Schoolyard and Public Space Heat Islands

A Study in Windsor-Essex, Sarnia-Lambton and Chatham-Kent, Ontario

Prepared for: Riverside Optimist Club, Windsor; and the Public Health Units of Windsor-Essex, Sarnia-Lambton, and Chatham-Kent
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Schoolyard and Public Space Heat Islands: A Study in Windsor-Essex, Sarnia-Lambton and Chatham-Kent, Ontario

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Abstract: Schoolyards and public spaces are hot places. Excess heat is associated with lower physical activity and higher ultraviolet ray exposure. This study sampled 275 schoolyards and 529 public spaces in Southwestern Ontario in 2009 using Landsat 7 satellite imagery. Average surface temperatures ranged from 9.0 to 103°C. Shade from trees is found to be the best heat mitigation strategy. Policy is needed to mandate and protect trees used to shade and cool schoolyards and public spaces to enable healthy and safe outdoor activity.

INTRODUCTION

Schoolyards and public spaces are hot places. They are heat islands, areas of higher temperature than the surrounding landscape, in the larger heat islands of the communities that surround them (Moogk-Soulis, 2002).

The paper reports the results of a study commissioned by the Riverside Optimist Club in Windsor in collaboration with the Public Health Units of Windsor-Essex, Sarnia-Lambton and Chatham-Kent. The study, conducted in 2009 and 2010, involved measuring the surface temperatures of schoolyards and public spaces, such as parks and sports fields, in Windsor-Essex, Sarnia-Lambton and Chatham-Kent using Landsat 7 satellite imagery. The purpose of the study was to measure the surface temperatures of schoolyards and public spaces relative to one another to identify those most in need of cooling. This is the first step towards creating a shade plan and policy for the study area. The hotter a schoolyard or public space is, the lower the activity level of people using it and the higher the likelihood of exposure to ultra-violet (UV) radiation, both of which have negative health consequences.

Landsat 7 is a mapping satellite with imagery output that includes a calibrated thermal band. The satellite passes the same spot on the globe every 16 days at a height of 705 km. Landsat 7 produces scenes large enough to sample the entire study area simultaneously with resolution high enough to reveal temperature variations within the sampled sites and on those sites abutting them.

The schoolyards of the Lambton-Kent District School Board, the Greater Essex County District School Board, the Saint Clair Catholic District School Board, the Windsor Essex Catholic District School Board, the Conseil scolaire de district du Centre-Sud-Ouest, the Conseil scolaire de district des écoles catholiques du Sud-Ouest and six independent schools were sampled. Of the 275 schoolyards that were sampled, data were analyzable for 254 schoolyards.

Public spaces such as parks, sports fields and squares were sampled in Windsor, Sarnia, Chatham, greater Lambton and greater Essex-Kent. Of the 529 nine public spaces that were sampled, data were analyzable for 464 public spaces.

Sampling took place at 10:20am on August 4, 2009.

RESULTS

Figures 1, 2 and 3 summarize the temperature conditions for the study area.

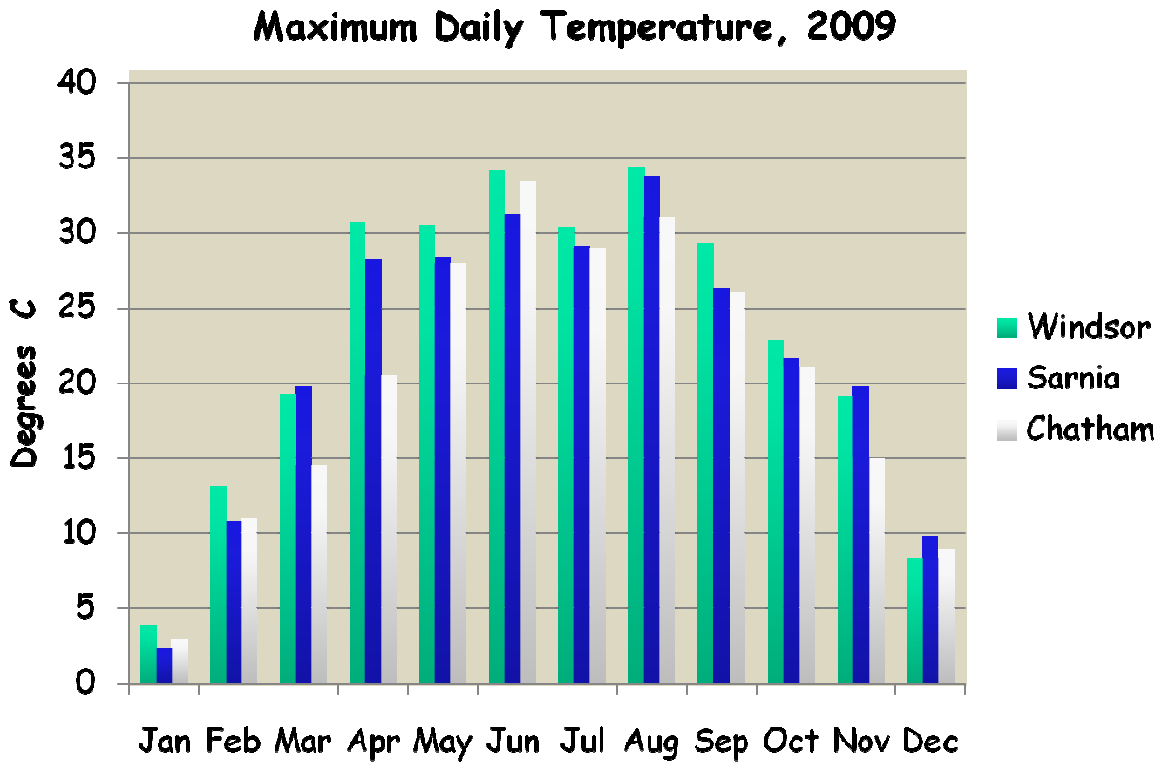
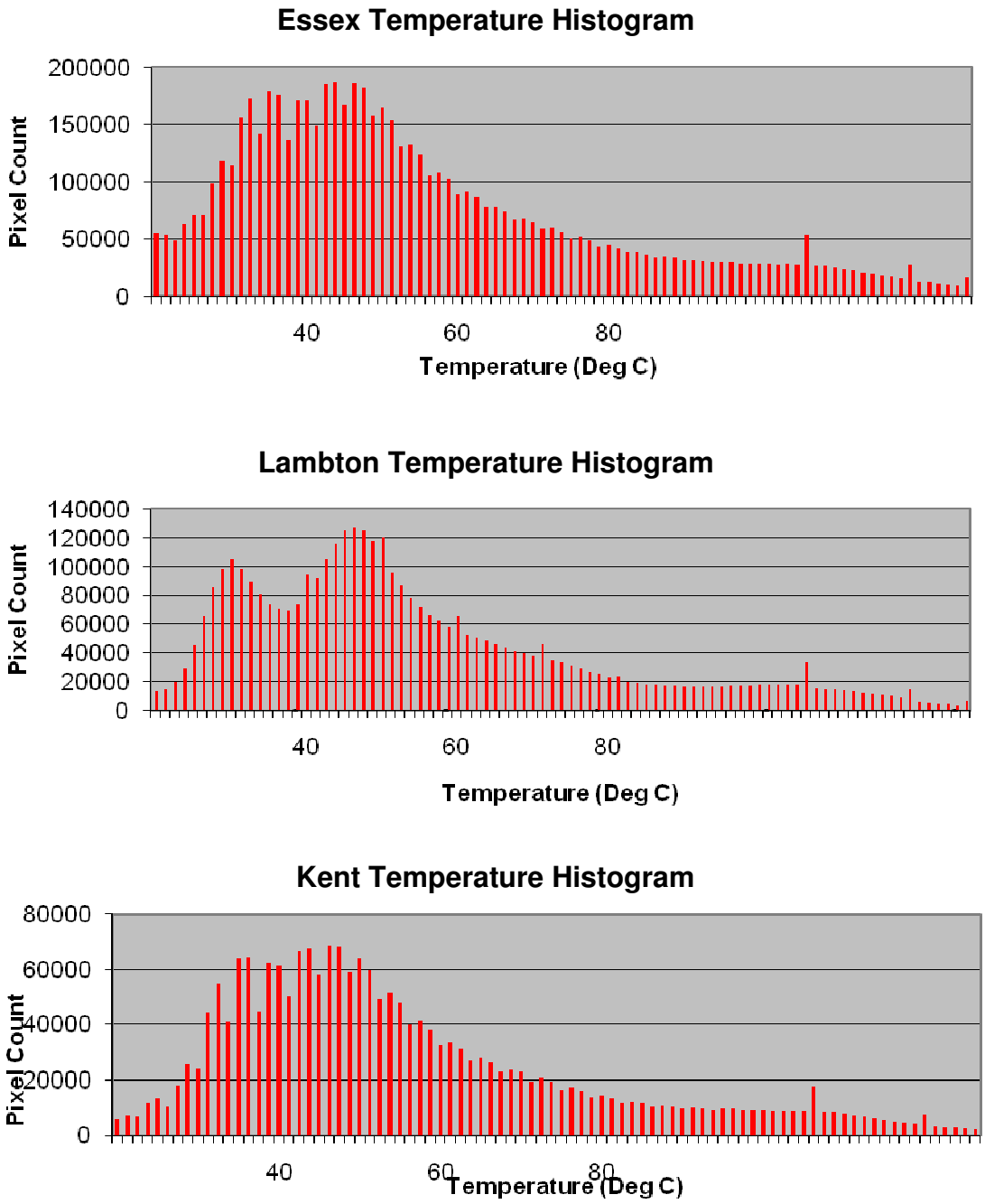


