THERMAL EFFECTS OF WOODY GREEN AREAS IN URBAN LANDSCAPES IN CAMPINAS CITY, BRAZIL

CRISTIANE DACANAL

FEDERAL UNIVERSITY OF SAO FRANCISCO VALLEY – PETROLINA/ BRAZIL

LUCILA CHEBEL LABAKI

UNIVERSITY OF CAMPINAS – CAMPINAS / BRAZIL

URBAN GREEN AREAS

Thermal effects :

- **Depend on class of vegetation and urban pattern**
- **Vary in magnitude and extension**

BACKGROUND

- **Jusuf et al. (2007) (Singapore): green areas are cooler than the city**
- **Jauregui (1990/91) (Mexico): the cooling effect is aproximatelly the width of the park**
- **Cox (2008) (Brazil); Leal et al (2014) (Brazil): neighborhoods next to woody areas present lower air temperature and higher relative humidity**
- **Gomes and Lamberts (2009) (Brazil): thermal effect of vegetation is greater in the dry season**
- **Cruz (2009) (Brazil): found that the thermal effects of green areas are local - cool islands**
- **UCZ classification according to Davenport et al (2000)**

OBJECTIVES

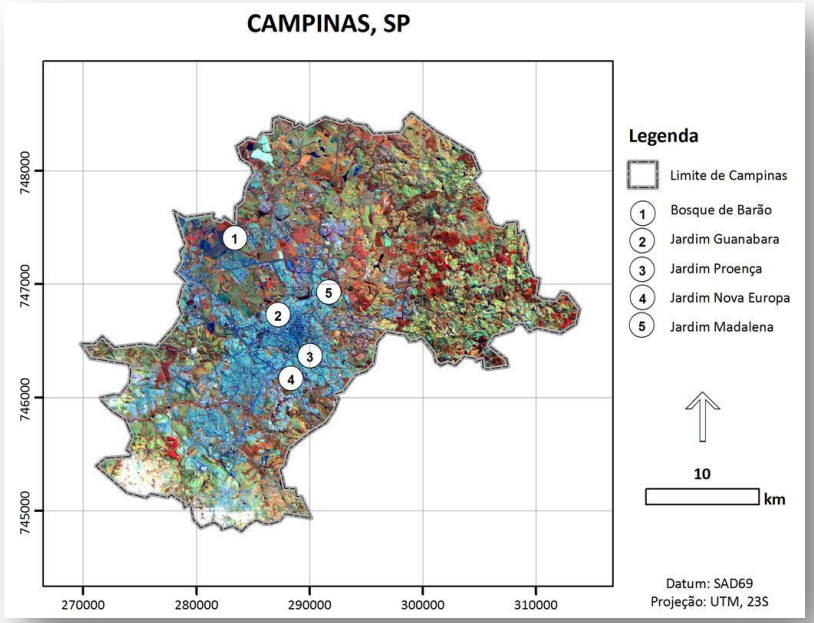
To establish environmental / urban parameters

- The minimum percentage of urban woody green areas able to produce thermal effect
- To quantify thermal effects of woody green areas in different urban patterns (Urban climate zones) in Campinas - Brazil

METHODS

Step 1 – to identify urban forests fragments (Brazilian Tropical Semi-deciduous Forest) in Campinas

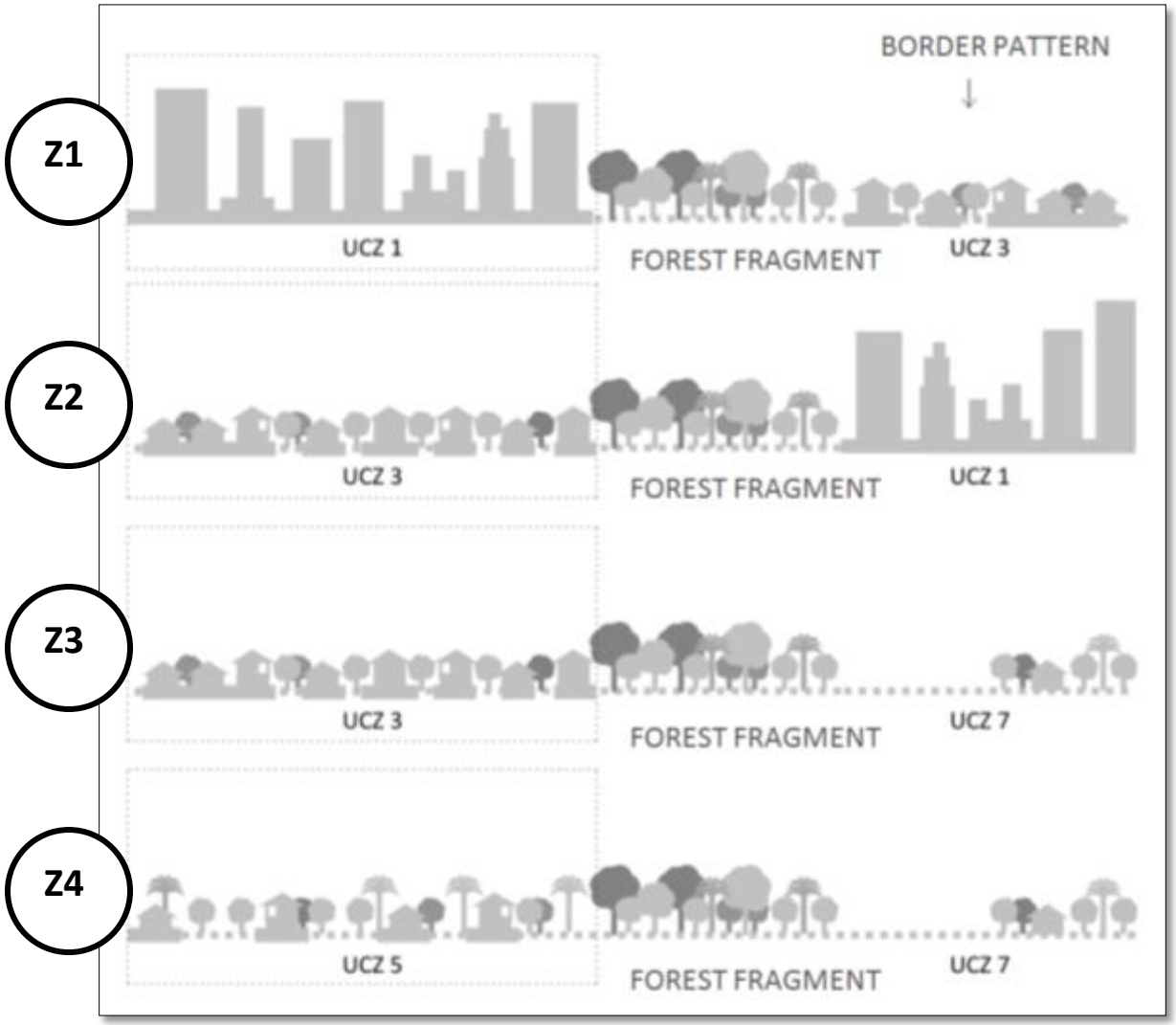
5 selected



URBAN PATTERN

Step 2 - Urban Pattern

Classification near the woody areas, including the border



METEOROLOGICAL CAMPAIGN

Step 3 – Mobile transects (Temperature and Humidity data logger + GPS)

