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Appendix

The average shadow range on the building facades was estimated for simplified geometric models representative of the different UTCs. The geometric models were built using the morphology parameterisation used by the UWG (Bueno et al., 2013) and TEB (Masson, 2000) models, namely, a regular layout of square-plan buildings with the same height (Figure A1). The geometric relationships between the parameters of the Site coverage ratio and the Façade-to-site ratio of each UTC and the corresponding values of the side of the square-plan building (a) and the side of the square delimited by the facades of the surrounding buildings (b) were derived by Bueno (Bueno, Norford, Pigeon & Britter, 2011).

$$\text{Site coverage ratio} = \frac{a^2}{\left(\frac{a}{2}+\frac{b}{2}\right)^2}$$

$$\text{Façade-to-site ratio} = \frac{4a*\text{h}}{\left(\frac{a}{2}+\frac{b}{2}\right)^2}$$

$$\text{Avg Building Height} = \text{h}$$

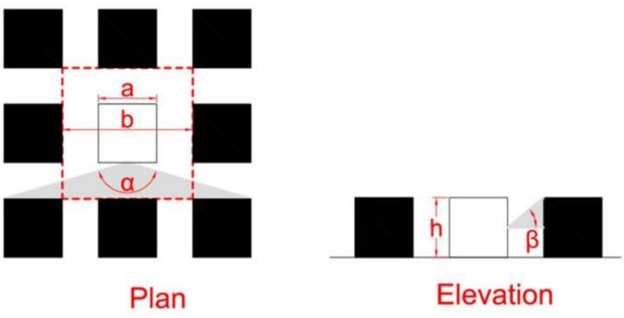

Figure A1. Method for the shadow masks calculation

The average shadow range was calculated on the central block of the grid, considering the obstruction angles α and β on the middle point of the façade. Ten shadow environments were considered because of the negligible variations of the obstruction angles among similar UTCs (Figure A2 and Table A1). In each geometric model of the UTC, the vertical obstruction angle β was calculated considering the height used for the energy models of each building type, namely, 6 m for the detached and terraced houses, 15 m for the apartment blocks and 60 m for the tall buildings. The BPS was conducted considering the same obstruction angles on all the façades.