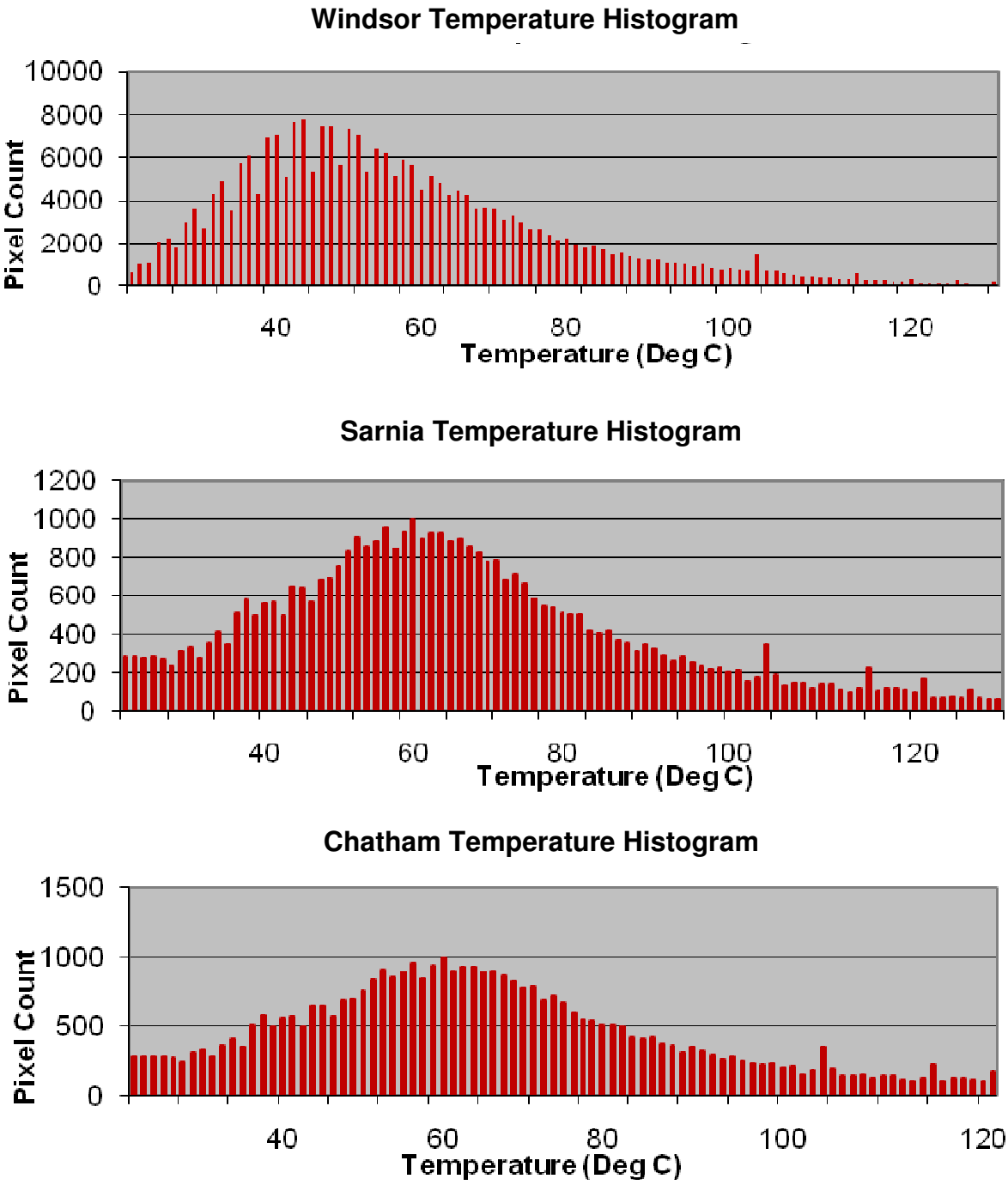
Figure 1: Monthly maximum daily air temperatures of Essex, Lambton and Kent Counties. Courtesy of Environment Canada National Climate Data Archive.



