URBAN AGE 2008
3-5 December
São Paulo

ENVIRONMENTAL URBAN DESIGN WITH SOCIAL-ECONOMIC BENEFITS

ECO BUILDING FOR SÃO PAULO

UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ARQUITETURA E URBANISMO
LABORATÓRIO DE EFICIÊNCIA ENERGÉTICA E CONFORTO AMBIENTAL

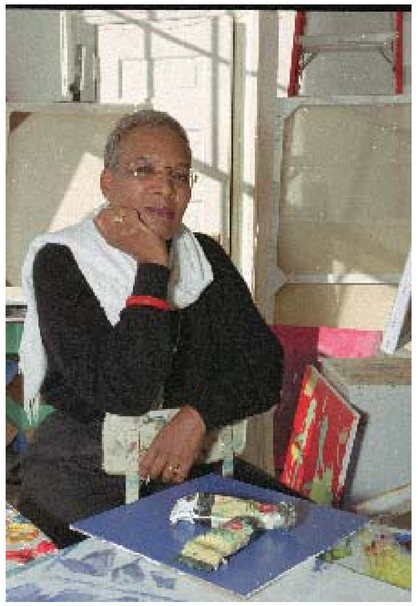
labaut

People and place

Leblon, Rio de Janeiro

People and place

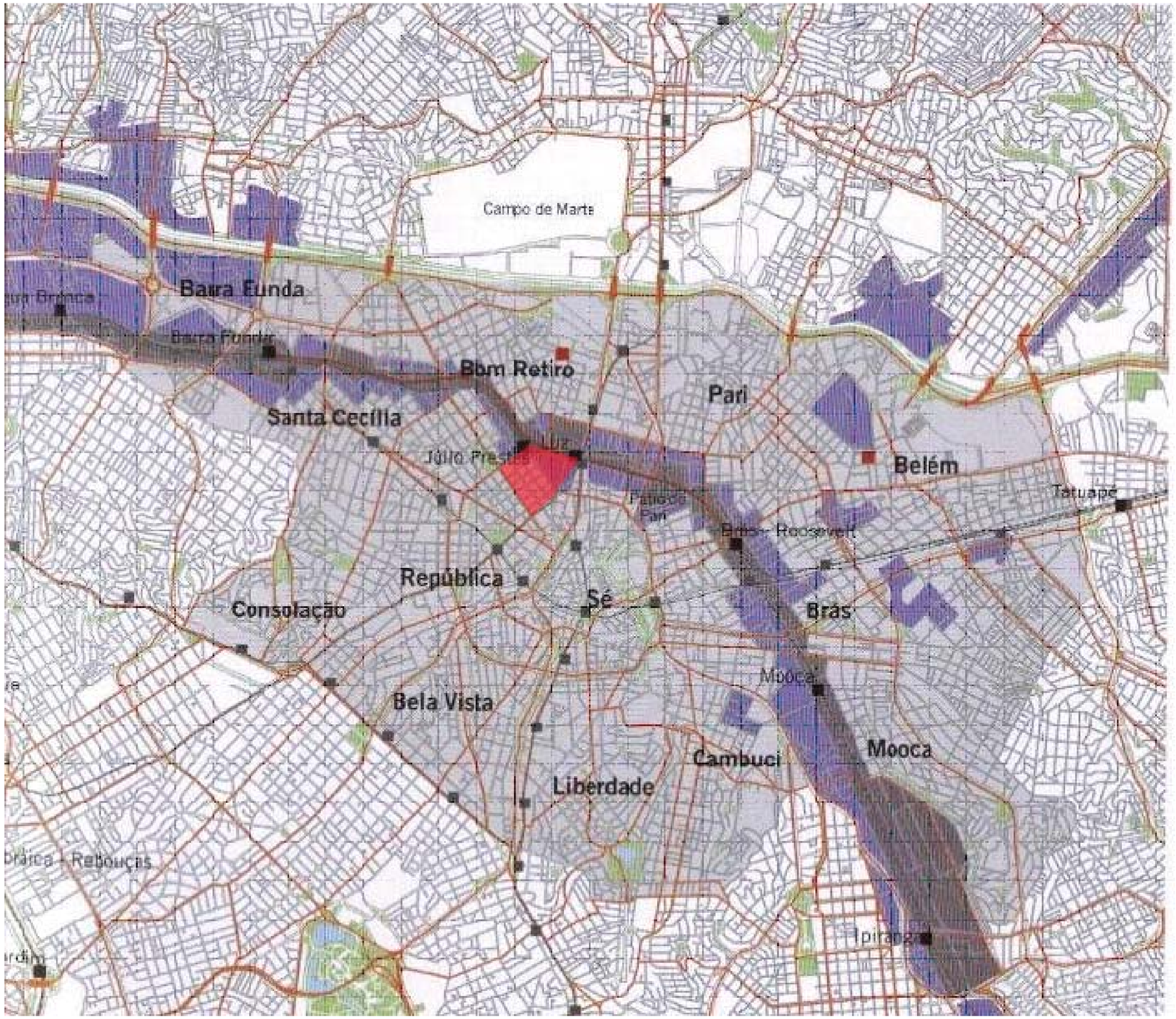
ECO BUILDING FOR SÃO PAULO



Where lays the potential for urban sustainability?

