

URBAN DESIGN AND THERMAL COMFORT:

**ASSESSMENT OF OPEN SPACES IN BARRA FUNDA, A BROWNFIELD SITE IN
SÃO PAULO, BY MEANS OF SITE MEASUREMENTS AND PREDICTIVE SIMULATIONS**

Denise Duarte, Joana Goncalves, Leonardo M. Monteiro
University of Sao Paulo, Sao Paulo, Brazil

Introduction

Object

thermal comfort conditions in different microclimates influenced by the urban design of Barra Funda, a neighborhood in the west side of the city of Sao Paulo.

Objective

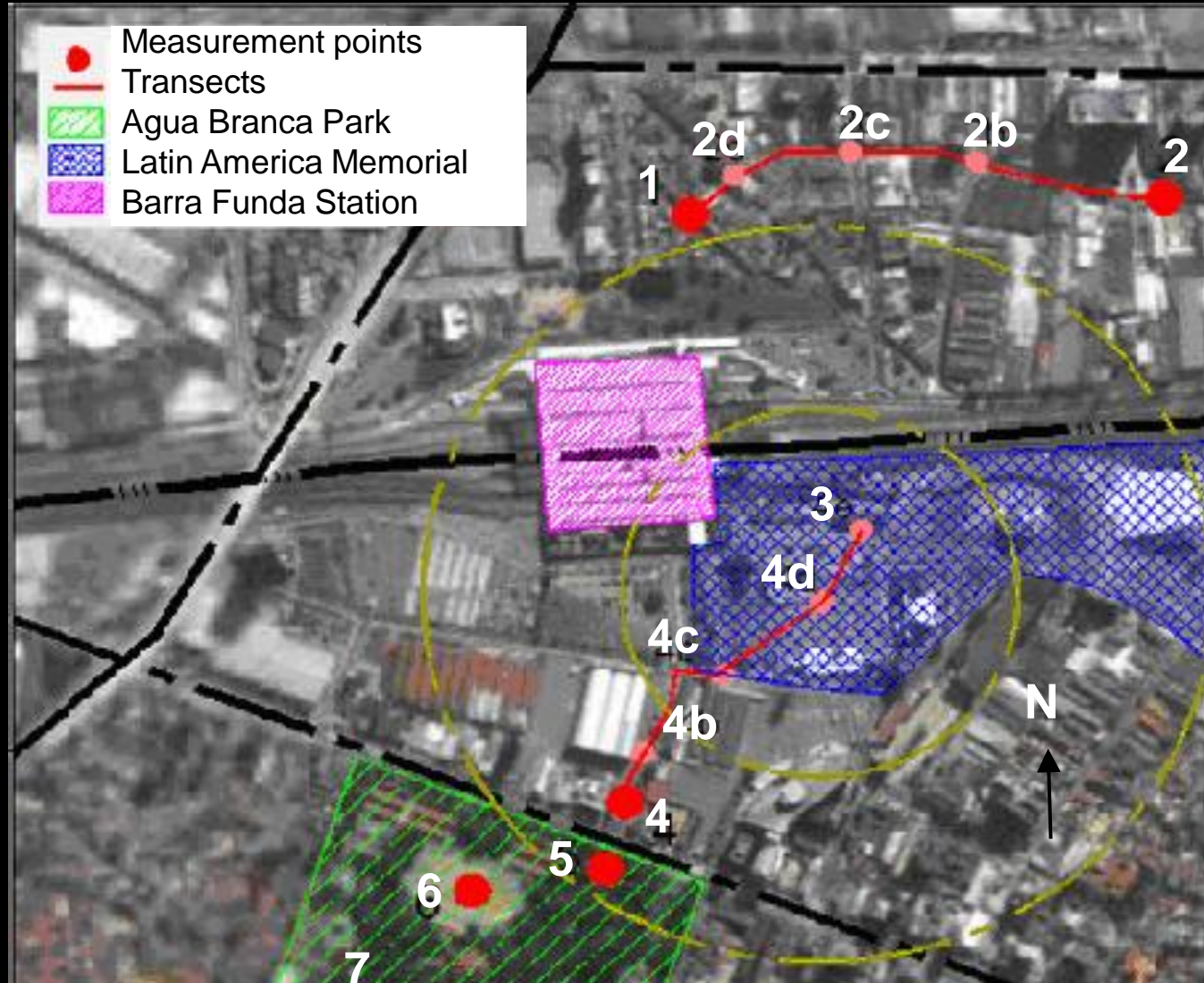
verify the adequacy of different configurations of urban outdoor spaces in Barra Funda, inferring possible correlations between thermal sensations and morphological characteristics, including vegetation, of each outdoor space studied.

