

HEAT STRESS MEASUREMENTS IN AMSTERDAM

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HEATWAVE 2015, THE NETHERLANDS

4TH JULY 2015 – TOUR DE FRANCE IN UTRECHT



RESEARCH QUESTIONS

What are the thermal conditions in Amsterdam on warm days?

How are the thermal conditions perceived?

Which urban environments are most comfortable?



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HEAT STRESS MEASUREMENTS IN AMSTERDAM



Lisette Klok, Jeroen Kluck, Nanda Piersma, Jordy Tak, Niek Rood, Hassan El Joudi and many student from the HvA

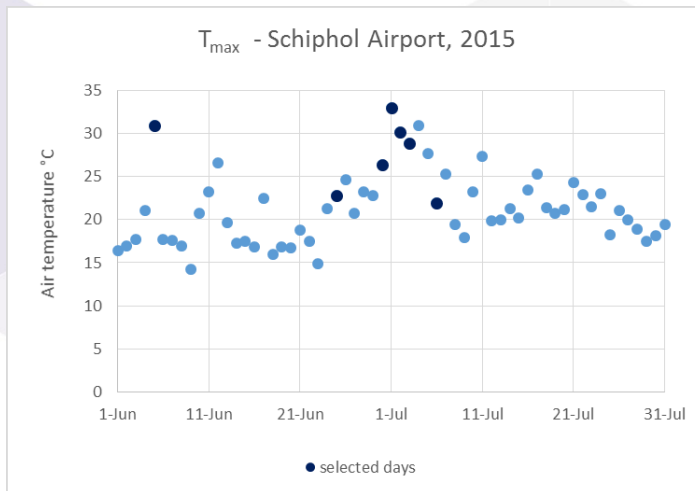
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7 DAYS, 13 LOCATIONS, 971 SURVEYS



7 MEASUREMENT DAYS – SUMMER 2015



13 LOCATIONS

Built (red)	Parks and grass (green)	Water (blue)
Dam*	Vondelpark*	IJ
Central Station	Museumplein*	Amstel
Leidseplein*		
Mahlerplein*		
NEMO-museum		
OBA library*		
Spui*		
Rembrandtplein		
Thorbeckeplein*		

* in sun and shade

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SURVEYS N = 971

1. General information	
a. Time	
Location	
i. Coordinates	
ii. In sun or shade	sun / shade
iii. Near weather station 1 or 2	1 / 2
c. Name interviewer	
2. Personal information	
a. Age	10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70+
b. Gender	m / f
c. Clothing	
i. Upper body	sleeveless / short sleeves / long sleeves
ii. Lower body	short trousers or skirt / long trousers or skirt
iii. Vest or jacket	vest / sweater / jacket / raincoat
iii. Accessories	sunglasses / cap / hat / umbrella
d. Activity level	sitting / standing / walking / running
e. Cultural background	
i. Do you live in Amsterdam?	yes / no
ii. What is your home country?	
iii. For how long are you in the Netherlands?	
f. Thermal history	
i. For how long are you here at this specific location?	
ii. Where were you before?	
iii. Were you outdoors 5 minutes ago?	yes / no
3. Thermal perception	
a. How are you feeling now?	cold / cool / slightly cool / neutral / slightly warm / warm / hot
b. What do you think of the sun at this moment?	I prefer more / OK / too much sun
c. What do you think of the wind at this moment?	static / little wind / OK / windy / too much wind
d. What do you think of the humidity at this moment?	damp / OK / dry
4. Thermal comfort	
a. Do you find this environment thermally:	comfortable / slightly uncomfortable / uncomfortable / very uncomfortable
5. Thermal preference	
a. How would you prefer it to be now:	cooler / no change / warmer
6. Thermal acceptability	
a. On personal level, this environment is for me:	acceptable / unacceptable

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TWO MOBILE WEATHER STATIONS

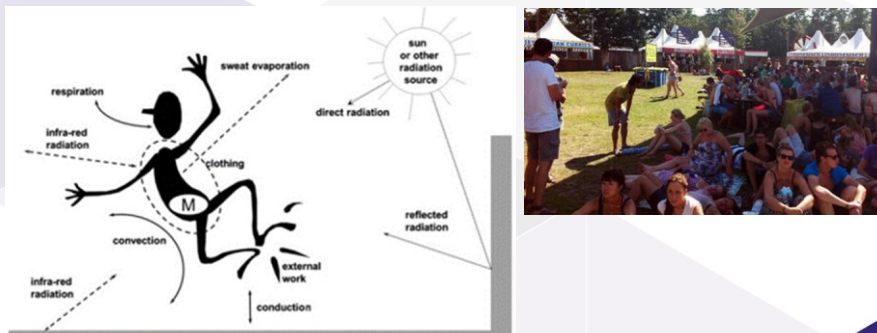
- Davis Vantage Pro
- Flat grey globe thermometer to estimate T_{mrt} (Thorsson et al., 2007)



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THERMAL INDEX – PET

PET – physiological equivalent temperature (Höppe and Mayer, 1987)
 computed by RayMan (Matzarakis et al., 2007)



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WHAT ARE THE THERMAL CONDITIONS IN AMSTERDAM DURING WARM DAYS?

