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INFLUENCE OF URBAN CANYONS ON INDOOR DAYLIGHT AVAILABILITY IN TROPICAL CLIMATES

INFLUÊNCIA DOS CÂNIONS URBANOS NA DISPONIBILIDADE DE LUZ NATURAL INTERNA EM CLIMAS TROPICAIS

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Abstract

This study investigates the influence of urban canyons on daylight availability in indoor environments in tropical regions. The analysis considered variations in canyon proportions (H/W ratios of 0.5, 1.0, and 2.0), solar orientations, Vertical Angle of Obstruction (VAO), and façade reflectances. Simulations were conducted using the TropLux software for a reference room placed in different canyon configurations, with façade reflectances of 0.900 and 0.427. The evaluation was based on the following metrics: Annual Average Illuminance (AAI), Spatial Daylight Autonomy (sDA), and Annual Solar Exposure (ASE). Results indicate that deeper canyons reduce daylight availability, although autonomy was achieved in all analyzed scenarios. Moreover, façade reflectances significantly influenced the available illumination, emphasizing their relevance in design strategies. Excessive levels of daylight were also observed in North, East, and West orientations, suggesting the need for appropriate daylight control strategies. In this context, the study highlights the influence of canyon geometry and façade reflectances on daylight availability, reinforcing their importance in the design of buildings for tropical climates.

Keywords: Daylight availability, urban canyons, H/W ratio, reflectance, tropical regions.

Resumo

Este estudo investiga a influência dos cânions urbanos na disponibilidade de luz natural em ambientes internos de regiões tropicais. A análise considerou proporções dos cânions (relações H/W de 0,5, 1,0 e 2,0), orientações solares, ângulo vertical de obstrução (AVO) e refletâncias das fachadas. Simulações foram realizadas com o software TropLux para uma sala de referência em diferentes configurações de cânions, com refletâncias de 0,900 e 0,427. A avaliação baseou-se nas métricas Iluminância Média Anual (EMA), Autonomia de Luz Natural Espacial (ALNe) e Exposição Solar Anual (ESA). Os resultados indicaram que cânions mais profundos reduzem a disponibilidade de luz natural, embora a autonomia tenha sido alcançada em todos os cenários. Além disso, as refletâncias influenciaram significativamente a iluminação disponível, ressaltando sua relevância para estratégias de projeto. Níveis excessivos de luz natural foram observados nas orientações Norte, Leste e Oeste, sugerindo a necessidade de estratégias de controle da iluminação. Nesse contexto, o estudo destaca a influência da geometria dos cânions e das refletâncias na disponibilidade de luz natural, reforçando sua importância no projeto de edificações em climas tropicais.

Palavras-chave: Disponibilidade de luz natural, cânions urbanos, relação H/W, refletância, regiões tropicais.

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INTRODUCTION

Urban canyons constitute fundamental components of the urban landscape, arising from the interaction between built volumes and urban roads (1). They result from the arrangement of two buildings with a defined height (H), flanking a central road (which may include setbacks or sidewalks), with a specific width (W) that indicates the distance between the faces of the buildings. The relationship between these dimensions, called the H/W ratio, defines distinct categories of urban canyons: avenue canyon (H/W < 0.5), regular canyon (H/W = 1.0), and deep canyon (H/W > 2.0) (2).

The investigation of urban canyons is crucial, as these structures directly influence multiple aspects of urban climates, including access to solar radiation, shadow formation, air circulation, thermal comfort, and the dispersion of vehicular pollutants (3). Aguiar et al. (1) conducted research connecting urban canyons to natural ventilation, concluding that canyons play a significant role in the orientation and intensity of wind flows, as well as impacting the temperature in the area between buildings. In another study, Muniz-Gäal et al. (4) focused on analyzing the implications of different H/W ratios on thermal comfort experience, revealing variations of up to 1.0°C between distinct configurations. Similarly, Drach, Krüger, and Emmanuel (5) demonstrated that the variability of daytime intra-urban temperatures is strongly related to both atmospheric stability and canyon morphology, with deep canyons tending to retain more heat compared to more open urban forms.

Another relevant aspect of urban canyons concerns the behavior of daylighting within these urban units. In tropical regions, the availability of sunlight is abundant, as is the energy consumption by buildings, making it imperative to study strategies that enhance the use of daylighting and, consequently, reduce the costs associated with electric lighting. Several investigations have demonstrated that canyon geometry and urban morphology strongly affect daylight availability, solar potential, and energy consumption. For instance, Strømann-Andersen and Sattrup (6) highlighted that dense canyon configurations can raise building energy demand by up to 30%. Petersen, Momme, and Hviid (7) advanced this discussion by developing a simplified assessment method for the early design stages, capable of estimating daylight levels and energy demand with good agreement when compared to Radiance simulations. Nasrollahi and Shokri (8) summarized decades of research on urban daylighting, emphasizing the role of orientation, reflectance, and canyon proportions. More recently, Rostami, Nasrollahi, and Khodakarami (9) presented a large-scale analysis showing that wide canyons may receive up to four times more solar radiation than narrow ones with dense vegetation.