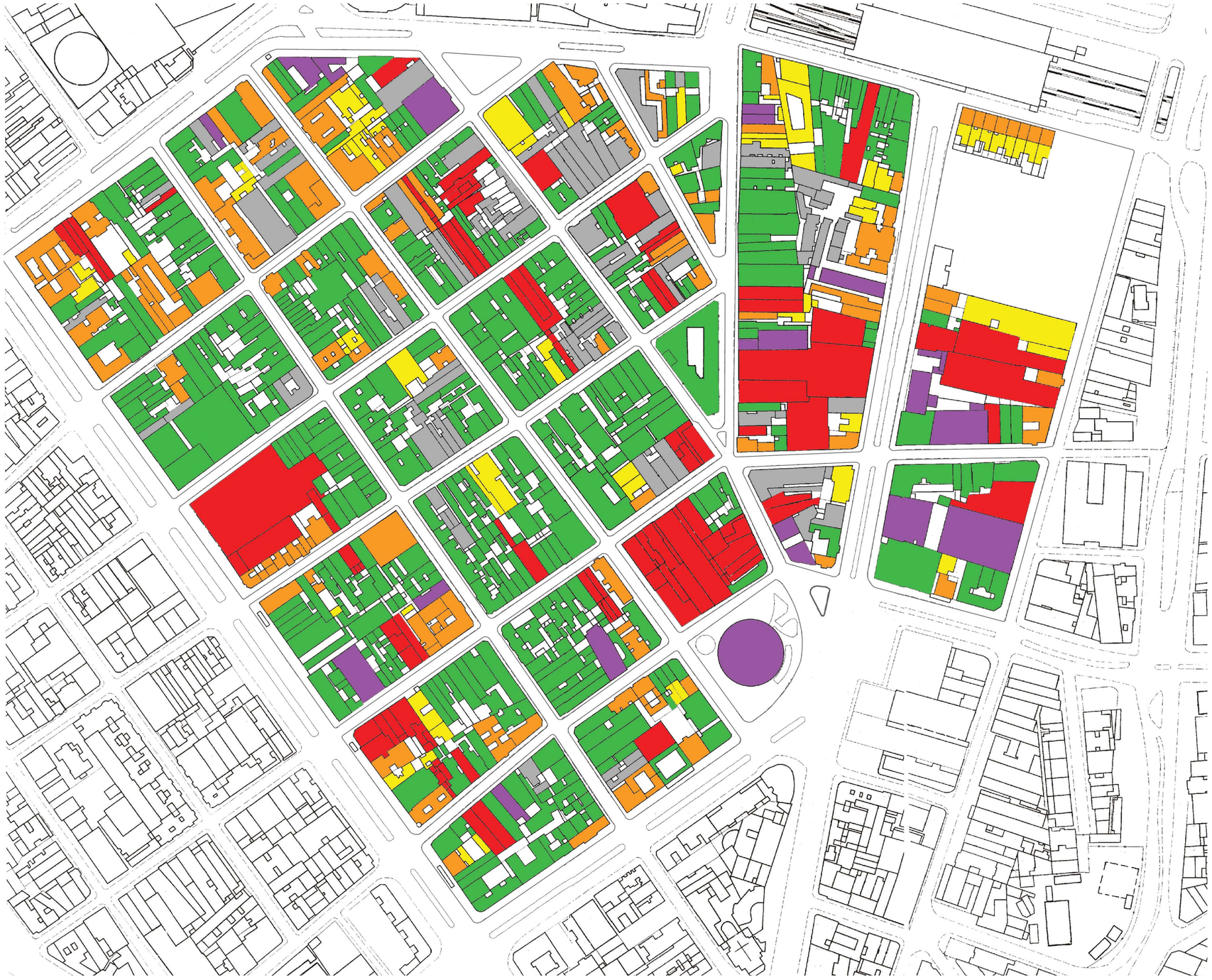
Context

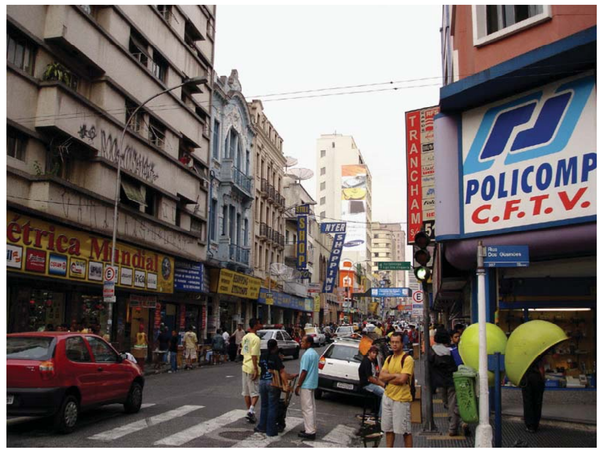
República district/ Luz neighbourhood



Context

Land use



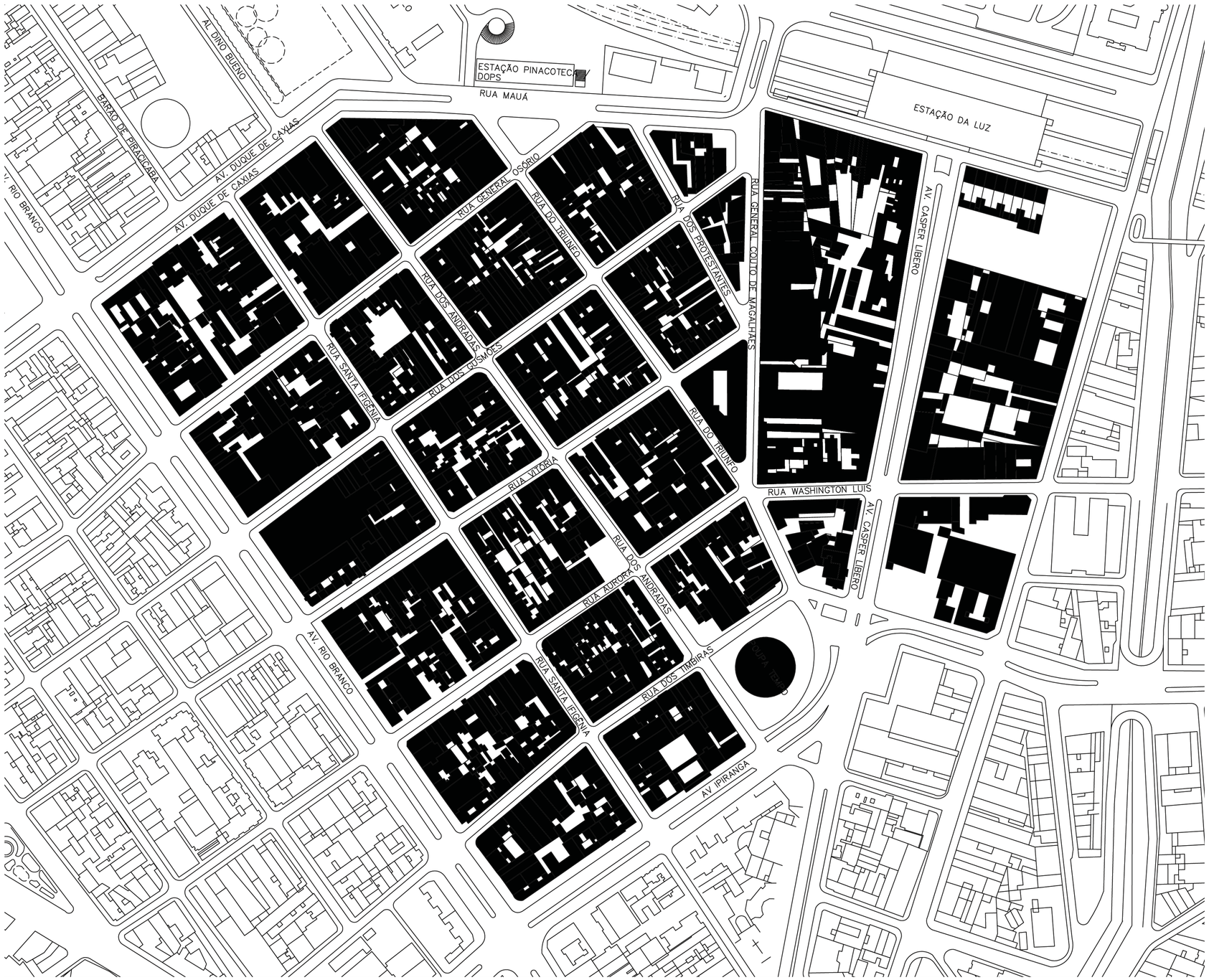


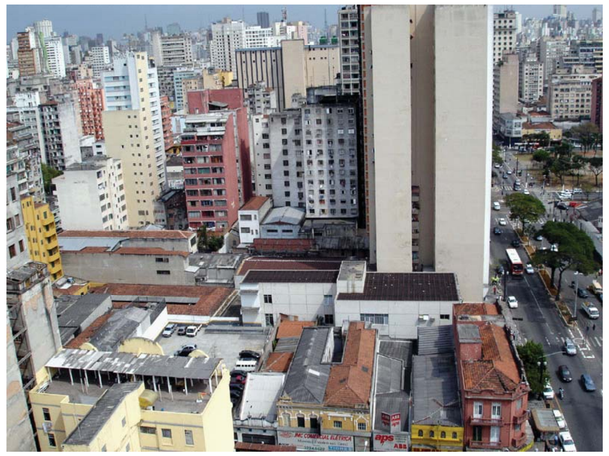
Context

Listed buildings and green

Context

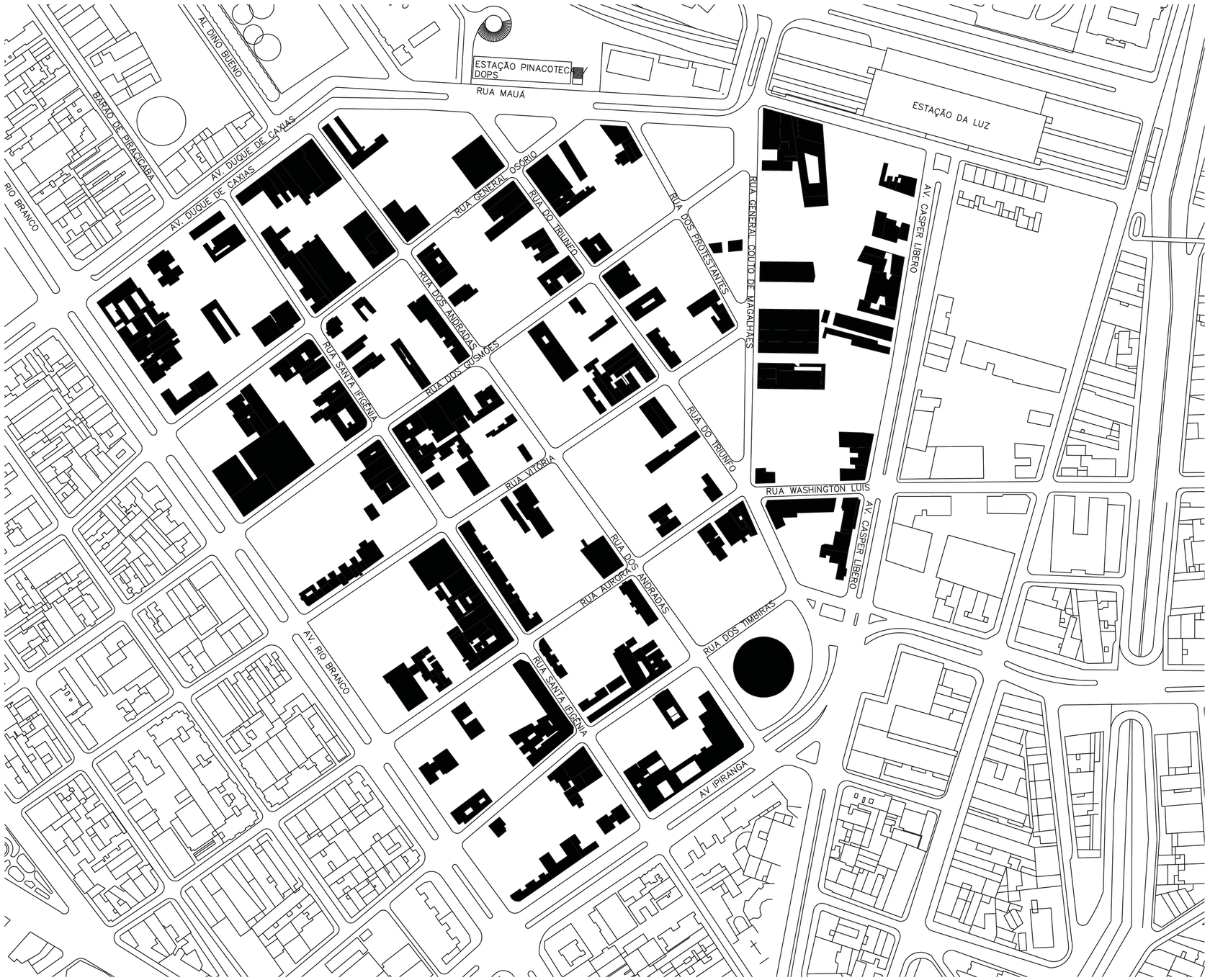
Actual built area





Context

Remained built area after proposed demolition



Design criteria

Air quality

Accessability

urban noise

Energy generation

Design criteria

Solar access

Landscape as a culture force

Drainage

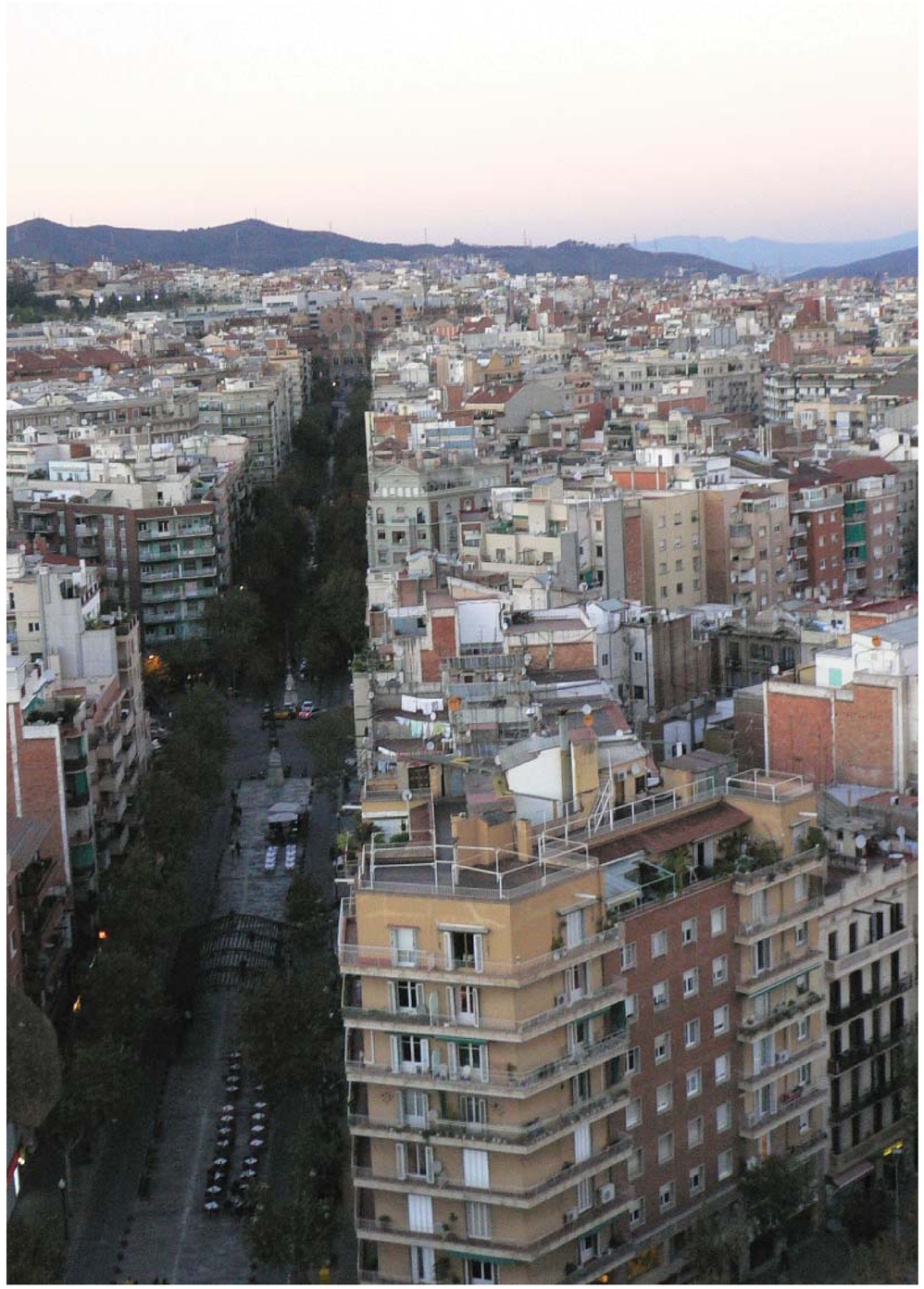
Outdoor comfort

2500 people/hectare

40% social housing
60% affordable housing

Urban design aproach

Perimeter block: Barcelona, Spain



Urban design aproach

Slab building: Brasília, Brazil

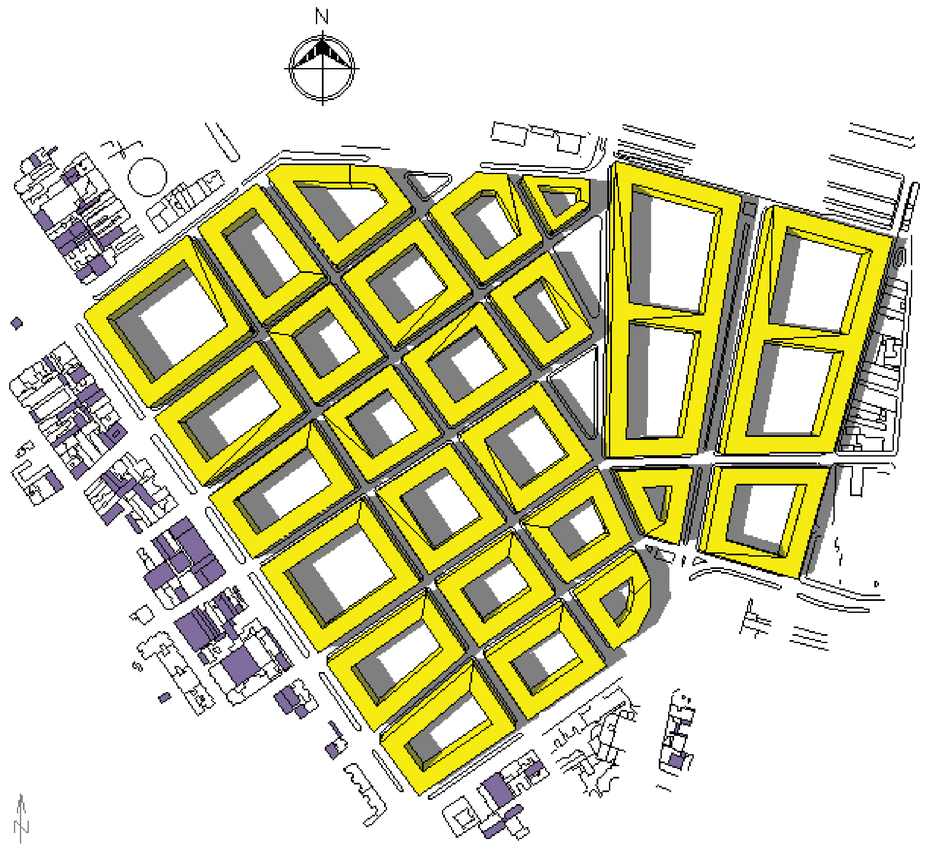
Urban design aproach

Tower block: New York City, USA

Study models

Shading analysis: perimeter block

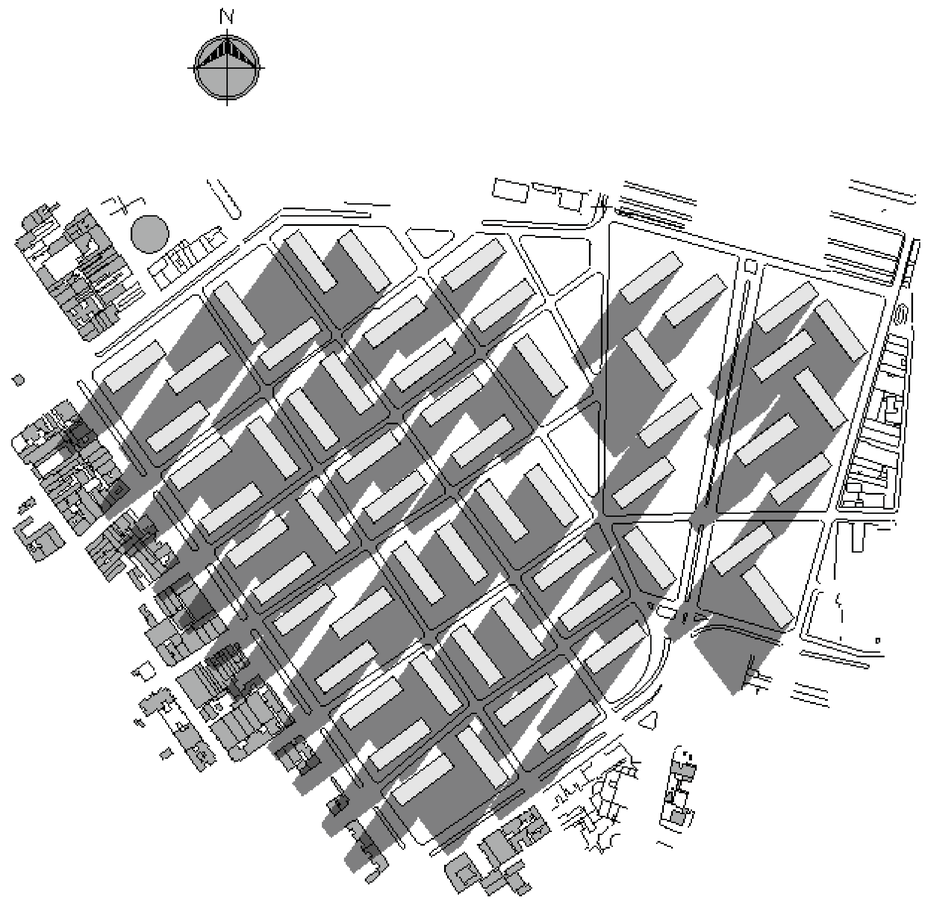
December 22nd
10:00 am



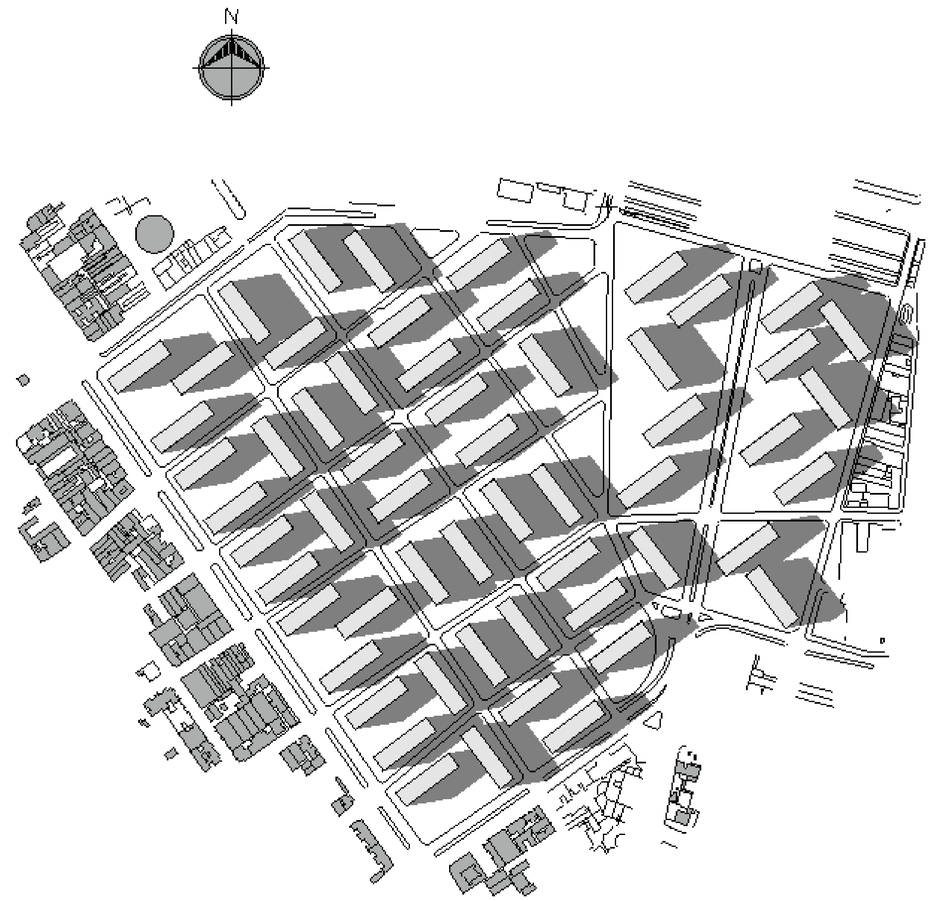
December 22nd
15:00 pm

Study models

Shading analysis: slab building



December 22nd
10:00 am



December 22nd
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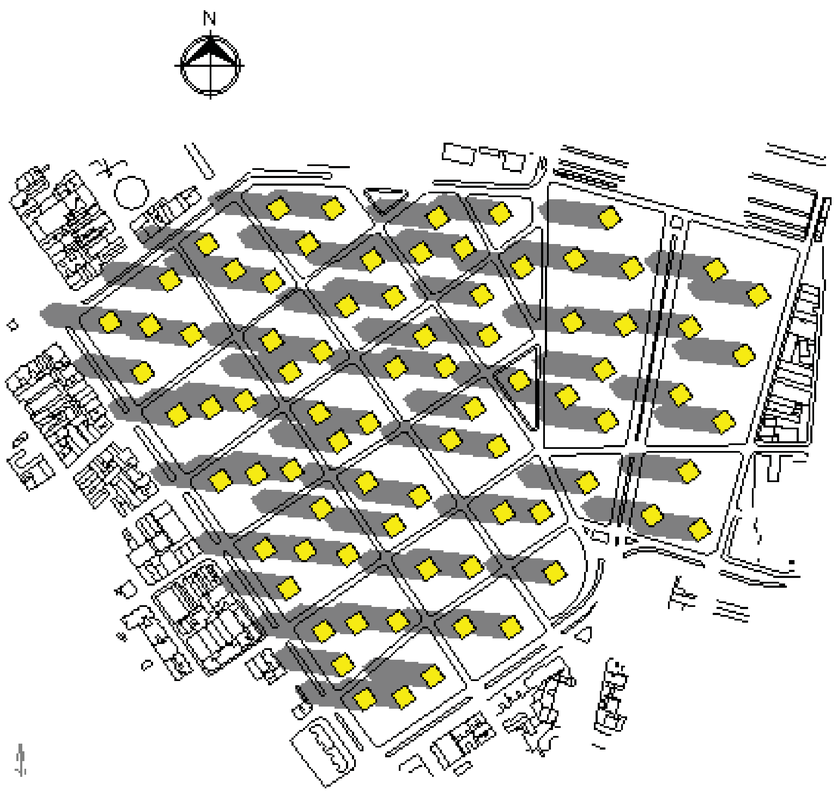
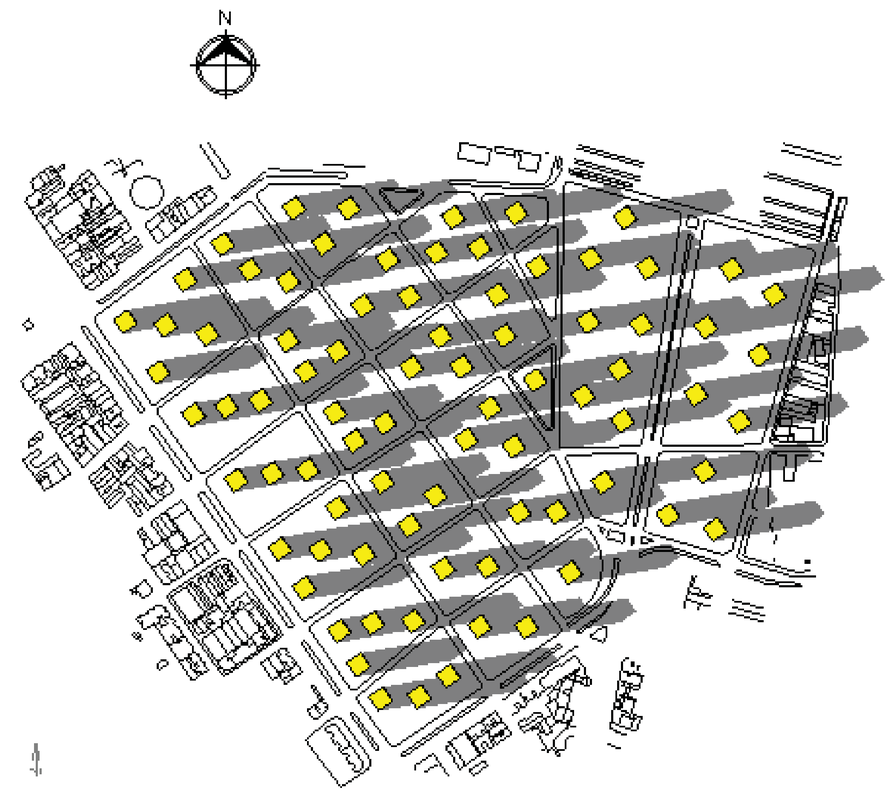
Study models

Shading analysis: tower block



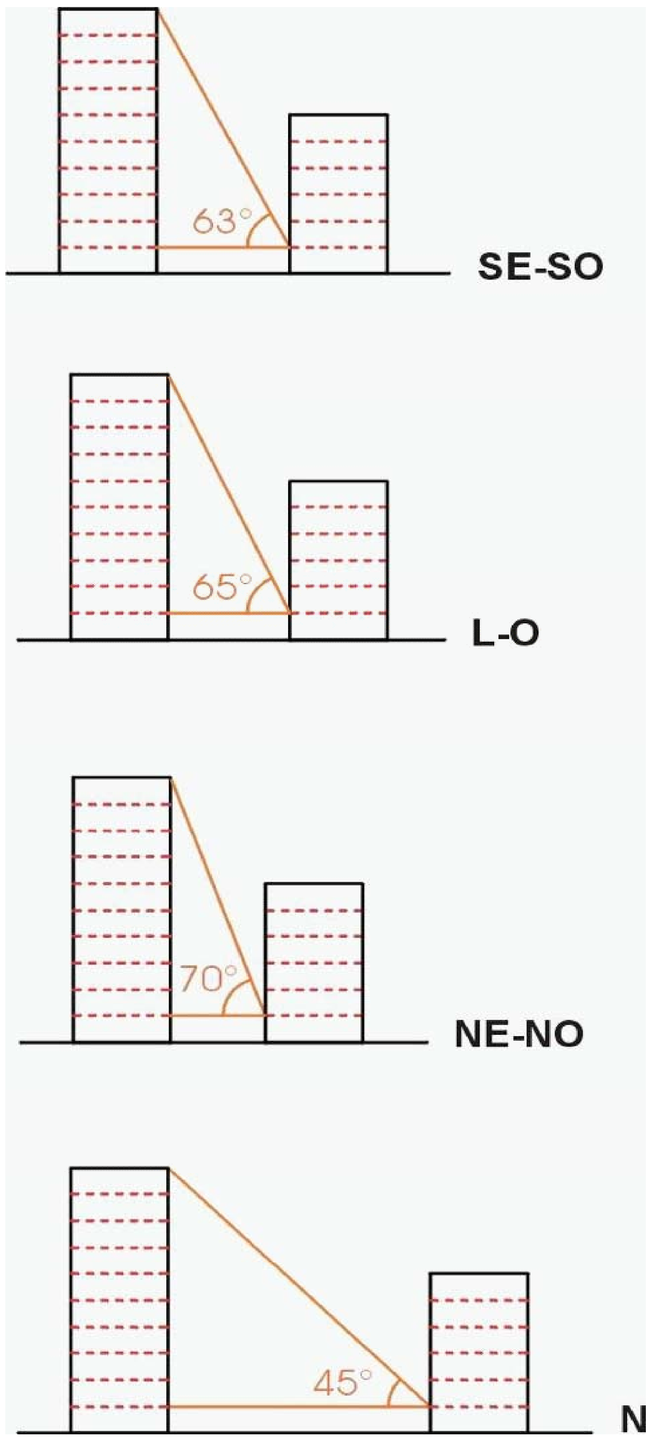
December 22nd
10:00 am

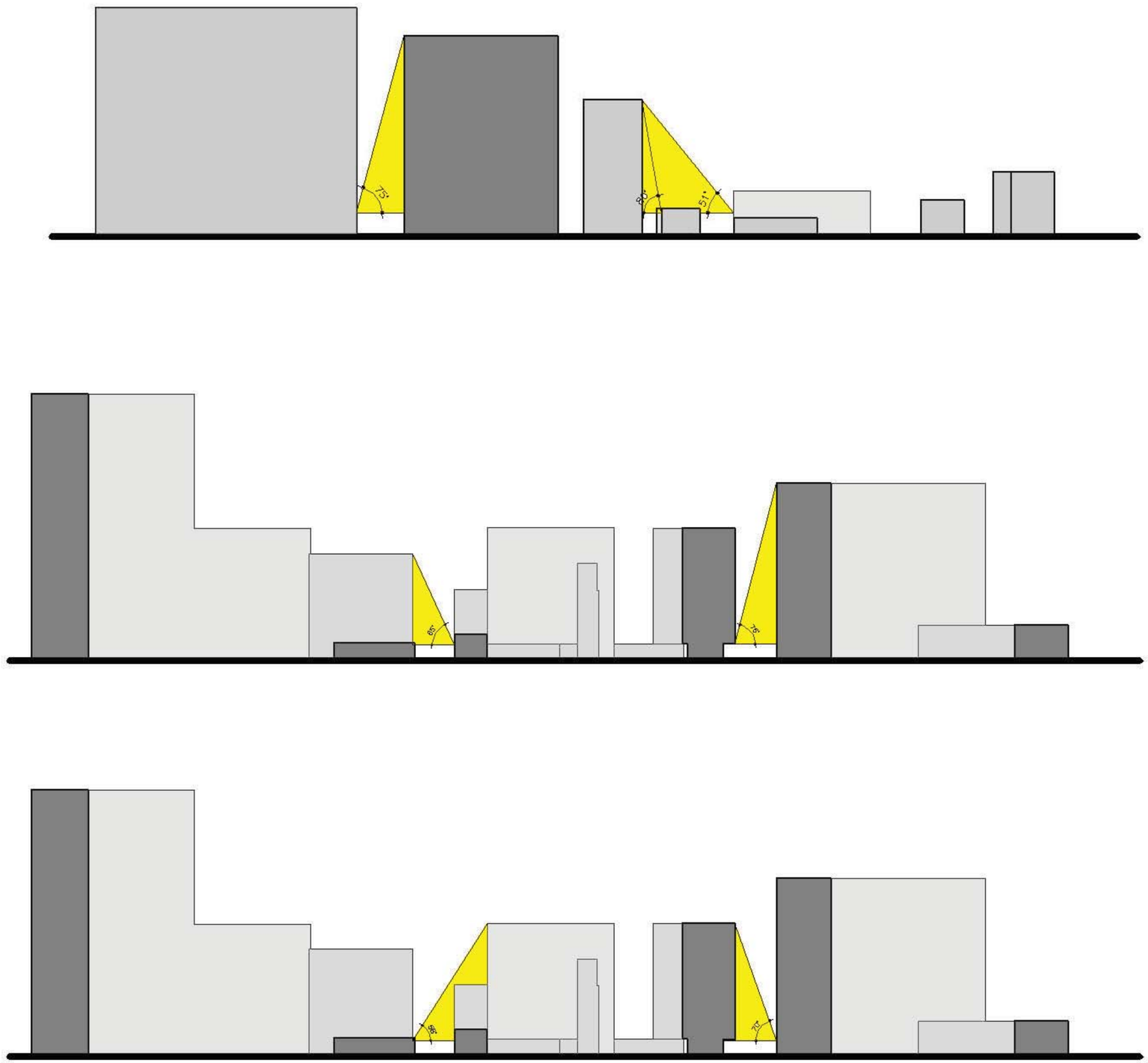


December 22nd
15:00 pm

Study models

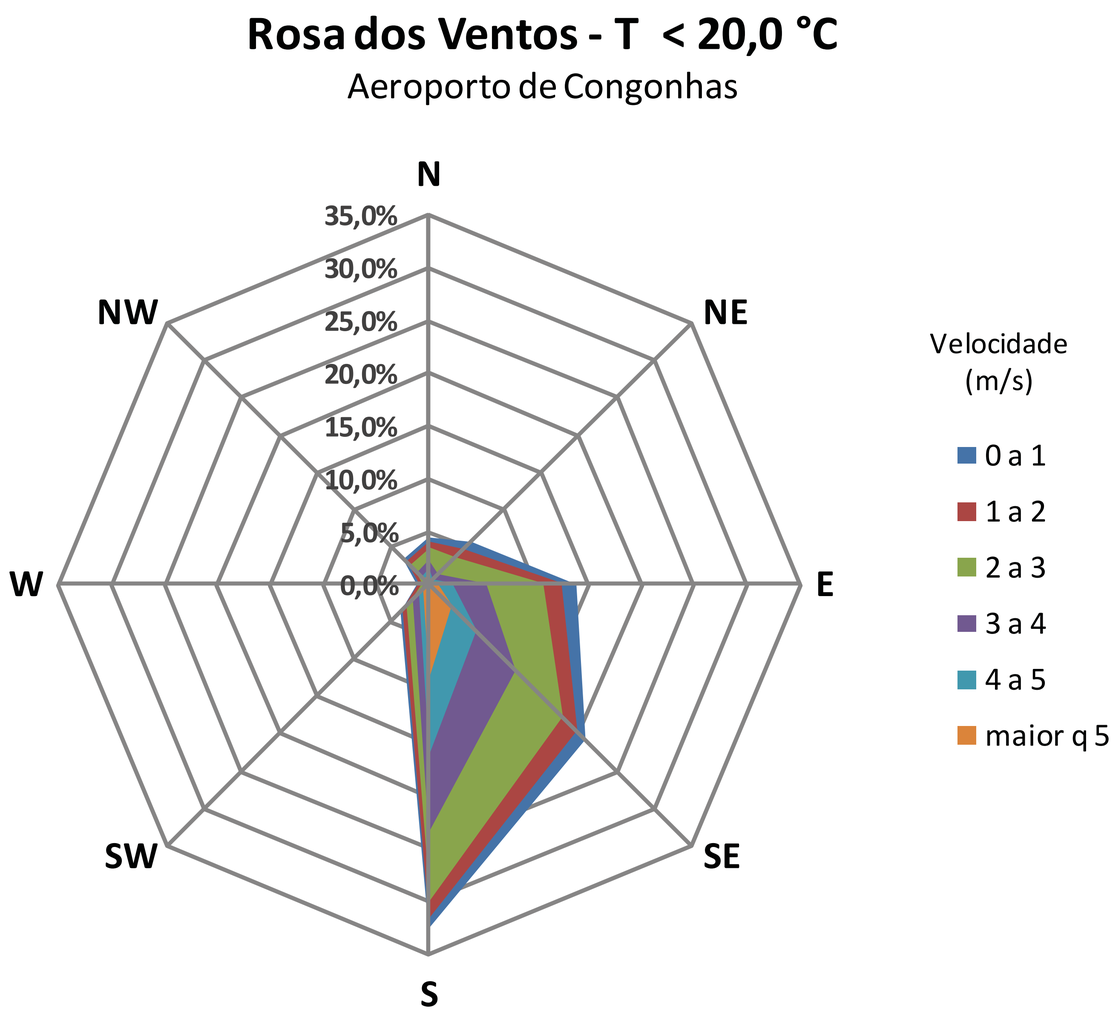
Solar access

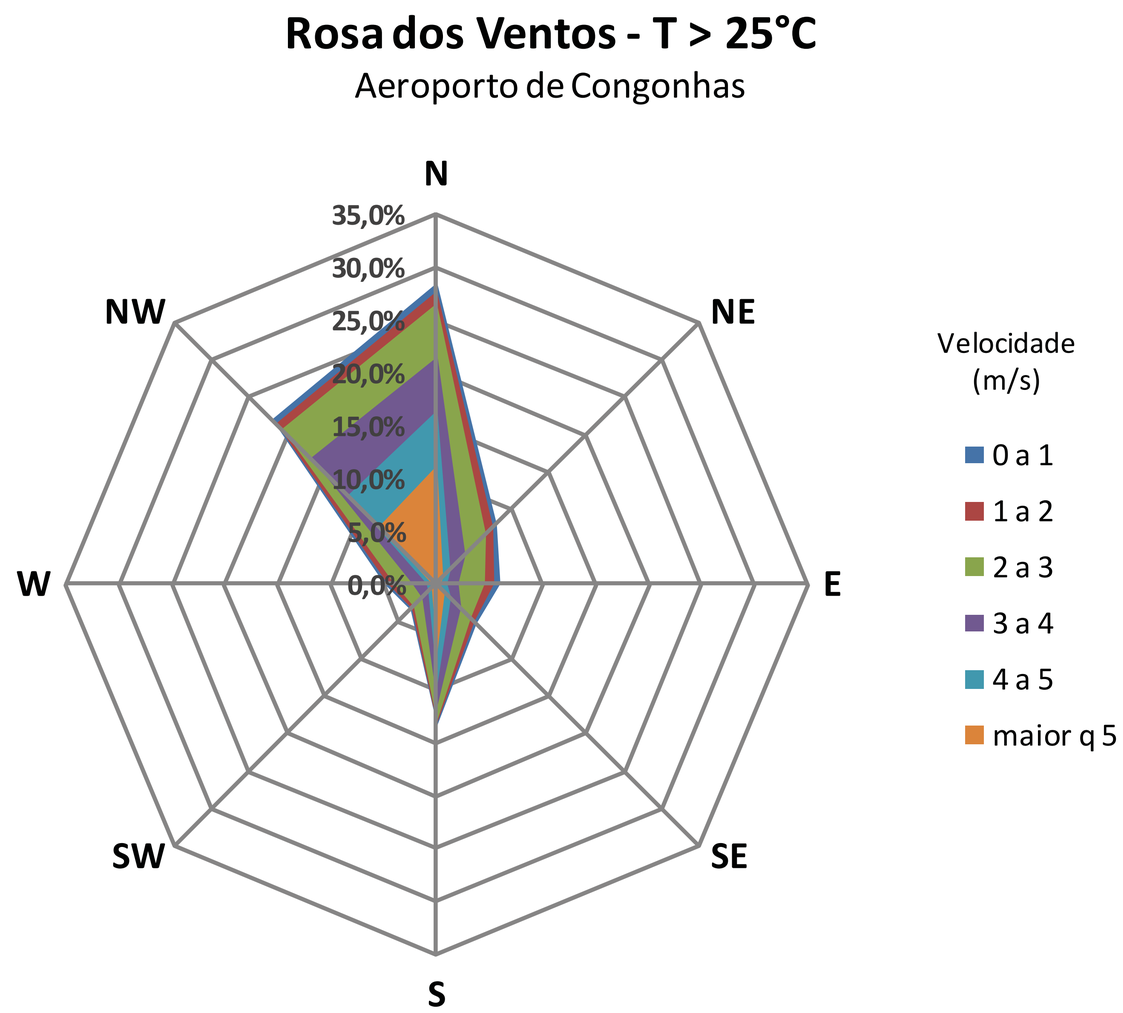




Study models

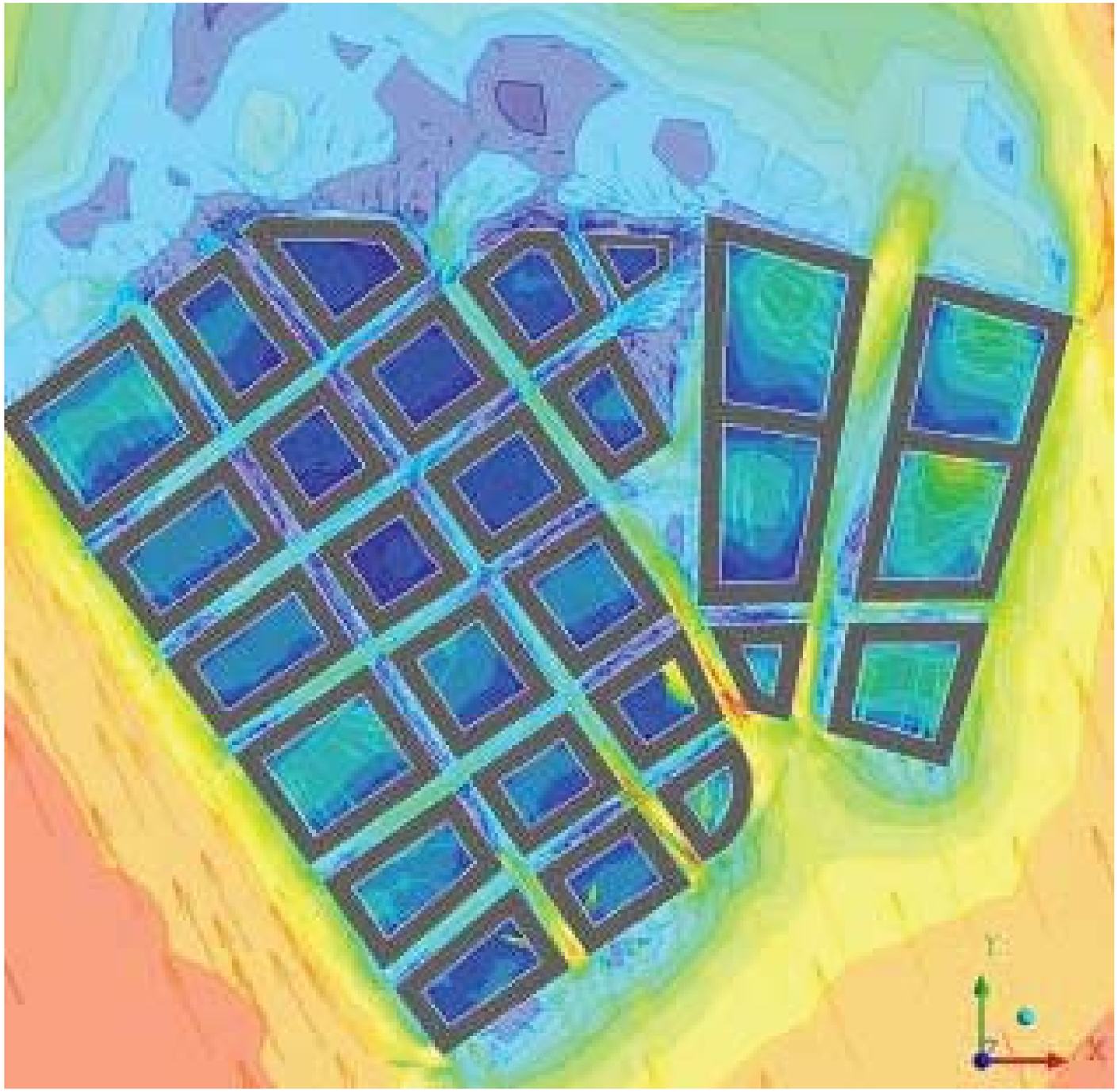
Predominant flows



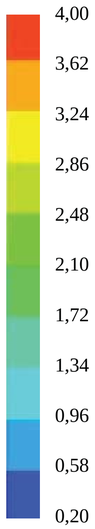


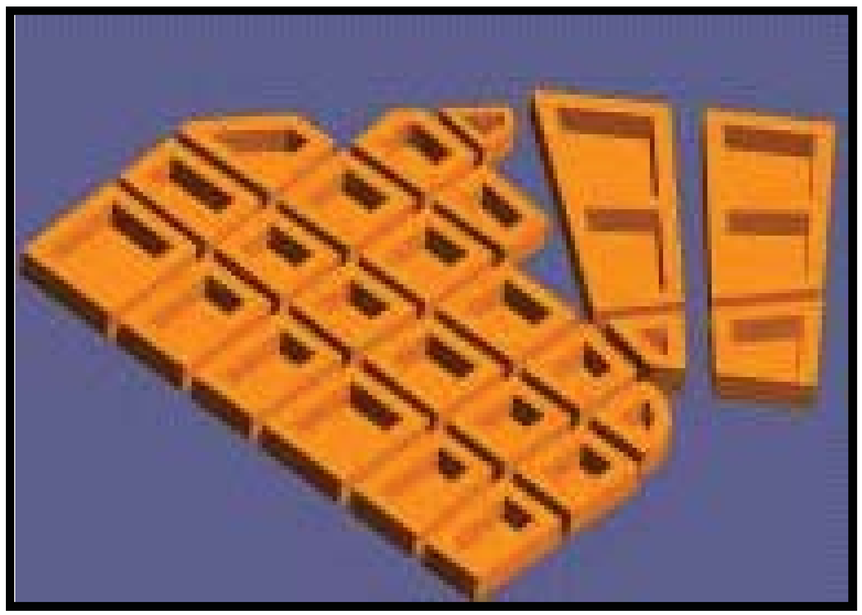
Study models

External air flows: perimeter block



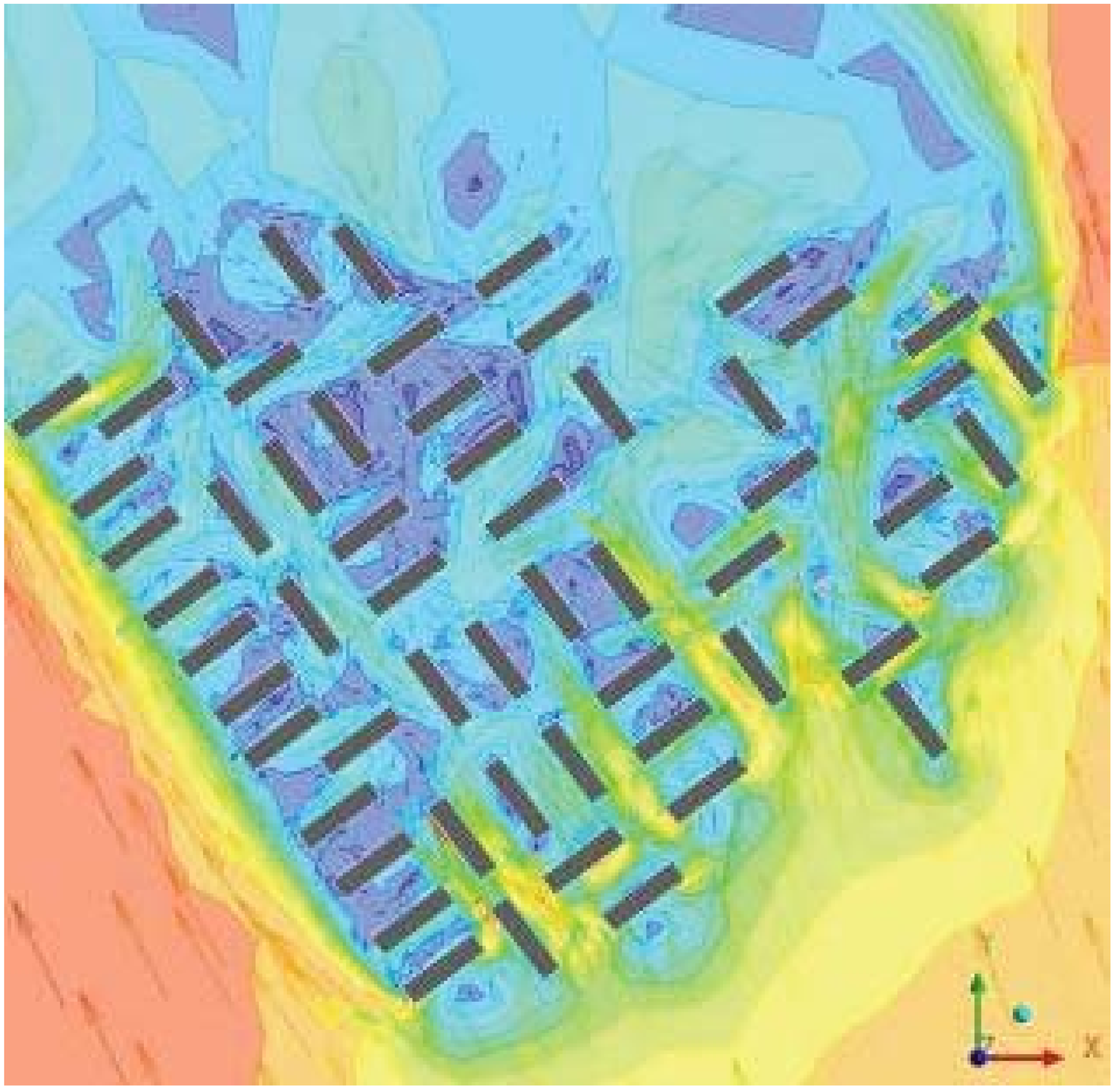
Air speed
(m/s)