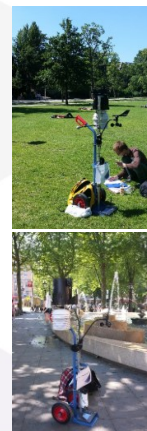
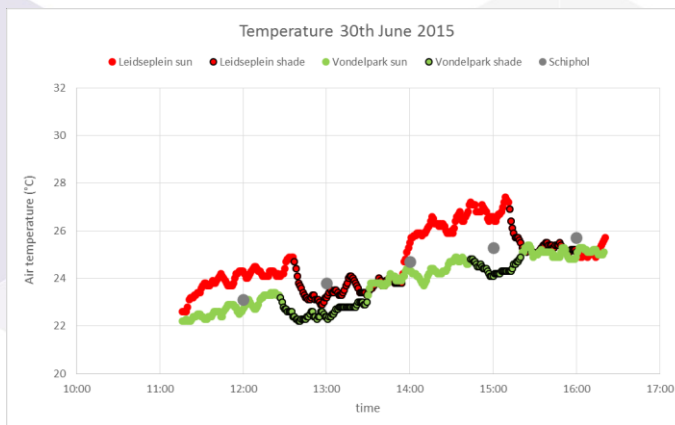
The urban heat island effect was small.
Extreme heat stress in the sun (PET > 41 °C).

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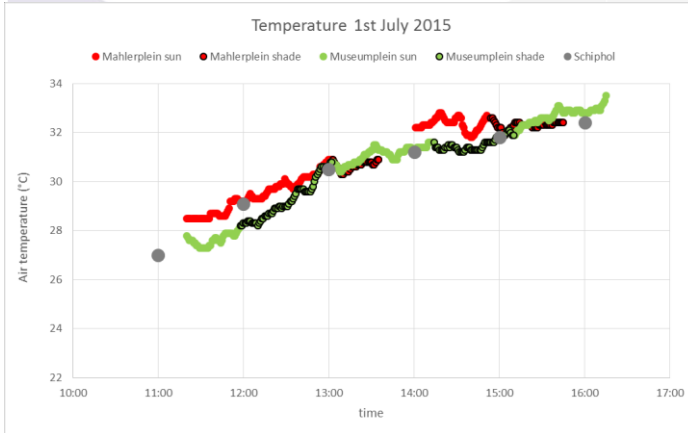


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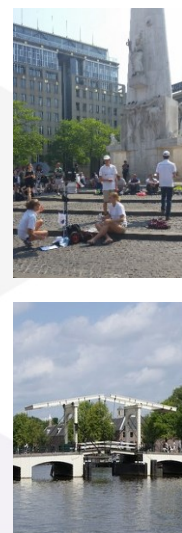
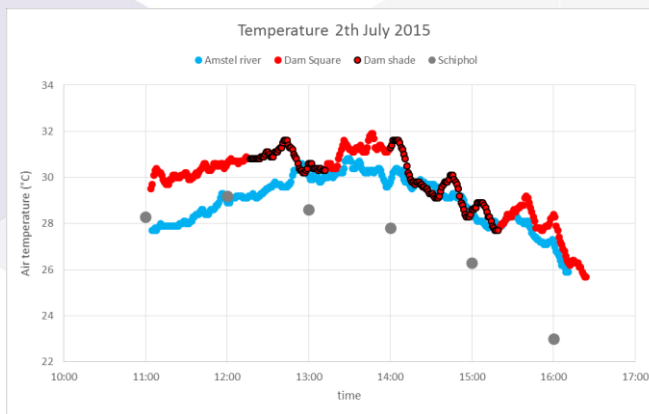
AIR TEMPERATURE 30 JUNE – VONDELPARK & LEIDSEPLEIN