In addition, specific parameters such as façade color, glazing area, and surface reflectance also influence the spectral characteristics and intensity of daylight within canyons. Šprah, Potočnik, and Košir (10) highlighted that façade coloration and window-to-wall ratio modify not only the intensity but also the spectral quality of daylight, with potential non-visual effects on occupants. Chen, Li, and Lou (11) developed a model to estimate irregular vertical sky components under different CIE skies, allowing a more accurate assessment of how obstructed façades in dense urban settings receive diffuse daylight. Mangkuto, Koerniawan, and Paramita (12) showed how canyon width and surroundings affect global illuminance and UV levels in tropical contexts. Carlos (13) proposed a simplified method to estimate daylight factors in canyon geometries. Hamzah and Lau (14) advanced an approach based on visible sky area to ensure minimum daylight provision in high-rise contexts such as Hong Kong. Abdollahzadeh and Biloria (15) developed a multi-objective evolutionary algorithm to optimize daylight performance simultaneously in urban spaces and building interiors, highlighting the relevance of integrated assessments that bridge urban morphology and architectural design. These studies demonstrate that orientation, canyon proportion, reflective surfaces, and obstruction angles are key determinants of daylight availability in urban environments.

In Brazil, research has also focused on this theme. Krüger and Suga (16-17) investigated height restrictions and aspect ratios for Curitiba, recommending planning guidelines to preserve daylight access in structural sectors of the city. Krüger and Dorigo (18) assessed daylight in standardized public school buildings, proposing adjustments in orientation and shading to improve luminous comfort. Santos, Auer, and Souza (19) analyzed dense tropical contexts in Cuiabá, showing that room depth is a key parameter for indoor daylight optimization.

Additionally, Laranja, Gazzaneo, and Cabús (20) investigated the effects of the height of obstructing buildings on the availability of internal daylight through the comparative analysis of Useful Daylight Illuminance (UDI) indices, applied to the city of Vitória-ES. For this investigation, sky types 3 (overcast), 7 (partly cloudy), and 12 (clear sky) were considered, as defined by the Commission Internationale de l'Eclairage, CIE (21). They concluded that as the height of obstructing buildings increases, the amount of accessible daylight within the evaluated spaces decreases. The authors emphasized the need to incorporate this aspect into urban planning guidelines.

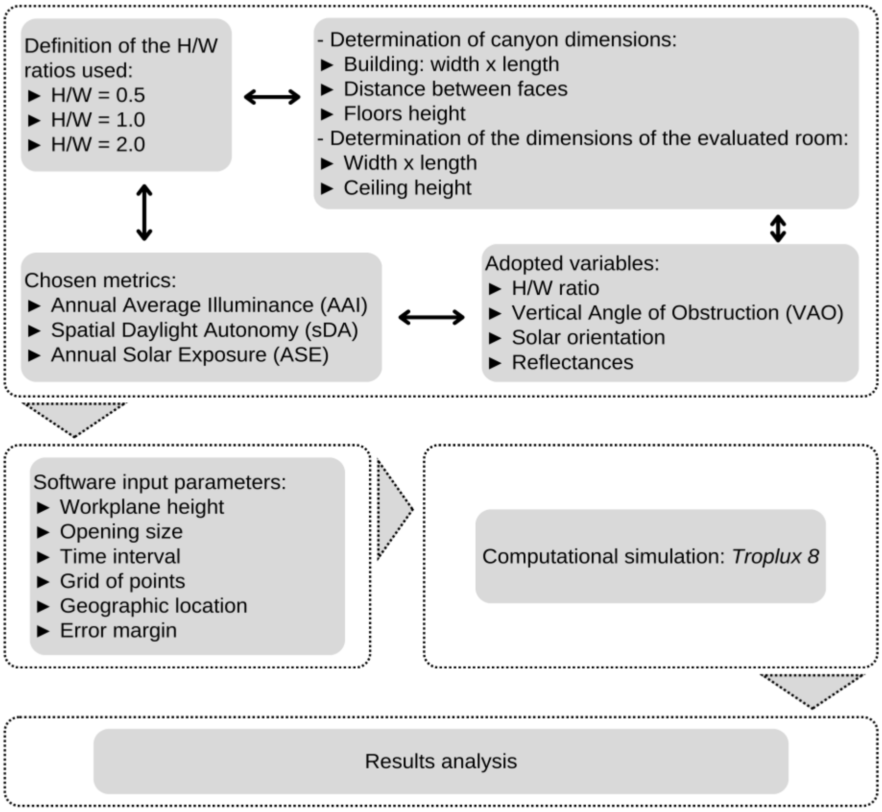
However, Araújo and Cabús (22) discuss how the built environment can enhance the entry of daylight into indoor spaces, even when shading devices are employed and modify the Sky Factor. The authors explore the increased contribution of reflected light, using the city of Maceió (Brazil) as a study scenario and simulations based on partly cloudy skies. They concluded that both the surrounding reflective surfaces and the orientation of openings need to be considered in the design phases in tropical regions. This highlights the validity of reflected light as a luminous source, reinforcing its relevance. Furthermore, they emphasize the importance of applying the insights gained from this investigation in the guidelines that outline urban planning.