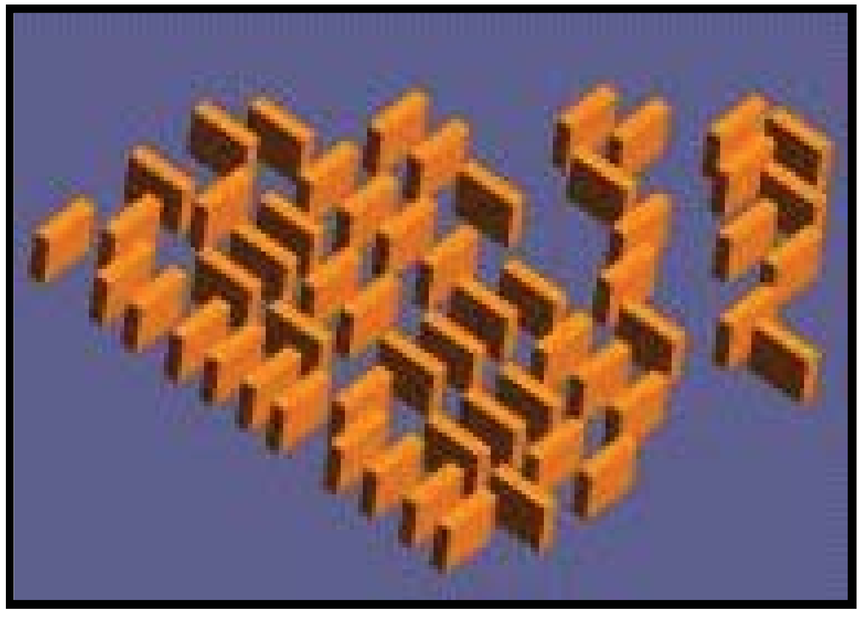
Study models

External air flows: slab building



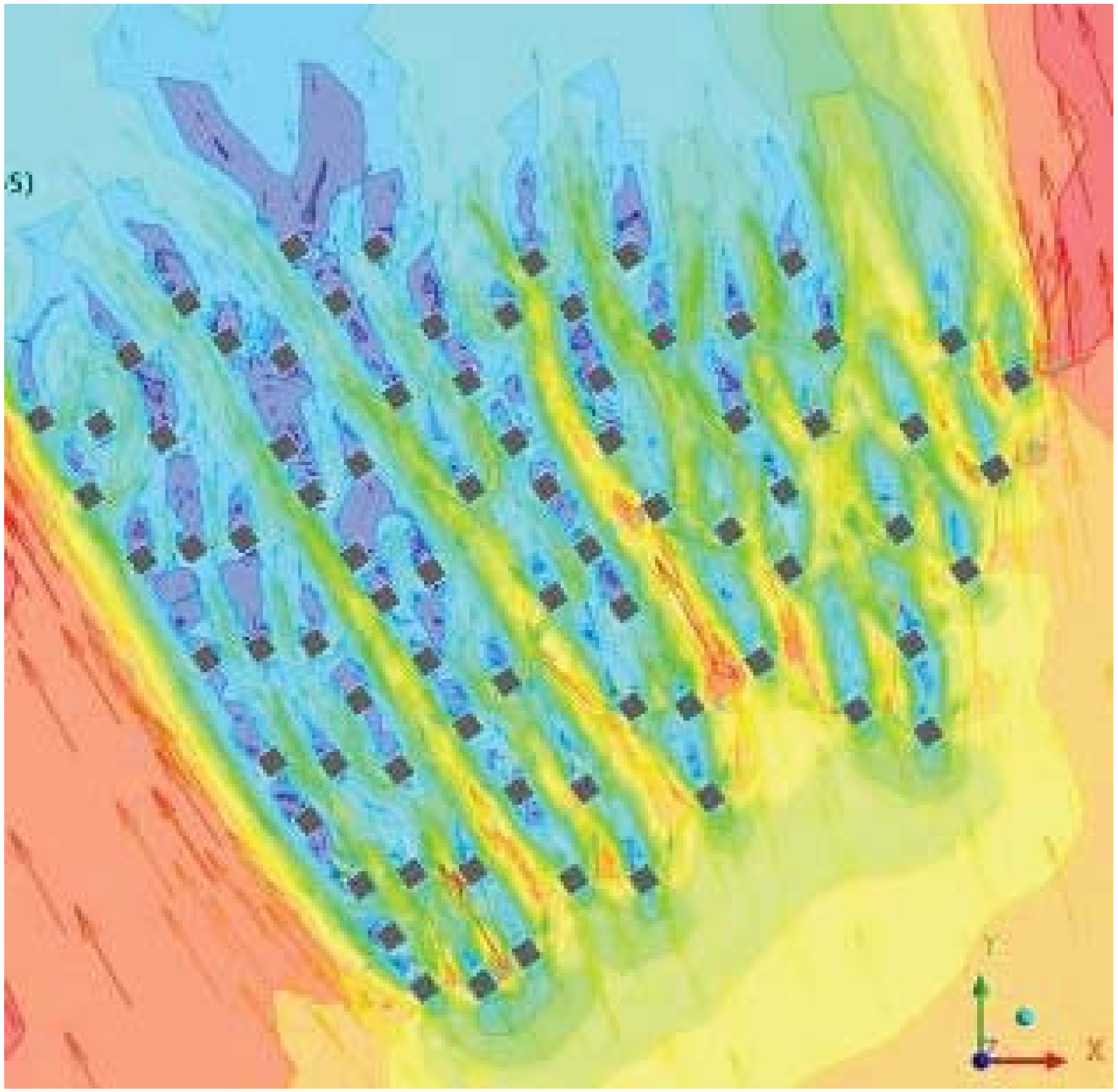
Air speed
(m/s)

4,00
3,62
3,24
2,86
2,48
2,10
1,72
1,34
0,96
0,58
0,20



Study models

External air flows: tower block



Air speed
(m/s)

4,00
3,62
3,24
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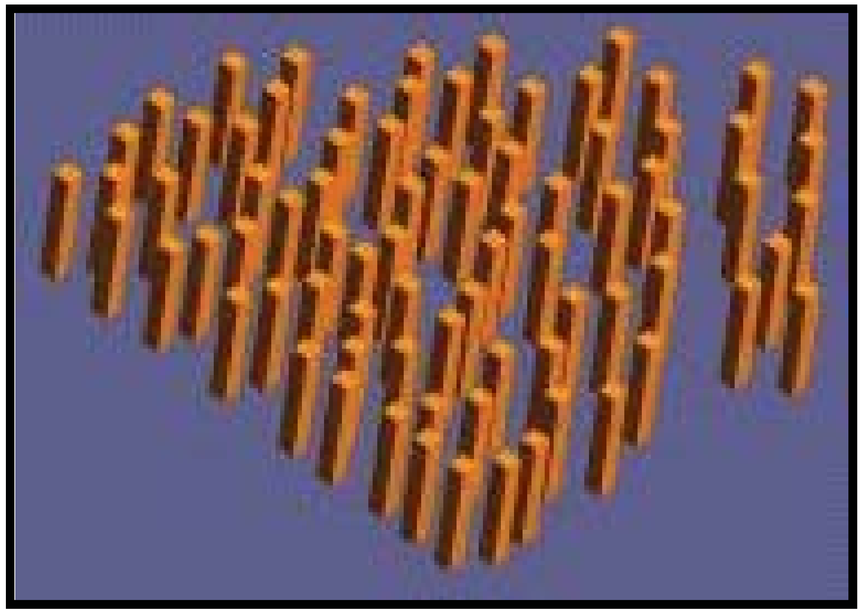
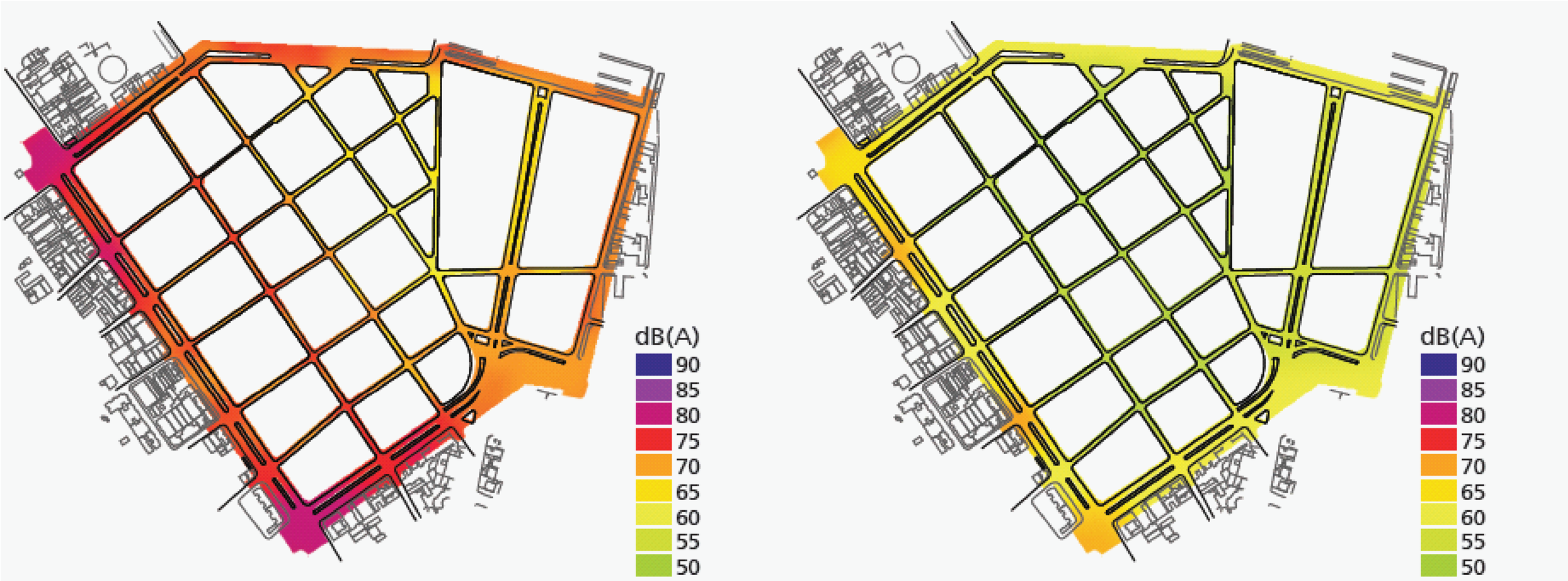
2,48
2,10
1,72
1,34
0,96
0,58
0,20



Study models

Urban acoustics



Leq (Equivalent Sound Level) - logarithmic average of noise levels.

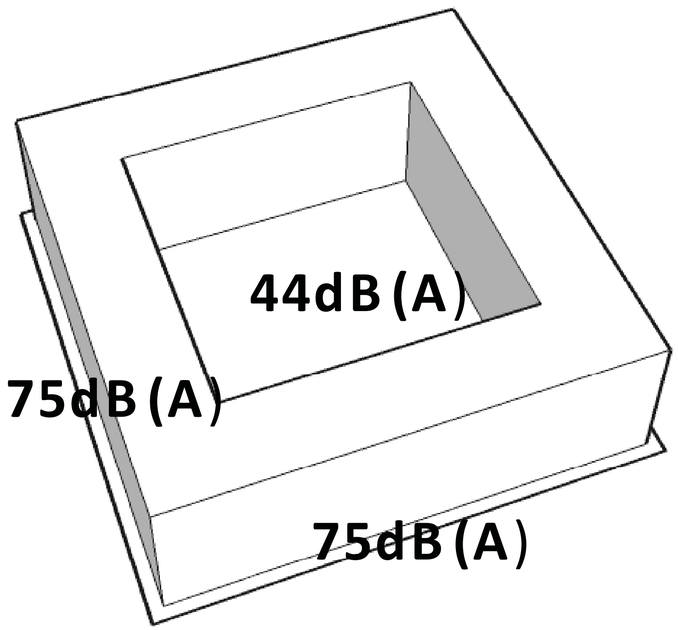
$$L_{eq} = 10 \log \left[\frac{1}{T} \int_0^T 10^{\frac{L_P(t)}{10}} dt\right]$$

Criteria for Noise Assessment

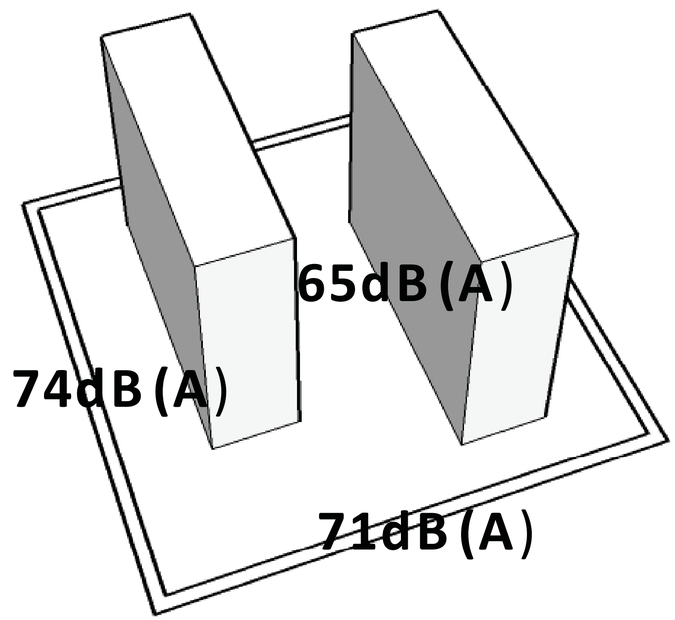
Area type	day	night
Predominantly Residential and Mixed-Use Area	55	50
Predominantly Comercial and Mixed-Use Area	60	55

