

NATURE et FRAÎCHEUR pour des villes en santé



Factsheet 1 From Heat Islands to Cool Islands

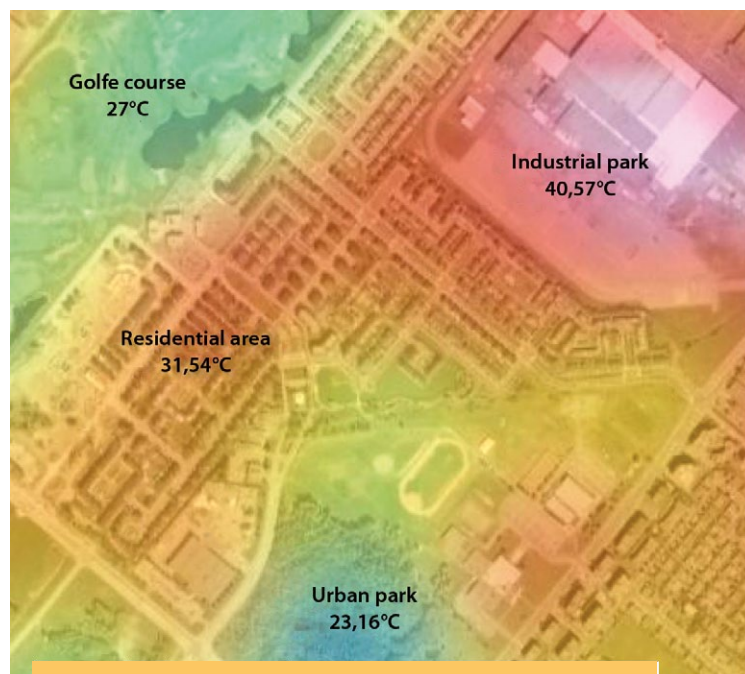
Urban heat islands (UHIs) are a growing cause for concern. UHIs have an impact on the environment (especially on air quality) and on human health, particularly affecting children, seniors, and people at greater risk of cardiovascular and pulmonary disease. Although green spaces and urban woodlands serve as cool islands and mitigate the effects of heat islands, we are currently seeing a major loss of these spaces, mainly due to urban sprawl and the development of large urban centres. As a result, there is a pressing need to preserve these urban natural environments in order to counter the heat island phenomenon.

Heat islands: a hot topic

An urban heat island is an urban area in which the temperature is significantly higher than in the surrounding areas.¹

Temperatures in a heat island may be 5°C to 12°C higher than in the surrounding natural environment.² A striking example is the Saint-Laurent borough of Montreal. In June 2005, the land surface temperature in one industrial park (40.6°C) was 17°C higher than in a nearby urban park (23.2°C) and 9°C higher than in a residential neighbourhood between the green and industrial spaces.³

Heat islands form in highly urbanized areas. Their intensity depends on the weather, the percentage of urbanization, sources of waste heat, and the time, day, season, etc.⁴



Heat islands (red) and cool islands (green and blue)

1 | Anquez, P. and A. Herlem, 2011. *Les îlots de chaleur dans la région métropolitaine de Montréal: causes, impacts et solutions*. Social Responsibility and Sustainable Development Chair, School of Management, UQAM, 16 pp.

2 | Guay, F. and Y. Baudouin, 2005. "Portrait des îlots de chaleur urbains à Montréal." FrancVert. [online, consulted April 27, 2011]. <http://www.francvert.org/pages/23articleportraitdesilotsdechaleur.asp>; Giguère, M., 2009. *Urban Heat Island Mitigation Strategies*. Institut national de santé publique du Québec, Biological, Environmental and Occupational Risks Branch, 95 pp. http://www.inspq.qc.ca/pdf/publications/1513_UrbanHeatIslandMitigationStrategies.pdf

3 | Martin, P., 2007, cited by Cavayas, F. and Y. Beaudoin, 2008. *Étude des biotopes urbains et périurbains de la CMM: Volets 1 et 2: Évolution des occupations du sol, du couvert végétal et des îlots de chaleur sur le territoire de la Communauté métropolitaine de Montréal (1984-2005)*. Montreal, Université de Montréal and Université du Québec à Montréal, 120 pp.

4 | Wypych, S. and A. Bokwa, 2004. "Îlots de chaleur." [online, consulted April 27, 2011]. http://www.atmosphere.mpg.de/enid/2_Climat_urbain/-_Ilots_de_chaleur_2uk.html

© Photo: Études des biotopes urbains et périurbains de la Communauté métropolitaine de Montréal (CMM). Évolution des occupations du sol, du couvert végétal et des îlots de chaleur sur le territoire de la CMM, January 2008, report for the CRE de Laval, prepared by the Université de Montréal and the Université du Québec à Montréal. Landsat-5 thermal band (June 27, 2005) superimposed on Google Earth 2006.