Considering the above, the significance of studying urban canyons in their multiple configurations becomes evident for a more comprehensive understanding of their implications in urban areas. In this context, this research aimed to contribute to the body of knowledge by investigating how urban canyons influence the availability of daylight in indoor spaces in tropical regions, according to variations in the H/W ratio, the Vertical Angle of Obstruction (VAO), solar orientation, and the reflectance of external surfaces.

METHODOLOGICAL PROCEDURES

The methodological approach consisted of a comparative study of the lighting performance of models, using computer simulations conducted with the TropLux software (23) to obtain data that allowed investigating the influence of the determined variables. The approach was structured into seven fundamental steps, outlined in Figure 1 and detailed in the subsequent sections.

Figure 1: Flowchart of the methodological approach used in the investigation.

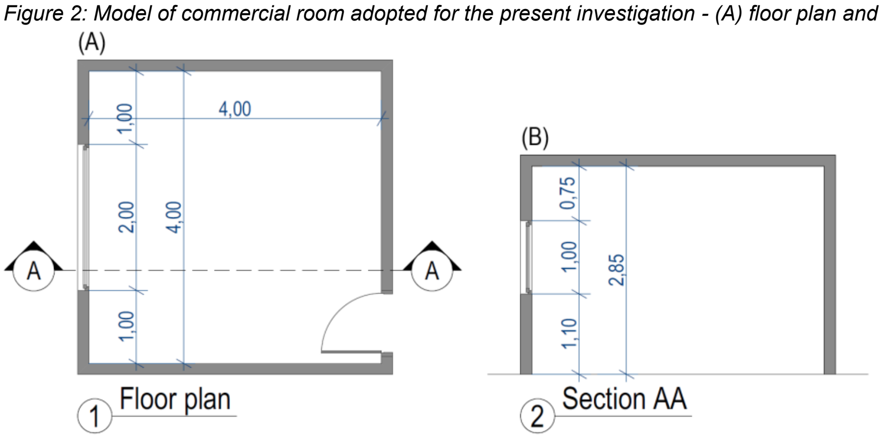


SIMULATED MODELS

The process began with the determination of the H/W ratios to be considered. According to the taxonomy developed by Afiq, Azwadi, and Saqr (2), three specific proportions were chosen: H/W = 0.5, 1.0, and 2.0, characterizing avenue or shallow canyons, regular canyons, and deep canyons, respectively.

Next, representative dimensions of a room in a standard commercial building in the city of Maceió (Brazil) were established. A square room measuring 4.00 m x 4.00 m, with a ceiling height of 2.85 m and a window facing the outside area oriented towards the urban canyon, measuring 2.00 m in width by 1.00 m in height and a windowsill of 1.10 m (Figure 2), was defined as the model.

Figure 2: Model of commercial room adopted for the present investigation - (A) floor plan and



The model room was inserted into a building with a commercial typology common in the city under study, hereafter referred to as Building (M), with five rooms oriented towards the urban canyon. The obstructing building, defined as Building (O), was positioned 12.00 m from Building (M), measured between their façades. In the present investigation, the central room highlighted in red was adopted because it receives the highest influence from the obstruction. A schematic visualization of this situation is summarized in Figure 3.

Figure 3: Schematic floor plan of the model building and the obstructing building.