Study models

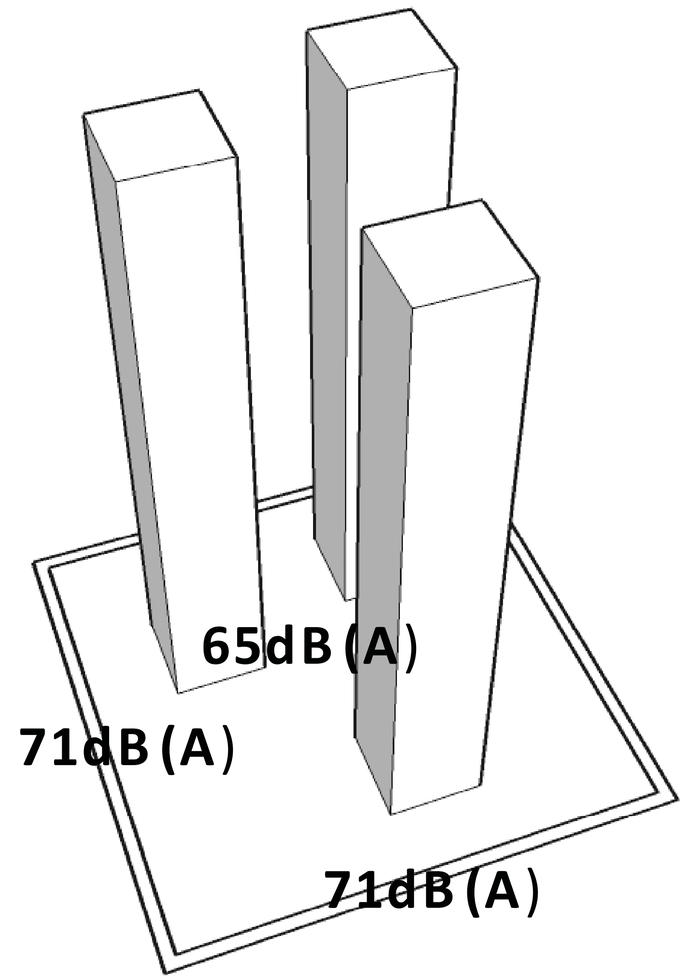
Urban acoustics



Perimeter block



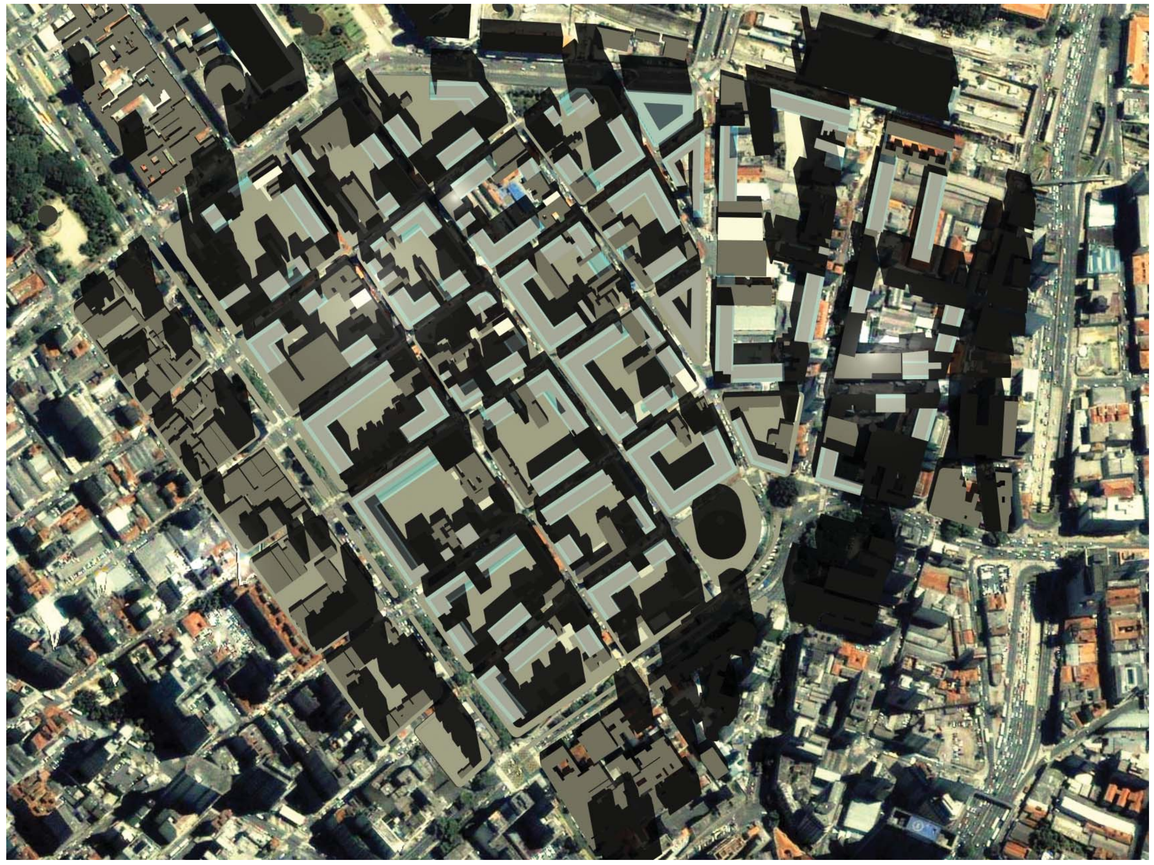
Slab building



Tower block

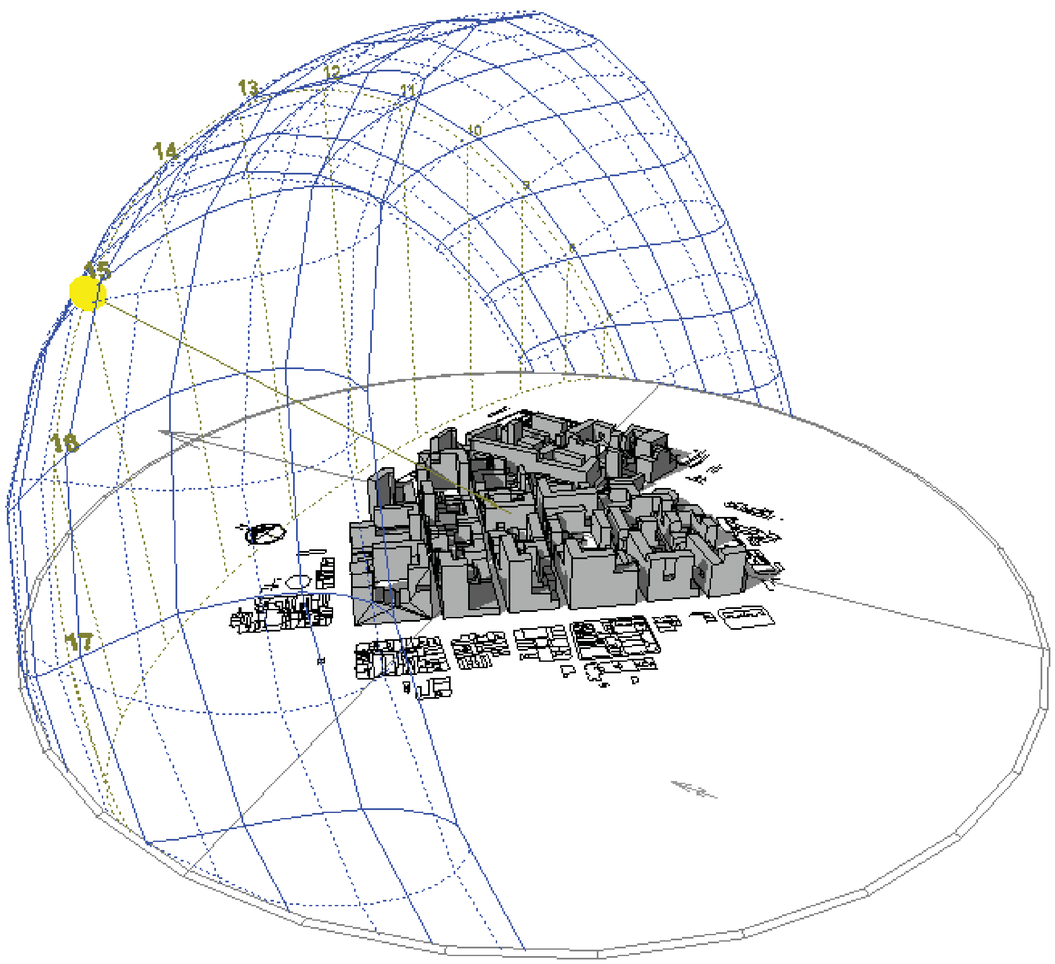
Proposals

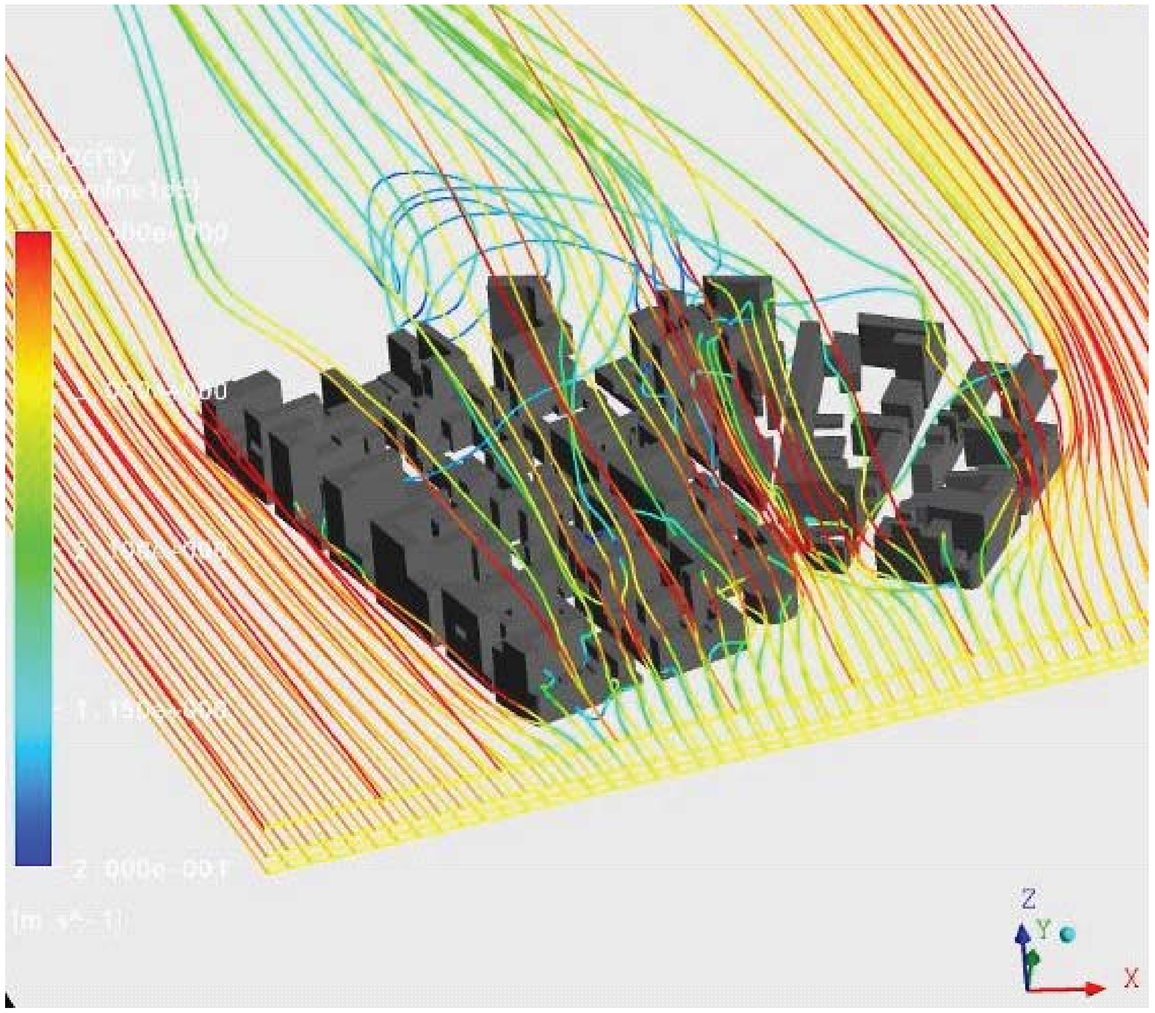
Perimeter block neighbourhood



Perimeter block

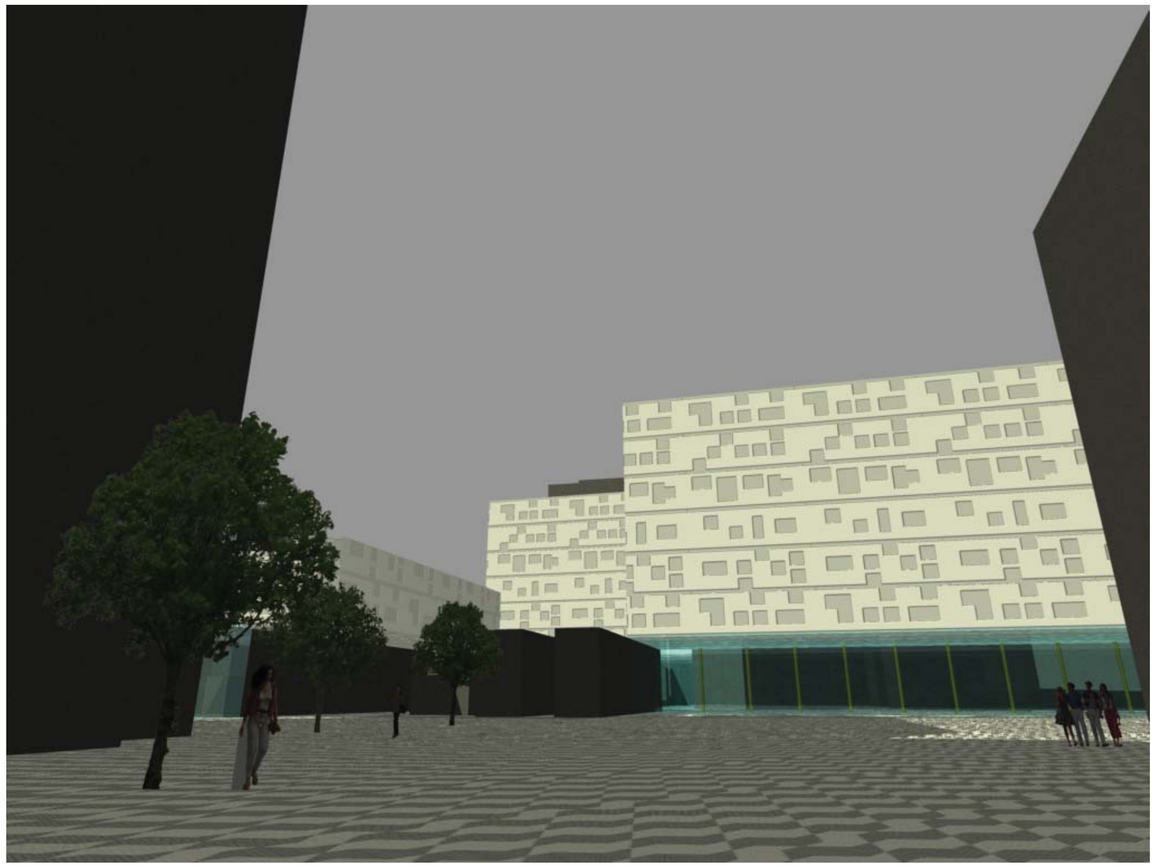
Solar path and predominant wind

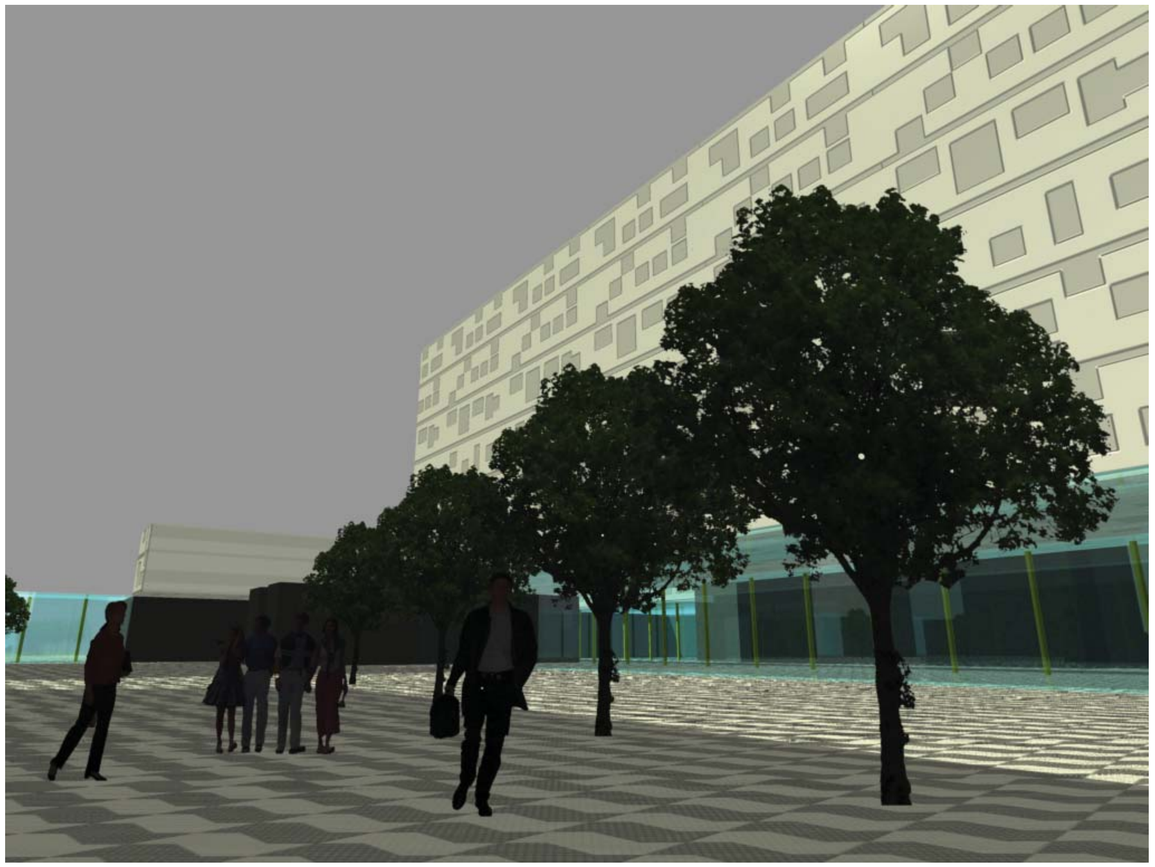




Perimeter block

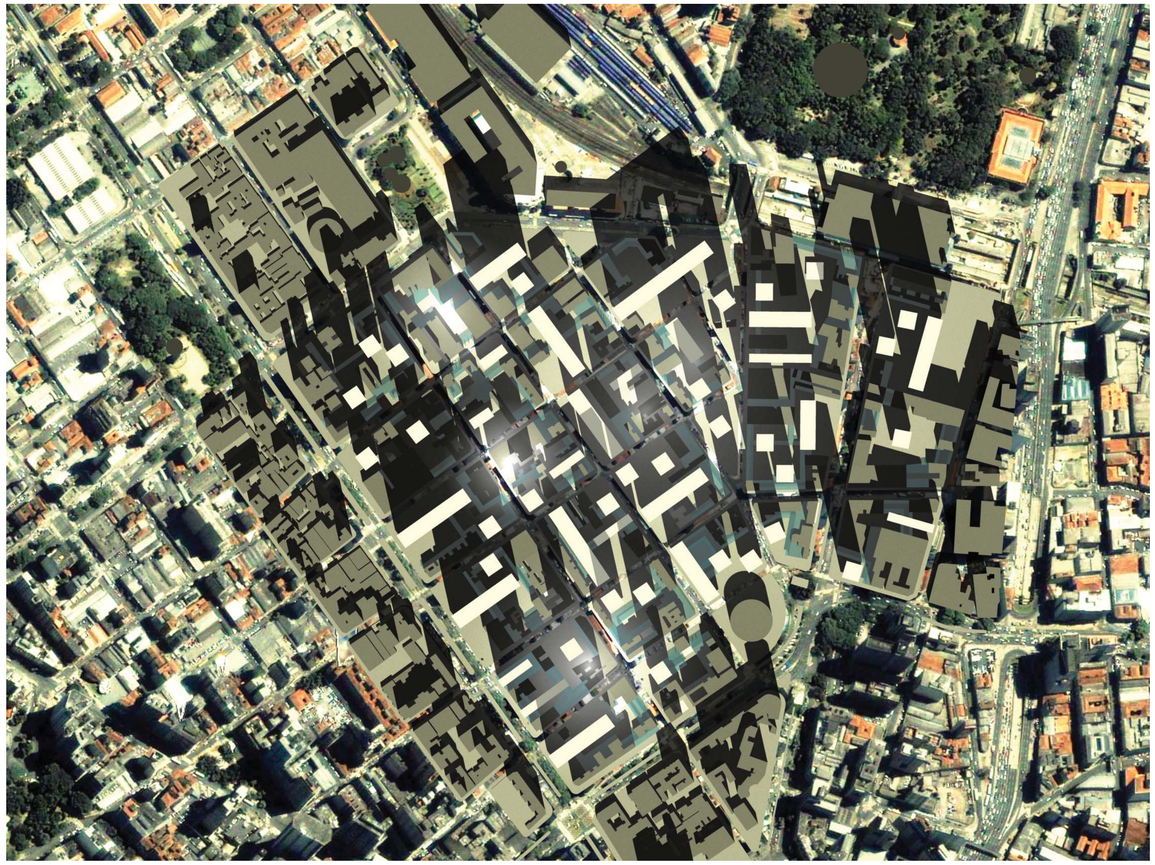
Pedestrian perception





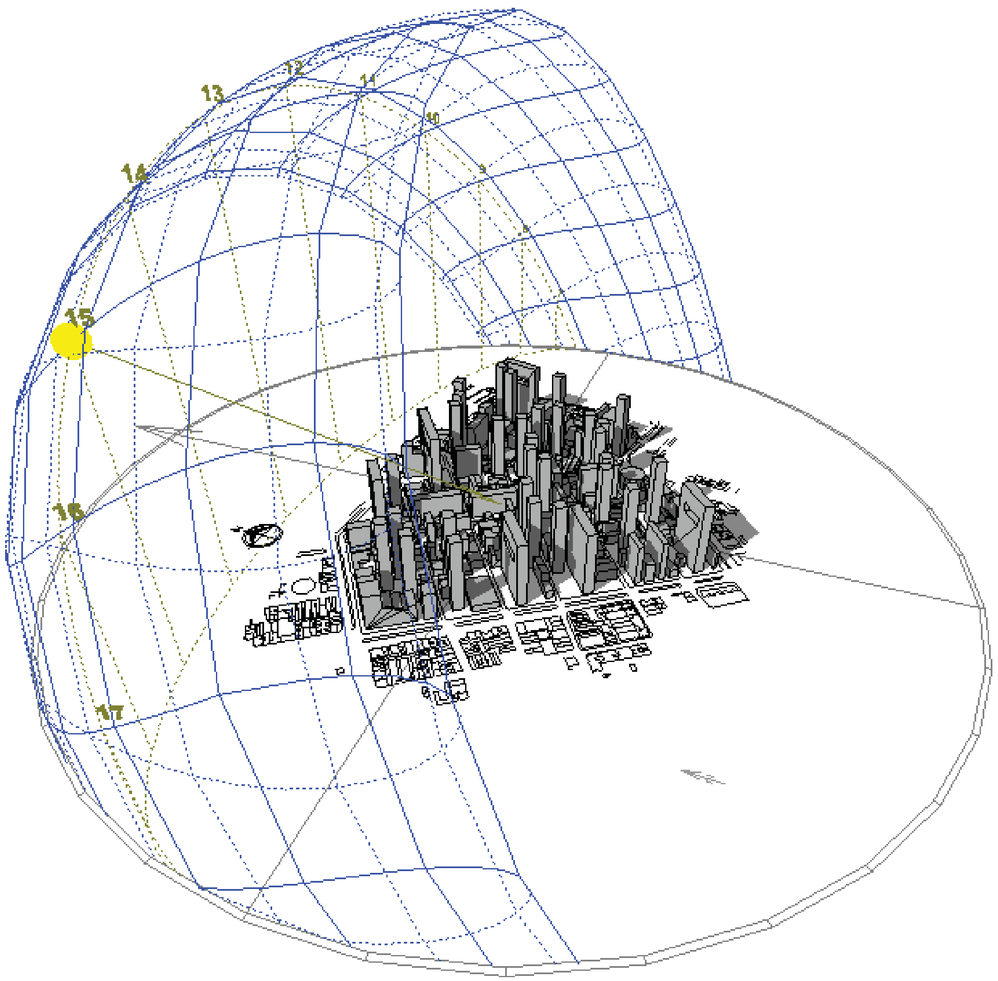
Proposals

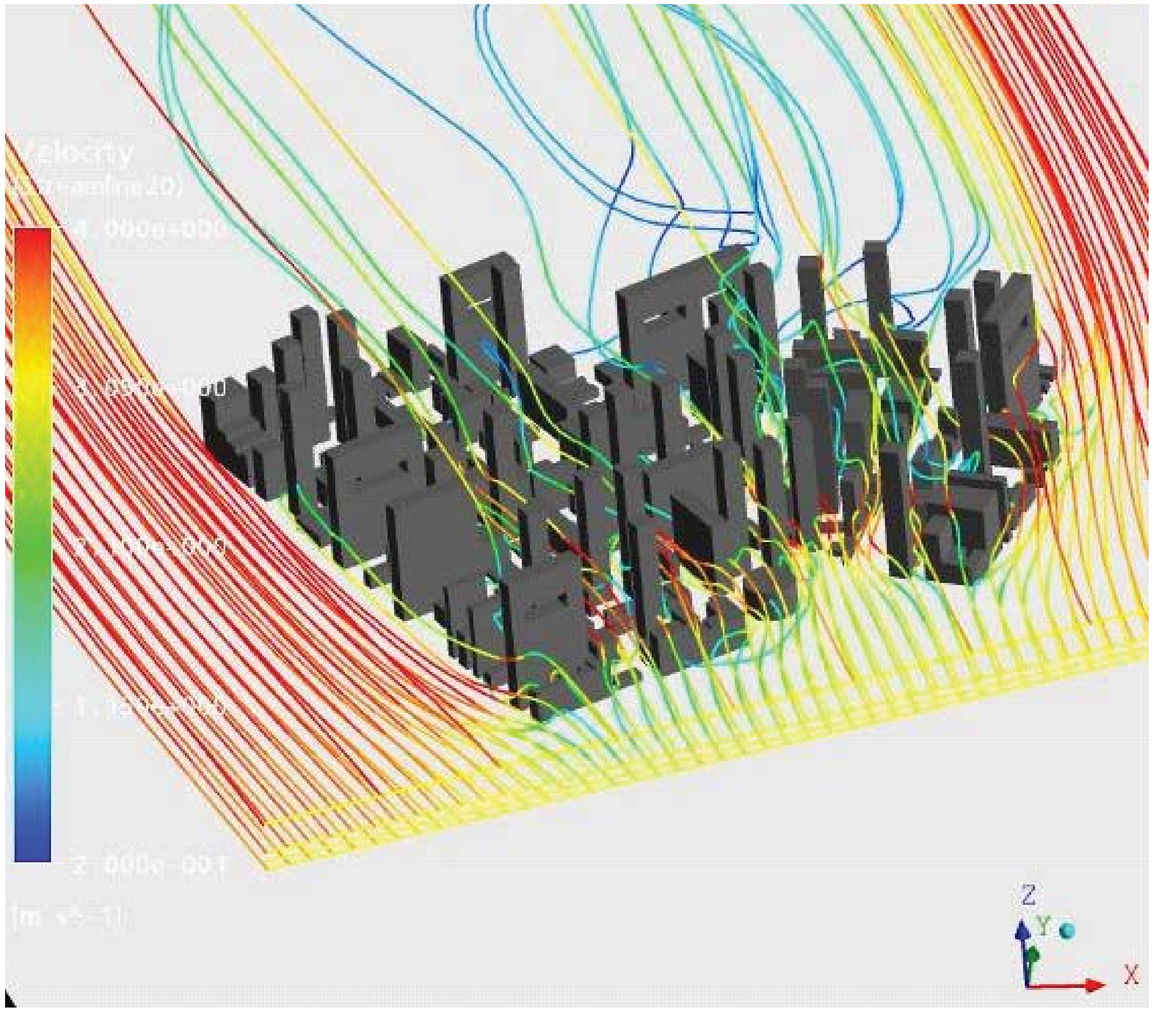
Slab + tower neighbourhood



Slab + tower

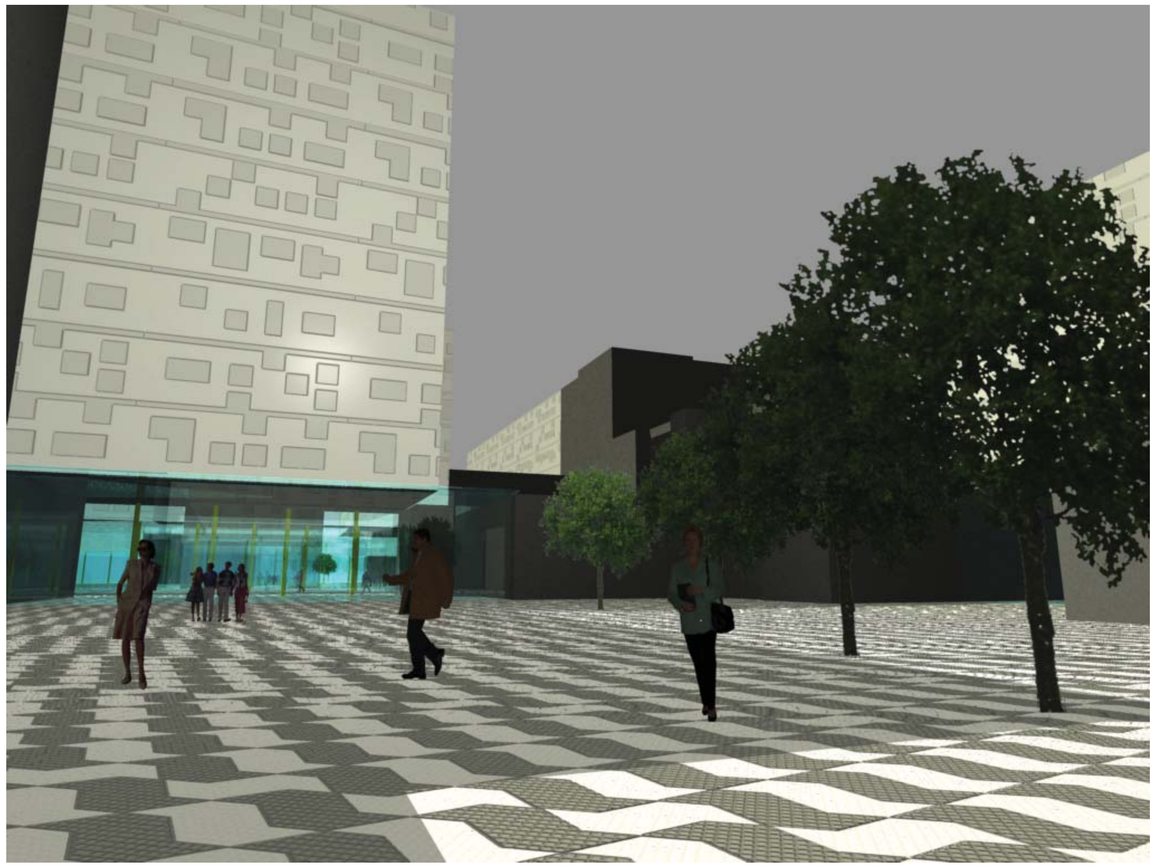
Solar path and predominant wind

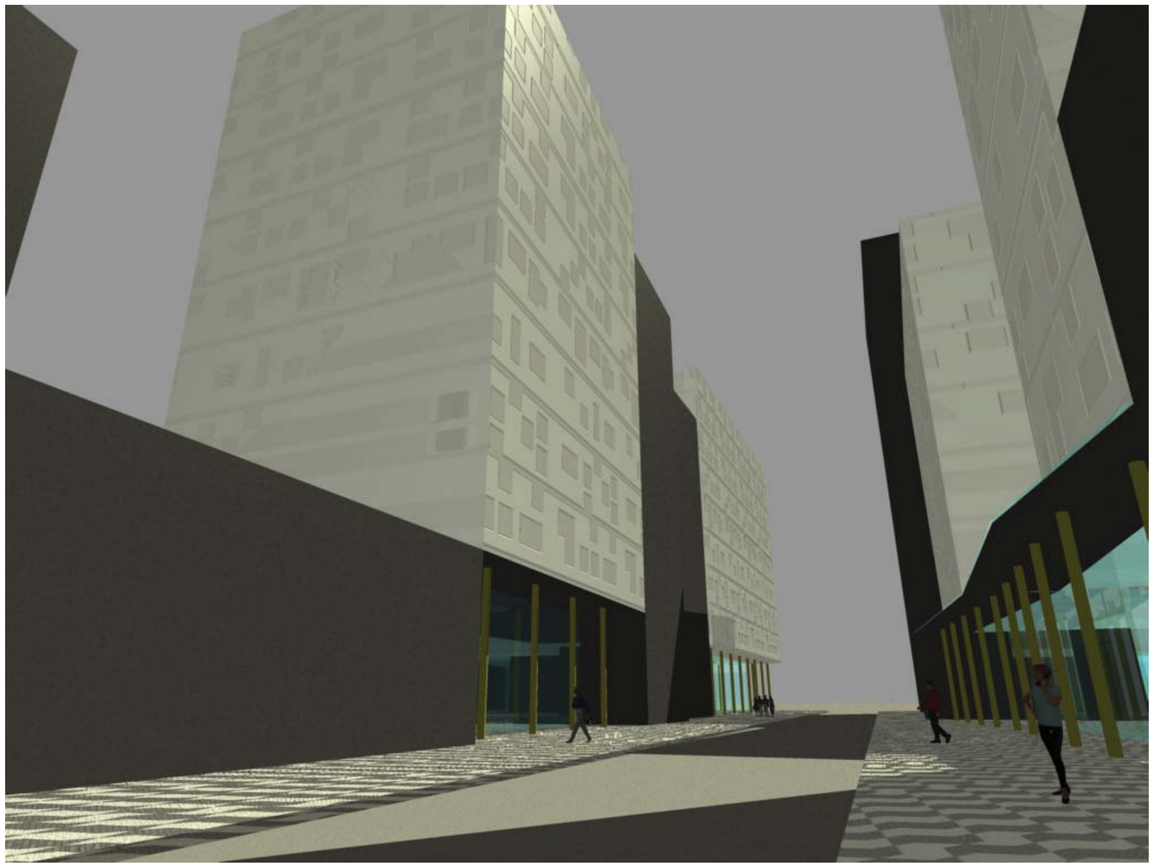




Slab + tower

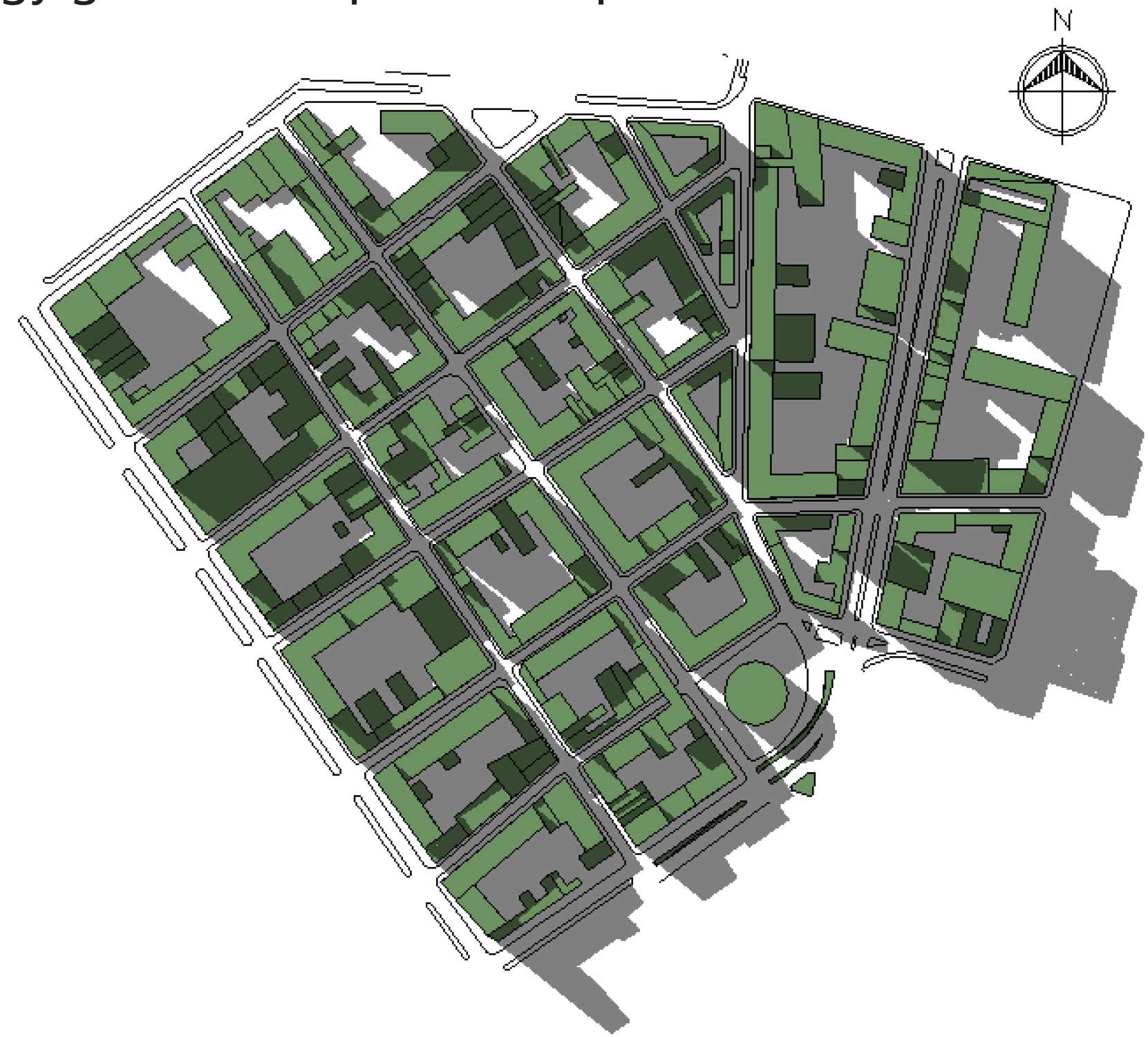
Pedestrian perception





Technical Studies

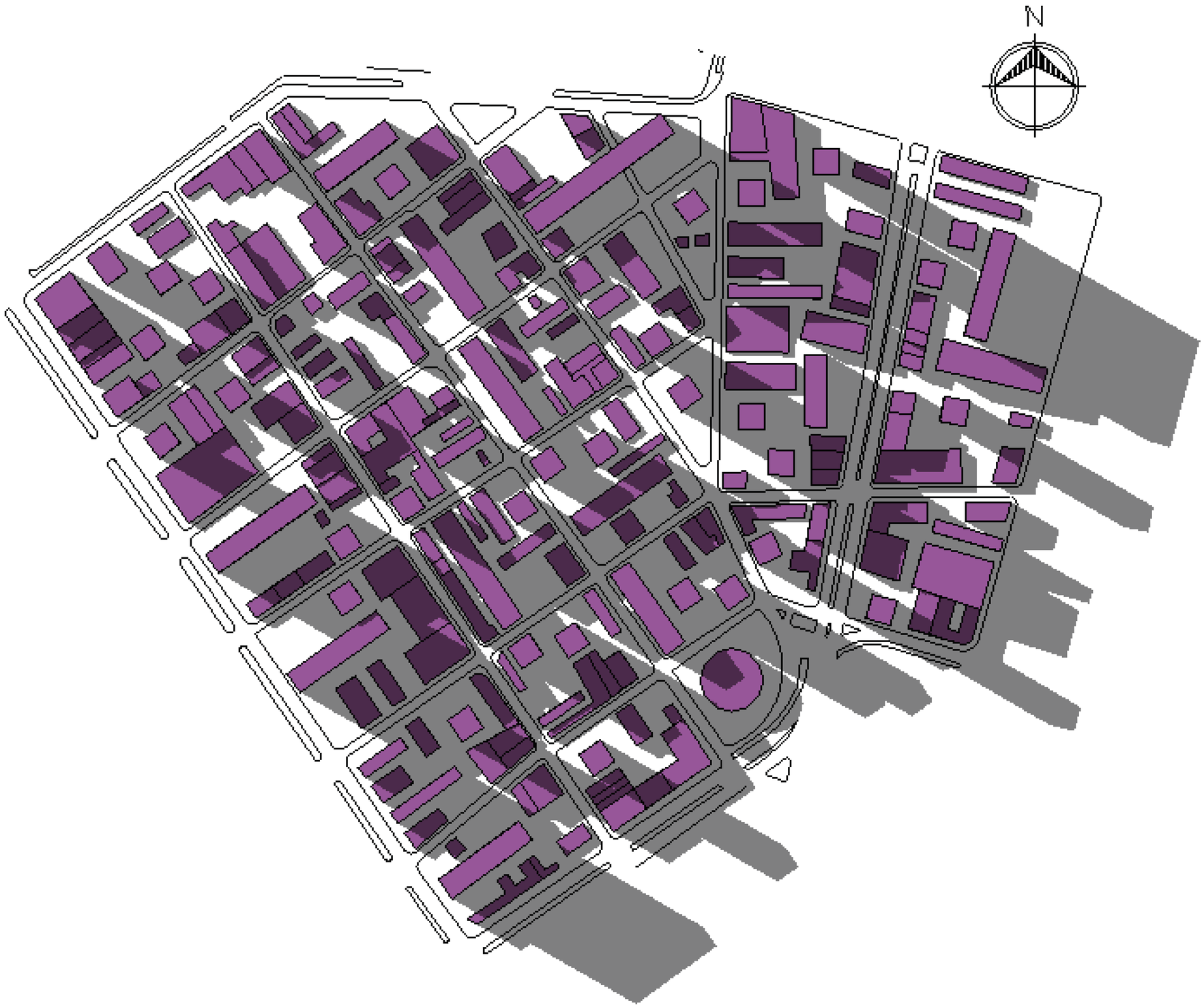
Energy generation potential: perimeter block



Energy generation potential: perimeter block

Technical Studies

Energy generation potential: slab + tower



Technical Studies

Energy generation potential: slab + tower

Technical Studies

Energy generation potential

CÁLCULO DA ÁREA PARA COLETOR TÉRMICO SOLAR CONFORME DECRETO 49.148 DE 21/01/2008

CÁLCULO DA DEMANDA MENSAL DE ENERGIA

$$E = \frac{V \times Cp \times (t_2 - t_1) \times 30}{3600}$$ [kWh/mês]

E Demanda de energia mensal
V Volume diário de água quente a ser aquecida em litros (Considerar para banho 80 litros por pessoa)
Cp Calor específico da água: 4,18 kJ /kg °C
t2 Temperatura da água quente (adotar 45°C)
t1 Temperatura da água fria: 20,2°C (São Paulo)

Legenda

Sombreamento	Cor	Fator de Insolação (Fi)
• Acima de 60%	Amarelo (área descartada)	
• Entre 30 e 60%	Laranja	0,55
• Abaixo de 30%	Vermelho	1

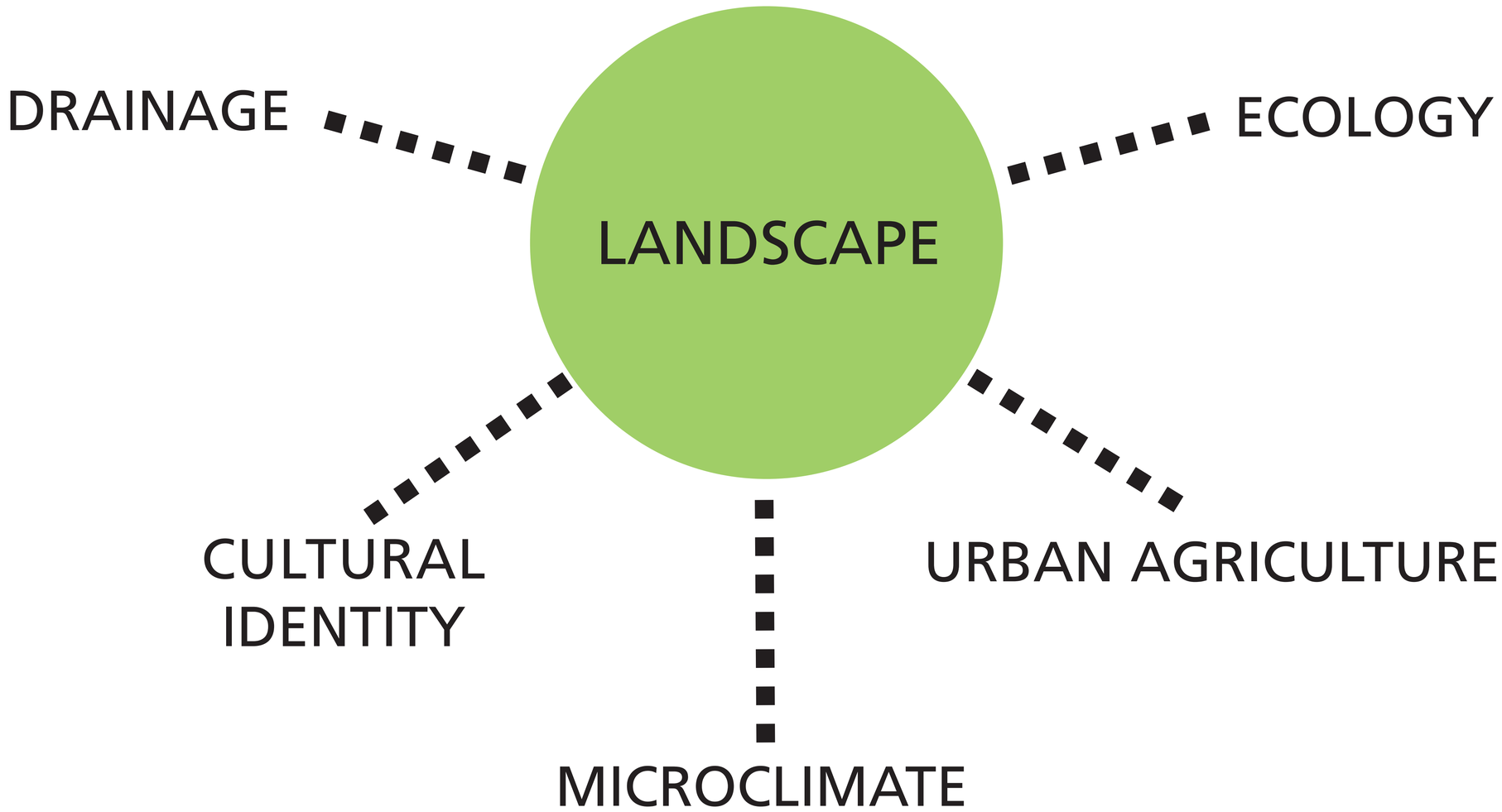
TABELA 1: Resumo do cálculo de aquecimento solar de água