Method

Empirical: microclimatic field measurements

Analytical: simulation of calibrated predictive model

Site of study and points of measurements

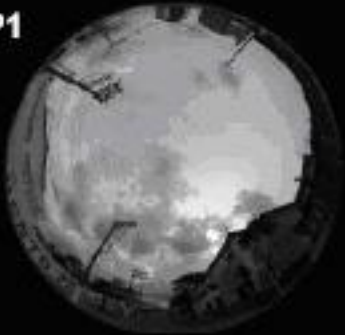


Spots of measurements and transects

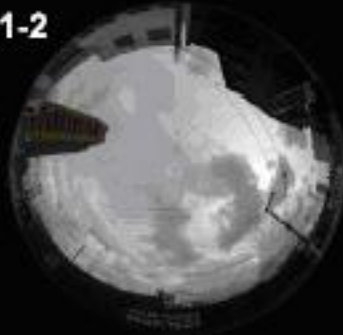


Sky view factor e nebulosity conditions

P1



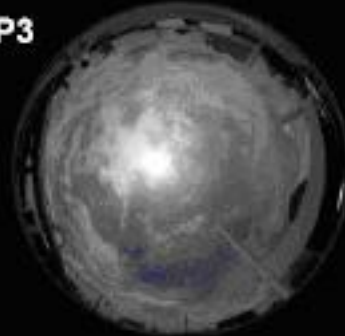
P1-2



