station	BS	2010009 0	2010009 2
Building	Coast guard station	BS	2010009 0	2010009 2
Chimney	Burner	BS	2060009 0	
Chimney	Unknown	BS	2060009 0	
Chimney	Industrial	BS	2060009 0	
Chimney	Flare stack	BS	2060009 0	
Tank	Horizontal, unknown	BS	2080009 0	2080009 2
Tank	Unknown, unknown	BS	2080009 0	
Tank	Vertical, other	BS	2080009 0	2080009 2
Tank	Vertical, water	BS	2080009 0	2080009 2
Tank	Vertical, unknown	BS	2080009 0	2080009 2
Cross	Cross	BS	2120009 0	
Navigational aid	Navigation beacon	BS	1250009 0	
Navigational aid	Navigation light	BS	1250009 0	
Navigational aid	Unknown	BS	1250009 0	
Silo	Silo	BS	2440009 0	
Tower	Communication	BS	2530009 0	
Tower	Control	BS	2530009 0	
Tower	Clearance	BS	2530009 0	
Tower	Firebreak	BS	2530009 0	
Tower	Lookout	BS	2530009 0	
Residential area	Residential area	BS		1370009 2
Cemetery	Cemetery	LX	1000039 0	1000039 2
Drive-in theatre	Drive-in theatre	LX	2070009 0	2070009 2
Domestic waste	Domestic waste		IC	1360019 2
Industrial solid depot	Industrial solid depot	IC	1360029 0	1360029 2
Gas and oil facilities	Gas and oil facilities	EN	1360049 0	1360049 2
Runway	Airport, indefinite	TR	1190009 0	1190009 2
Runway	Airport, nonofficial	TR	1190009 0	1190009 2
Runway	Airport, official	TR	1190009 0	1190009 2
Runway	Heliport, indefinite	TR	1190009 0	
Runway	Heliport, nonofficial	TR	1190009 0	
Runway	Heliport, official	TR	1190009 0	
Runway	Hospital heliport, nonofficial	TR	1190009 0	
Runway	Hospital heliport, official	TR	1190009 0	
Runway	Water aerodrome, indefinite	TR	1190009 0	
Runway	Water aerodrome, official	TR	1190009 0	

- Ideas: similar to presentation at Forum Nature
- - show die Raupe + logistic growth and mention cancer? – done.
- - show quote from Picht about responsibility – done.
- NN's slides -> show Pierrefonds zoom-in? -> sent her an email to ask her.
- Use slides for CBC and Forum Nature Montreal? – yes.
- Consequences from EEA report: table -