+

-Fixed stations disposed in each zone

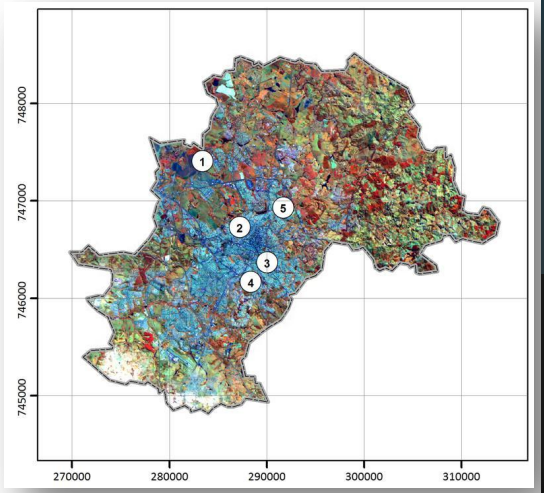
9am

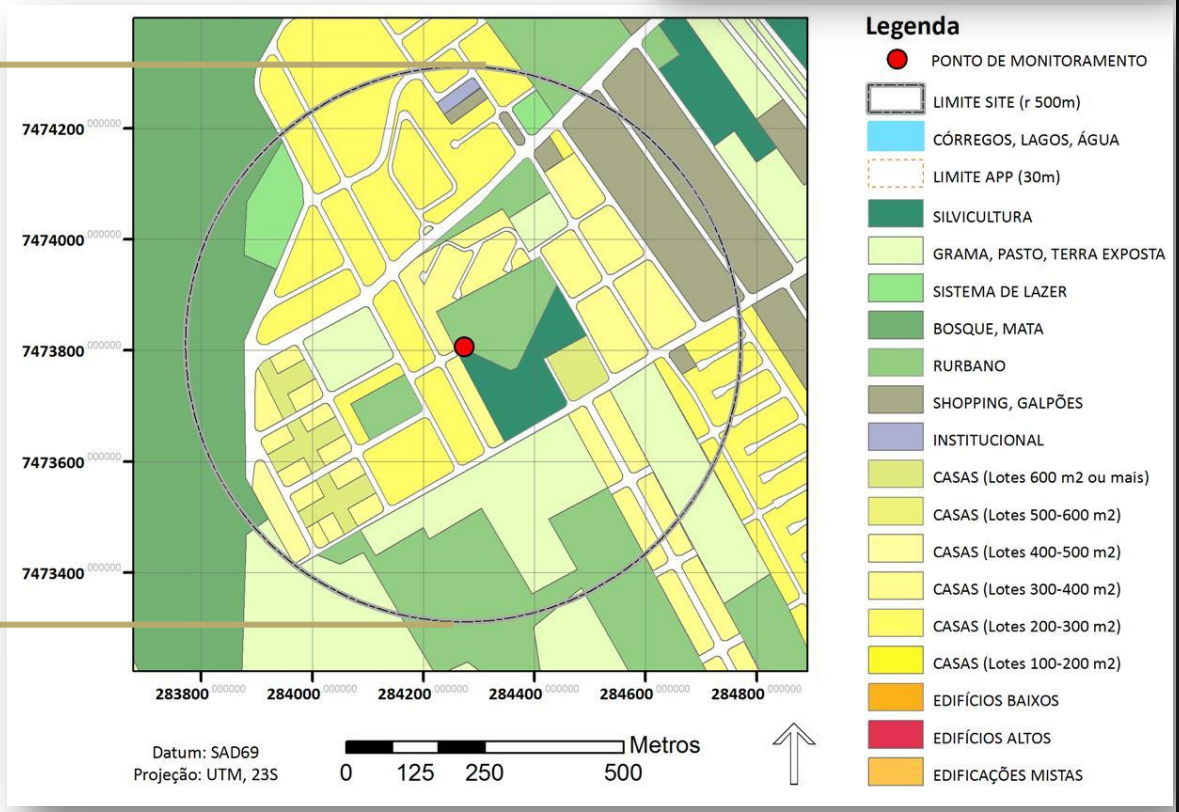
3pm ..... 4 days

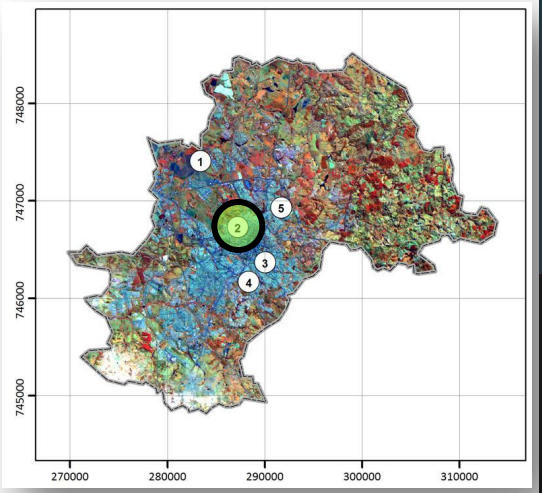
9pm

FIXED STATIONS

Above rugosity layer: at 1,5 m and 10 m height



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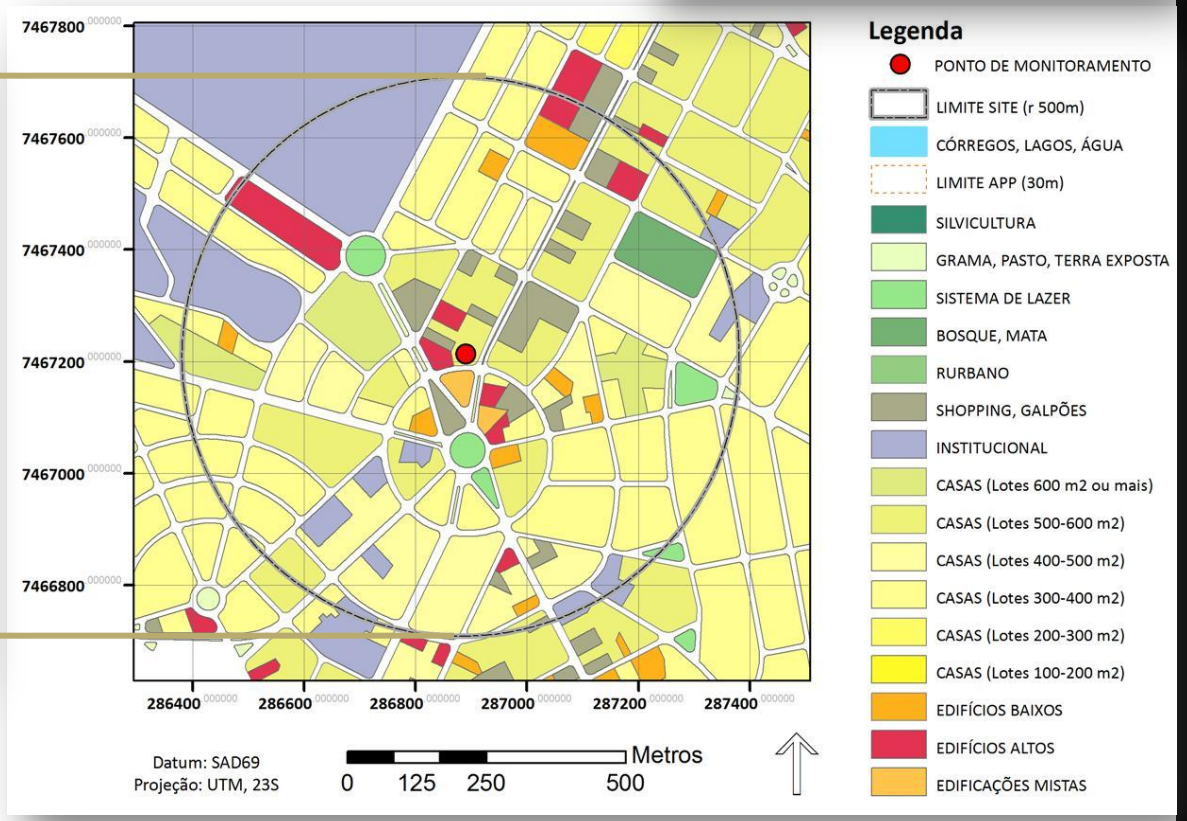
Bosque dos Italianos
500m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Legenda
PONTO DE MONITORAMENTO
LIMITE SITE (r 500m)
CÓRREGOS, LAGOS, ÁGUA
LIMITE APP (30m)
SILVICULTURA
GRAMA, PASTO, TERRA EXPOSTA
SISTEMA DE LAZER
BOSQUE, MATA
RURBANO
SHOPPING, GALPÕES
INSTITUCIONAL
CASAS (Lotes 600 m2 ou mais)
CASAS (Lotes 500-600 m2)
CASAS (Lotes 400-500 m2)
CASAS (Lotes 300-400 m2)
CASAS (Lotes 200-300 m2)
CASAS (Lotes 100-200 m2)
EDIFÍCIOS BAIXOS
EDIFÍCIOS ALTOS
EDIFICAÇÕES MISTAS
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Projeção: UTM, 23S