Source: Martin. P., 2007. (see Note 3 opposite)

A number of causes specific to the built environment explain the heat island phenomenon, including the presence of low-albedo materials (see box below⁵), that absorb heat, and soil impermeability, which causes the rapid runoff of stormwater. For example, as asphalt and concrete surfaces warm up, they cause the ambient air temperature to rise while reducing the infiltration of water into the soil. The use of air conditioning to cool buildings also has a negative effect by producing waste heat released outside the buildings.

Climate change is magnifying the heat island effect by generating increasingly frequent and intense periods of extreme heat. It is predicted that average summer temperatures in Quebec will rise by at least 2°C to 3°C by the end of the century.⁶ This temperature increase could heighten the discomfort felt from the heat island phenomenon for people living in southern Quebec.

Albedo (taken from the Latin word for “whiteness”) refers to a material’s ability to reflect sunlight. The more a material reflects the sun’s rays, the less heat accumulates on its surface. Albedo is measured on a scale of zero to one. A material (generally white) that reflects 100% of solar energy has an albedo of one, while a material (generally black) that reflects 0% of solar energy (total absorption) has an albedo of zero. A roof with a high albedo (i.e. a roof that is white or light in colour) will absorb and release less heat into the surrounding environment.

5| Boucher, I. and N. Fontaine, 2010. *La biodiversité et l’urbanisation : guide de bonnes pratiques sur la planification territoriale et le développement durable*. Ministère des Affaires municipales, des Régions et de l’Occupation du territoire, 178 pp.
 6| Hulme, M.A. and N. Sheard, 1999, cited by Ouranos, 2004. “S’adapter aux changements climatiques.” [online, consulted April 17, 2011]. <http://www.ouranos.ca/fr/publications/ouvrages-generaux.php>

Heat islands pollute... and can kill!

It has been shown that heat islands affect human health, especially in vulnerable populations (people with chronic illnesses, very young children, seniors, etc.). Heat is responsible for many health problems, as listed below.

Impacts of Heat on Health⁷

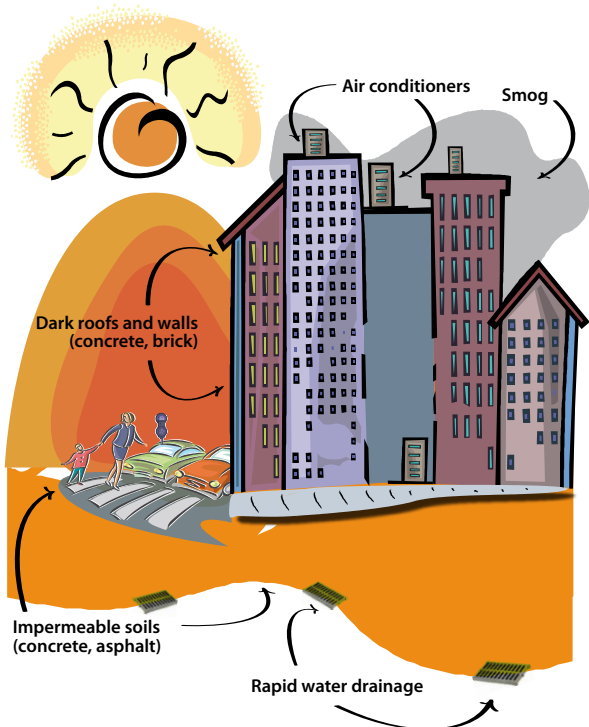
Heat Related Symptoms	Chronic Illnesses with Effects Worsened by Heat
Discomfort Weakness Impaired consciousness Cramps Fainting	Diabetes Respiratory failure Cardiovascular disease Neurological disease Cerebrovascular disease Kidney disease

The conditions that create heat islands also promote the deterioration of ambient air quality by contributing to smog formation. These air pollutants, produced by the use of fossil fuels, among other factors, are associated with many illnesses, including atherosclerosis, myocardial infarction, stroke and sudden death.⁸

7| Giguère, M., 2009. *Op. cit.*
 8| Reeves, F., 2011. “Février : mois du cœur. Février 2011 : début de l’année internationale de la forêt.” David Suzuki Foundation. [online, consulted April 26, 2011]. <http://www.davidsuzuki.org/fr/blogues/cercle-scientifique/2011/03/fevrier-mois-du-coeur-fevrier-2011-debut-de-lannee-internationale-de-la-foret/>



A heat island
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The cooling power of vegetation: urban cool islands

An urban cool island (UCI) is defined as an urban area whose cooling effect directly or indirectly prevents or counters the effects of heat islands. The existence of a cool island stems directly from: 1 | the presence of vegetation that helps cool the air through shading and/or evapotranspiration; 2 | the use of generally light-coloured (i.e. high-albedo) materials, which help reflect ambient heat.