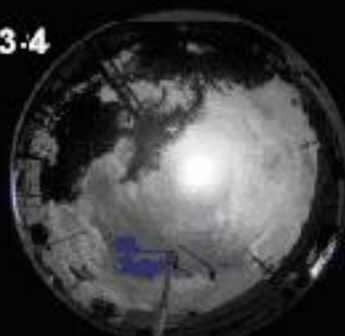
P2



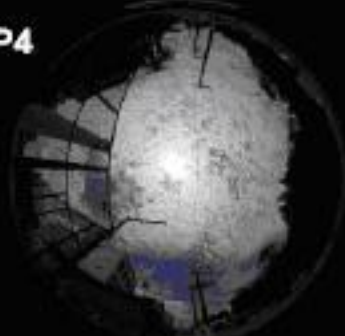
P3



P3-4



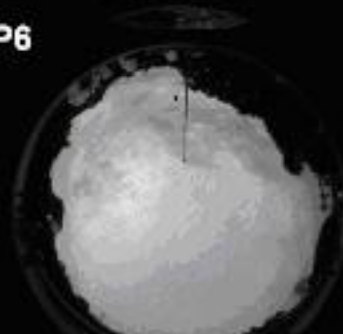
P4



P5



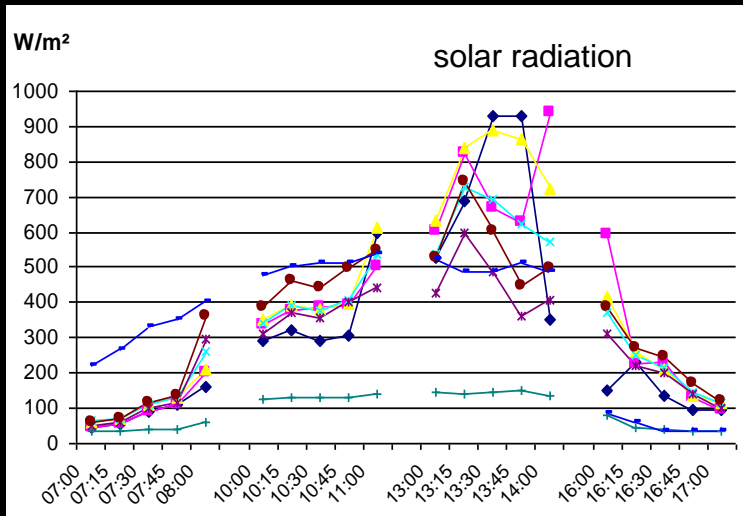
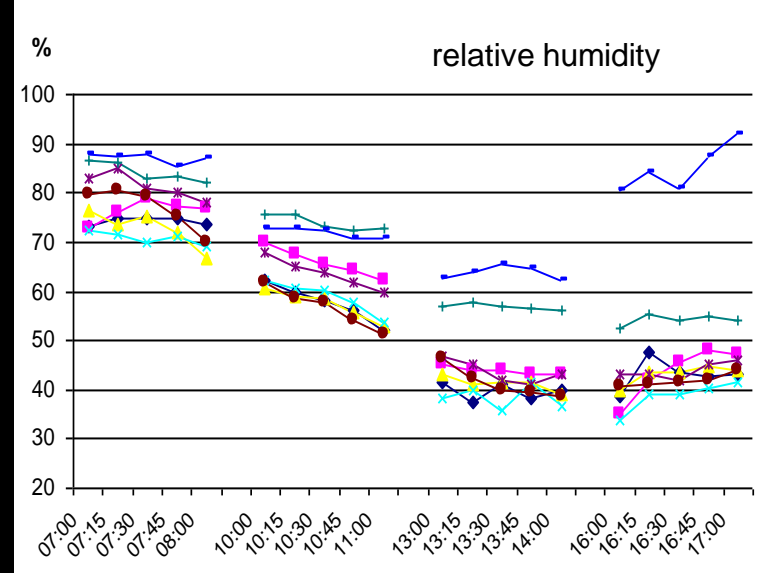
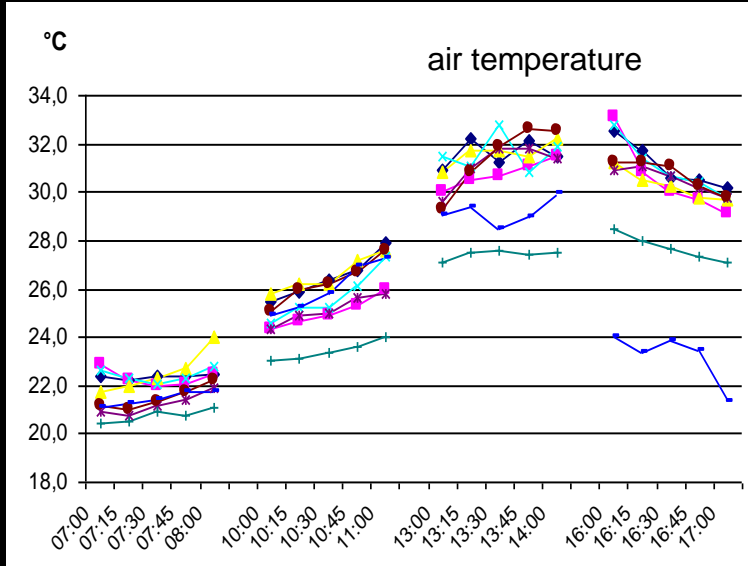
P6



P7

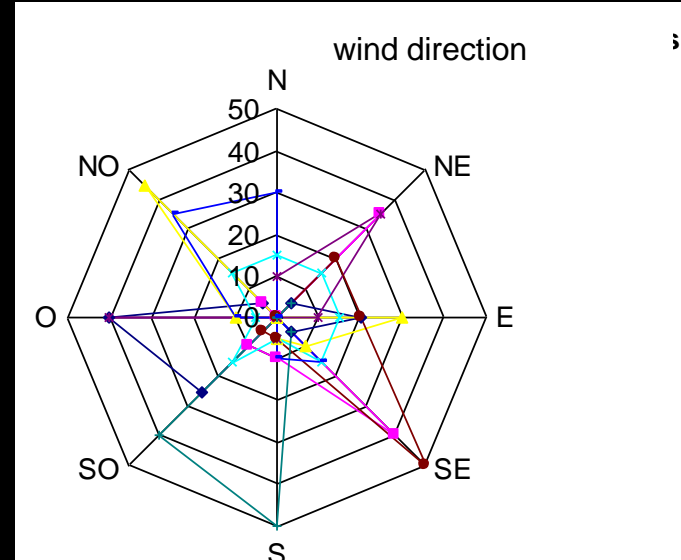
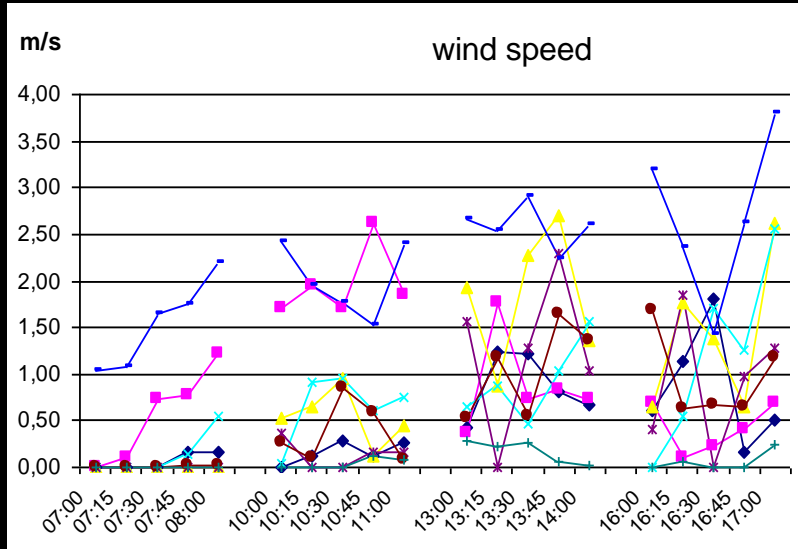