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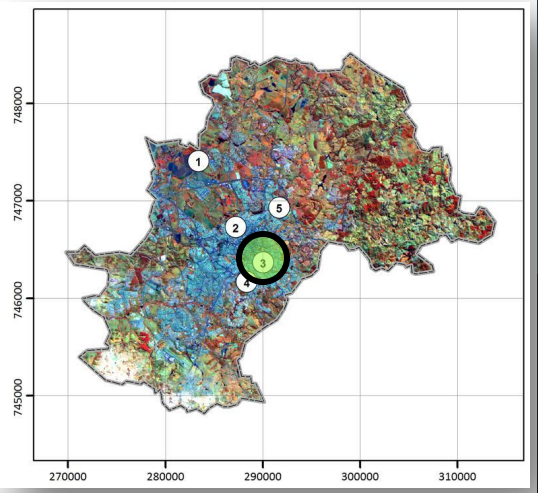
125
250
500
Metros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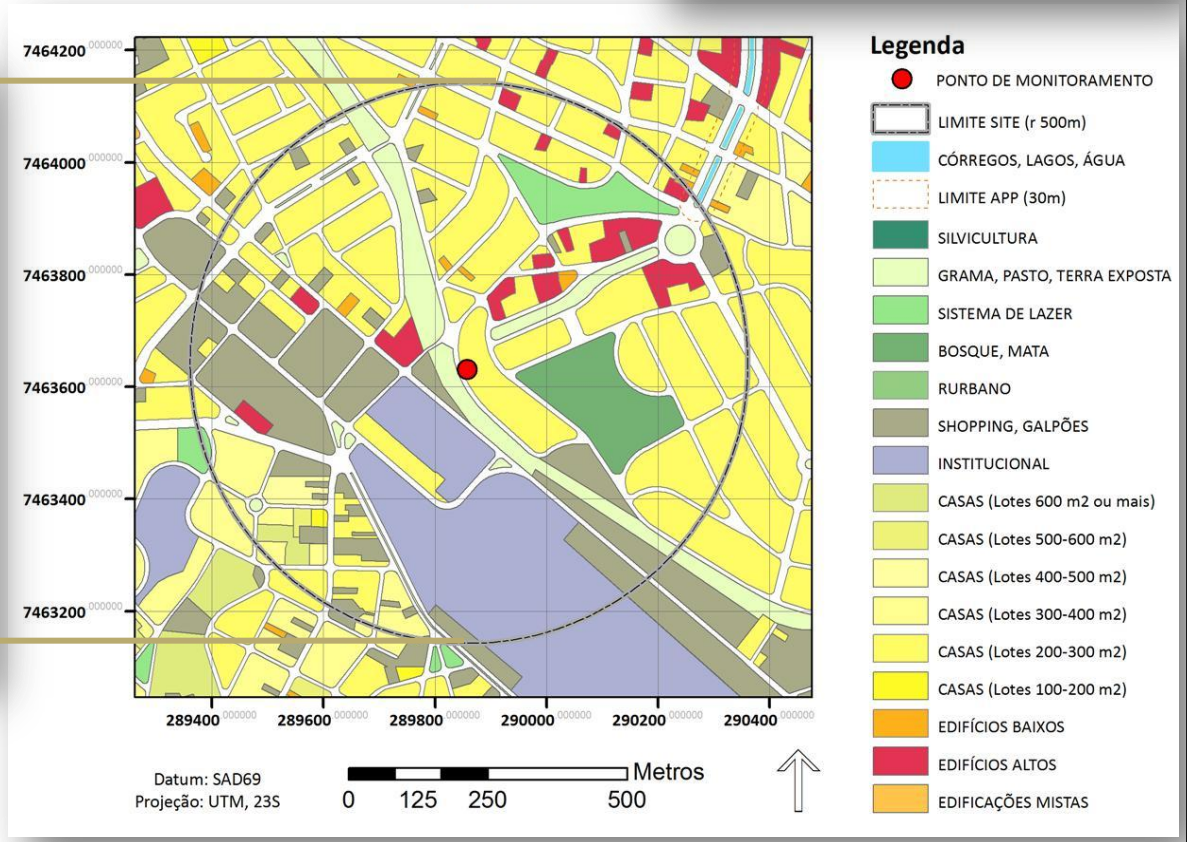
Bosque
São José
500m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Legenda
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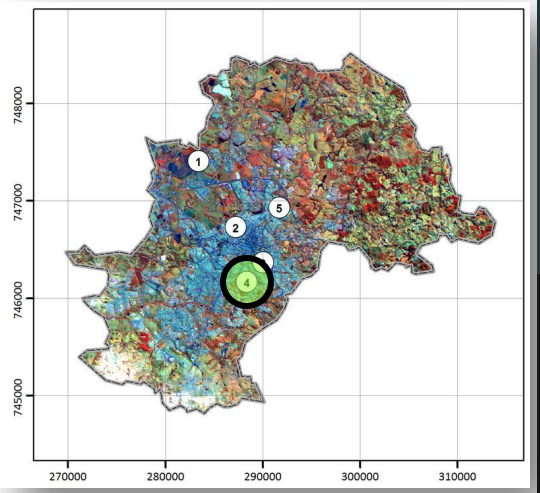
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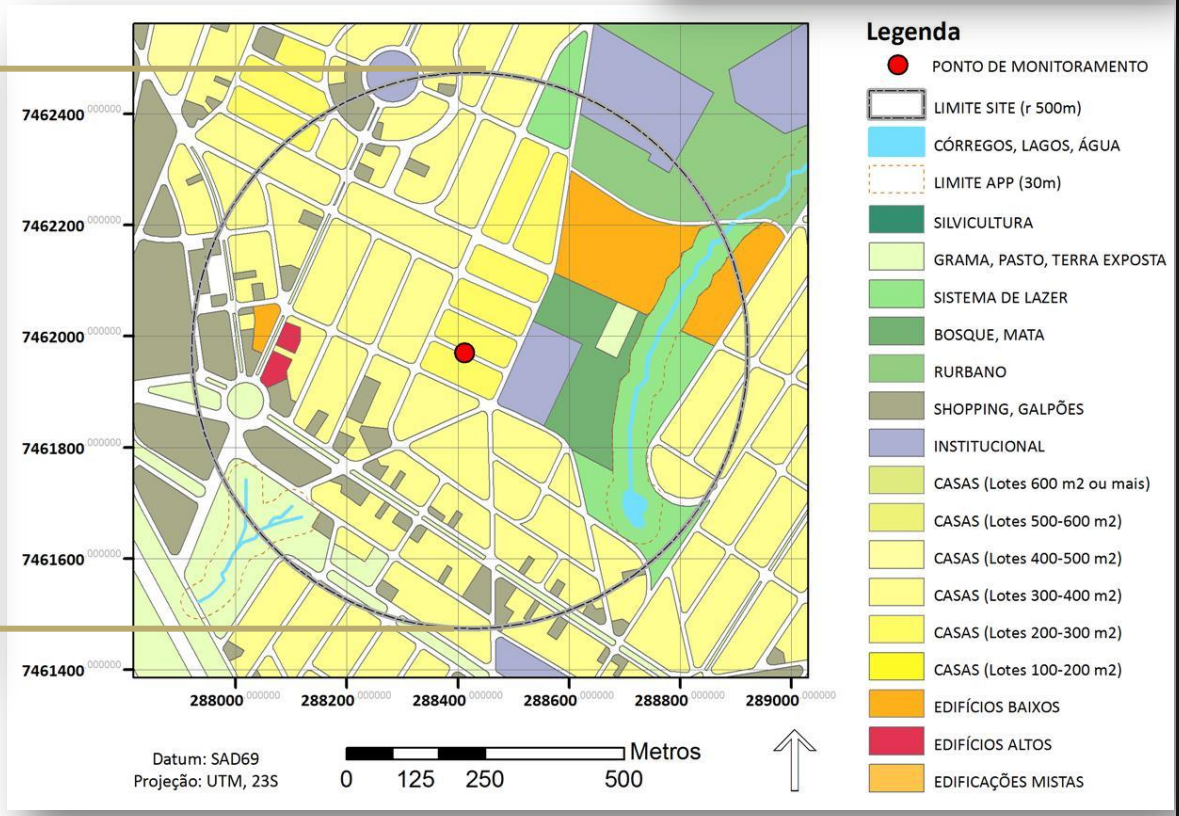
Bosque dos Guarantãs
500m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Metros
Legenda
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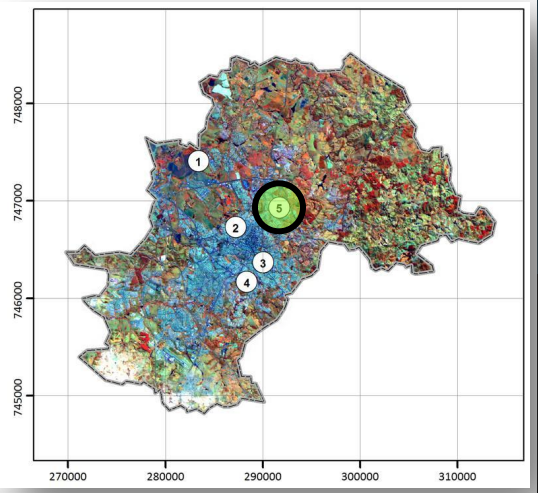
EDIFÍCIOS ALTOS
EDIFICAÇÕES MISTAS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2
3
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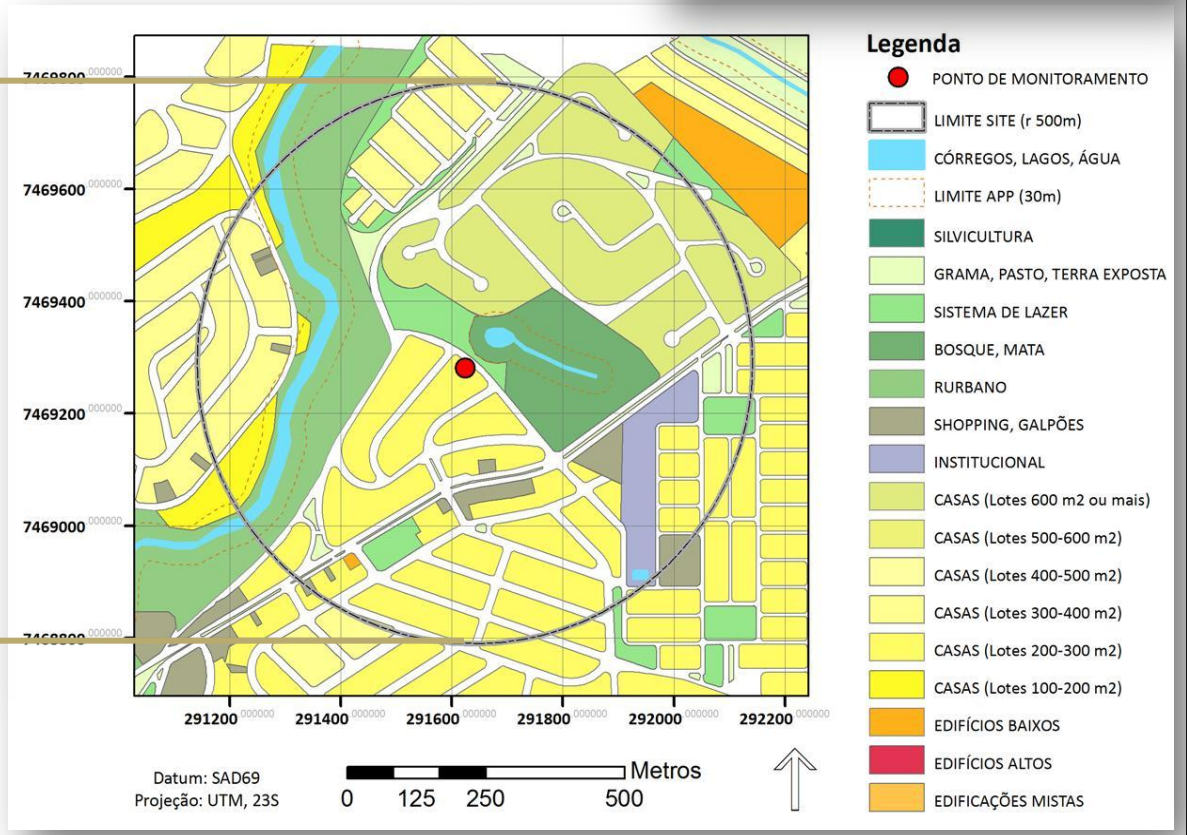
5