Average Temperatures (°C)

Essex:	**51.2**	**Lambton:**	**51.4**	**Kent:**	**53.1**

Figure 2: Temperature histograms of the surface temperatures of Essex, Lambton and Kent Counties and their average surface temperatures, from Landsat 7, August 4, 2009.

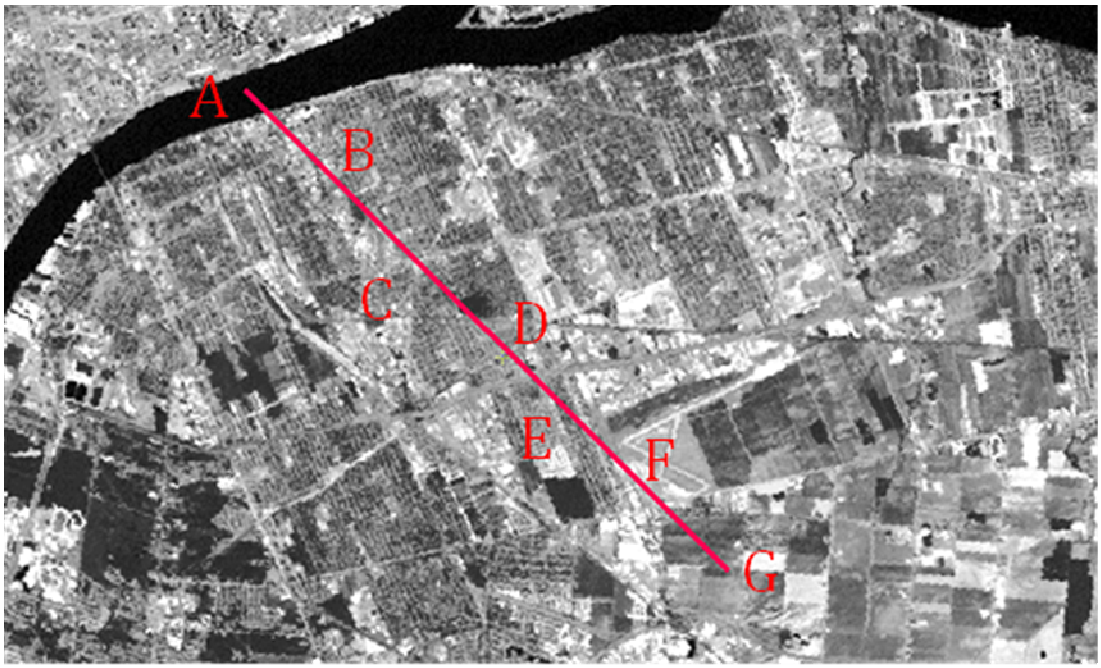


Average Temperatures (°C)

Windsor: 54.8 Sarnia: 53.1 Chatham: 61.6

Figure 3: Temperature histograms of the surface temperatures of Windsor, Sarnia and Chatham and their average surface temperatures, from Landsat 7, August 4, 2009.

Figures 4, 5 and 6 are cross-sections of Windsor, Sarnia and Chatham respectively. Each cross-section shows that the surface temperature of each city is higher than that of the surrounding countryside thus demonstrating that each city is a heat island. In addition, the points noted on each cross-section demonstrate that the surface heat does not form a uniform dome but rather that features such as industrial areas, high density areas, major roads and railways are heat islands in the heat island of each city.



Windsor Temperature Profile

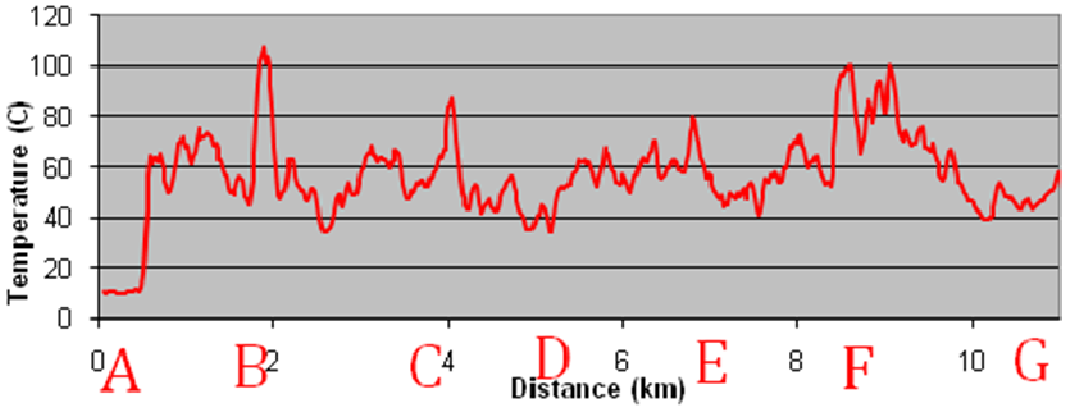
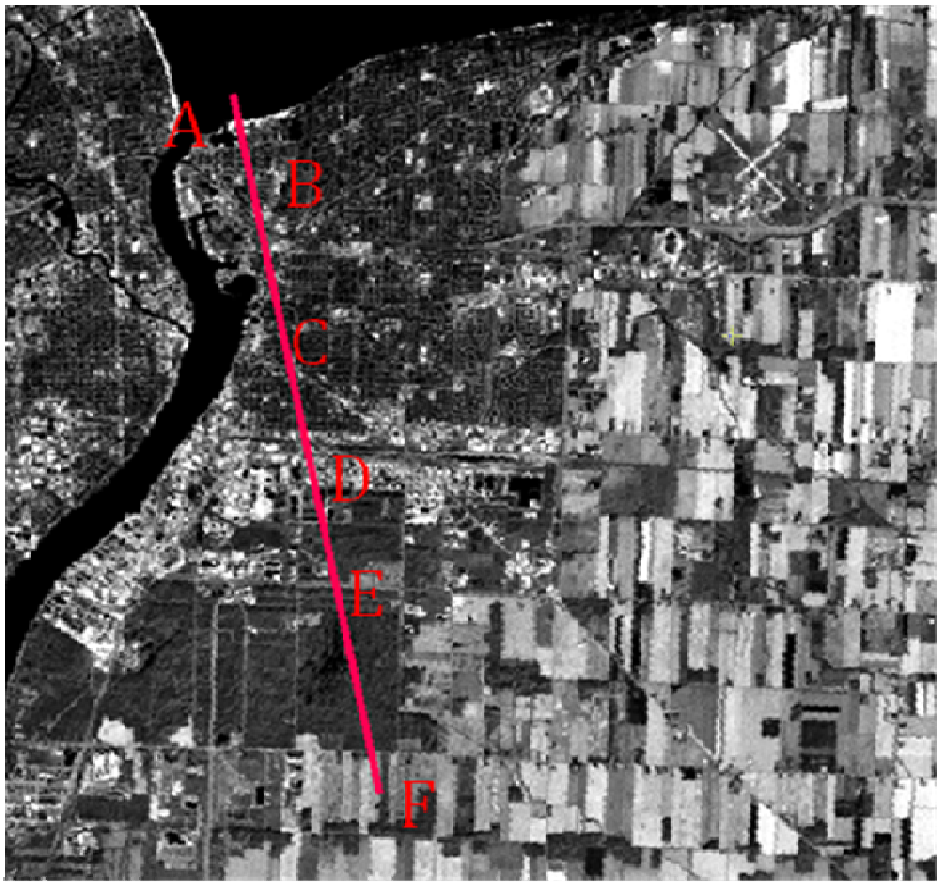