Aquecimento de água		População	65000
Tipologia	Usuários Atendidos	%	Contribuição Solar
Lâmina + Torre	62830	96,66%	0,6
Perímetro	73451	113,00%	0,8
Tudo Lâmina	67486	103,83%	0,6
Tudo Torre	45104	69,39%	0,4
Tudo Perímetro	109948	169,15%	0,8

TABELA 2: Resumo do cálculo dos Painéis Fotovoltaicos

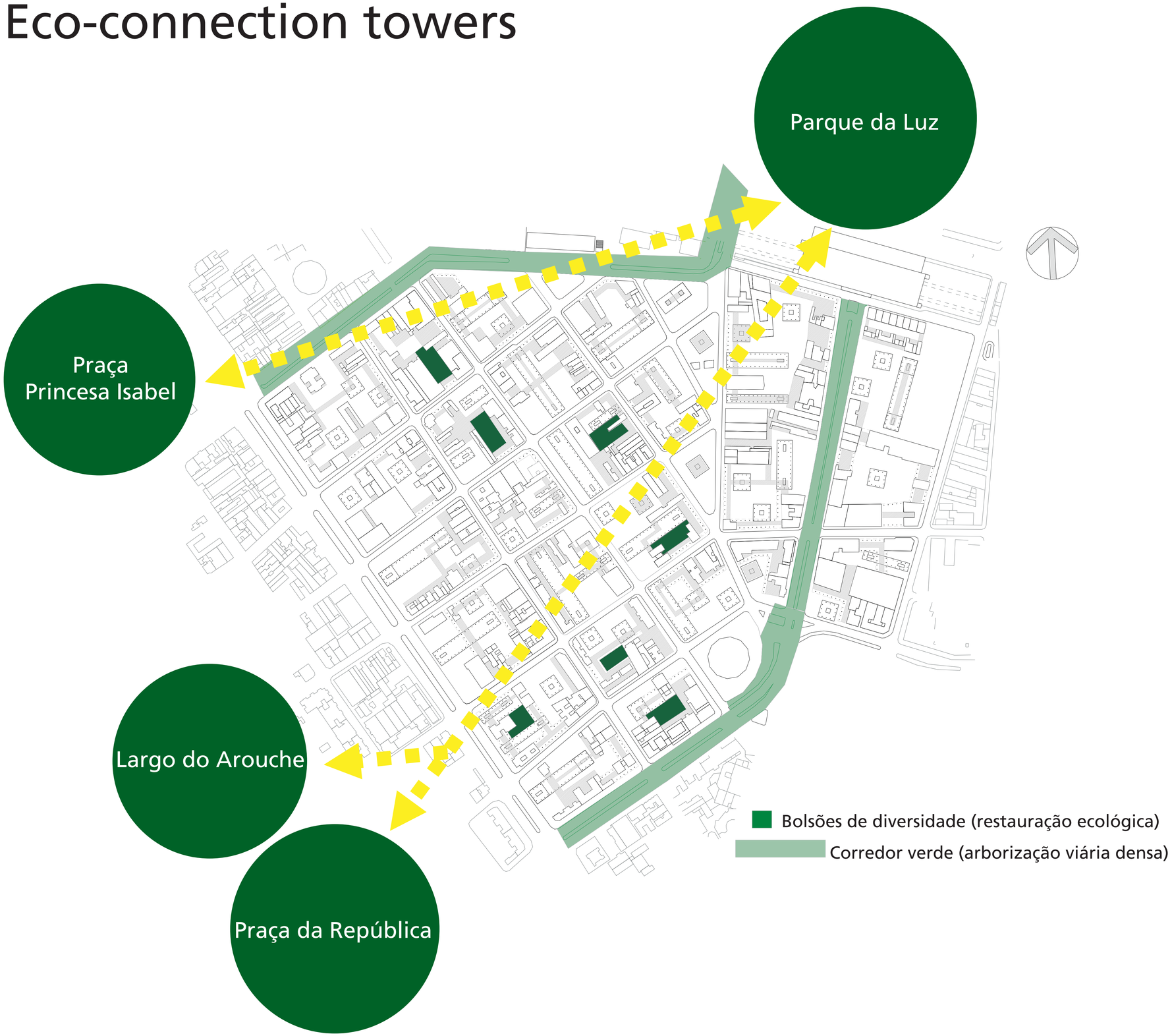
Painéis Fotovoltaicos		População	65000
Tipologia	Usuários Atendidos	%	
Lâmina + Torre	4853	7,47%	
Perímetro	8096	12,46%	
Tudo Lâmina	5806	8,93%	
Tudo Torre	2587	3,98%	
Tudo Perímetro	12218	18,80%	

Landscape


DRAINAGE
ECOLOGY
LANDSCAPE
CULTURAL IDENTITY
URBAN AGRICULTURE
MICROCLIMATE

Landscape

Eco-connection towers



Green corridors
Biodiversity pockets

Landscape

Pedestrian and bicycle roots

Fluxo perimetral (calçada) de pedestres

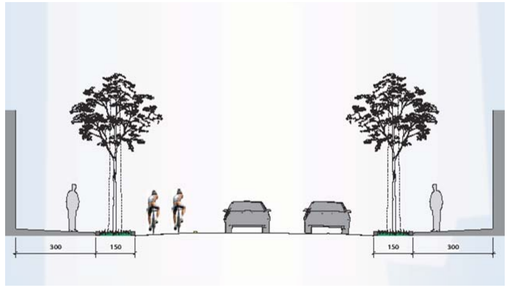
Fluxo alto

Fluxo médio

Fluxo baixo

Fluxo intra-quadras de pedestres

Ciclovia

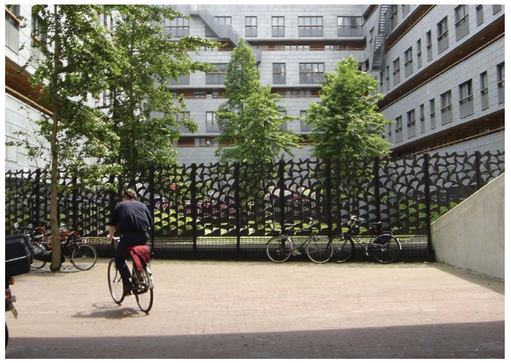


Landscape

Based on sun path

Insolação (meio-período a dia inteiro)

- Áreas insolaradas no verão
- Áreas insolaradas no inverno
- Áreas insolaradas no inverno/verão

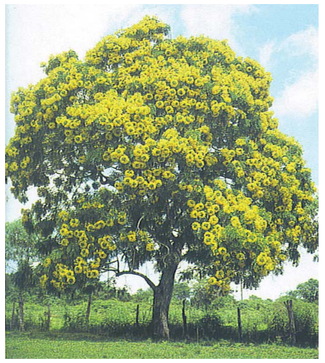


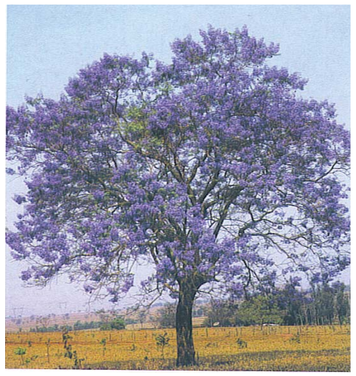
Landscape

Vegetation

Vegetação

- herbácea + arbustiva
- herbácea + arbustiva+ arbórea
- herbácea + arbustiva+ arbórea (caducifólia)
- Agricultura urbana (sobre laje)
- Bolsões de diversidade (restauração ecológica)
- Corredor verde (arborização viária densa)





Landscape

Outdoor thermal confort

Biodiversity pockets

Green corredors

Green infrastructure

Landscape

Outdoor thermal confort

Summer squares

Winter squares

Drainage

Storing

Infiltration

Drainage

Macro intervention

Project unit - basin

Micro intervention

Project unit - square

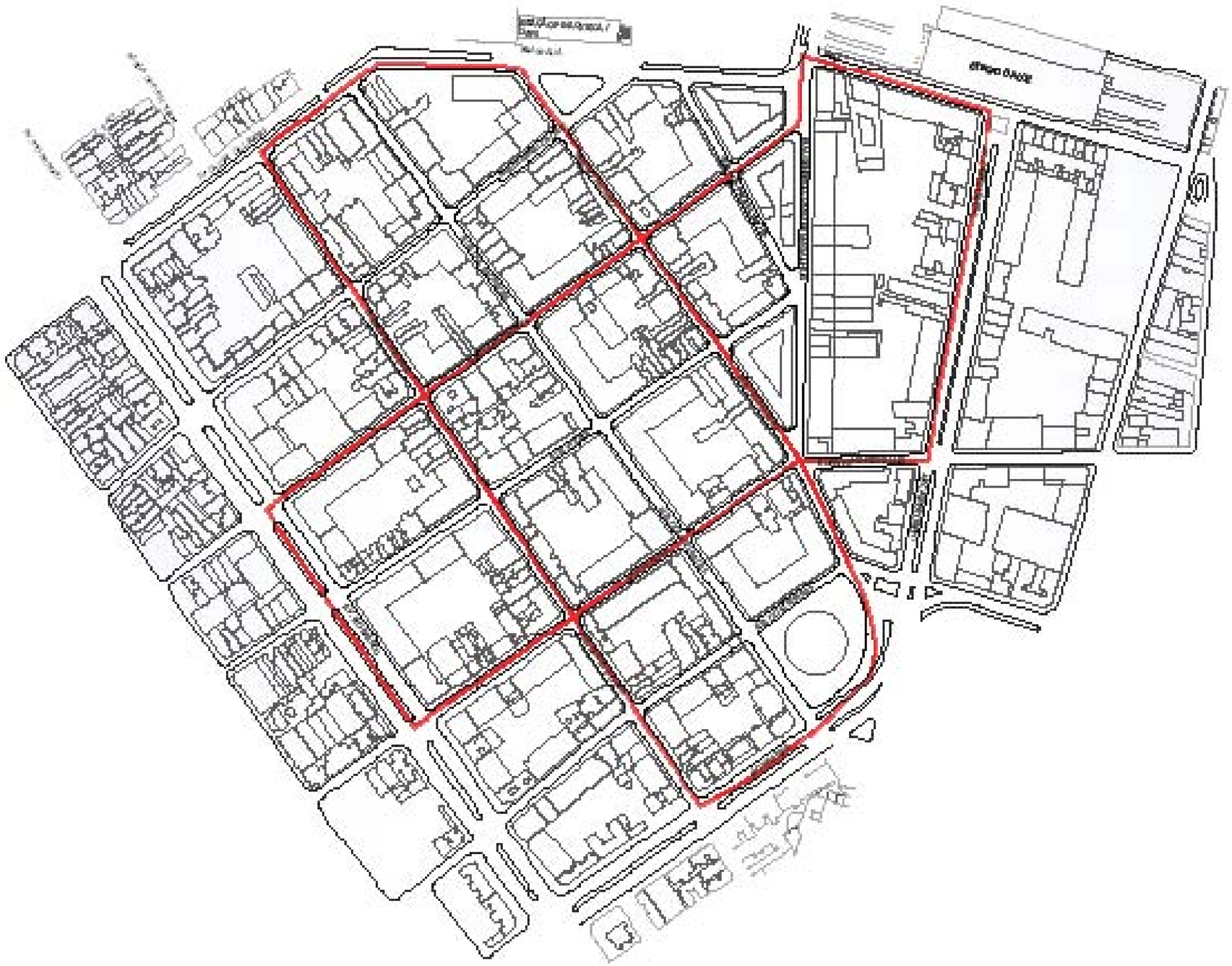
Drainage

Universal Design

Accessible routes

Universal Design

Bicycle routes

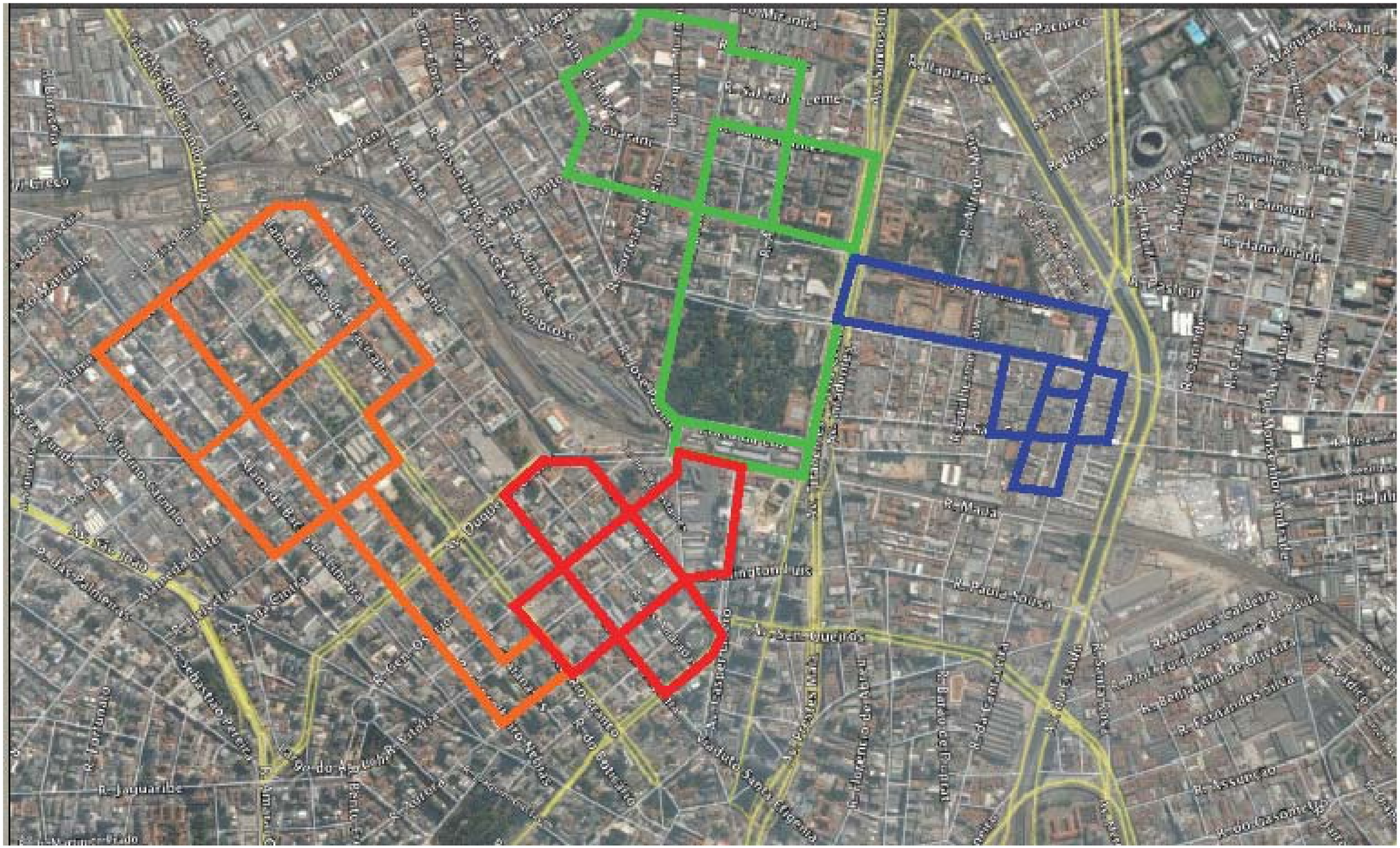


Universal Design

Bicycle routes

Universal Design

Bicycle routes



Public Lighting

ECO BUILDING FOR SÃO PAULO

Outdoor thermal comfort

Empirical thermal studies

“Canyon”
Summer conditions

tar (ta)	29,9 °C
trm (mrt)	30,2 °C
ur (rh)	44,5 %
var (va)	1,6 m/s

Outdoor thermal comfort

Empirical thermal studies

“Square”
Summer conditions

tar (ta)	30,7 °C
trm (mrt)	32,1 °C
ur (rh)	45,3 %
var (va)	1,7 m/s

Outdoor thermal comfort

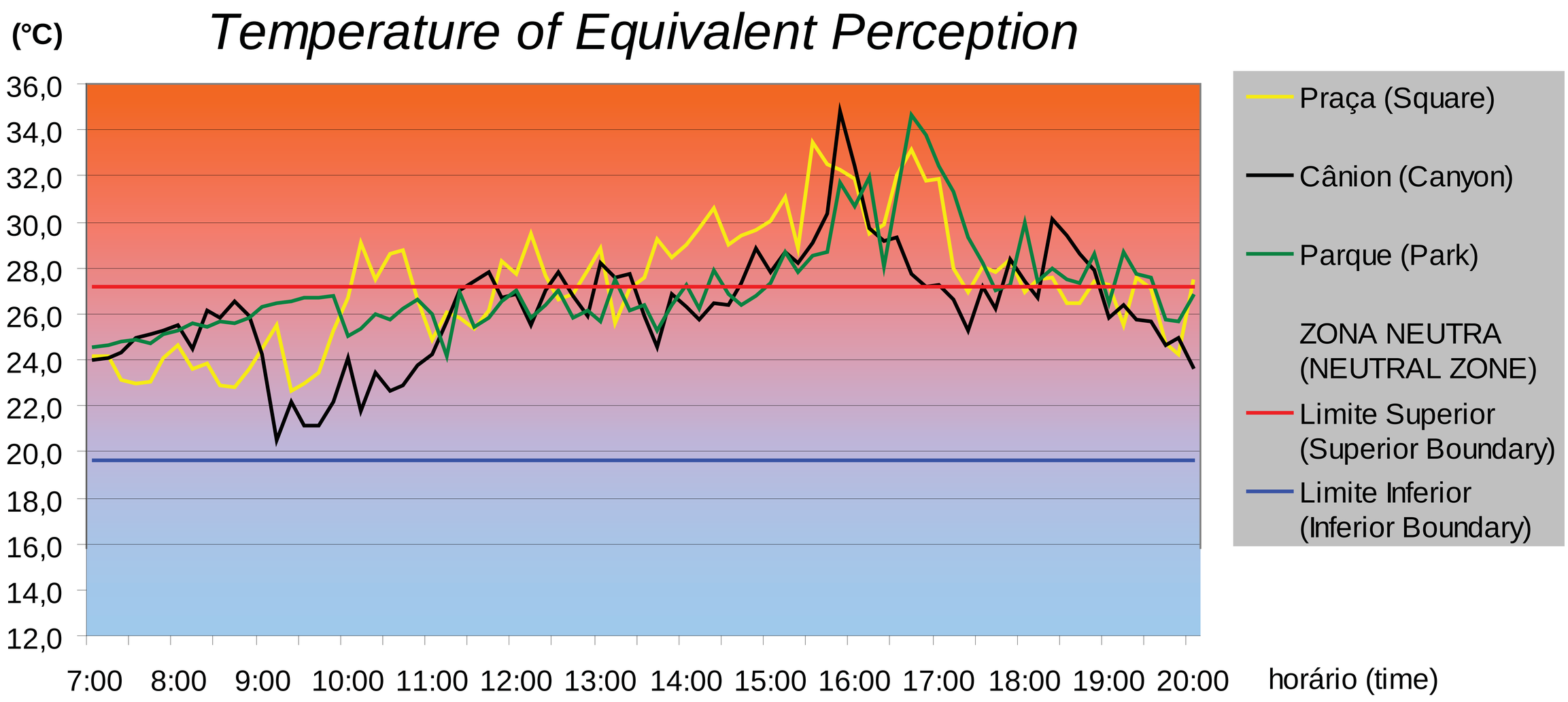
Empirical thermal studies

“Park”
Summer conditions

tar (ta)	28,5 °C
trm (mrt)	29,2 °C
ur (rh)	53,4 %
var (va)	1,0 m/s

Outdoor thermal comfort

ECO BUILDING FOR SÃO PAULO



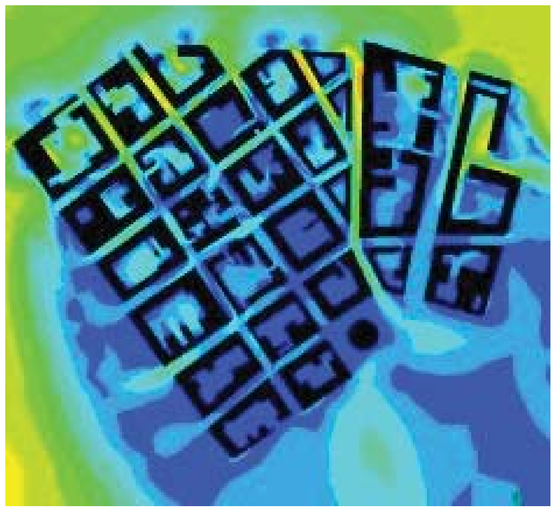
$$TEP = -29{,}877 + 0{,}4828 \cdot TAR + 0{,}5172 \cdot TRM + 0{,}0802 \cdot UR - 2{,}322 \cdot VAR - 0{,}1742 \cdot TM + 5{,}118 \cdot M + 38{,}023 \cdot I_{CL}$$

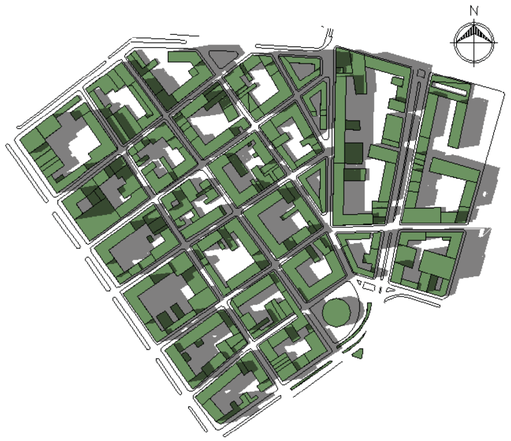
Outdoor thermal comfort

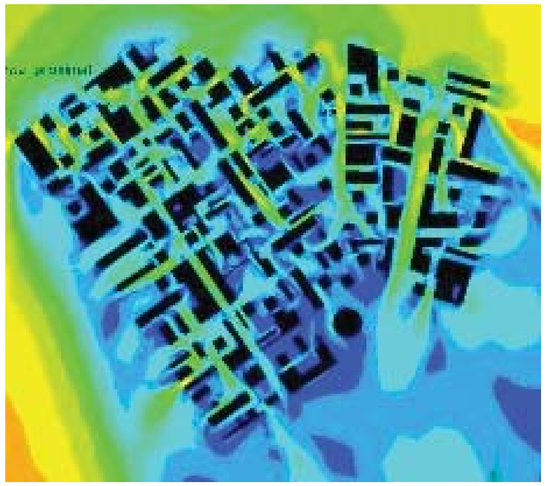
ECO BUILDING FOR SÃO PAULO

Considered variables

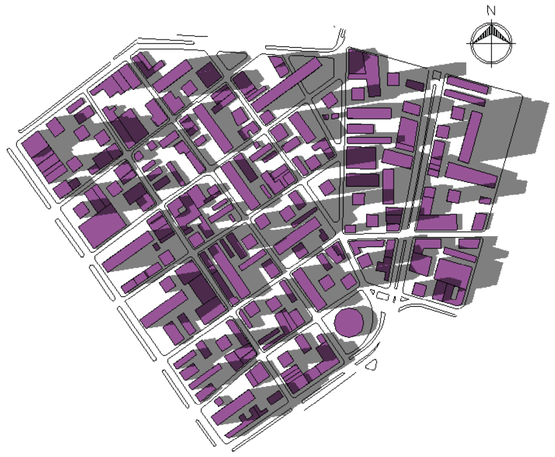
MEAN VALUES	TA	RH	V	IG	MMT	M	ICL
JAN 15H (JAN 3PM)	27,5oC	60 %	4M/S	NNW 630 W/M2	22,5 oC	1-2,4 MET	0,3-0,7 CLO