Bosque da Paz
500m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Legenda
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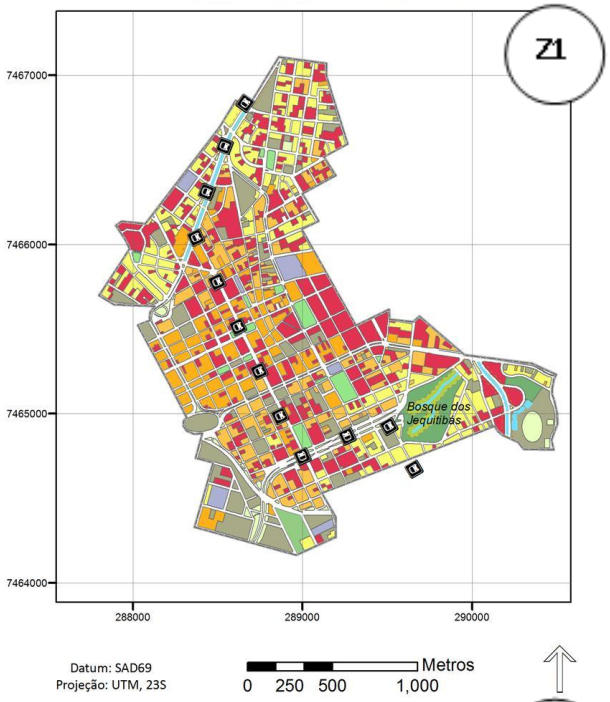
CASAS (Lotes 200-300 m2)
CASAS (Lotes 100-200 m2)
EDIFÍCIOS BAIXOS
EDIFÍCIOS ALTOS
EDIFICAÇÕES MISTAS