AIR TEMPERATURE 1 JULY - MAHLERPLEIN & MUSEUMPLEIN



AIR TEMPERATURE 2 JULY – DAM & AMSTEL

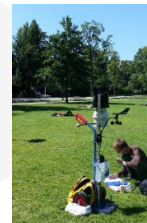
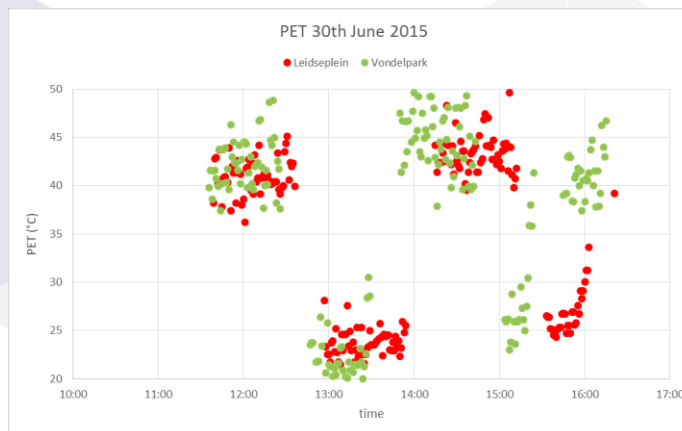


MAX URBAN HEAT ISLAND EFFECT (°C)

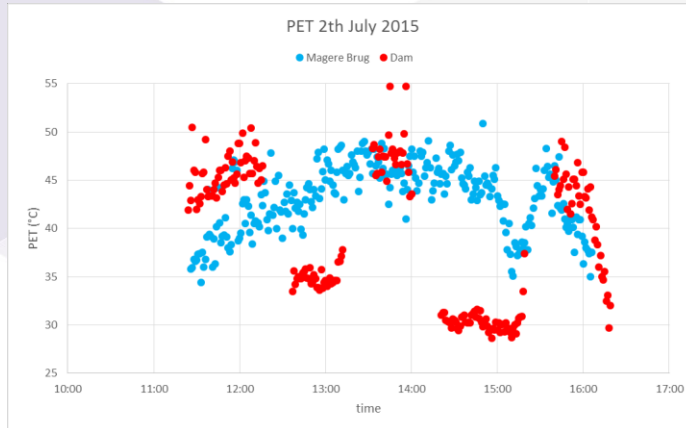
Built (red)		Parks and grass (green)		Water (blue)	
Dam	1.6; 5.4	Vondelpark	-0.4	IJ	0.2
Central Station	1.0	Museumplein	0.4	Amstel	4.2
Leidseplein	1.3				
Mahlerplein	1.0				
NEMO-museum	0.4				
OBA library	1.3				
Spui	1.1				
Rembrandtplein	0.9				
Thorbeckeplein	0.9				

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PET 30 JUNE – VONDELPARK & LEIDSEPLEIN



PET 2 JULY – DAM & AMSTEL

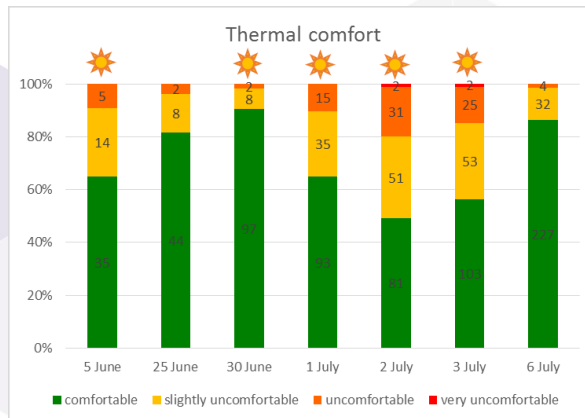


HOW ARE THE THERMAL CONDITIONS PERCEIVED?

Most people (63-70%) perceived the thermal conditions as comfortable.



THERMAL COMFORT



70% of the respondents perceive the environment as thermally comfortable (63% on ☀ summer days).

FACTORS THAT INFLUENCE COMFORT

meteorological factors
Air temperature
Relative humidity
Wind speed
Solar radiation
Globe temperature

significance 95%
significance 90%

1. General information	
a. Time (hh:mm)	
b. Location	
i. Coordinates	
ii. In sun or shade	sun / shade
iii. Near weather station 1 or 2	1 / 2
c. Name interviewer	
2. Personal information	
a. Age	10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70+
b. Gender	m / f
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e. Cultural background	
i. Do you live in Amsterdam?	yes / no
ii. What is your home country?	
iii. For how long are you in the Netherlands?	
f. Thermal history	
i. For how long are you here at this specific location?	
ii. Where were you before?	
iii. Were you outdoors 5 minutes ago?	yes / no

WHICH URBAN ENVIRONMENTS ARE MOST COMFORTABLE?