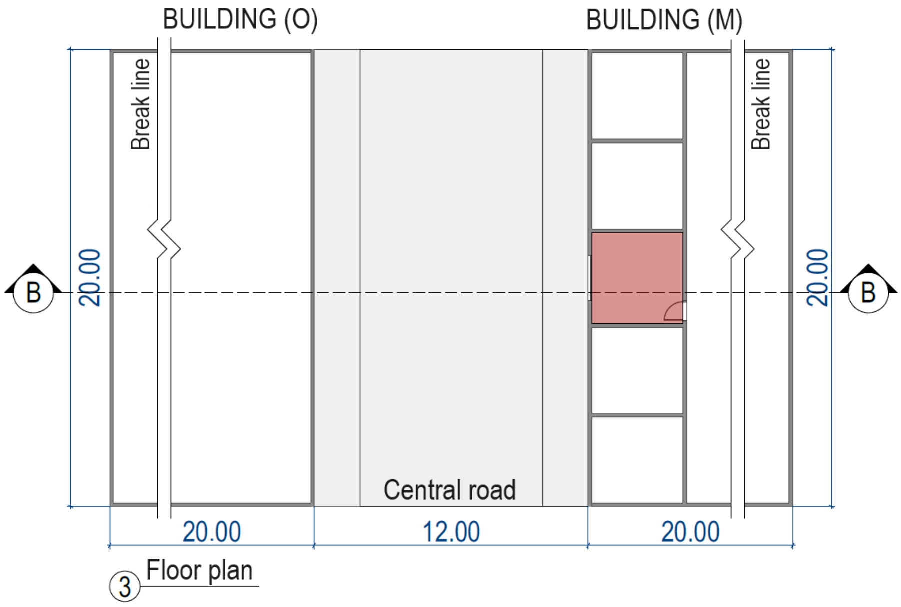
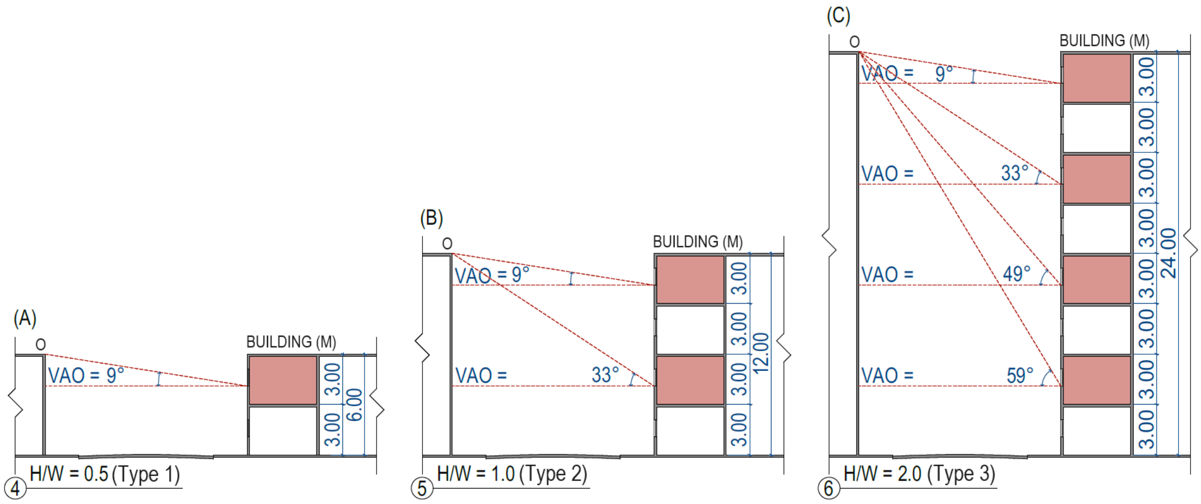


Figure 4 shows the three urban canyon configurations considered in the present investigation. In the avenue or shallow canyon configuration, buildings have two floors, totaling 6.00 m in height (Figure 4A). In this scenario, only the central room located on the 2nd floor was analyzed. In the regular canyon, buildings are 12.00 m high, with four floors (Figure 4B). In this scenario, the central rooms on the 2nd and 4th floors were analyzed. Finally, in the deep canyon configuration, buildings are 24.00 m in height, with eight floors each (Figure 4C). In this scenario, the central rooms on the 2nd, 4th, 6th, and 8th floors were analyzed. The analysis of alternating floors was performed to optimize computational simulation time and the volume of generated data.

Figure 4 also presents the Vertical Angle of Obstruction (VAO) of the respective openings, measured from the windowsills of the analyzed floors. The VAOs are directly influenced by the distance between faces, the height of the windowsill, and the height of the obstruction.

Figure 4: Urban canyon configurations considered in the investigation - (A) avenue or shallow canyon (H/W = 0.5); (B) regular canyon (H/W = 1.0); and (C) deep canyon (H/W = 2.0).



For each urban canyon configuration, two variations of reflectance for the façades of the model building (M) and the obstructing building (O) were considered, a higher and a lower one (rA = 0.900 and rB = 0.427). The reflectances were defined based on the specification of matte acrylic paints from the manufacturer Suvinil, in the colors Snow White and Suede (24), respectively. The adopted values are similar to those reported by Danieleski, Oliveira, and Medeiros (25), with r = 0.9047 for a polished white porcelain tile and r = 0.4549 for a satin gray porcelain tile. The different reflectances were combined, generating four analyzed situations (Table 1).

Table 1: Combination of reflectances on the façades of both buildings.

Scenario	Reflectances	
	Model building (M)	Obstructing building (O)
MAOA	0,900 (MA)	0,900 (OA)
MBOA	0,427 (MB)	0,900 (OA)
MAOB	0,900 (MA)	0,427 (OB)
MBOB	0,427 (MB)	0,427 (OB)

Finally, for each of the three urban canyon configurations combined with the two different reflectances, variations regarding the orientation of the opening were analyzed, considering South, West, North, and East orientations, totaling 48 simulated scenarios.