ROUTES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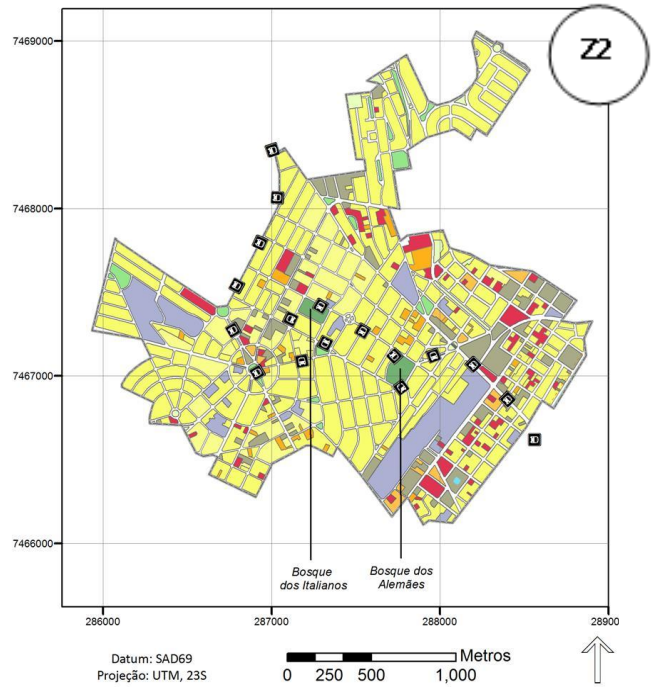
Metros
0 250 500 1,000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Metros
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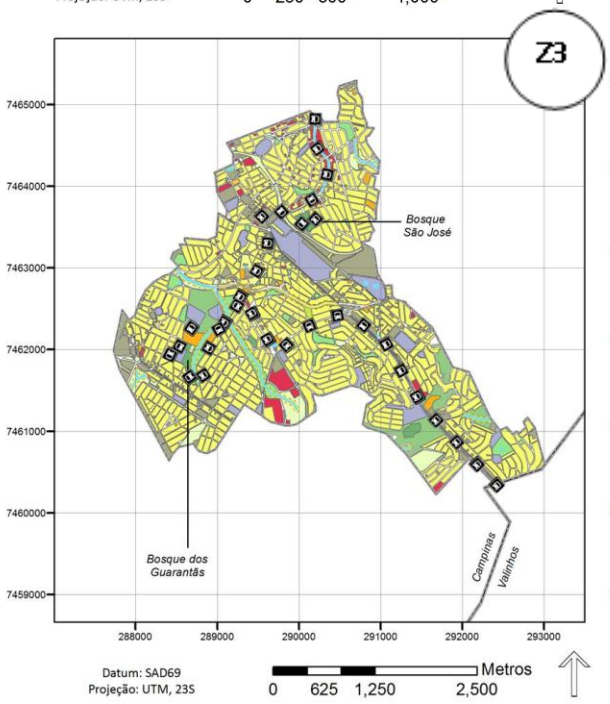
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Bosque dos Guarantãs
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Valinhos
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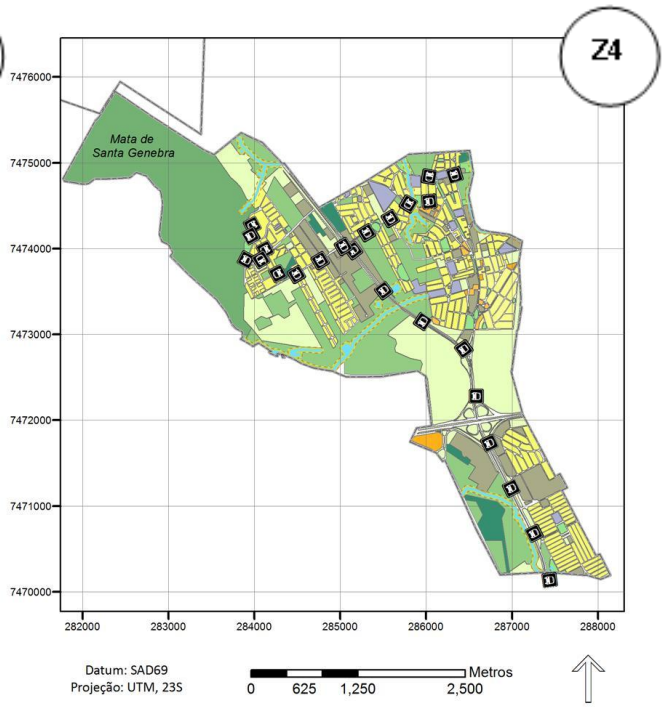
Metros
0 625 1,250 2,500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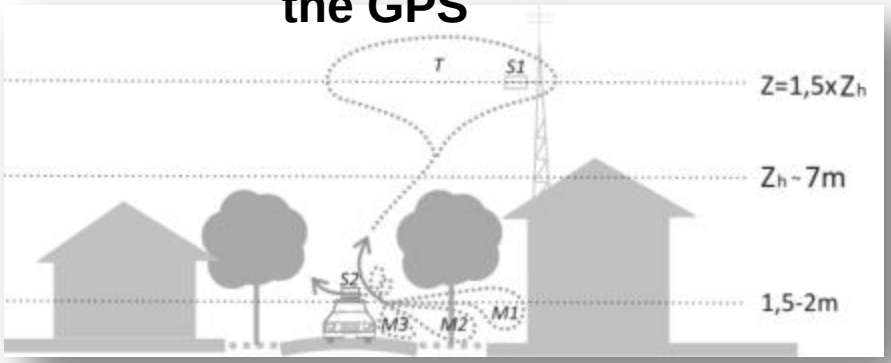
287000
288000
Mata de Santa Genebra
Datum: SAD69
Projeção: UTM, 23S
Metros
0 625 1,250 2,500

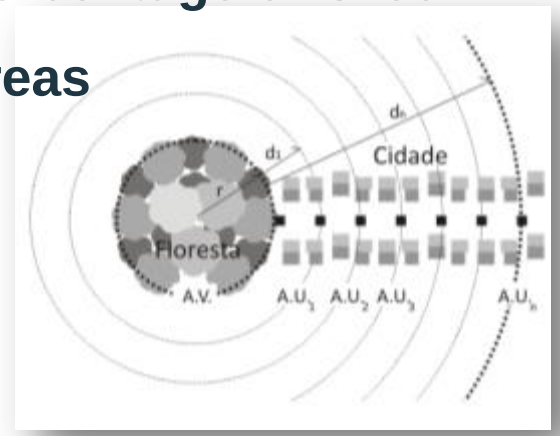
DATA ANALYSIS

Delay of data acquisition (route ~ 50 min)

- **Mobile data were parameterized to data of fixed points, observing the exact time of the acquisition registered by the GPS**



Percentage of Green areas

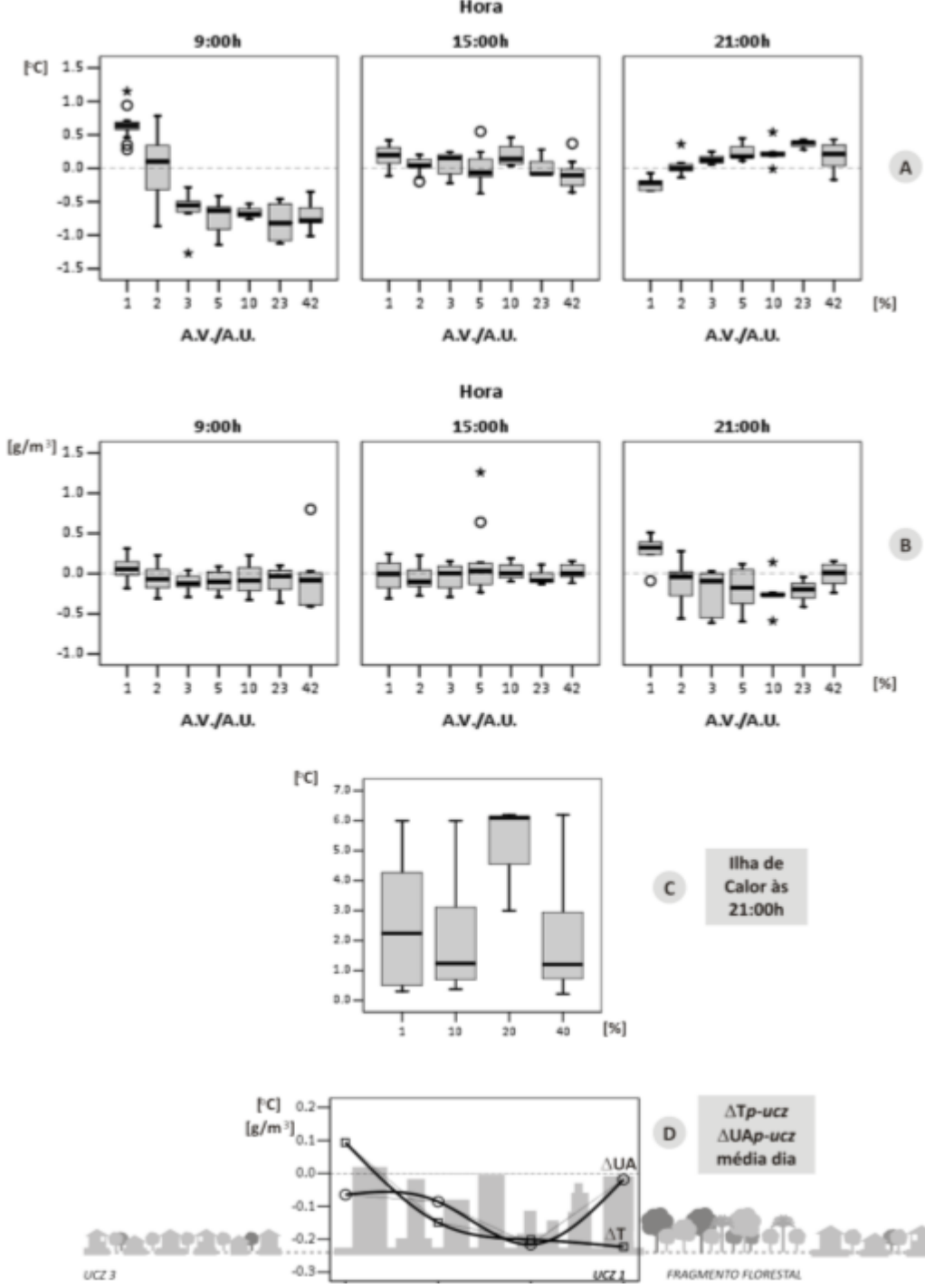


Descriptive statistical analysis:

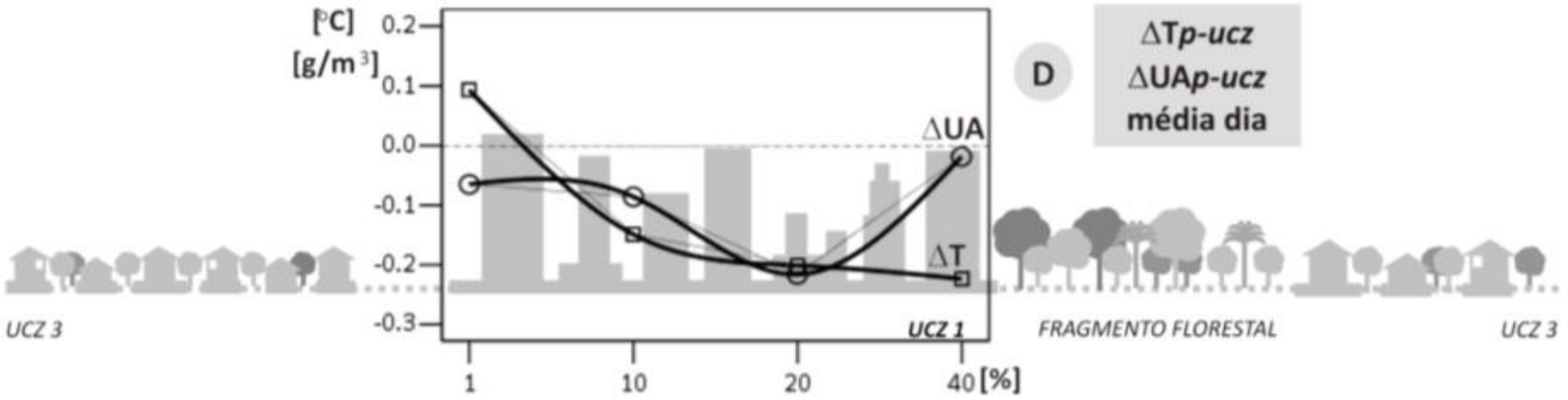
- **average of air temperature and air humidity of each zone = Reference (T_{UCZ})**
- $\Delta T_{POINTS-UCZ}$
- $\Delta U_{POINTS-UCZ}$

RESULTS

Zone 1

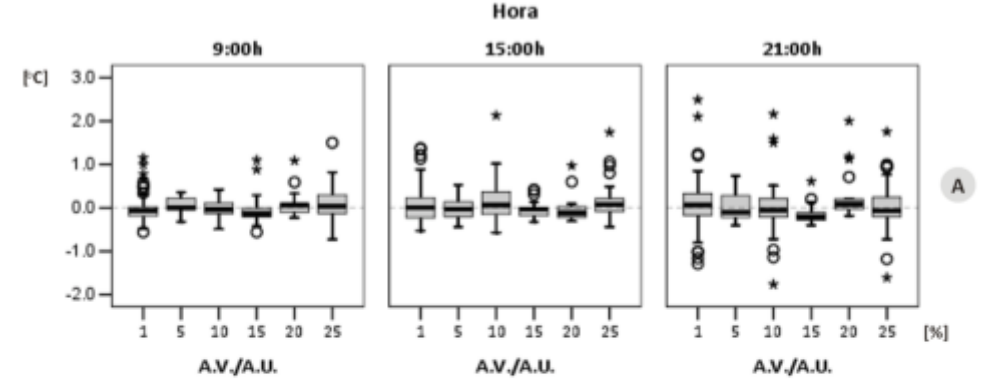


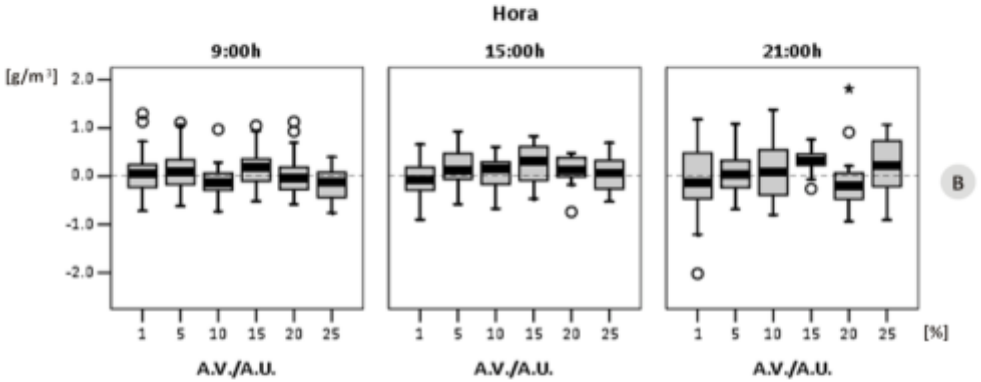
ZONE 1

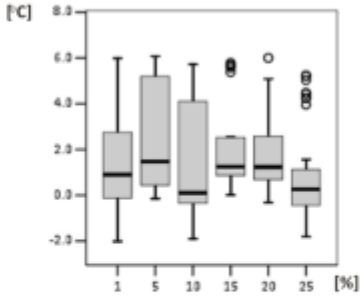

[°C]
[g/m³]
0.2
0.1
0.0
-0.1
-0.2
-0.3
ΔUA
ΔT
UCZ 1
1
10
20
40 [%]
D
ΔTp-ucz
ΔUAp-ucz
média dia
UCZ 3
FRAGMENTO FLORESTAL
UCZ 3