Microclimatic data



- ◆ P1: Low rising buildings street
- P2: Fórum Square
- ▲ P3: Latin America Latina Memorial
- ✕ P4: Francisco Matarazzo Avenue
- * P5: Agua Funda Park – Gate
- P6: Agua Funda Park – Arena
- + P7: Agua Funda Park – Trees
- Meteorological Station (FSP)

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Methods for estimating thermal comfort conditions

Thero physiological balance

$$S = M - W + L + R_c + C + E_{sk} + R_{es}$$

Mean radiant temperature

$$T_{rm} = [(R_c + 0,5 L_c + 0,5 L_p) / (0,95 \cdot 5,667 \cdot 10^{-8})]^{0,25} - 273$$

$$L_c = 5,5 \cdot 10^{-8} (273 + t)^4 [0,82 - 0,25 \cdot 10^{(-0,094 \cdot 0,75 v_p)}]$$

$$L_p = 5,5 \cdot 10^{-8} (273 + T_p)^4$$

Skin superficial temperature

$$T_s = (26,4 + 0,02138 T_{rm} + 0,2095 t - 0,0185 u_r - 0,009 v) + 0,6 (I_{cl} - 1) + 0,00128 M$$

Heat Load Index

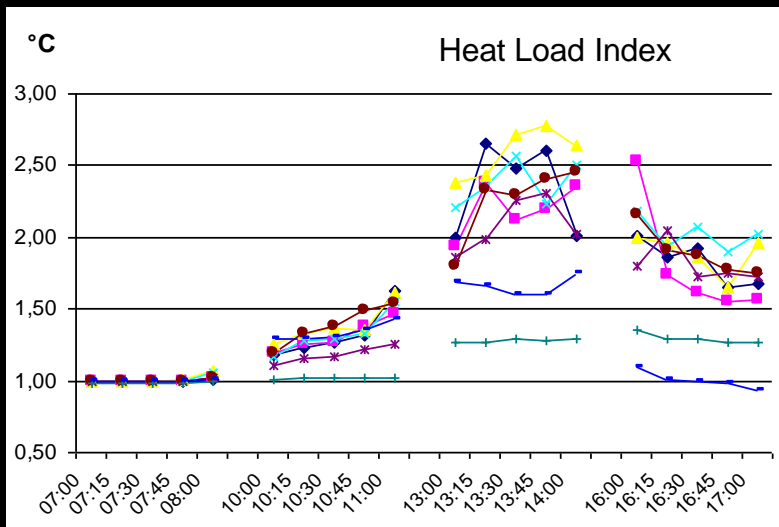
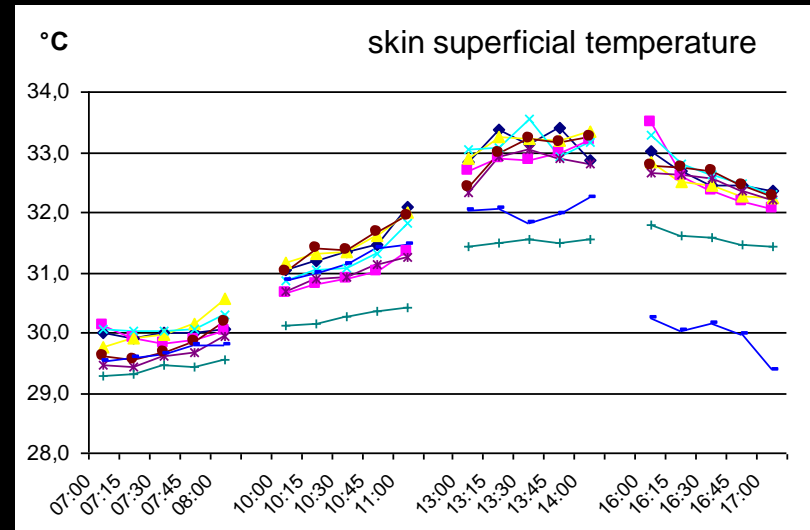
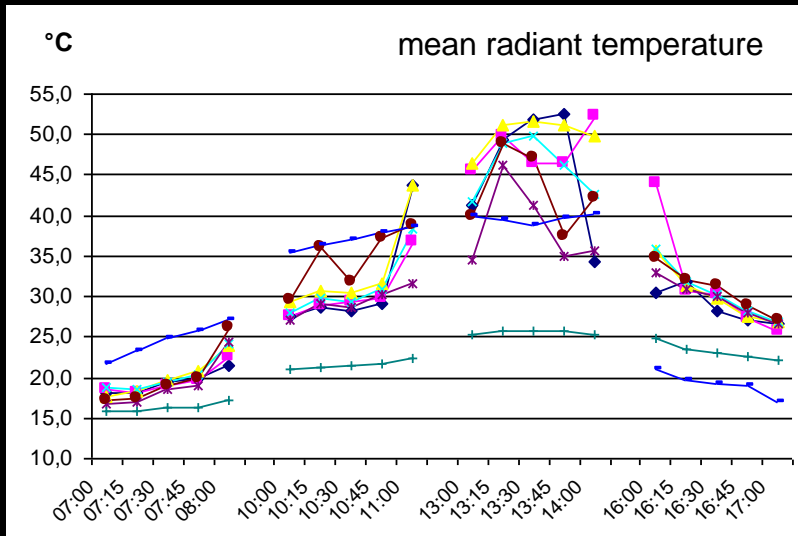
$$S \leq 0 \text{ W/m}^2 \text{ and } E_{sk} \geq -50 \text{ W/m}^2 \quad HL = [(S + 360) / 360] [2 - 1/(1+R_c)]$$