To facilitate understanding and make it easier to identify each situation, a code was created and structured as shown in Table 2:

Table 2 - Construction of the code for model identification.

Variables	Acronyms
Canyon type	T1 = avenue or shallow type canyon T2 = regular type canyon T3 = deep type canyon
Floor	F2 = 2nd floor F4 = 4th floor F6 = 6th floor F8 = 8th floor
Reflectance combination	MAOA = r_A 0,900 (M) - r_A 0,900 (O) MBOA = r_B 0,427 (M) - r_A 0,900 (O) MAOB = r_A 0,900 (M) - r_B 0,427 (O) MBOB = r_B 0,427 (M) - r_B 0,427 (O)

Thus, the scenario T1-F2-MAOA, for example, corresponds to a shallow canyon type, room analyzed on the 2nd floor, with model and obstructing buildings having an external reflectance of 0.900.

ANALYZED METRICS

The metrics chosen to enable the analysis of the influence of urban canyons on daylight availability inside the studied environment were: Annual Average Illuminance (AAI), Spatial Daylight Autonomy (sDA), and Annual Solar Exposure (ASE).

AAI consists of the average illuminance of the points contained in an established work plane, measured every day of the year at a specific instant. The analysis time interval is 10 hours daily, and for the tropical region, the interval considered is from 7 a.m. to 5 p.m. It is a very interesting metric for comparative studies.

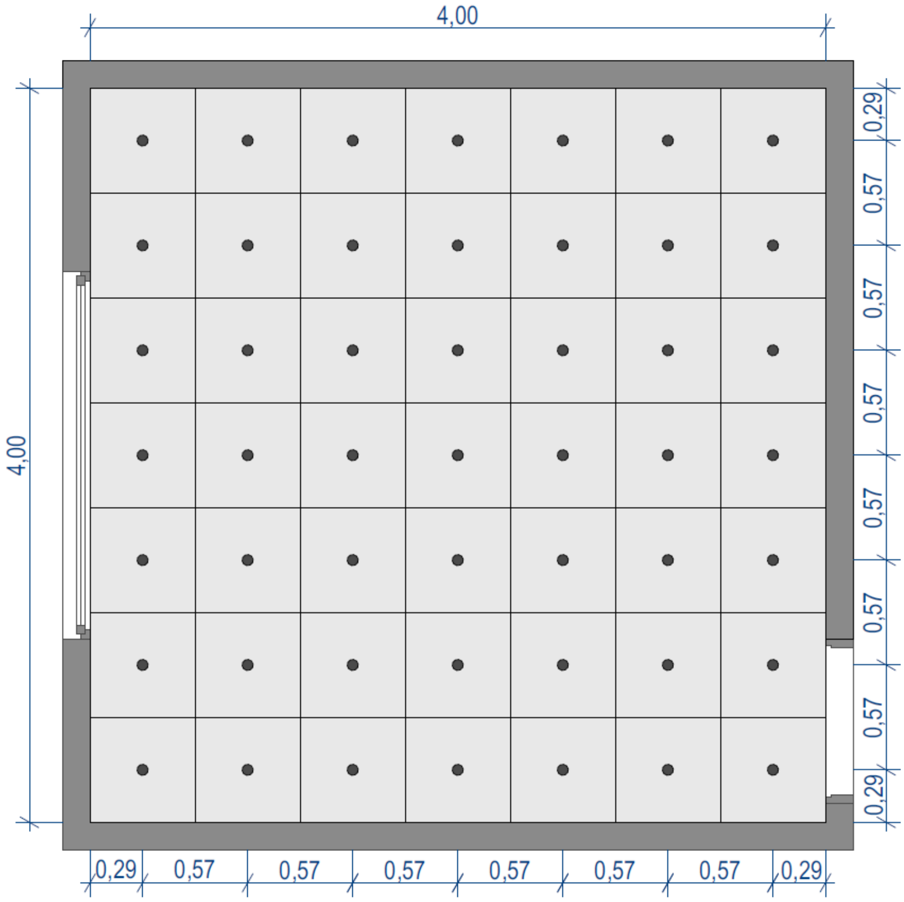
sDA evaluates the percentage of the area within the analyzed room that achieves a minimum illuminance value over a specific interval. The American standard LM-83-12 (26) stipulates that the autonomy percentage should be at least 50% of the area, that the minimum illuminance value should be 300 lx, and that the analyzed interval should be 10 hours daily throughout the year. The standard also proposes two classifications: favorable or preferred – for a result of 75% or more of the area, and neutral or acceptable – for more than 55% of the area.

ASE quantifies the potential discomfort caused by excessive direct sunlight, above a threshold of illuminance limit and time interval, incident in the room. This metric determines the percentage of area that surpasses 1000 lx for more than 250 hours per year (26). The analysis interval for ASE is the same as proposed for AAI and sDA, 10 hours per day for 365 days. Its classification varies into three levels: unsatisfactory, ASE > 10%; neutral, ASE < 7%; and acceptable, ASE < 3%.