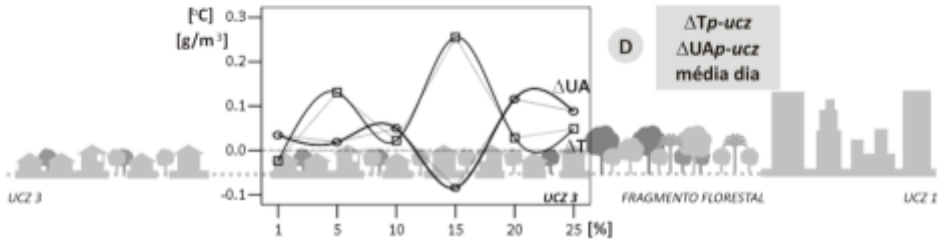
RESULTS

Zone 2

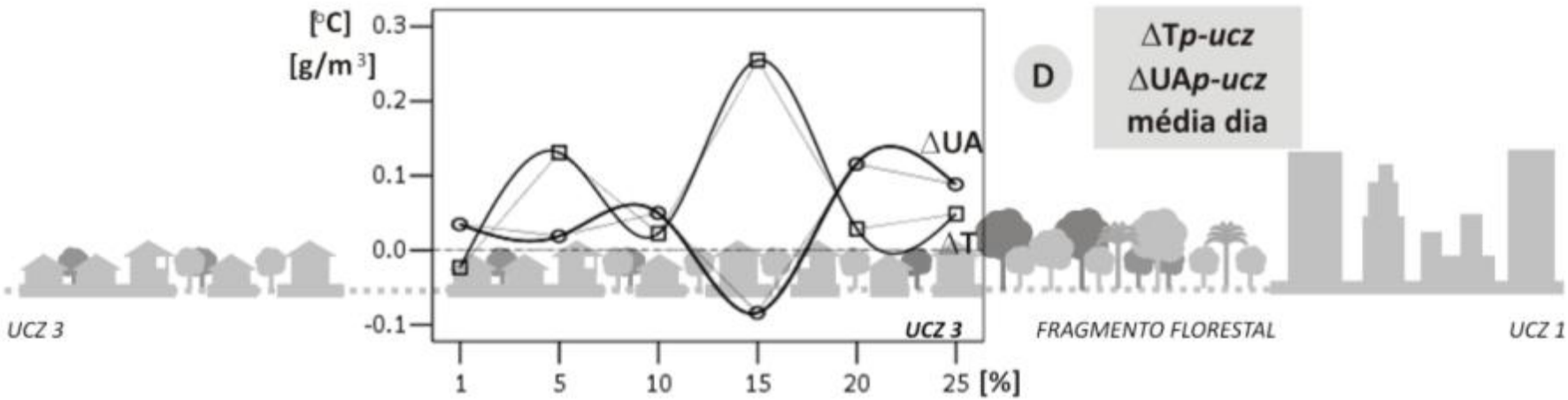








ZONE 2


[°C]
[g/m³]
0.3
0.2
0.1
0.0
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ΔUA
ΔT
UCZ 3
1
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10
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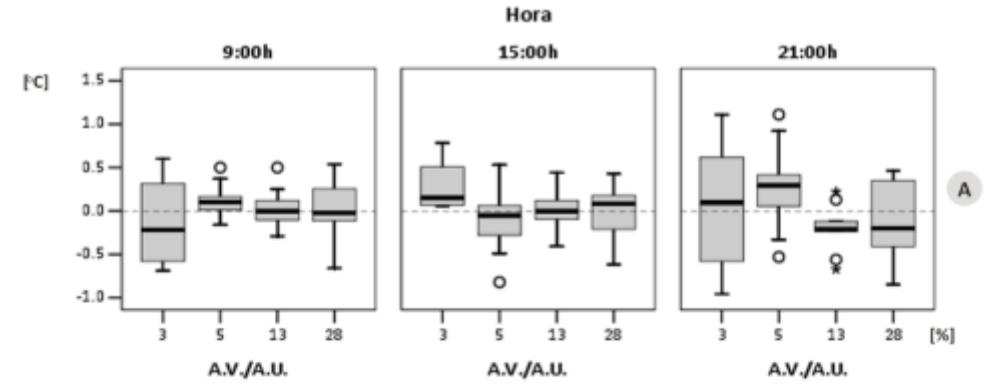
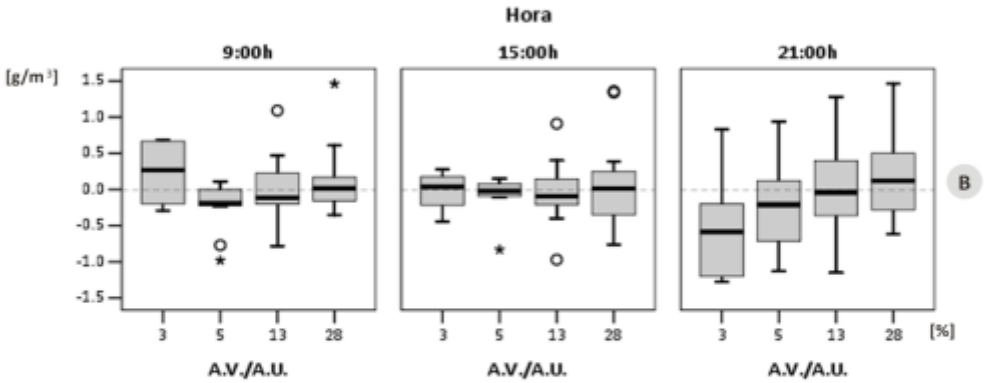
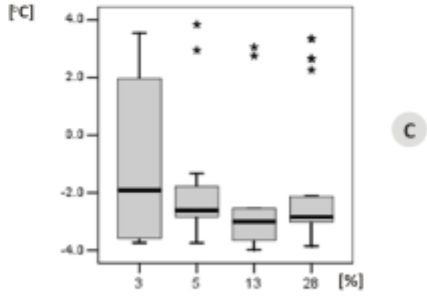
25 [%]
D
ΔTp-ucz
ΔUAp-ucz
média dia
UCZ 3
FRAGMENTO FLORESTAL
UCZ 1