Figure 4: Surface temperature cross-section of Windsor, Ontario, August 4, 2009.



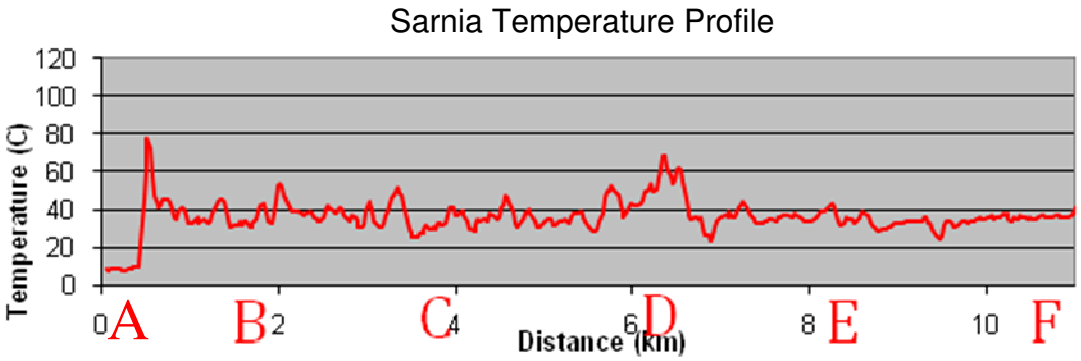


Figure 5: Surface temperature cross-section of Sarnia, Ontario, August 4, 2009.

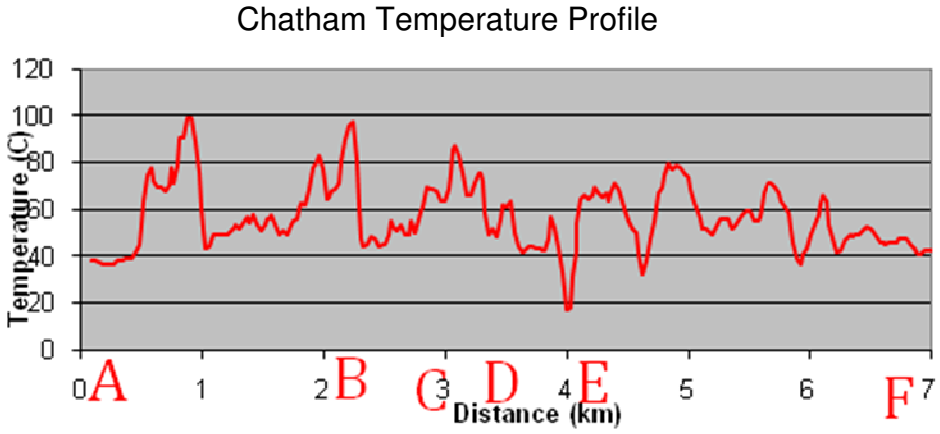
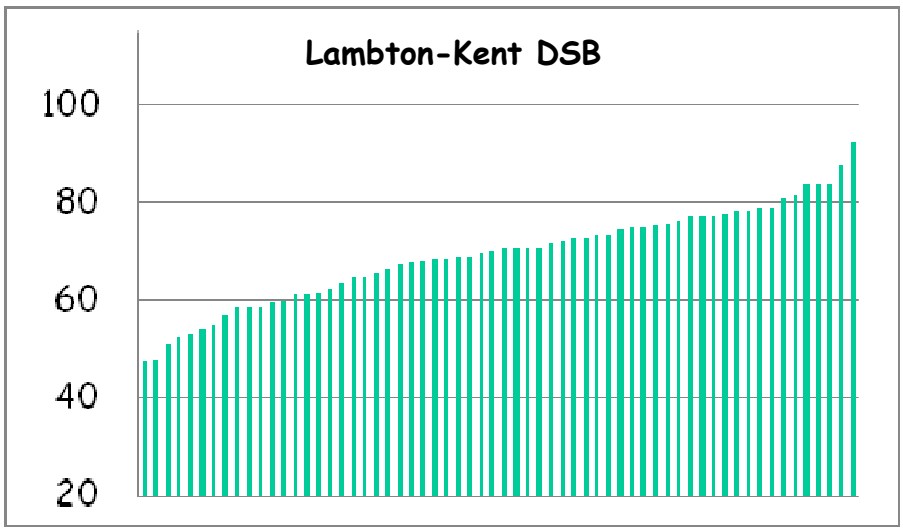


Figure 6: Surface temperature cross-section of Chatham, Ontario, August 4, 2009.

Schoolyards and public spaces are heat islands because they contain the three hottest materials found in the urban landscape: asphalt; steel or tar and chip roofs; and mowed turf. Dry conditions make the situation worse.