PARAMETERS OF THE COMPUTATIONAL SIMULATION

For data input into the software, some parameters were fixed. The work plane has the same height in all analyses: 0.75 m from the floor of each level. The internal reflectances adopted were: 0.30 for the floor (22), 0.90 for the ceiling, and 0.86 for the walls, considering these latter surfaces painted with matte paints from the manufacturer Suvinil in the color Snow White, acrylic and PVA type, respectively (24). The geographical location chosen for the study was the city of Maceió (Brazil), whose geographical coordinates are Latitude 9° 40' S and Longitude 35° 42' W. Both the time interval (10 hours daily, from 7 a.m. to 5 p.m., throughout the year) and the grid of points used (7x7) were defined based on LM-83-12 (26). The indicated grid of 7x7 totals 49 uniformly distributed points, as shown in Figure 5.

Figure 5: Grid of points.



The Dynamic Luminance Distribution (DLD) sky model was adopted as it closely approximates reality. This sky model results from the combination of the most probable sky types occurring during the analyzed times and days at a specific location. This determination is automatically performed by the TropLux software (23). The error of the diffuse component adopted in the processing was 5%. The settings are summarized in Table 3.

Table 3: Input parameters for computational simulation in TropLux software.

Parameters	Data
Workplane height	0.75 m
Reflectances	Floor: 0.30 | Ceiling: 0.90 | Walls: 0.86
Geographic location	Maceió 9º 40’ S / 35º 42’ W
Time interval	10 h/day, 7 a.m. to 5 p.m., 365 days/year
Grif od points	7x7
Sky type	DLD