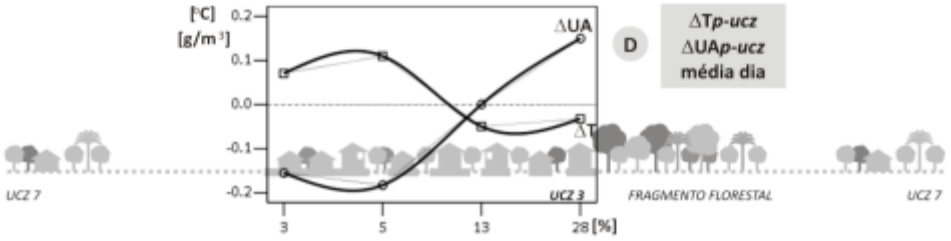
RESULTS

Zone 3

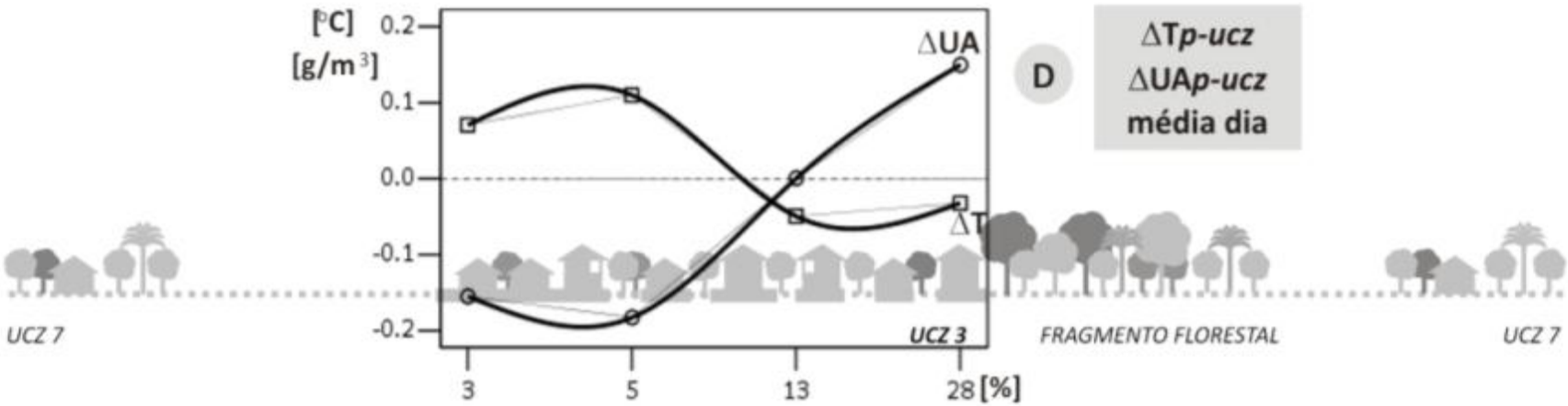








ZONE 3


[°C]
[g/m³]
0.2
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-0.1
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ΔUA
ΔT
UCZ 3
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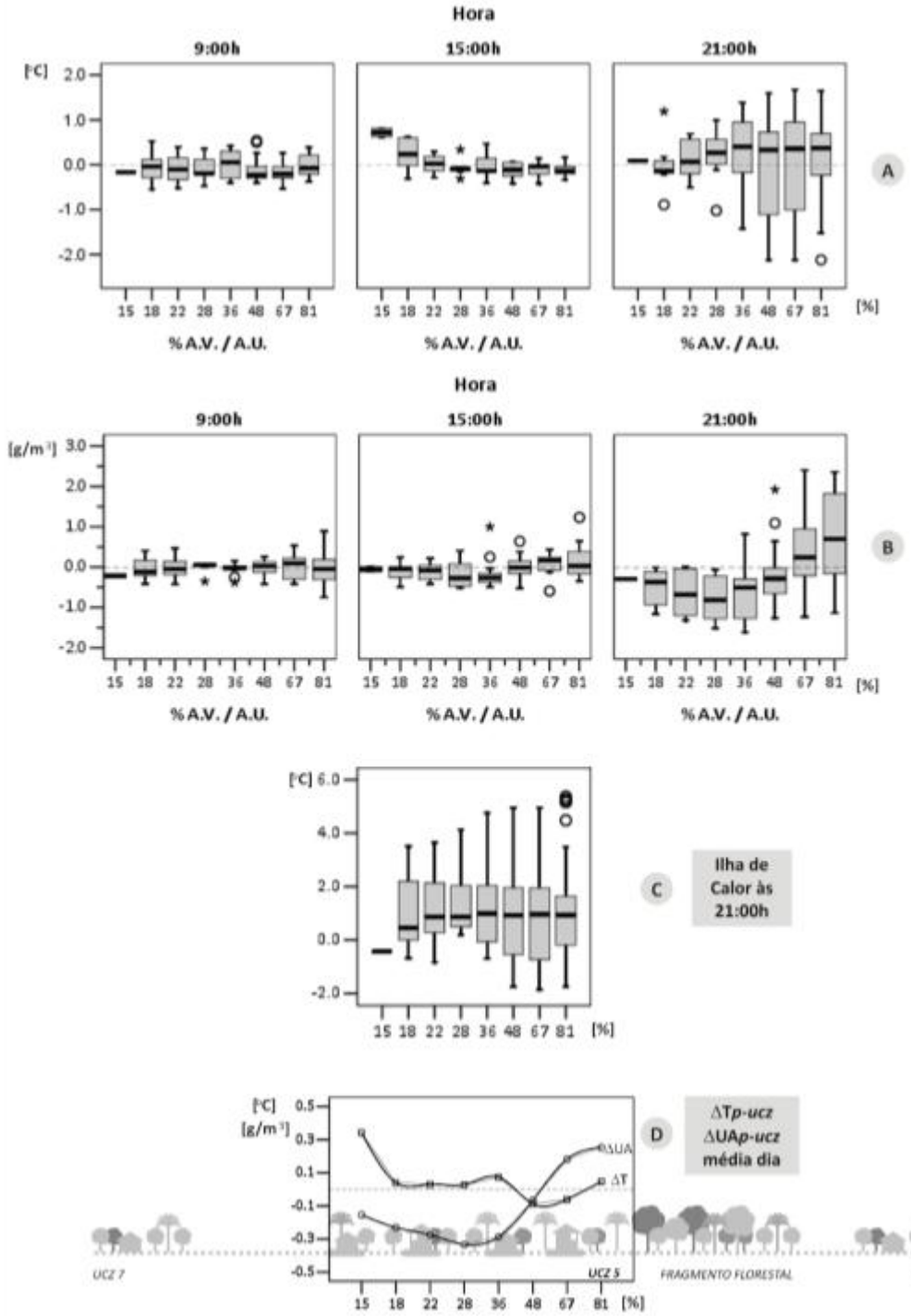
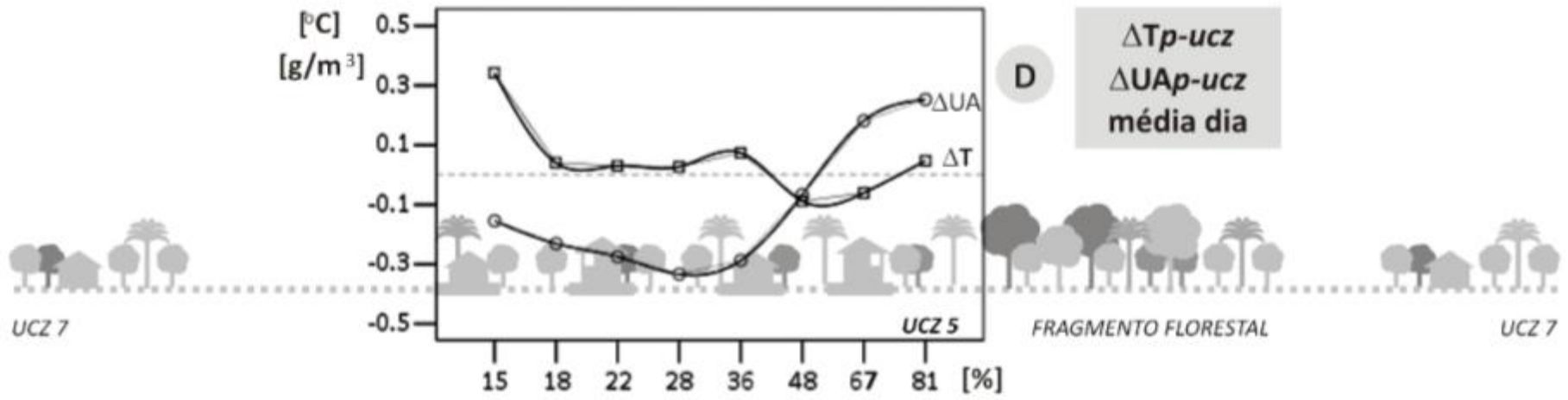
média dia
UCZ 7
FRAGMENTO FLORESTAL
UCZ 7

RESULTS

Zone 4



ZONE 4


[°C]
[g/m³]
0.5
0.3
0.1
-0.1
-0.3
-0.5
ΔUA
ΔT
UCZ 5
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18
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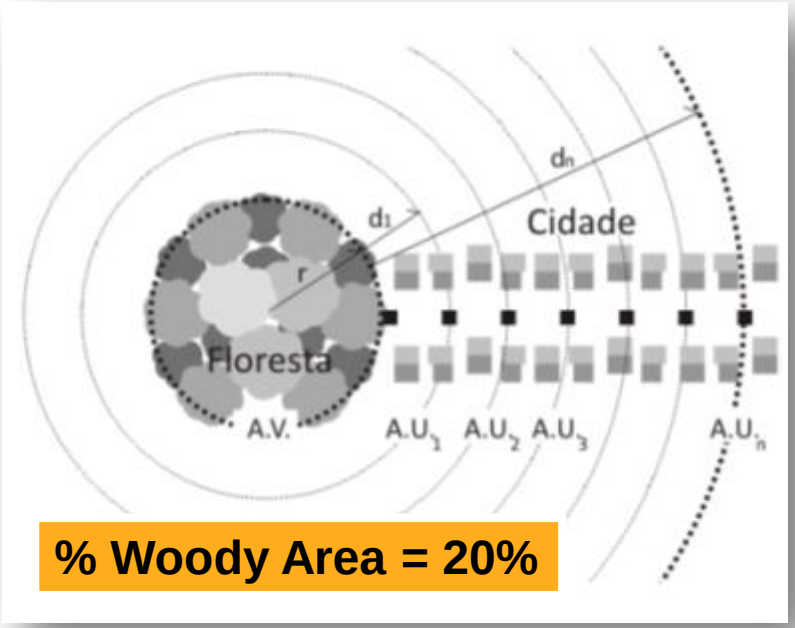
28
36
48
67
81
[%]
D
ΔTp-ucz
ΔUAp-ucz
média dia
UCZ 7
FRAGMENTO FLORESTAL
UCZ 7

ESTABLISHING URBAN PARAMETER

UCZ	Percentage of Forest Area to start thermal effect	Minimum percentage of forest to observe thermal effect in terms of temperature and air humidity
Z1	20%	> 40%
Z2	15%	20%
Z3	4%	13%
Z4	18% thermal stability 30% increase air humidity	50%

CONCLUSIONS



Borders of Woody Areas:

- **Cool Islands during the day**
- **Heat islands at night.**

Thermal effects:

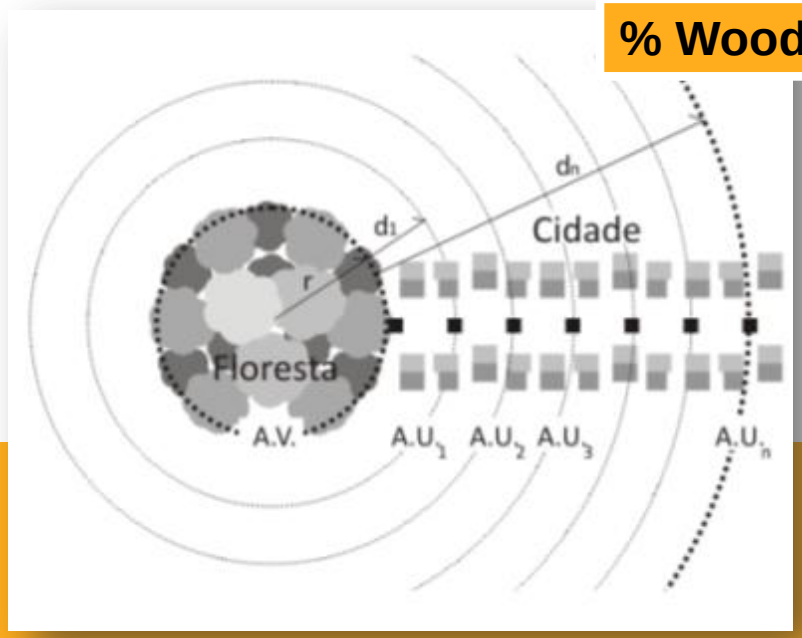
- **Temperature: at least 20% green area**
- **Temperature + Humidity in verticalized urban areas / agricultural lands / exposed soils and grasses - 40-50% of green area**

Extension of the effect

- **Approximately equal to the diameter "*d*" of a circumference with an area equivalent to that of the forest**
- **Two or more green areas - 1,5 . *D***

CONCLUSIONS

Based on the results, it is recommended to plant at least 20% of urban forest areas on the urban total, with a regular format, homogeneously distributed over the urban fabric.



THANK YOU!

cristiane.dacanal@univasf.edu.br

lucila@fec.unicamp.br