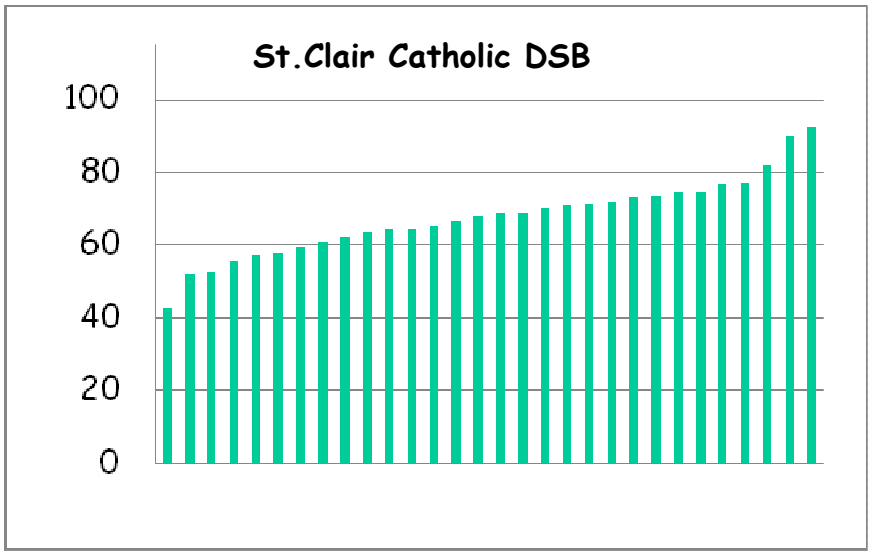
Schoolyards

Figure 7 presents the summary of the average surface temperature of each of the 254 schoolyards sampled and analyzed, arranged by school board. Each bar represents one schoolyard. The schoolyards with the five hottest and coolest surface temperatures are listed.



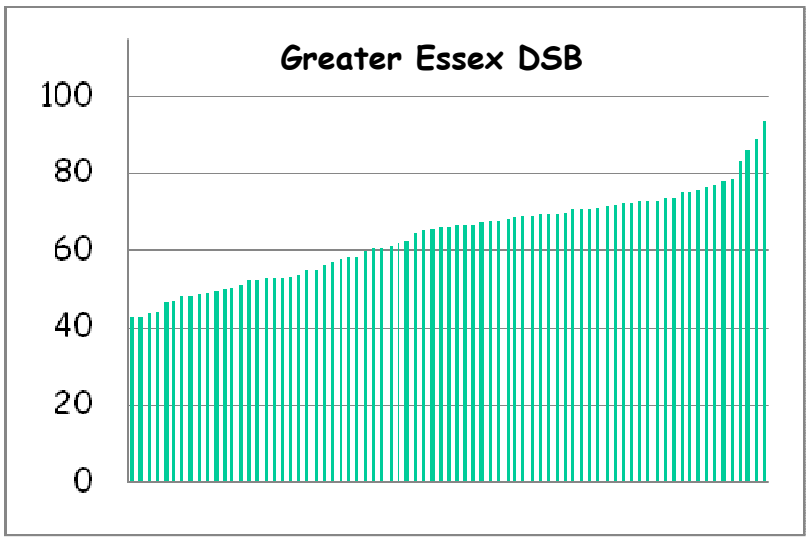
LKDSB Coolest Schools	LKDSB Hottest Schools
47.8 : Alternative, Sarnia	92.4 : Ridgetown D.H.S., Ridgetown
48.1 : Hillcrest, Petrolia	87.9 : Ridgeview Moravian, Ridgetown
51.0 : P.E. McGibbon, Sarnia	84.1 : Queen Elizabeth II, Chatham
52.4 : North Lambton S.S., Forest	83.9 : John McGregor S.S., Chatham
53.3 : Queen Elizabeth II, Petrolia	83.9 : Wheatley Area, Wheatley

Figure 7a: Lambton-Kent District School Board average schoolyard surface temperatures (°C)



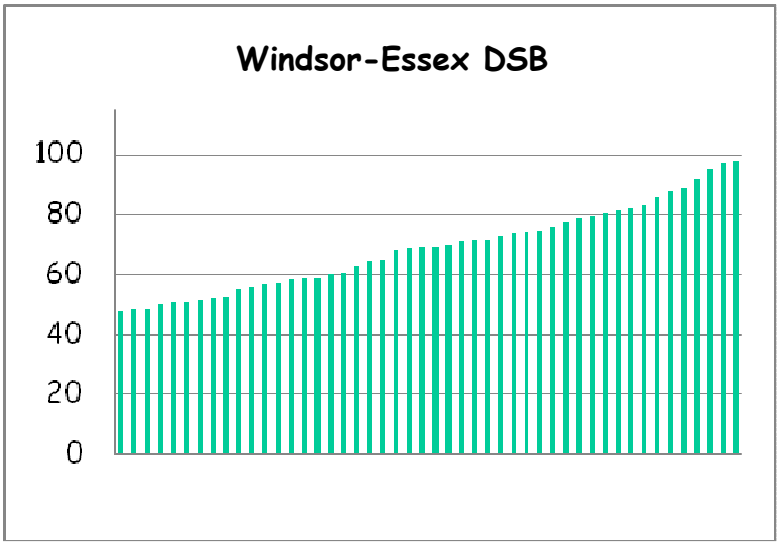
SCCDSB Coolest Schools	SCCDSB Hottest Schools
42.6 : St. Elizabeth Catholic, Wallaceburg	92.7 : Georges P. Vanier Catholic, Chatham
51.9 : Sacred Heart Catholic, Sarnia	89.8 : St. Micheal Catholic, Ridgetown
52.5 : Holy Family Catholic, Wallaceburg	81.8 : St. Joseph Catholic, Chatham
55.6 : Gregory A. Hogan Catholic, Sarnia	77.0 : St. Anne Catholic, Blenheim
57.1 : Christ the King Catholic, Wallaceburg	76.7 : St. Micheal Catholic, Bright's Grove

Figure 7b: St. Clair Catholic DSB average schoolyard surface temperatures (°C)



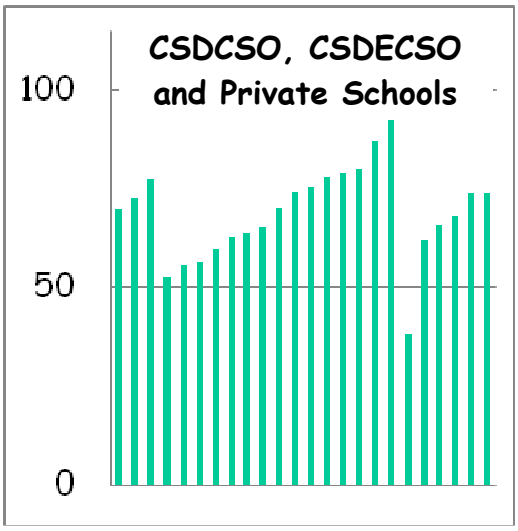
GECDSB Coolest Schools	GECDSB Hottest Schools
42.9 : Queen Victoria, Windsor	93.1 : Lakeshore Discovery, Emeryville
43.0 : Maryvale, Windsor	88.8 : Glengarda, Windsor
43.7 : Kingsville, Kingsville	85.9 : Talbot Trail, Windsor
43.9 : D. M. Eagle, St.Clair Beach	83.3 : Dougall, Windsor
46.4 : Walkerville High School, Windsor	78.4 : Northwood, Windsor