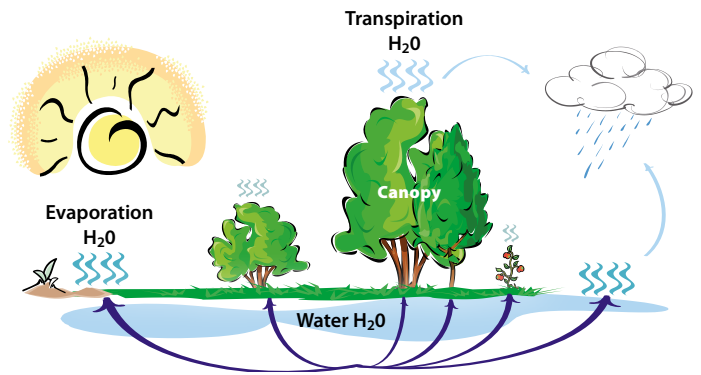
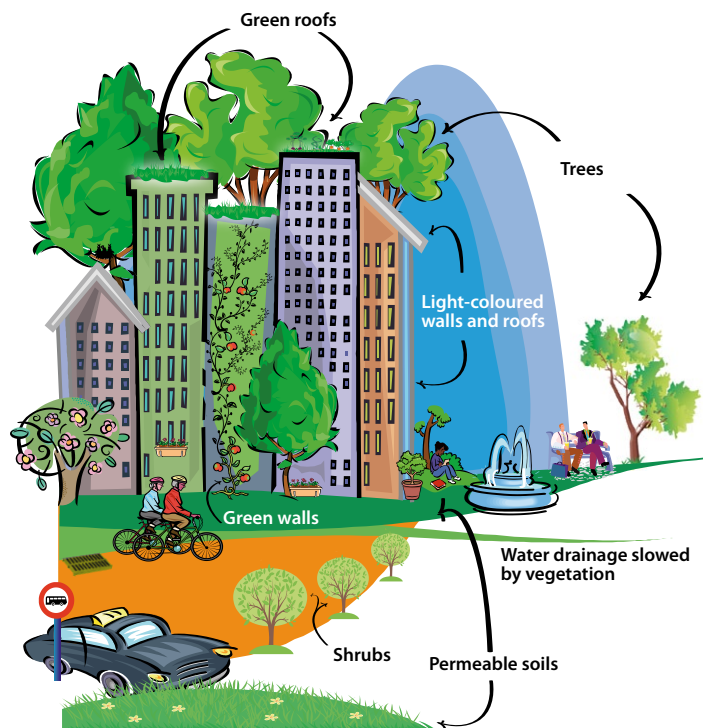
In a city, cool islands can take various forms including white roofs, green spaces (parks, gardens), planted structures (green walls), street trees, and areas of planted or vacant land. Vegetation can help reduce temperatures through the shade and evapotranspiration it produces.

The shade from trees helps lower the surface temperature of the ground, buildings and infrastructure.⁹ The tree canopy, which contains over 80% of the foliage, captures most of the solar energy. A tree with a sparse canopy intercepts between 60% and 80% of sunlight, while a tree with a dense canopy intercepts up to 98% of it.¹⁰

Evapotranspiration is a natural process involving: 1 | transpiration from plants which, after absorbing water from the soil to obtain nutrients, lose some of that water through their leaves; and 2 | evaporation of the water that is in the soil. In the evaporation process, this water absorbs heat from the ambient air, causing localized cooling.

9 | Giguère, M., 2009, *op. cit.*

10 | Johnston, J. and J. Newton, 2004. **Building Green: a Guide to Using Plants on Roofs, Walls and Pavements.** London, Ecology Unit, 95 pp.



As a result of evapotranspiration, a mature tree can transpire up to 450 litres of water a day and generate significant cooling, equivalent to five air conditioners running for 20 hours a day.¹¹ A strip of vegetation 50 to 100 metres wide can lower the temperature in the surrounding area by 3.5°C, and the cooling can be felt within a 100 metre radius.¹²

In addition, plants improve air quality by absorbing carbon dioxide and capturing other contaminants such as dust and fine particles. For example, the 136,000 trees in Jersey City, New Jersey, sequester 600 tonnes of carbon a year.¹³ This means that vegetation is able to capture some of the elements that contribute to smog and can reduce heat islands.