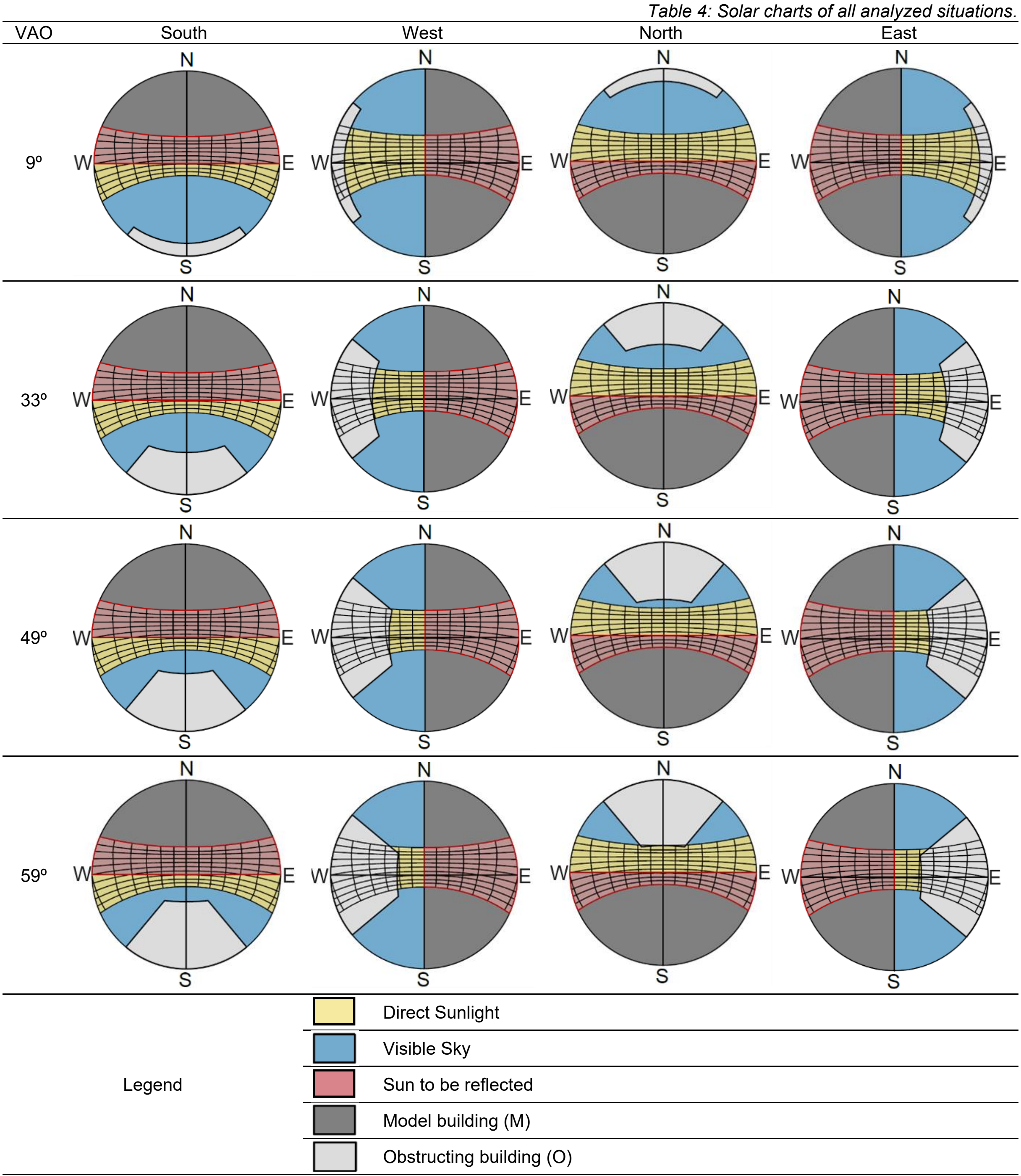
RESULTS AND DISCUSSION

The first analysis was conducted using solar charts presented in Table 4. These charts were developed with the information defined in the methodology stage. The VAO increases as the analyzed floor level decreases, which results in a larger obstructed area and, consequently, a smaller visible sky area, indicated by the Visible Sky Factor (VSF).

It is noted that in the South orientation, building O (obstructive) did not interfere with the direct sunlight component incident in any situation. In the North orientation, this behavior repeated from 9º to 49º, but when the VAO reached 59º (on the 2nd floor of the Type 2 situation, H/W = 2.0), there was a slight obstruction.

In the West and East orientations, building O obstructed direct sunlight in all analyzed situations, resulting in a reduced amount of daylight reaching the studied environment. The lower the floor level, the lower the Visible Sky Factor (higher the VAO), and consequently, the lower the illuminance level.

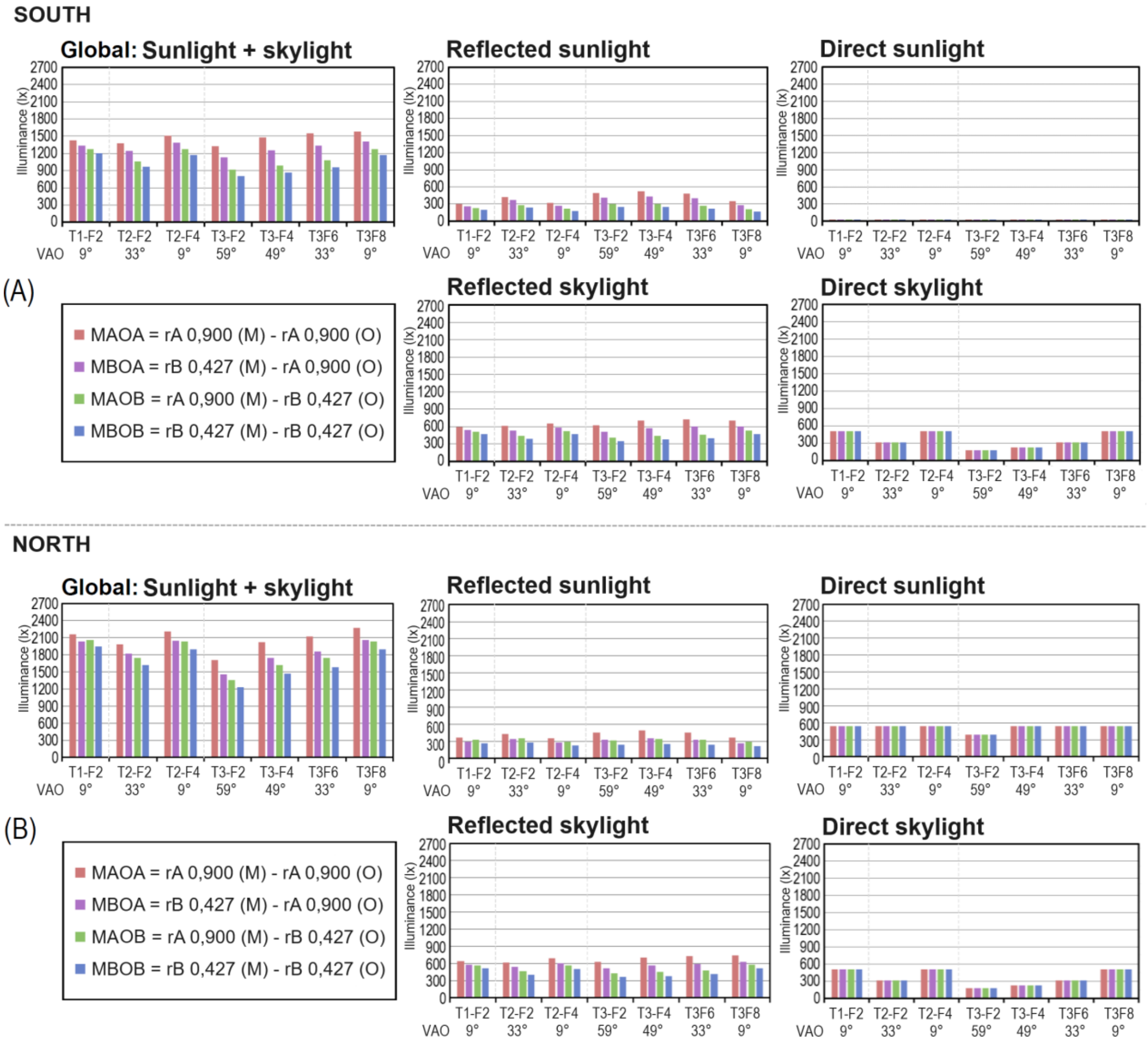
Table 4: Solar charts of all analyzed situations.