Figure 7c: Greater Essex County DSB average schoolyard surface temperatures (°C)



WECDSB Coolest Schools	WECDSB Hottest Schools
47.9 : St. Theresa, Harrow	97.5 : F. J. Brennan HS, Windsor
48.5 : St. Anne Fr. Immersion, Windsor	97.1 : St. Joseph's HS, Windsor
48.7 : St. Gregory, Tecumseh	95.1 : Holy Cross, LaSalle
50.1 : St. Anthony, Harrow	91.9 : St. John de Brebeuf, Kingsville
50.5 : St. Thomas of Villanova HS, Lasalle	88.8 : Our Lady of Mount Carmel, Windsor

Figure 7d: Windsor-Essex Catholic DSB average schoolyard surface temperatures (°C)



CSDCSO Coolest Schools
70.0 : École Secondaire Franco-Jeunesse, Sarnia

CSDECSO Coolest School
52.6 : Éécc Pavillon des Jeunes, Belle River

Coolest Private School
38.4 : Windsor Adventist Elementary School, Windsor

CSDCSO Hottest School
77.6 : École élémentaire L'Envolée, Windsor

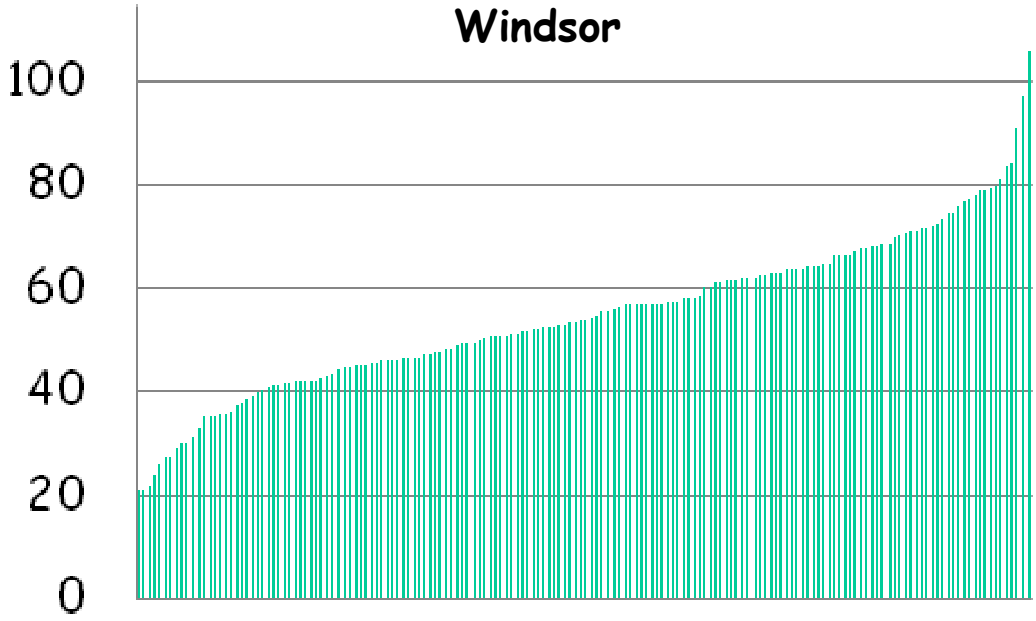
CSDECSO Hottest School
92.2 : École élémentaire catholique Saint-Francis, Tilbury

Hottest PrivateSchool
73.9 : John Knox Christian, Wyoming

Figure 7e: Left to right, CSDCSO, CSDECSO, and Private School average schoolyard temperatures (°C)

Public Spaces

Figure 8 is the summary of the average surface temperatures of each of the 464 public spaces sampled and analyzed. Each bar represents one public space. The public spaces with the five hottest and coolest average surface temperatures are listed.



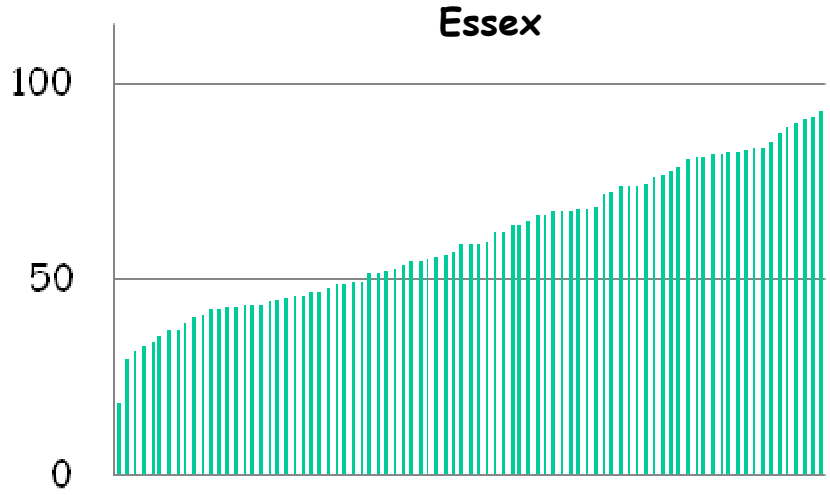
Coolest Windsor Spaces

20.8 : Brumpton Park,
22.0 : Girardot Street Parkette
23.9 : South Cameron Woodlots
26.0 : Mackenzie Hall Park
27.4 : Coventry Gardens (Reume Park)

Hottest Windsor Spaces

105.8 : Capt. John Wilson Park
97.0 : Pearson Park
90.7 : Gino A. Marcus C.C
84.5 : McHugh Park
84.0 : Firgrove Boulevards

Figure 8a: Windsor public space average surface temperatures (°C)