Choosing building materials on the basis of their albedo can also help reduce heat islands. The materials used must have a high albedo to reflect more of the sun's rays than they absorb. Heat absorption is affected by the type of material, as well as its colour. Light-coloured surfaces, such as grey brick, are better for this than dark surfaces, such as black asphalt shingles, which absorb a large amount of heat.

11 | Johnston, J. and J. Newton, 2004. *Idem.*

12 | Liébard, A. and A. DeHerde, 2005. **Traité d'architecture et d'urbanisme bioclimatiques : concevoir, édifier et aménager avec le développement durable.** Paris, Le Moniteur, 776 pp.; Shashua-Bar, L. and M.E. Hoffman, 2000. "Vegetation as a Climatic Component in the Design of an Urban Street: an Empirical Model for Predicting the Cooling Effect of Urban Green Areas with Trees". **Energy and Buildings**, Vol. 31 (3), pp. 221-235.

13 | Nowak, D.J. and J.F. Dwyer, 2007, cited by Massé, A., 2010. **Stratégies de protections des milieux naturels de Sherbrooke : en route vers une politique de conservation.** Master's thesis. Sherbrooke, Centre universitaire de formation en environnement, Université de Sherbrooke, 104 pp.



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Cool islands: Good for your health and your state of mind!

Woodland trees can filter out up to 85% of suspended particulate matter in the air.¹⁴ This helps to improve the quality of the air people breathe and reduce the incidence of some diseases.

In addition, the presence of vegetation has health benefits – such as helping people manage stress¹⁵ – that improves the quality of life of urban residents. The pleasing aesthetics of well-vegetated neighbourhoods helps encourage physical activity such as walking.¹⁶ It is therefore in cities' interests to create, conserve, and develop cool islands to improve people's health and help reduce heat islands.

Green spaces may also reduce health inequalities, as well as material and social inequalities.¹⁷ These spaces, which include trees, grass and other vegetation, can encourage contact between neighbours and increase surveillance of city streets, thereby strengthening the sense of community in neighbourhoods and potentially reducing crime.¹⁸

Lastly, trees have economic value: they reduce the amount of drainage infrastructure needed and the costs related to increased risk of flooding and spill-over.¹⁹ In some North American cities, trees can intercept from 7% to 22% of the runoff that would end up in storm sewers.²⁰ Wooded areas also create significant economic activity, providing jobs and helping municipalities to attract tourists and future home owners.

Since the loss of vegetation cover contributes to increased urban air temperatures, the preservation and creation of green spaces as well as greening urban areas (green roofs, street tree planting) are essential for improving the health and quality of life for residents. The idea here is not to prevent urban development, but to better align it with people's needs, including by protecting natural spaces, or recreating those natural features and spaces that have been lost. This is also an opportunity to raise society's awareness of current environmental issues including the conservation and enhancement of urban natural environments.²¹



Cool islands are good for people's health and lift their spirit!

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*This factsheet is the first in a series of three published in connection with the project **Nature et fraîcheur pour des villes en santé**.*

More information:

www.naturequebec.org/ilotsdefraicheur

14 | Johnston, J. and J. Newton, 2004. *Op. cit.*

15 | Boucher, I. and N. Fontaine, 2010. *Op. cit.*

16 | Ball, K., A. Bauman, E. Leslie and N. Owen, 2001. "Perceived Environmental Aesthetics and Convenience and Company Are Associated with Walking for Exercise among Australian Adults". *Preventive Medicine*, Vol. 33, pp. 434-440.

17 | Vida, S., 2010. "Les espaces verts urbains et la santé". *Cyberpresse*. [online, consulted April 27, 2011]. http://www.cyberpresse.ca/opinions/201004/16/01-4271221-les-espaces-verts-urbains-et-la-sante.php?utm_categorieinterne=traficdrivers&utm_contenuinterne=cyberpresse_lire_aussi_4263392_article_POS2

18 | Sullivan, W.C., F.E. Kuo and S.F. DePooter, 2004. "The Fruit of Urban Nature – Vital Neighborhood Spaces". *Environment and Behavior*, Vol. 36 (5), pp. 678-700.

19 | Lessard, G. and E. Bouffroy, 2008. *Les rôles de l'arbre en ville*. Centre collégial de transfert de technologie en foresterie de Sainte-Foy (CERFO). Québec City, p. 19.

20 | Société de l'arbre du Québec, 1998. *Des arbres pour vivre en santé. Guide pour la réalisation de projets de plantation*. Québec. 20 pp.

21 | Massé, A., 2010. *Op. cit.*

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