Air flow



Shading

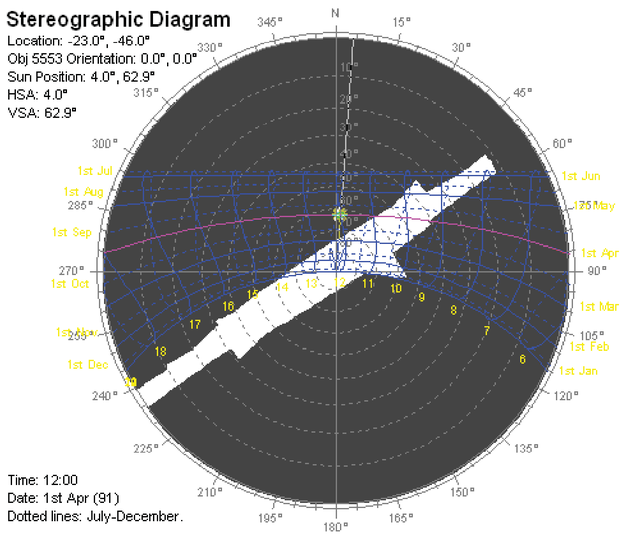
Vegetation

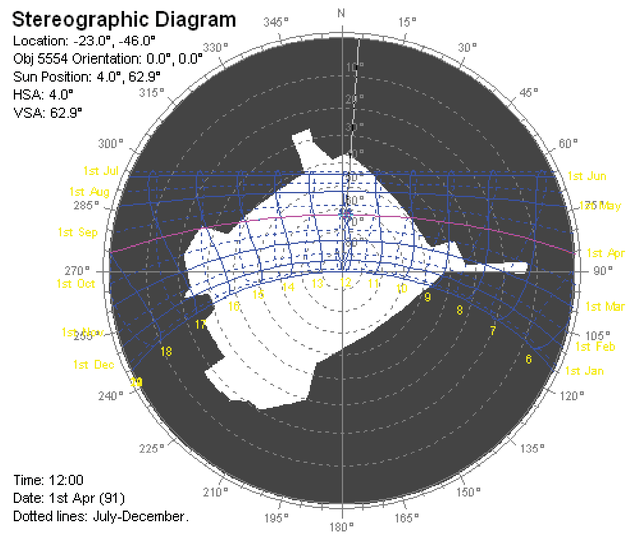
Pedestrian flow

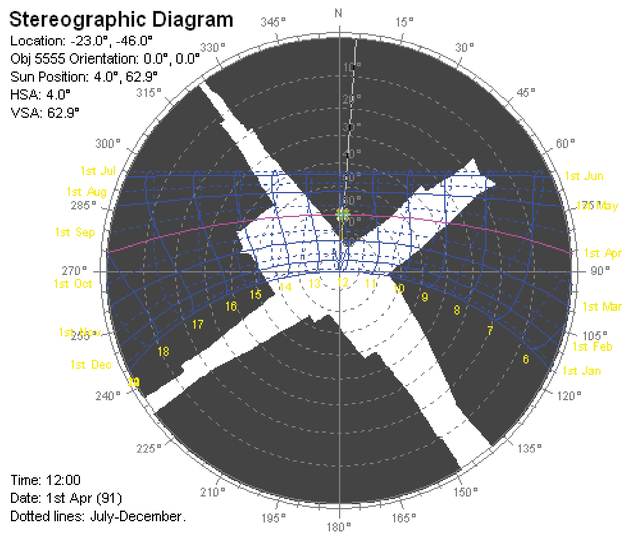
Outdoor thermal comfort

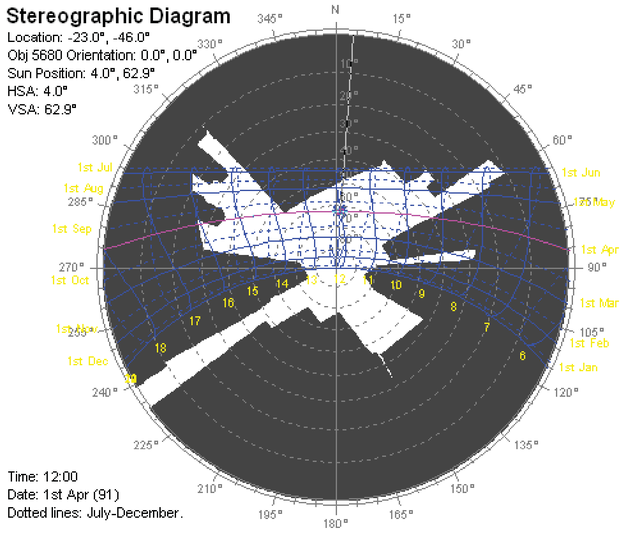
ECO BUILDING FOR SÃO PAULO

Sky view factor

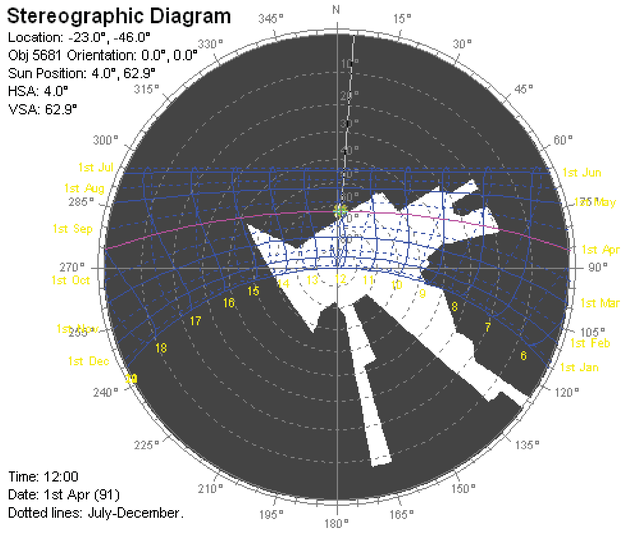




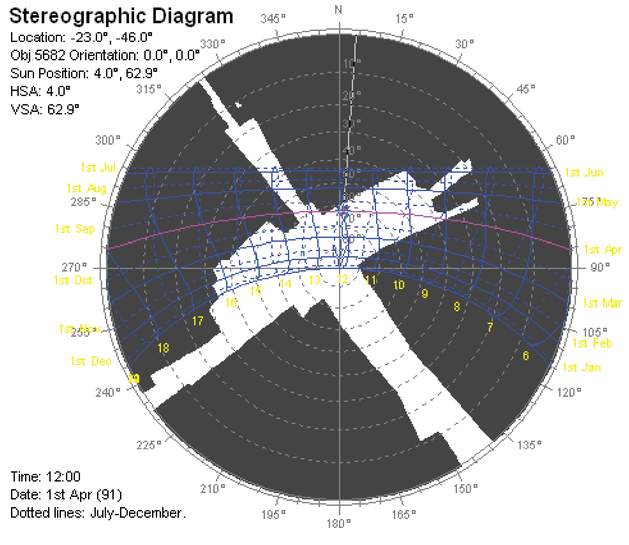




Sidewalk



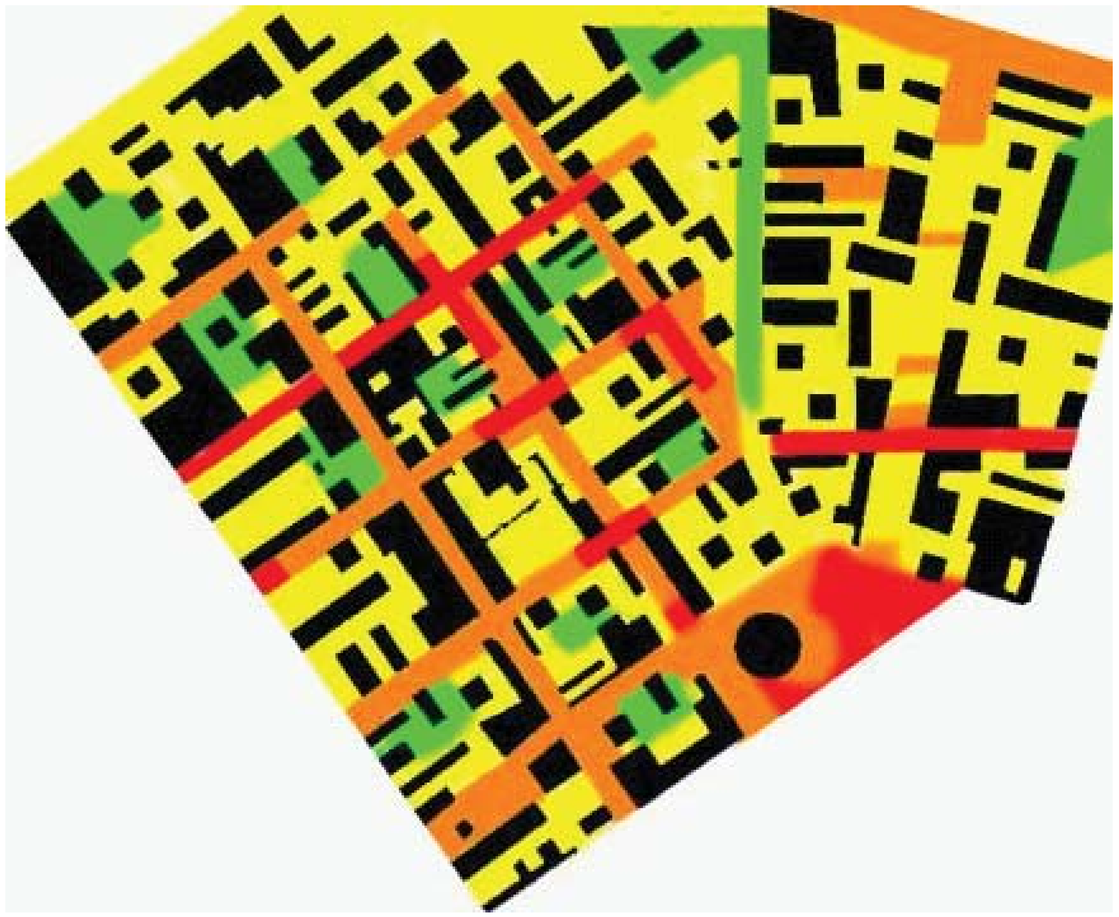
Block's core



corner

Outdoor thermal comfort

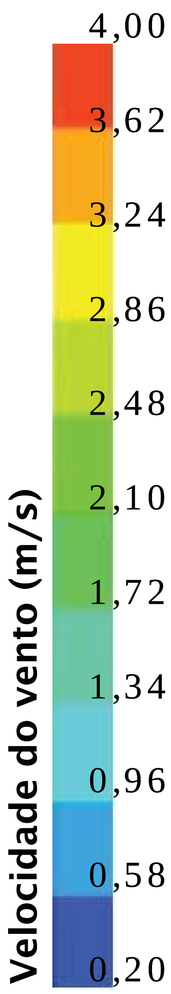
Mapping

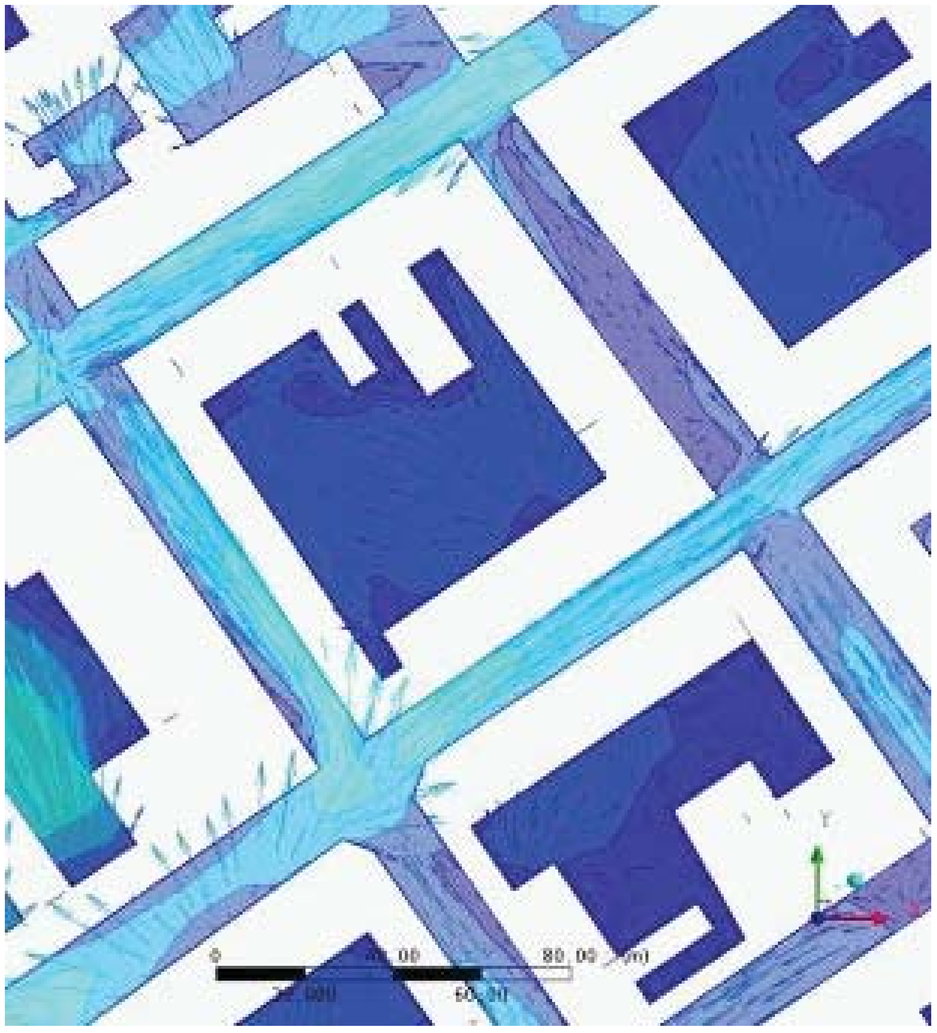


- very hot
- hot
- warm
- neutrality

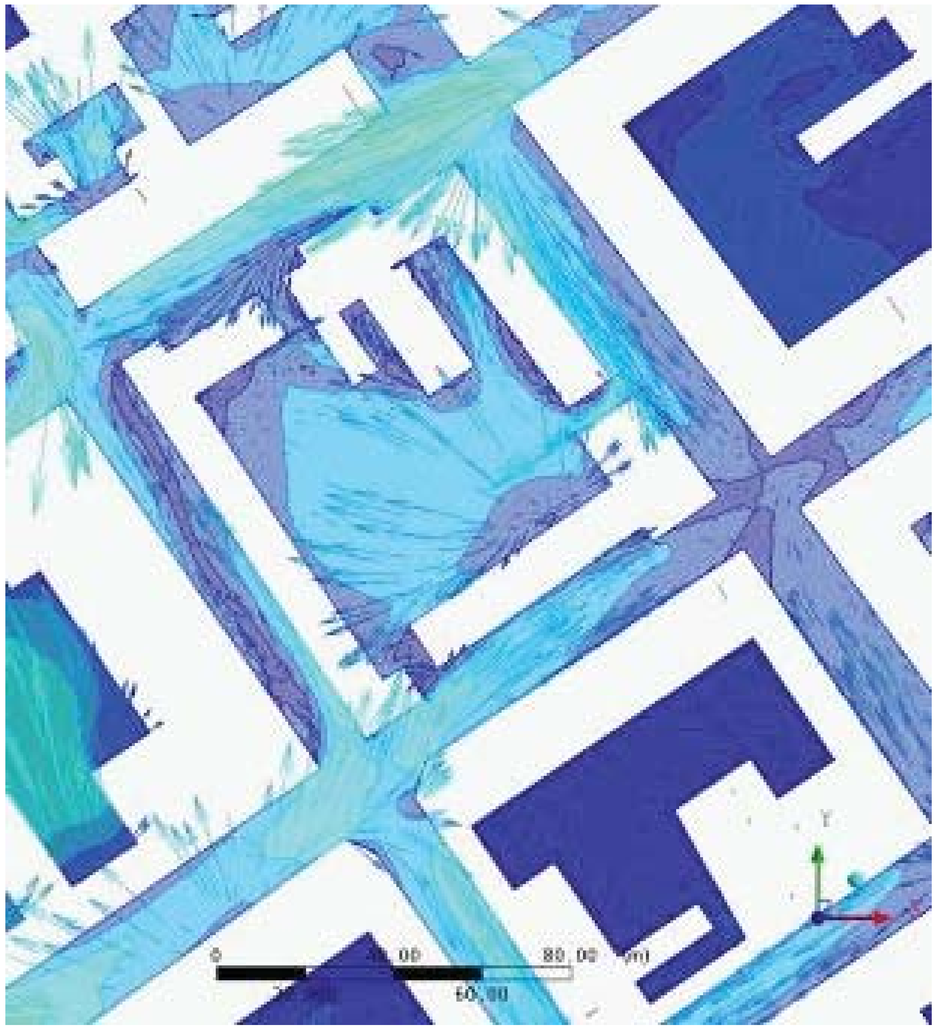
Block analysis

Air pollution dispersion: perimeter block





not considering groundfloor



considering groundfloor

Block analysis

Air pollution dispersion: perimeter block

Velocidade do ar (m/s) para dispersão do CO - monóxido de carbono

		PADRÃO	ATENÇÃO (9ppm Q_{af}=23m³/s)	ALERTA (15ppm Q_{af}=14m³/s)	CRÍTICO (30ppm Q_{af}=7m³/s)
R1	P		0.78	0.47	0.23
	TL		1.69	1.01	0.51
R2	P		0.67	0.40	0.20
	TL		1.91	1.15	0.57
R3	P		4.62	2.77	1.39
	TL				
R4	P		1.06	0.63	0.32
	TL		1.70	1.02	0.51

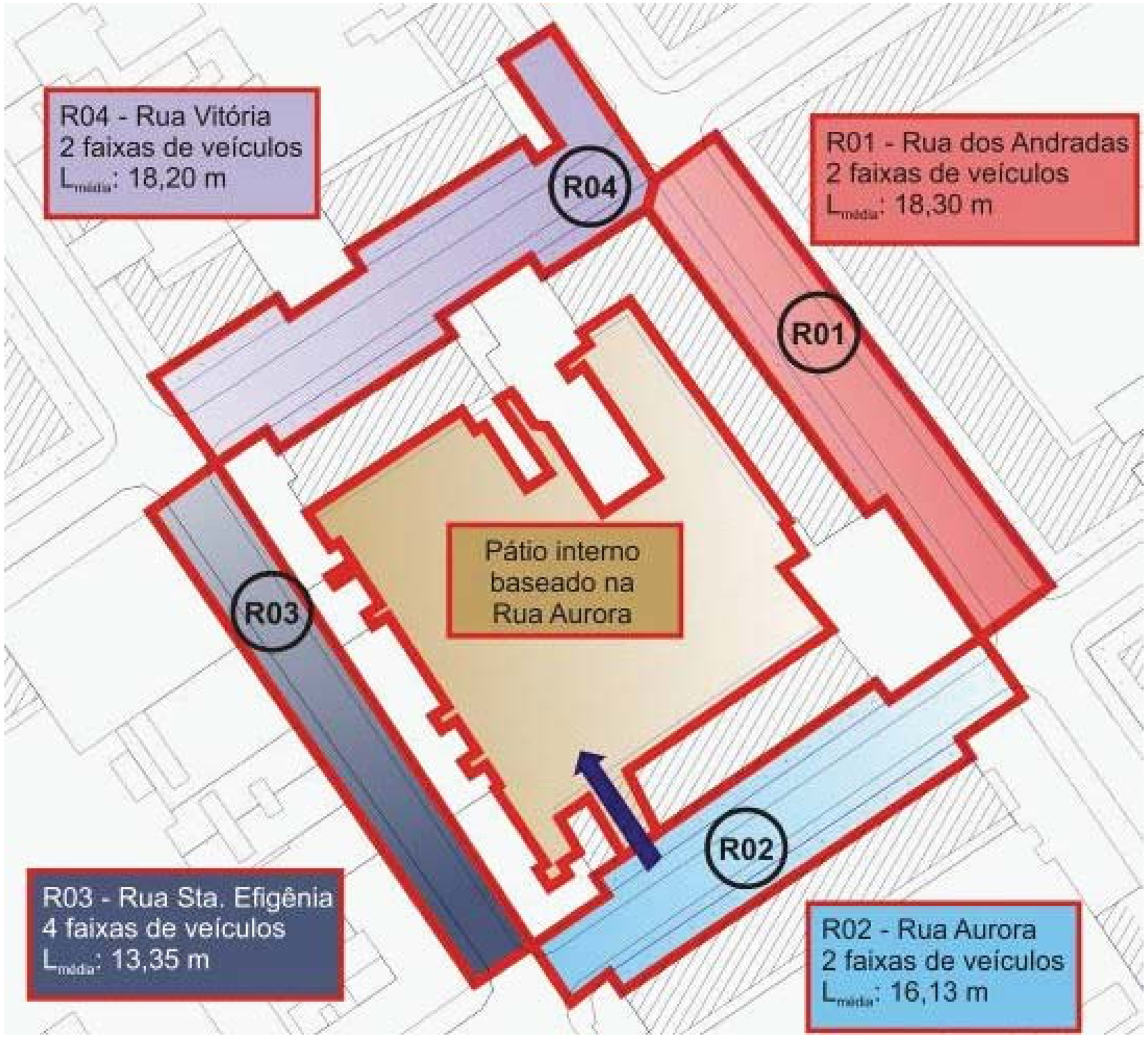
Padrões Nacionais de Qualidade do Ar
CO - monóxido de carbono
(Resolução CONAMA nº 03 de 28/06/90)
Fonte:http://www.cetesb.sp.gov.br/Ar/ar_indice_padroes.asp

Cálculo de velocidade do ar (m/s) para dispersão do CO - monóxido de carbono

$$Q_{af}\,[m^3/s] = \frac{q^0_{CO} * f_{vel} * f_{ram} * f_{alt}}{3600} * \frac{1\times10^6}{CO_{lim}\,[ppm]}$$

$$U_{solo} \geq \frac{n^o veículos * Q_{af}}{A} \Leftrightarrow U_{solo} \geq m/s$$

Fonte: PIARC - World Road Association. Congres Mondial de la Route. Publication 1987 e 2001.



Block analysis

Air pollution dispersion: perimeter block

Velocidade do ar (m/s) para dispersão do CO - monóxido de carbono

		9ppm $Q_{af}=23m^3/s$	15ppm $Q_{af}=14m^3/s$	30ppm $Q_{af}=7m^3/s$
		PADRÃO / ATENÇÃO	ALERTA	CRÍTICO
R1	P	0.78	0.47	0.23
	TL	1.69	1.01	0.51
R2	P	0.67	0.40	0.20
	TL	1.91	1.15	0.57
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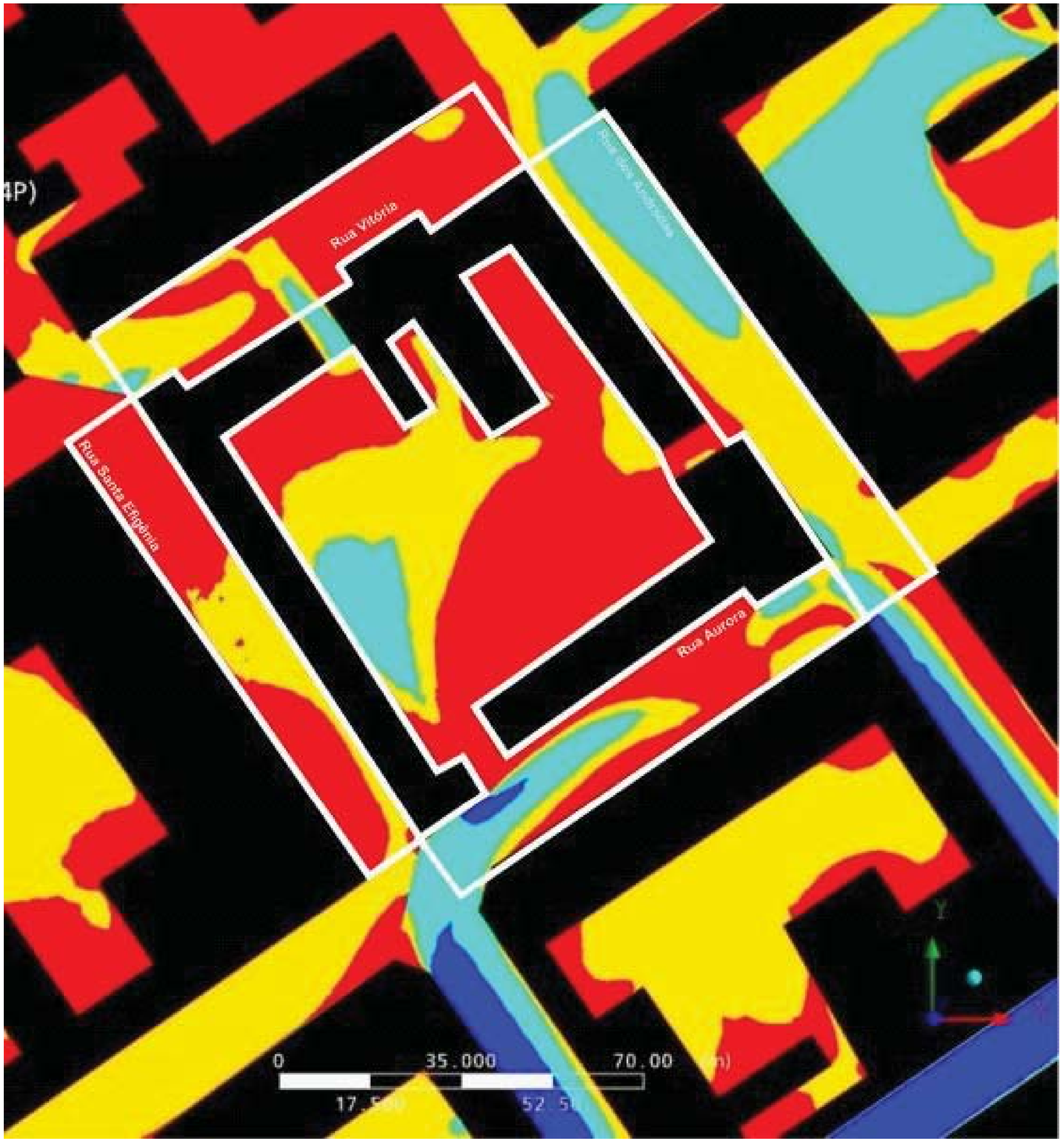
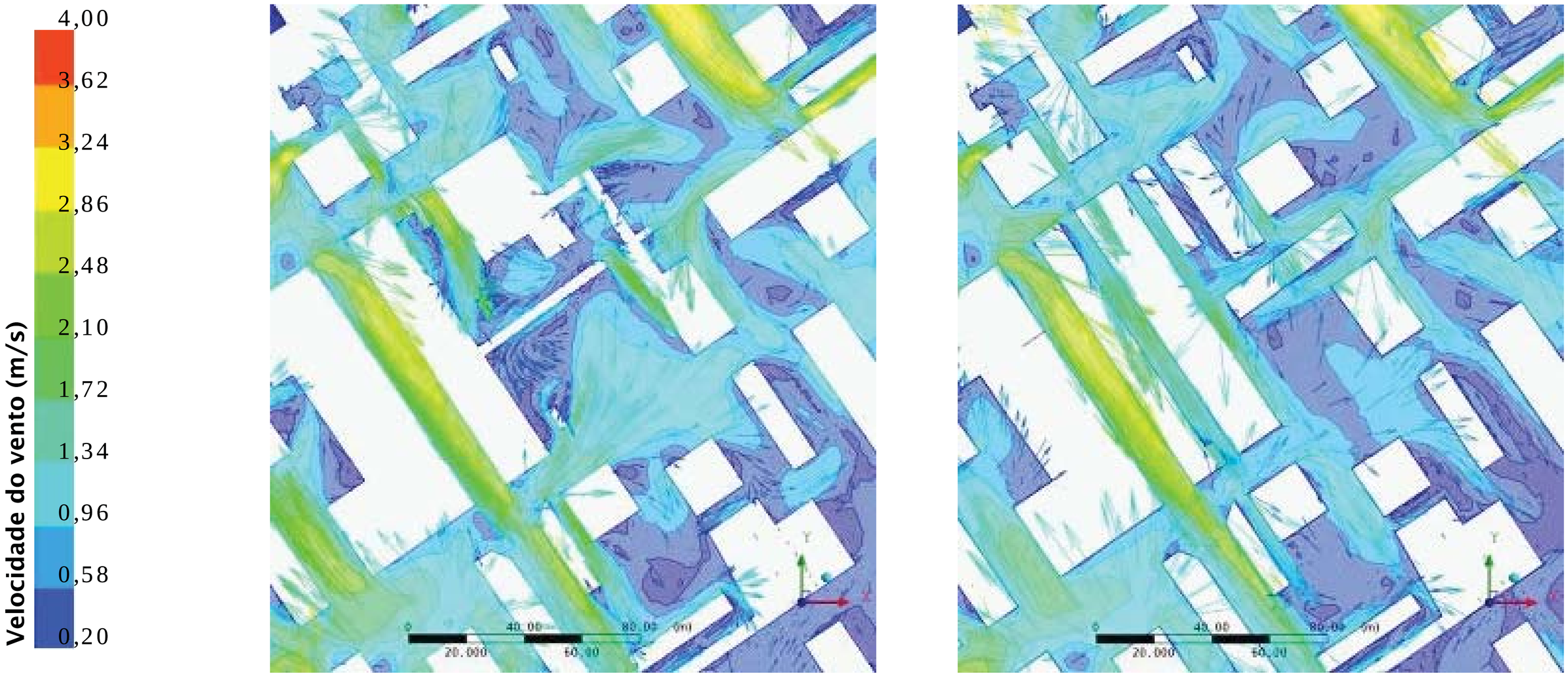


Block analysis

Air pollution dispersion: slab + tower



not considering groundfloor

considering groundfloor

Block analysis

Air pollution dispersion: slab + tower

Velocidade do ar (m/s) para dispersão do CO - monóxido de carbono

		9ppm Q_{af}=23m³/s	15ppm Q_{af}=14m³/s	30ppm Q_{af}=7m³/s
		PADRÃO / ATENÇÃO	ALERTA	CRÍTICO
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	TL	1.69	1.01	0.51
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	TL	1.91	1.15	0.57
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R4	P	1.06	0.63	0.32
	TL	1.70	1.02	0.51

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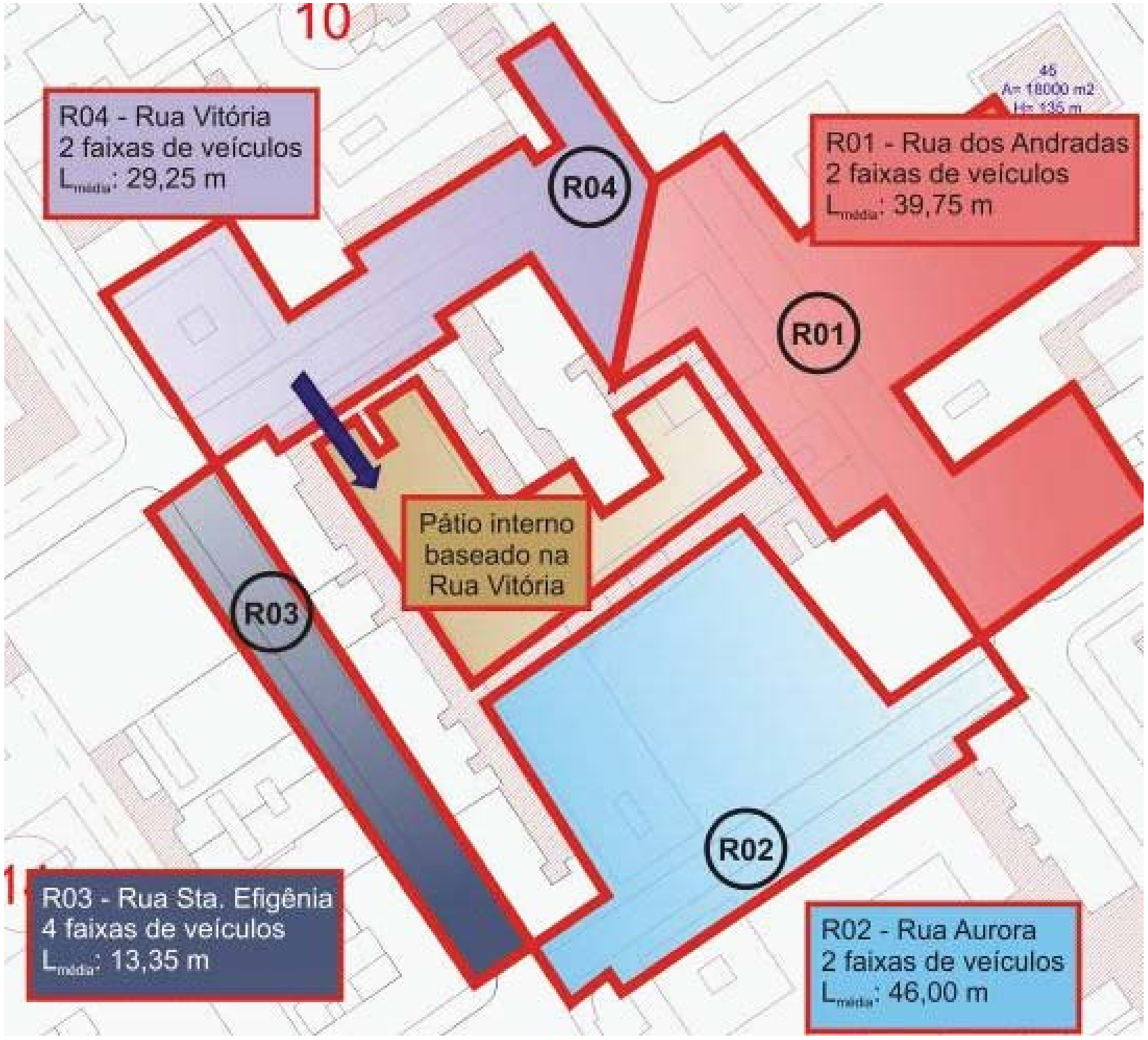

Block analysis

Air pollution dispersion: slab + tower

Velocidade do ar (m/s) para dispersão do CO - monóxido de carbono

		9ppm $Q_{af}=23m^3/s$	15ppm $Q_{af}=14m^3/s$	30ppm $Q_{af}=7m^3/s$
		PADRÃO / ATENÇÃO	ALERTA	CRÍTICO
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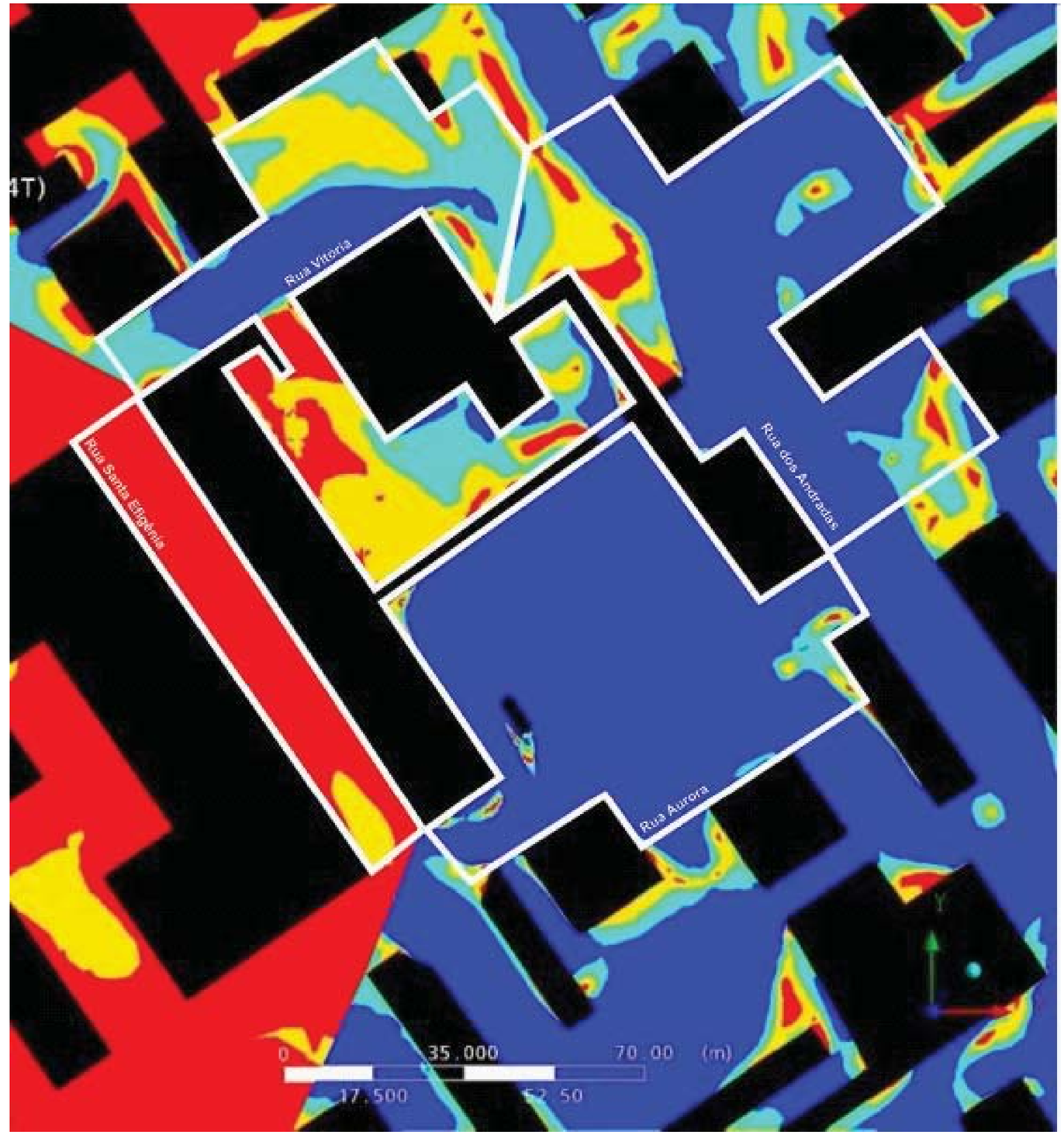
$$Q_{af}\left[m^3/s\right] = \frac{q^0_{CO} * f_{vel} * f_{ram} * f_{alt}}{3600} * \frac{1\times10^6}{CO_{\lim}\left[ppm\right]}$$

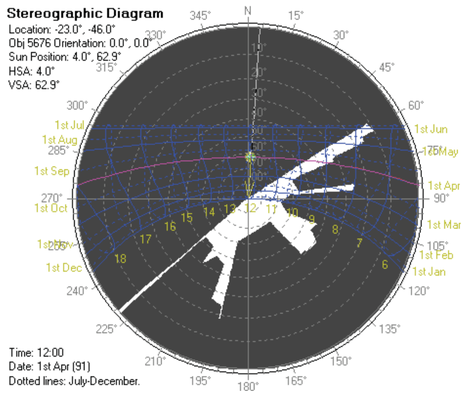
$$U_{solo} \geq \frac{n^o veículos * Q_{af}}{A} \Leftrightarrow U_{solo} \geq m/s$$

Fonte: PIARC - World Road Association. Congres Mondial de la Route. Publication 1987 e 2001.