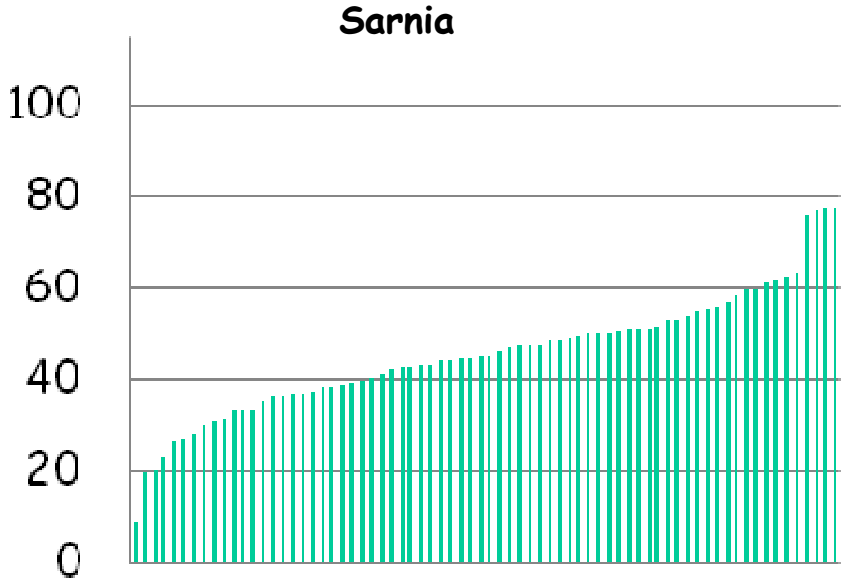
Coolest Essex Public Spaces

18.7 : Ojibway Oaks, LaSalle
29.7 : St. Paul Lucier, LaSalle
31.8 : Katrishe Parkette, Kingsville
33.3 : McCallum St., Kingsville
33.9 : Pollard, Harrow

Hottest Essex Public Spaces

92.7 : Malden Centre, Malden Centre
91.4 : Bill Wigle, Amherstburg
90.8 : Kingsville Arena, Kingsville
90.2 : CoAn, McGregor
89.3 : Marie Crescent, Leamington

Figure 8b: Essex County public space average surface temperatures (°C)



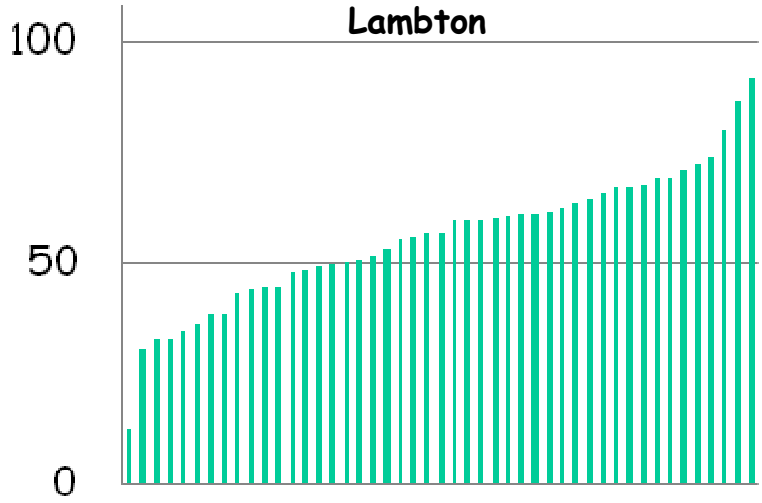
Coolest Sarnia Public Spaces

9.0 : Nisbet
20.0 : Kathleen
20.3 : Crescent
23.1 : Saredaca Ed Centre
26.5 : Aspen

Hottest Sarnia Public Spaces

77.7 : Errol Russell
77.5 : Ferry Dock Hill
77.3 : High Park, Sarnia
76.1 : Clearwater C.C.
63.8 : City Hall and Patio

Figure 8c: Sarnia public space average surface temperatures (°C)



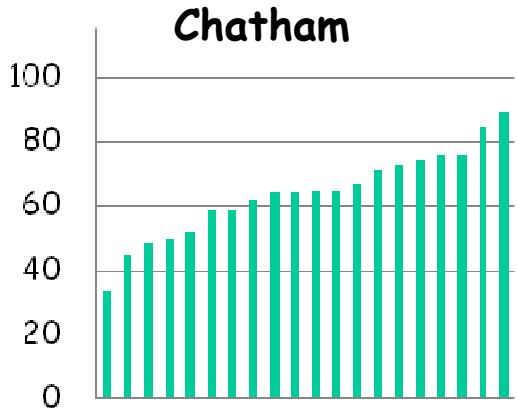
Coolest Lambton Public Spaces

12.5 : Elks Park, Point Edward
30.4 : Courtright Waterfront Park, Courtright
33.0 : Stoney Creek Park, Bright's Grove
33.0 : Canatara Park, Point Edward
34.5 : Parkdale Optimist Park, Corunna

Hottest Lambton Public Spaces

92.0 : Niagara Ball Diamond, Wyoming
84.0 : BAI Arena and Grounds, Alvinston
74.1 : Community Hall, Courtright
72.4 : Wyoming Fairgrounds, Wyoming
70.9 : Brigden Optimist Park, Brigden

Figure 8d: Lambton County public space average surface temperatures (°C)



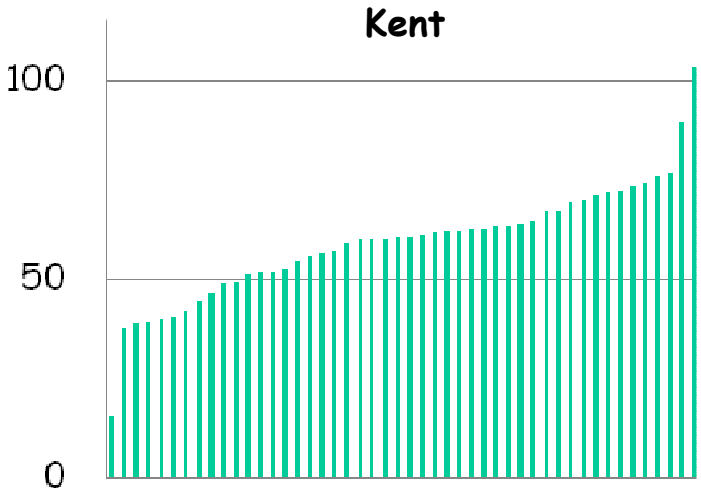
Coolest Chatham Public Spaces

33.2 : Water Street Park
44.9 : Tecumseh Park
48.3 : Oxley Dr Park
50.0 : Riverview Dr Park
58.3 : Grand Avenue Park

Hottest Chatham Public Spaces

88.9 : Phillip Street Park
84.9 : Mud Creek Park
75.7 : Ross Babcock Park
75.7 : Jackson Drive Park
74.2 : Croyden Steet Park

Figure 8e: Chatham public space average surface temperatures (°C)



Coolest Kent Public Spaces

15.0 : Tiffin Park North, Dresden
37.5 : Riverside Park, Wallaceburg
38.7 : Bridal Path Park, Wallaceburg
39.0 : Rotary Park, Dresden
40.2 : Crothers Park, Wallaceburg

Hottest Kent Public Spaces

103.3 : Ridgetown Arena, Ridgetown
89.7 : Merlin Parks and Rec Ball Diamond, Merlin
76.8 : J R Smith, Morpeth
75.6 : Luster, Wallaceburg
74.0 : Lavern Kelly Memorial Park, Erieau

Figure 8f: Kent County public space average surface temperatures (°C)

DISCUSSION

The characteristics of the hottest schoolyard and public space surfaces are: an absence of trees; a large proportion of the surface is of the three hottest urban surfaces, asphalt, steel or tar and chip roofs, mowed turf ; and a proximity to other hot areas.