$$S > 0 \text{ W/m}^2 \text{ and } E_{sk} \geq -50 \text{ W/m}^2 \quad HL = [(S + 360) / 360] [2 + 1/(1+R_c)]$$

$$S \leq 0 \text{ W/m}^2 \text{ and } E_{sk} < -50 \text{ W/m}^2 \quad HL = (E_{sk}/-50) \cdot [(S + 360) / 360] [2 - 1/(1+R_c)]$$

$$S > 0 \text{ W/m}^2 \text{ and } E_{sk} < -50 \text{ W/m}^2 \quad HL = (E_{sk}/-50) \cdot [(S + 360) / 360] [2 + 1/(1+R_c)]$$

Estimated data



- ◆ P1: Low rising buildings street
- P2: Fórum Square
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Predictive model and calibration adopted

HL	Classification	Calibration	Sensation
		$\geq 1,65$	very hot
$\geq 1,600$	high stress (hot)	1,23 - 1,65	hot
1,186 - 1,600	stress (hot)	1,08 - 1,23	warm
0,931 - 1,185	neutrality	0,88 - 1,08	neutral
0,811 - 0,930	stress (cold)	0,72 - 0,88	cool
$\leq 0,810$	high stress (cold)	0,65 - 0,72	cold
		$\leq 0,65$	very cold

HL (Blazejczyk, 2002) and proposed calibration by Monteiro and Alucci (2007)

Results



HL	P1	P2	P3	P4	P5	P6	P7	MS
7 am	N	N	N	N	N	N	N	N
	N	N	N	N	N	N	N	N
	N	N	N	N	N	N	N	N
	N	N	N	N	N	N	N	N
	N	N	N	N	N	N	N	N
10 am	PC	PC	C	PC	PC	PC	N	C
	C	C	C	C	PC	C	N	C
	C	C	C	C	PC	C	N	C
	C	C	C	C	PC	C	N	C
	C	C	C	C	C	C	N	C
1 pm	MC	MC	MC	MC	MC	MC	C	MC
	MC	MC	MC	MC	MC	MC	C	MC
	MC	MC	MC	MC	MC	MC	C	C
	MC	MC	MC	MC	MC	MC	C	C
	MC	MC	MC	MC	MC	MC	C	C
4 pm	MC	MC	MC	MC	MC	MC	C	PC
	MC	MC	MC	MC	MC	MC	C	N
	MC	C	MC	MC	MC	MC	C	N
	C	C	MC	MC	MC	MC	C	N
	C	C	MC	MC	MC	MC	C	N

Final Considerations

- Relationships between different morphologies and vegetation and their influence in the microclimatic conditions
- Consideration of urban design in order to provide proper thermal situations in outdoor spaces

Further research works:

1) Analysis of thermal adequacy:

verification of the results of the original and calibrated indexes;
analysis in full detail of the influence of radiation and ventilation;
comparative application of adaptive model.

2) Intervention proposes, contributing to:

possible urban design interventions for environmental requalification
and also design for occupation of brownfields and open spaces.

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