Block analysis

Solar access: slab + tower



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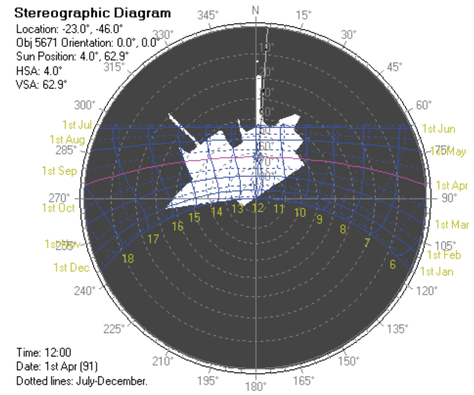

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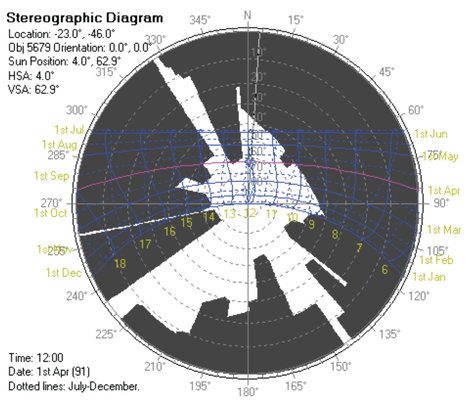

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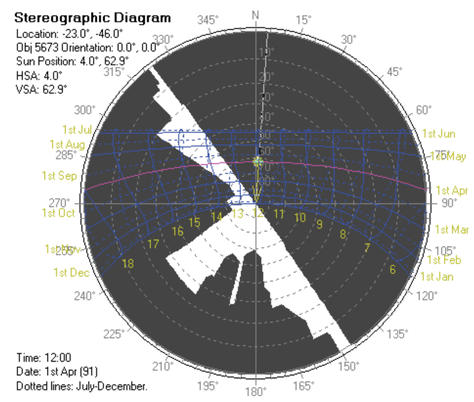
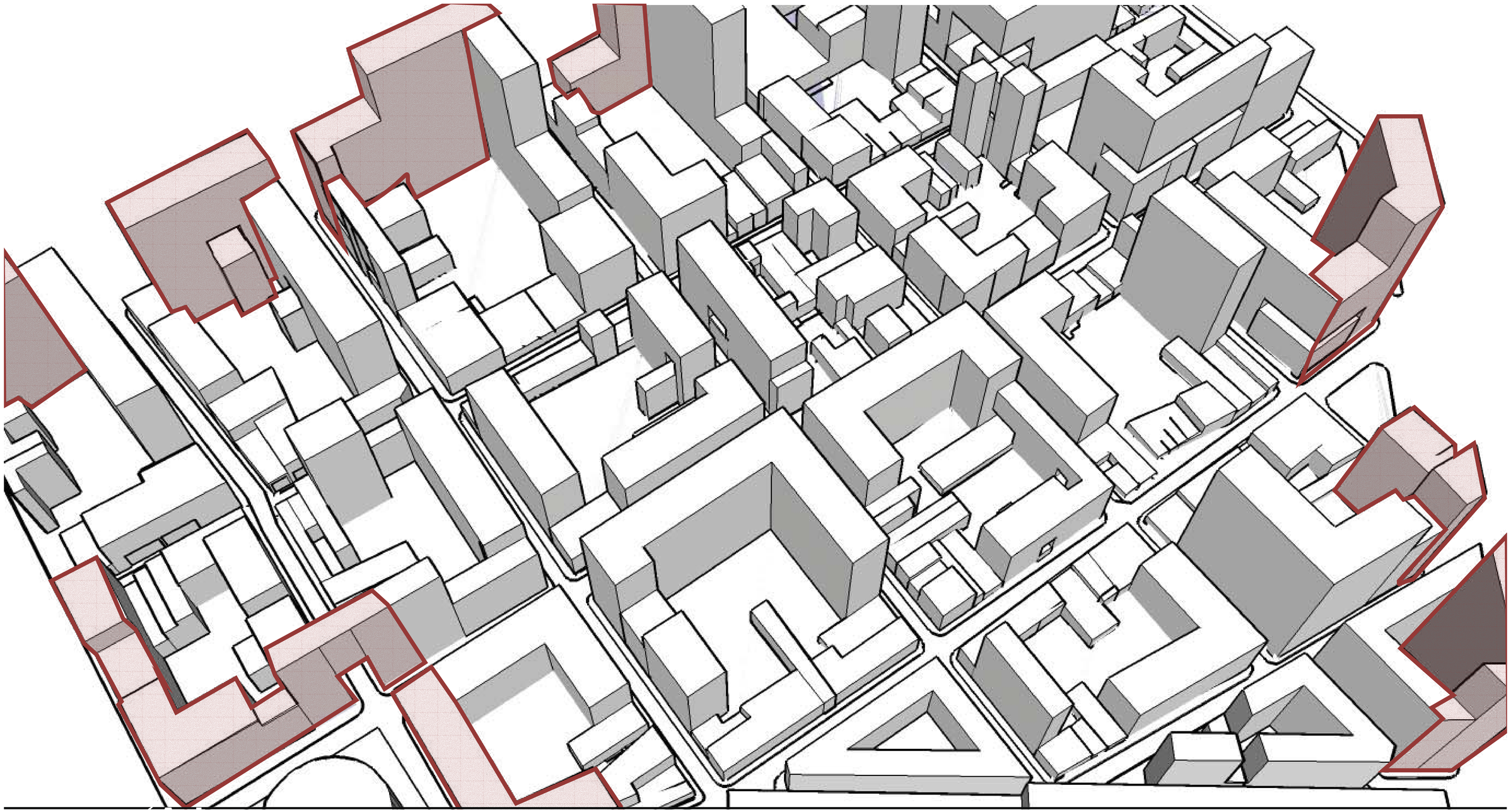


03

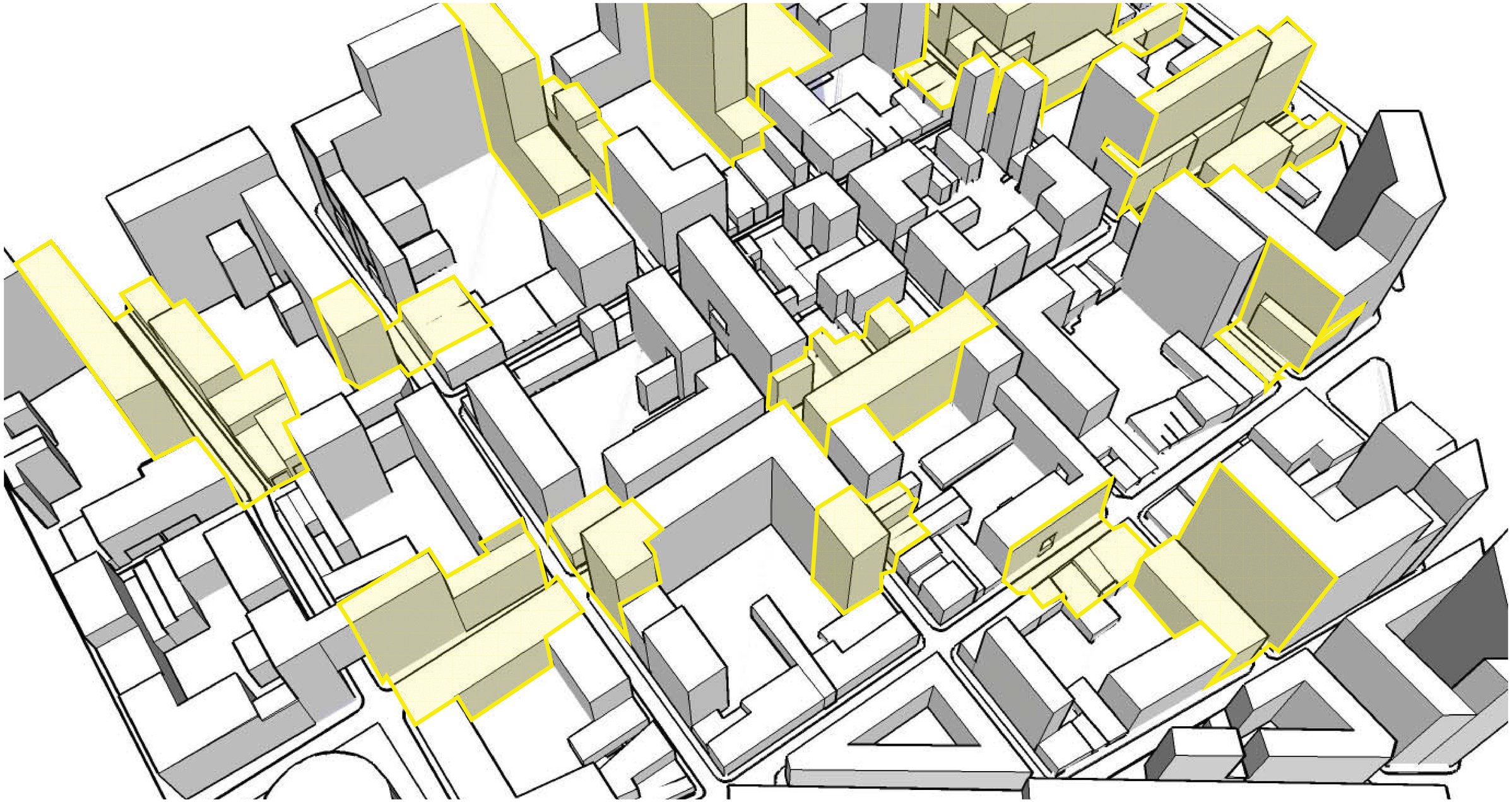
Detailed analysis

Urban acoustics: perimeter block



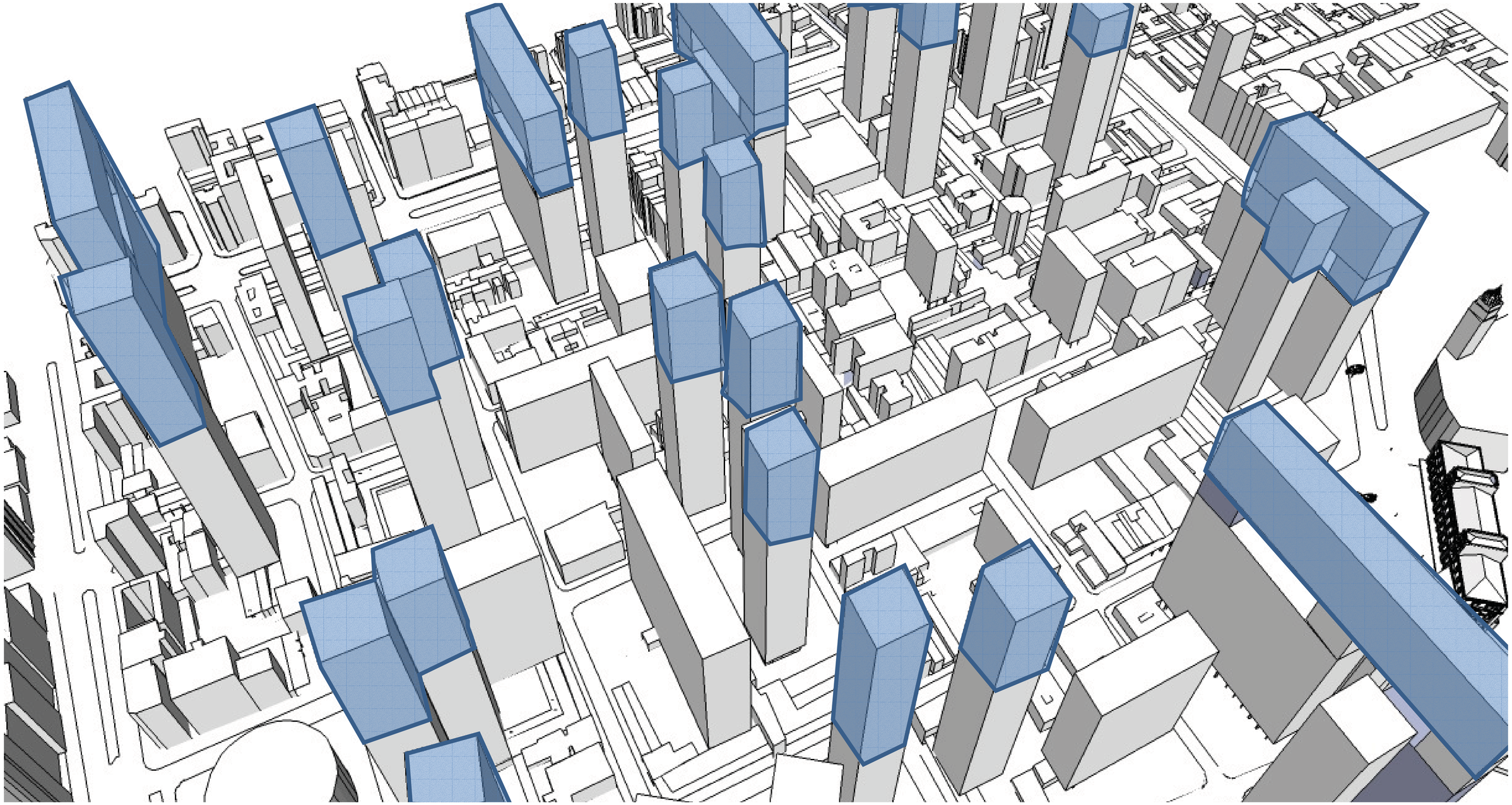
Detailed analysis

Urban acoustics: perimeter block



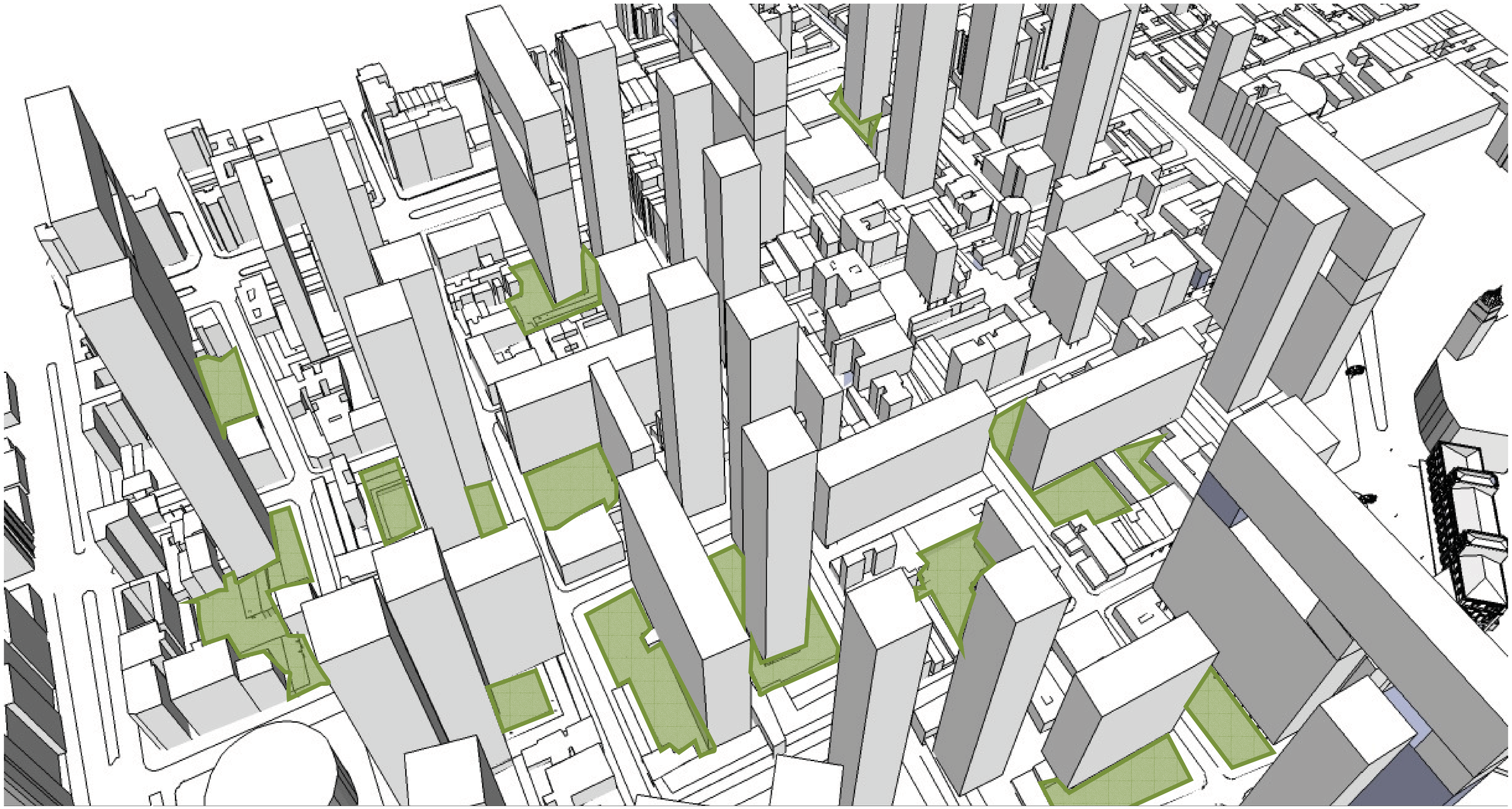
Detailed analysis

Urban acoustics: slab + tower



Detailed analysis

Urban acoustics: slab + tower



Retrofit

Santa Josefa Building

	Actual situation	Retrofit
Residential units	202	214

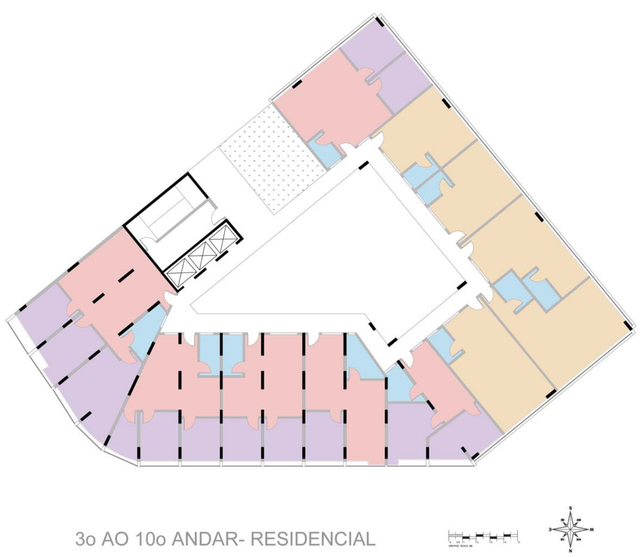
Retrofit

Santa Josefa Building

ECO BUILDING FOR SÃO PAULO

Typology

- Kitchennetts
- 1 Bed
- 2 Bed
- 3 Bed

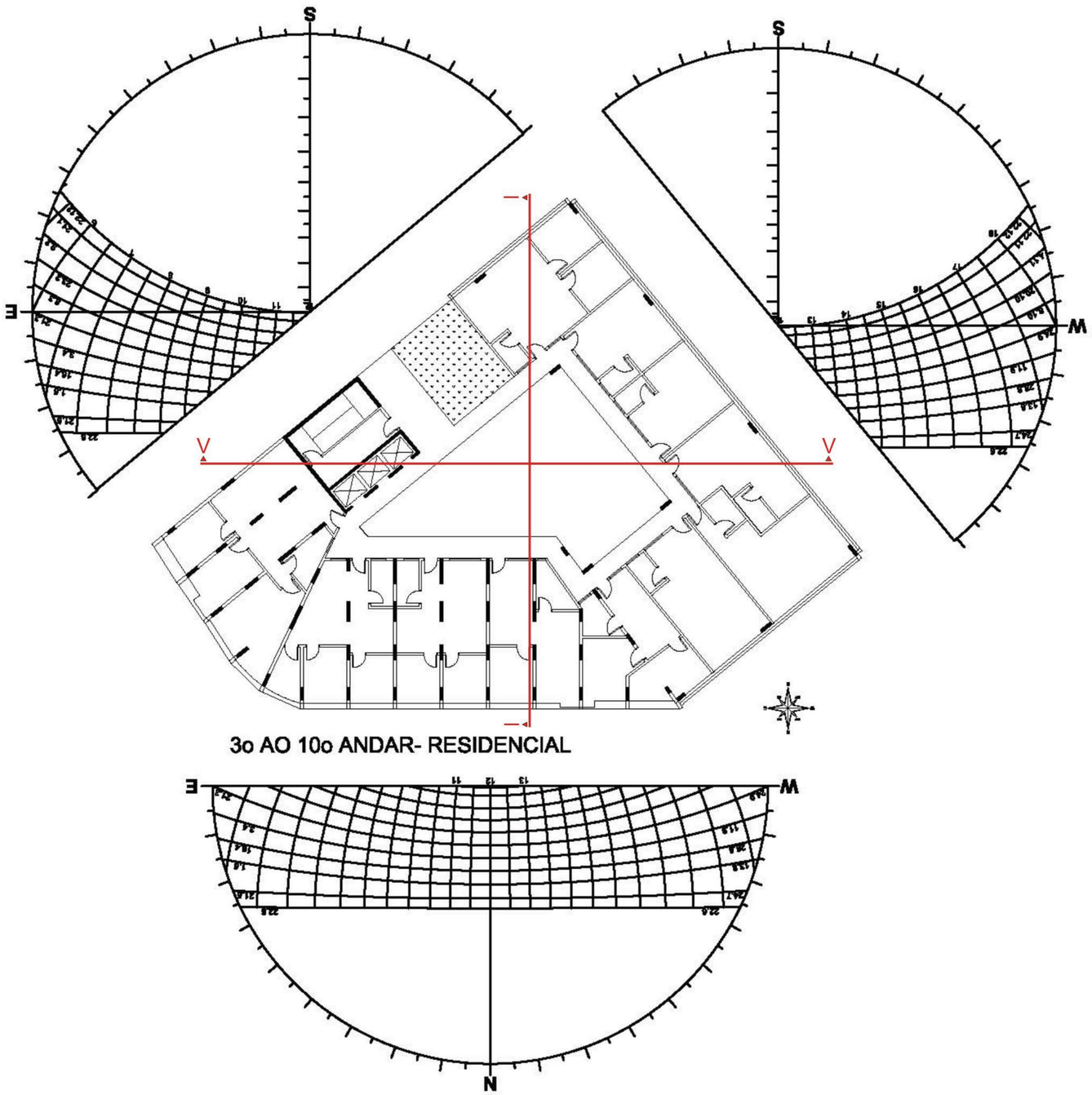


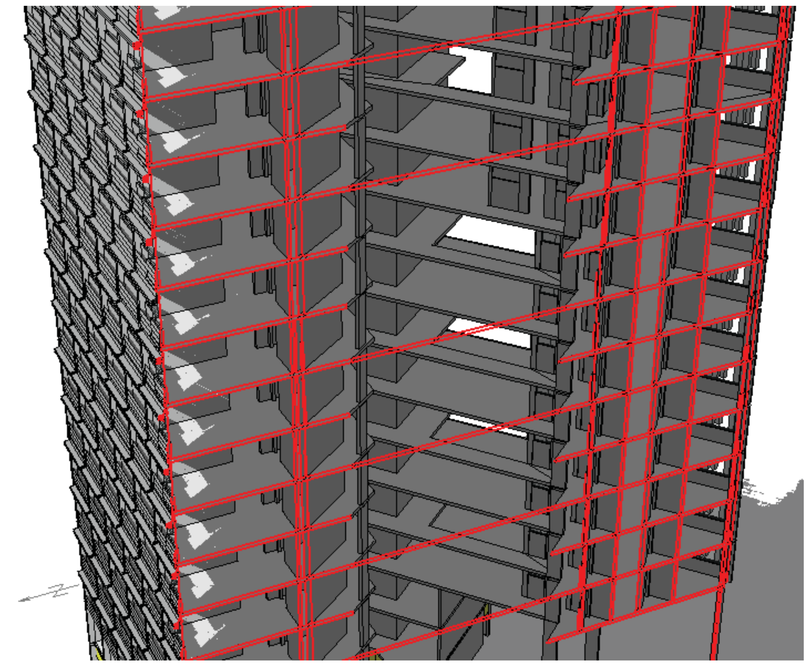
Rooms

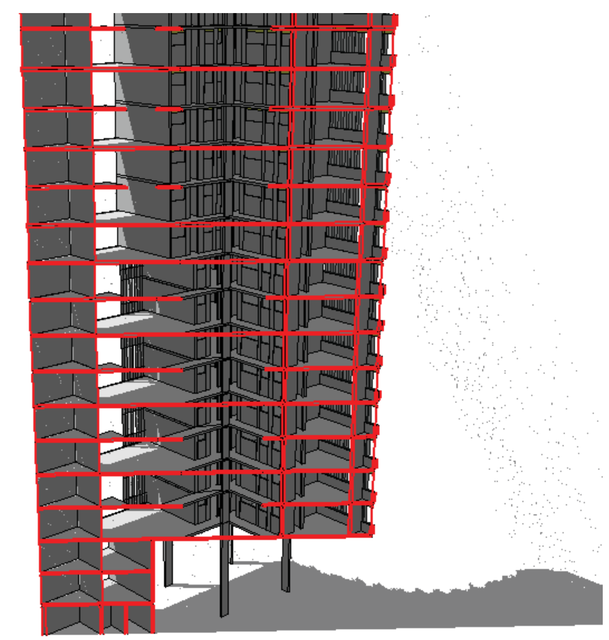
- Living Room + Kitchen
- Bedroom
- WC
- Studio Flat (Kitchennetts)
- Permaculture