The characteristics of the coolest schoolyard and public space surfaces are: a presence of trees; located in cooler surrounding areas; and mixing of air.

Figure 9 shows the effect of shade on surface temperatures at a schoolyard from an earlier study (Moogk-Soulis, 2002). When the unshaded surface temperature is 53 degrees C, the shaded surface is 20 degrees C cooler. This is consistent with the temperature differences that occur within the boundary layer (Oke, 1987).

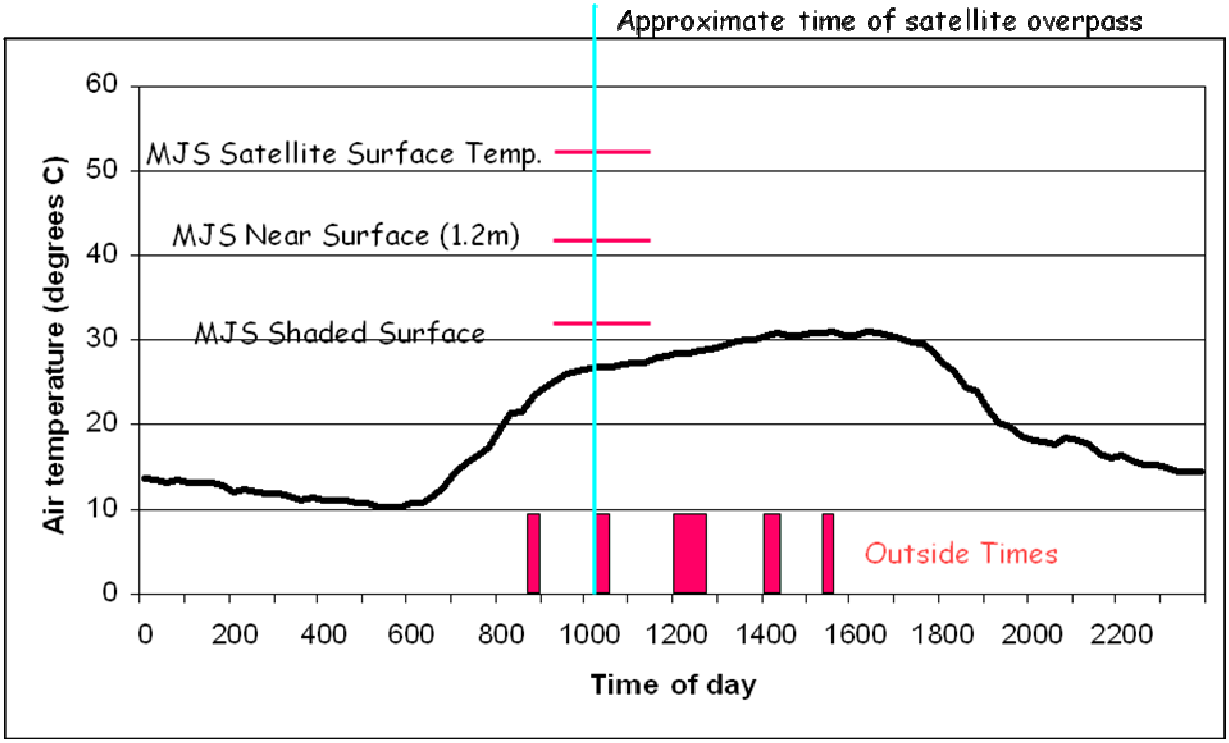


Figure 9: The effect of shade on surface temperatures at Mary Johnston Public School, Waterloo. Air temperature data courtesy of the University of Waterloo Weather Station. (Moogk-Soulis, 2002)

Figure 10 shows the benefits of trees on schoolyards and in public spaces for users, building operation, neighbours, the city and the general public.

For Schoolyard and Public Space Users
- Decrease shaded surface temperature ~ up to 25 degrees C
- Decrease shaded air temperature ~ 10 degrees C

For Building Operation
- Decrease cooling costs by 25% for that proportion of the building surface shaded by trees
- Decrease cooling costs due to cooling of intake air (typically 40% of cost) by as much as 10 degrees C

For Neighbours
- Decrease radiant and convective heat gains to properties within ~ 80 m

For the City
- Contribute to overall City cooling

For the General population
- Reduce UV ray exposure with a dense canopy

Figure 10: The benefits of trees on schoolyards and in public spaces for users, building operation, neighbours, the city and the general public.

The best mitigation strategy for the hot surfaces of the schoolyards and public spaces is to shade them. Furthermore, the most effective way to provide shade is with trees. Trees are the only capital expenditure that increases in value and effectiveness over time (Moogk-Soulis, 2002).

RECOMMENDATIONS

Trees are most effective, at providing protection from harmful UV radiation and cooling sites so that site users are cool enough that they will engage in physical activity, when trees are planted not only strategically to provide optimum shade on a site but also in sufficient numbers to provide shade for all of the expected users of the site and their anticipated activities. Provide enough shade for all. Clumps and groves of trees, rather than isolated single trees or trees widely spaced in a row, provide the most usable shade in the shortest time. We need shade for people today, not just for those two generations from now. Attractive shade will draw the expected site users and it will not be necessary to dictate the use of the shade for UV protection or cooling.

Cooler people are more active people. It may not be possible to shade all outside workers or playing fields. However, it is possible to provide shade oases for outside workers or sports players and spectators to take a break from the radiation and heat of the sun.

Policies are needed to mandate shade in the design of schoolyards and public spaces. Policies are also needed to retrofit existing schoolyards and public spaces and to maintain and protect the shade once it has been provided.

If heat islands are identified with their risks of lower physical activity and higher UV exposure; if policy is created to provide and protect trees used to shade and cool heat islands; then we will create healthy schoolyards and public spaces that enable healthy and safe outdoor activity for generations to come.

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