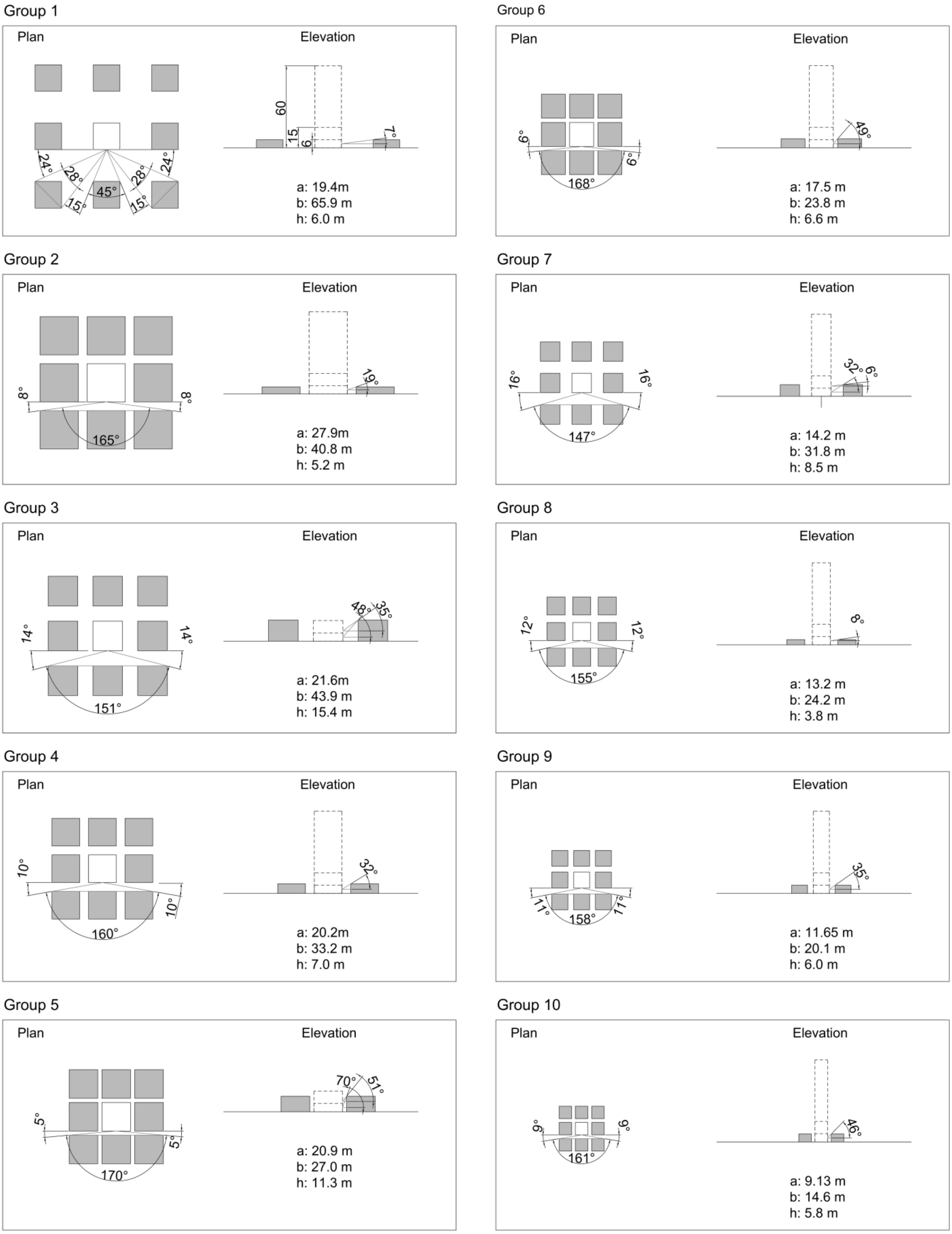

Figure A2. Groups for shadow masks

Table A1. Method for the shadow masks calculation

Shadow group	a	b	h	UTC
1	19.4	65.9	6.0	Antofagasta UT5; Lima UT6; Guayaquil UT5
2	27.9	40.8	5.2	Lima UT5
3	21.6	43.9	15.4	Antofagasta UT3; valparaiso UT3; Valparaiso UT4
4	20.2	33.2	7.0	Lima Ut4
5	20.9	27	11.3	Antofagasta UT1
6	17.5	23.8	6.6	Antofagasta UT2; Valparaiso UT1; Valparaiso UT2; Lima UT1; Lima UT2
7	14.2	31.8	8.5	Lima UT3
8	13.2	24.2	3.8	Guayaquil Ut4
9	11.65	20.1	6.0	Antofagasta UT4; Guayaquil UT2
10	9.13	14.6	5.8	Guayaquil UT1; Guayaquil UT3

The long-wave radiation exchange from the external surfaces to the atmosphere was calculated considering the effective sky temperature as a function of the ambient temperature, air humidity, cloudiness factor and local air pressure. The calculation was performed using the TRNSYS Type 69 (Klein et al., 2009).

For the rural context, the sky view factor of the building facades was set to 0.5. For the urban context, the sky view factor (SVF) of external walls was calculated based on the same geometric models used for shadow computations (Figure A2).

The ground temperatures for rural and urban environments were calculated according to equations 1 and 2, respectively (ASHRAE, 2009; O'Callaghan and Probert, 1977):

$$T_{ground} = T_{environemnt} + \frac{\alpha \times I_H - 100 \times \varepsilon \times (1-C)}{9.42 + 3.68 \times v} \quad (1)$$

$$T_{ground} = T_{urban\ environment} + 0.2 \times \alpha \times I_H \times svf \quad (2)$$

where:

v is the wind speed (m/s)

α is the solar absorption of the ground (0-1)

I_H is the total incoming radiation on the horizontal area (W/m^2)

ε is the emissivity of the ground (0-1)

C is the cloudiness factor (0-1)

svf is the sky view factor

In TRNSYS, the infrared radiation exchange between walls and the environment is considered to be uniform, i.e., all the surfaces that exchange radiation with the walls are assumed to be at the same temperature equal to the ground temperature; for this reason, the long wave interchange is assumed to be 0 in the urban case. In the rural environment, the long wave interchange is estimated to be 100 W/m^2, and the surface loss coefficient is approximately 20 W/m^{2}ºC, leading to a difference of 5 ºC between a high emissivity surface and the environment during a clear night (the temperature difference is 0 if the sky is cloudy).

In the urban environment, the absence of wind was assumed in the convective loss factor calculation; this is an acceptable assumption for urban areas with an average value of the ratio of building height to street width above 1 (Oke, 1988; Georgakis, & Santamouris, 2006; Di Bernardino, Monti, Leuzzi, & Querzoli, 2015). The average UHI effect was included in the BPS using the weather file generated by UWG for each UTC of each city (changes in temperature and humidity).

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