Retrofit

Santa Josefa Building







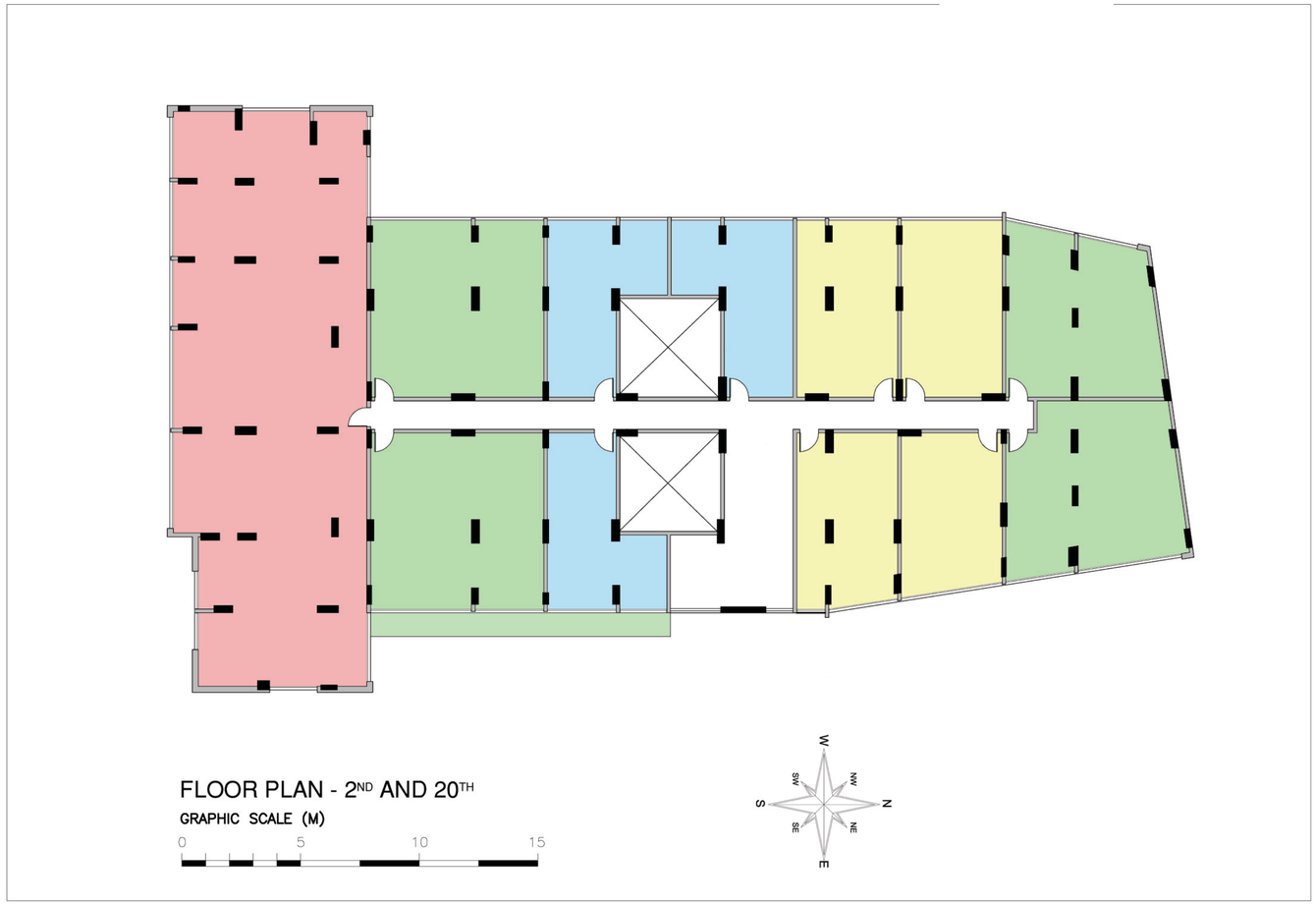
Retrofit

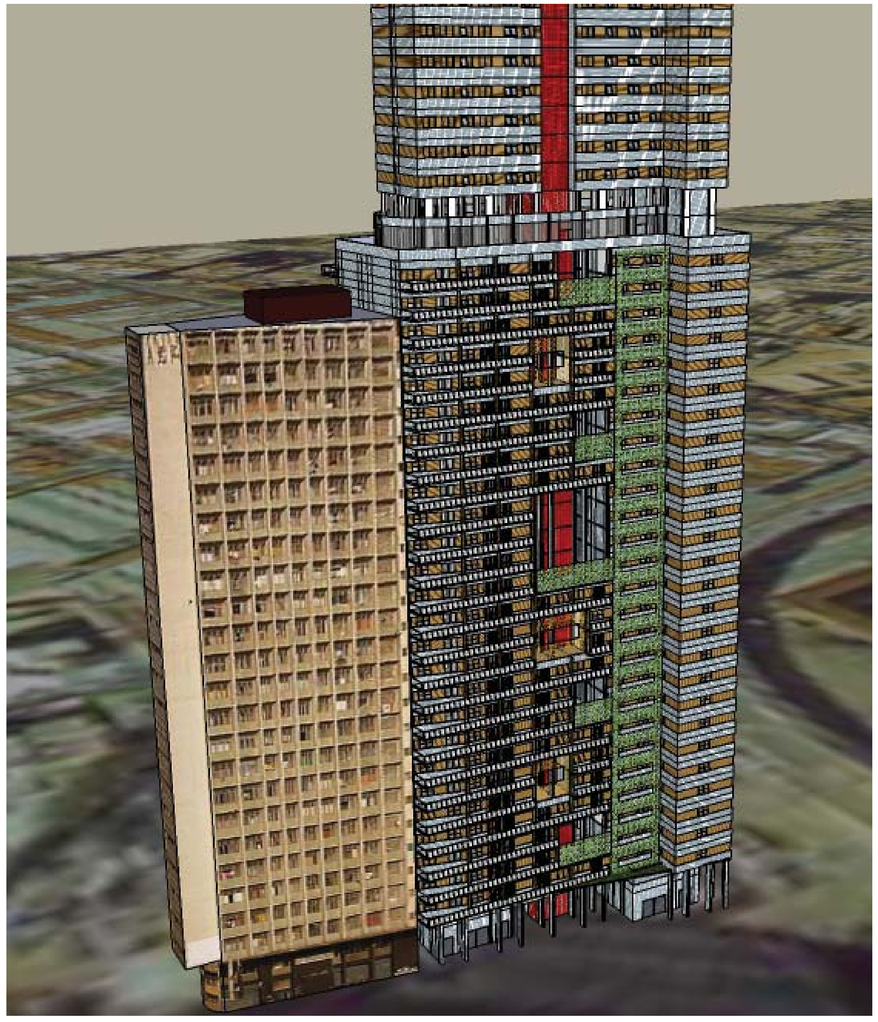
São Vito Building

	Actual situation	Retrofit
Residential units	600	300

Retrofit

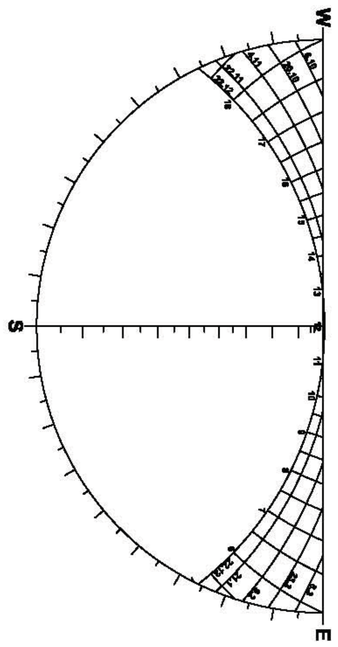
São Vito Building

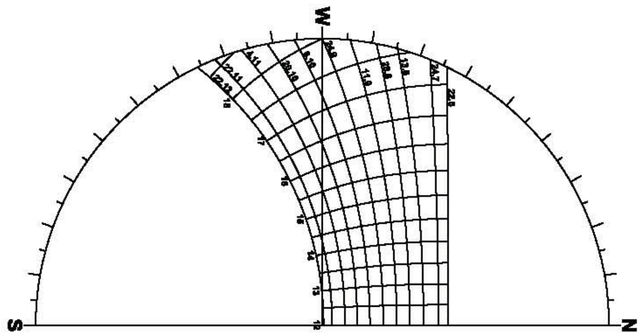


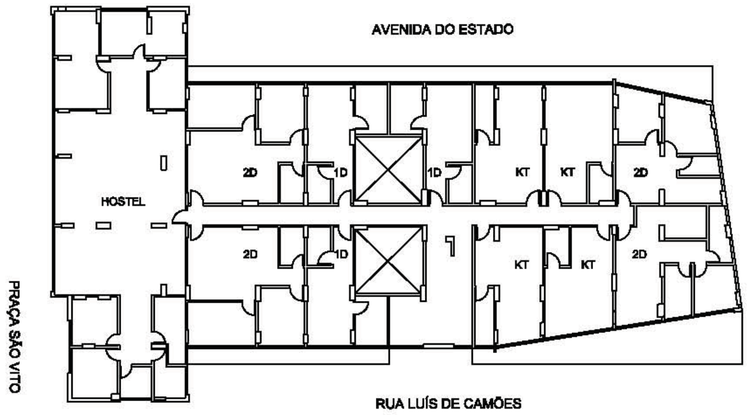


Retrofit

São Vito Building

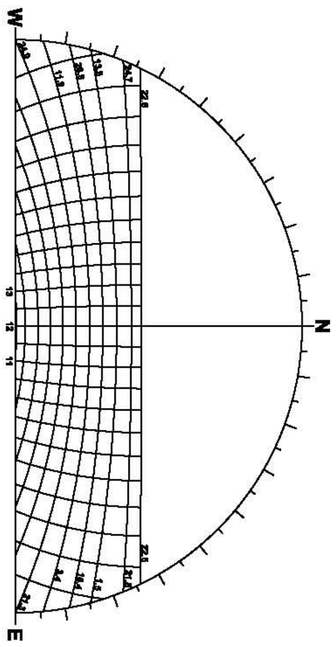


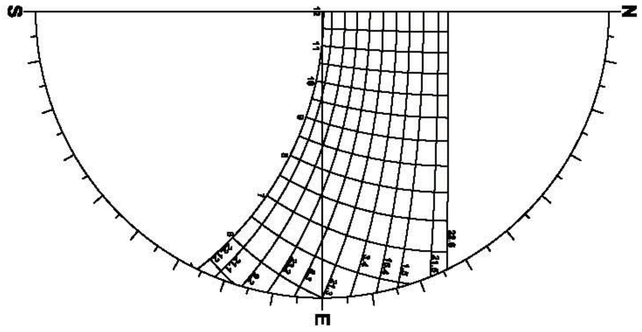


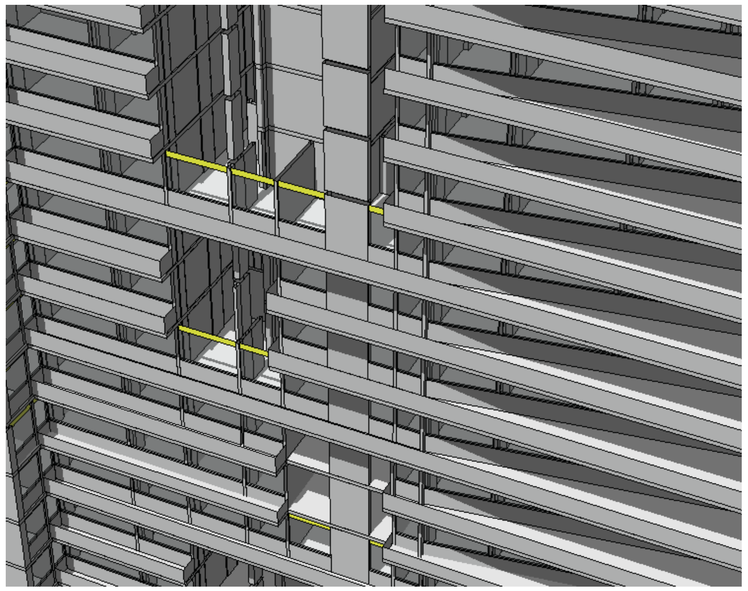


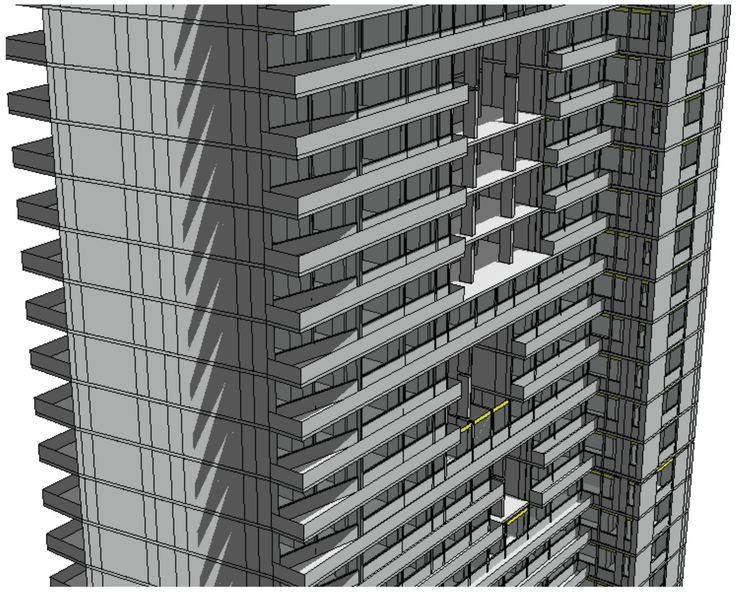
PLANTA DO 1º, 7º E 24º ANDAR

ESCALA 1:200



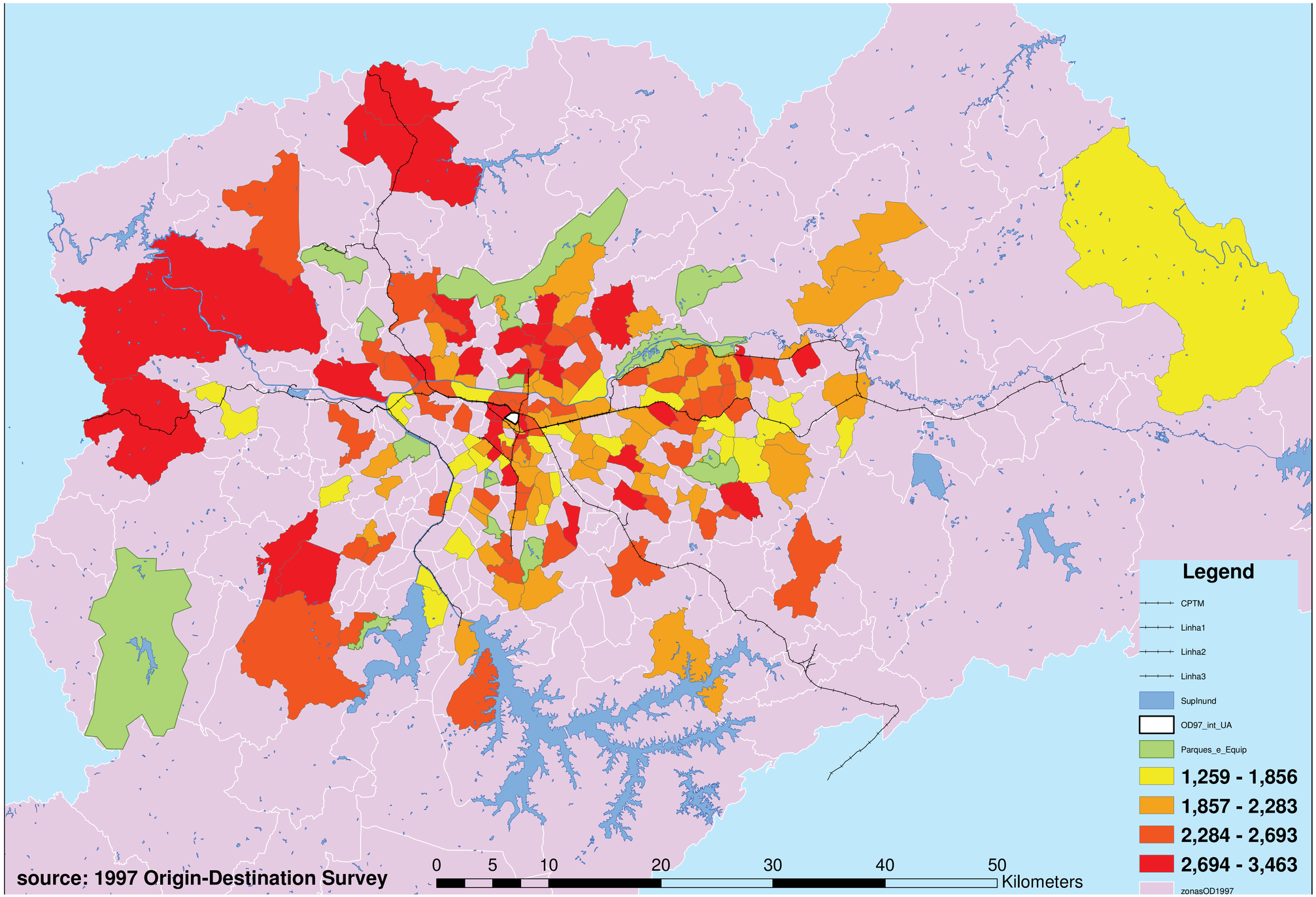






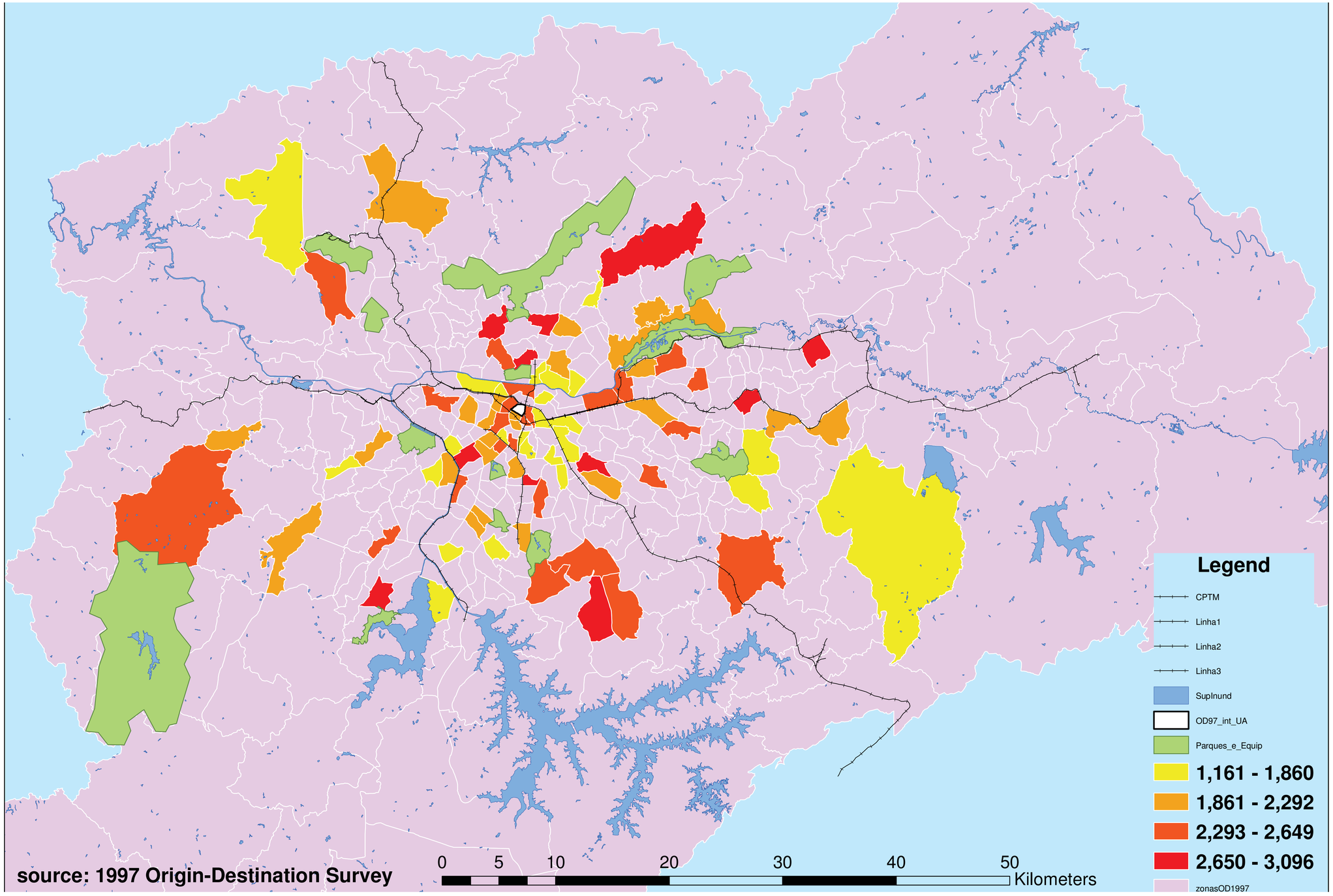
Impact on transport

Public transportation



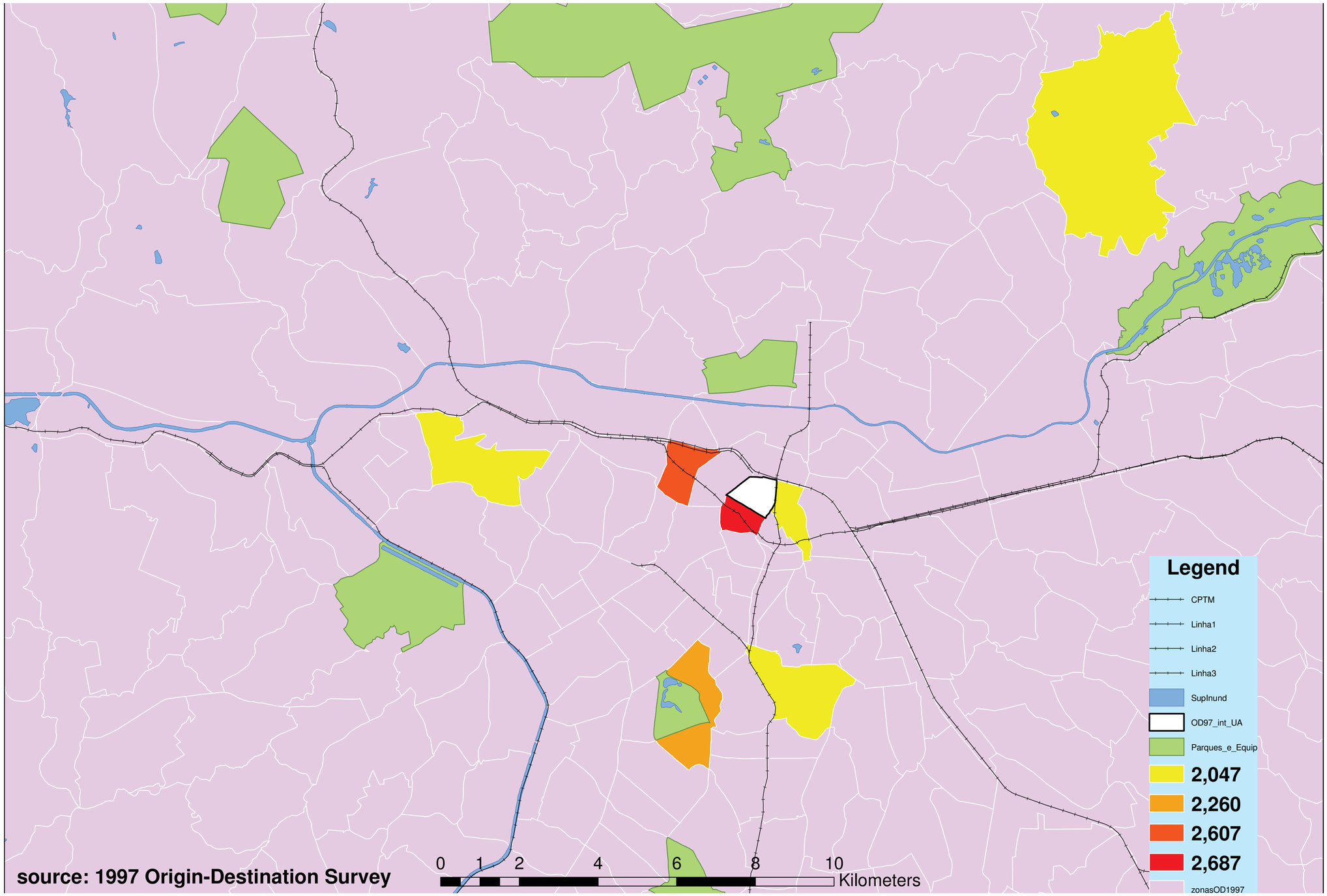
Impact on transport

Motorized individual transportation



Impact on transport

Pedestrian



Viability

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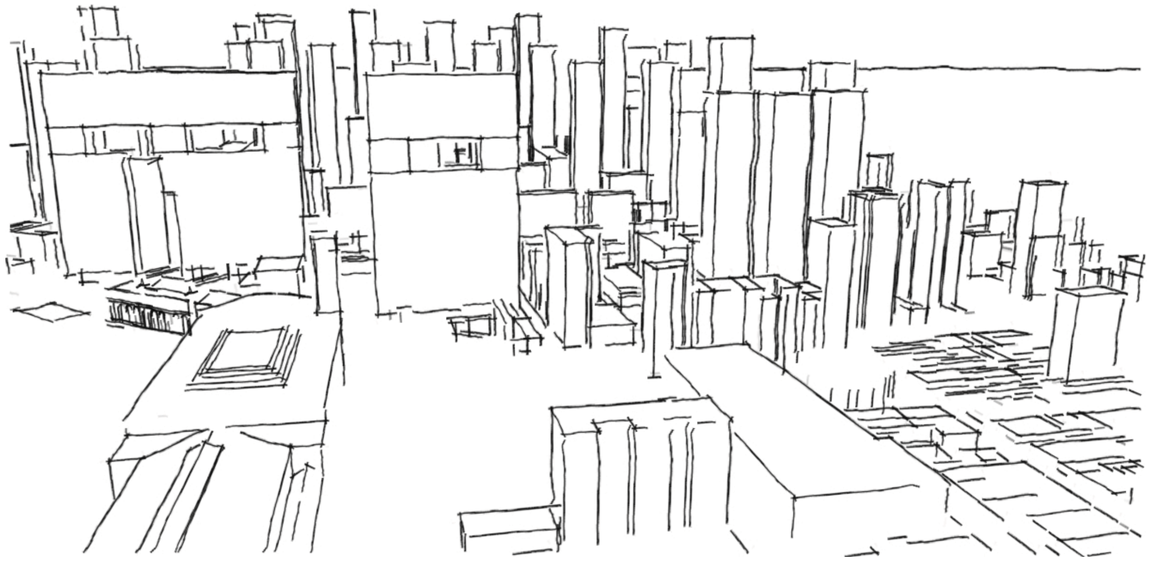

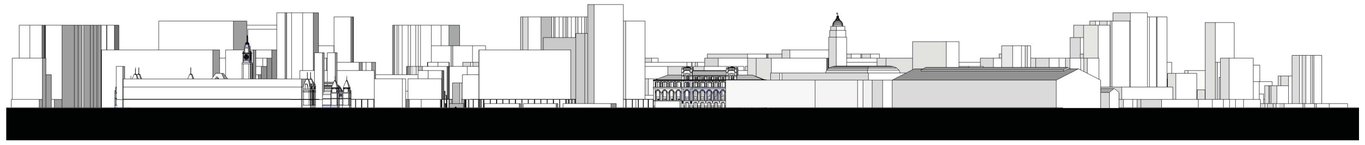

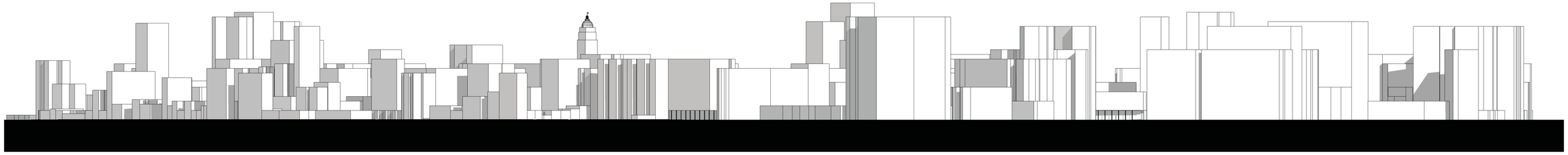

What remains the most difficult challenge?

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Vision

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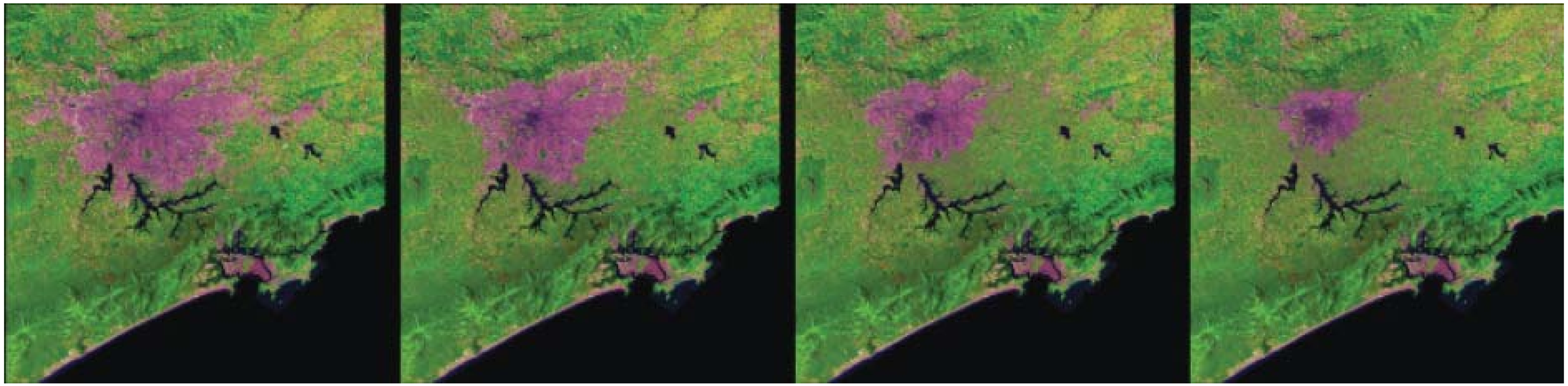

Design Team

ECO BUILDING FOR SÃO PAULO