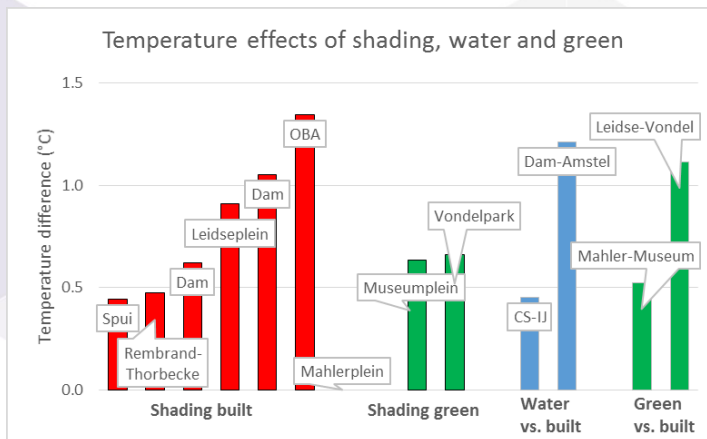
Shaded locations decreased PET values by 12 to 22 °C and are perceived as more comfortable than sunny locations.

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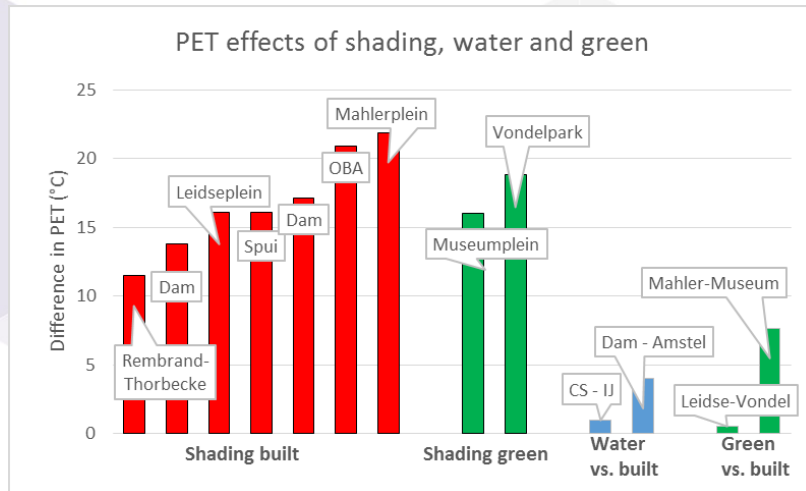
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DIFFERENCES IN AIR TEMPERATURE



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DIFFERENCES IN PET



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DIFFERENCE IN PERCEIVED COMFORT

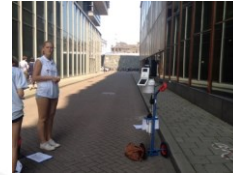
Shading effect in built environment	
Dam (5 June and 2 July)	no
Leidseplein	no
Mahlerplein	yes
OBA Library	yes
Spui	no
Rembrandtplein-Thorbeckeplein	no
TOTAL	yes
Shading effect in green environment	
Vondelpark	no
Museumplein	no
TOTAL	no

water vs. built	
Central Station - IJ	no
Dam - Amstel	no
TOTAL	no

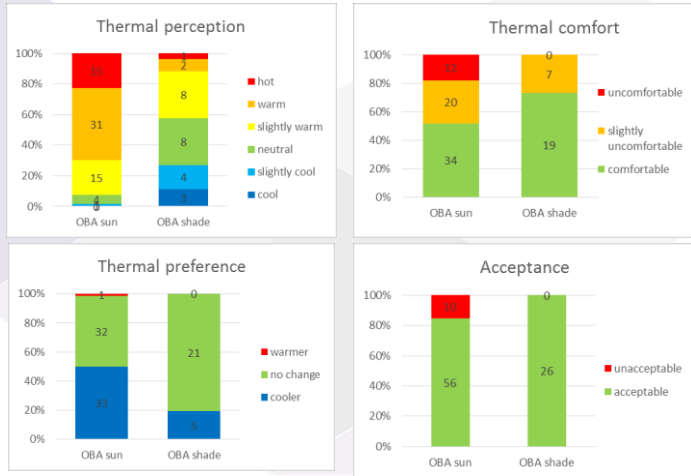
green vs. built	
Leidseplein - Vondelpark	yes
Mahlerplein - Museumplein	no
TOTAL	no

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comfortable / slightly uncomfortable / uncomfortable / very uncomfortable



OBA LIBRARY: SUN VS. SHADE



CONCLUSIONS

- The urban heat island effect was generally small (~ 1 °C).
- In the sun, PET values indicated extreme heat stress (> 41 °C).
- 63% of the respondents perceived the urban environment as thermally comfortable.
- Temperatures in shaded, green or blue areas were about 1 °C lower.
- Shading decreased PET values by 12 to 22 °C, while green and blue areas decreased PET by < 8 °C.
- Shaded locations were perceived as more comfortable than sunny locations.
- Vondelpark was perceived more comfortable than Leidseplein.

RESULTING ADVICE: SHADING !



**...when the ambition is to keep
the city comfortable during hot
days!**



CHALLENGES

- What about the (vulnerable) people that were not outside, or avoided these locations with extreme heat stress?