Annual Average Illuminance (AAI)

Figure 6 presents the AAI values for the South and North orientations. Evaluating the global AAI values in the graphs, it is possible to notice that daylight availability decreases as the canyon becomes deeper; higher floors show higher illuminances due to the greater VSF and lower VAO. For the same reason, in all situations, direct skylight decreased as the VAO increased.

Figure 6: AAI in the South (A) and North (B) orientations.



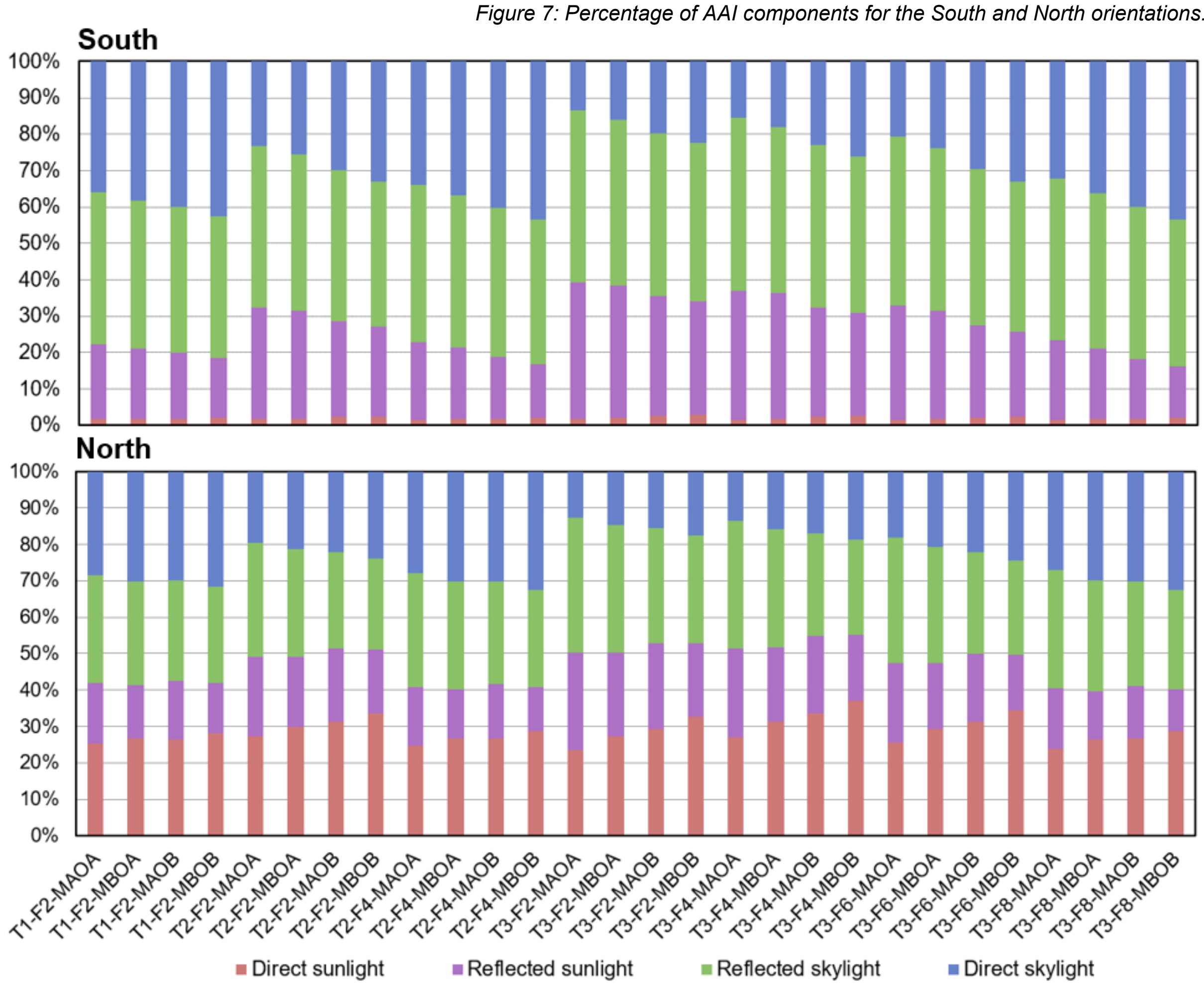
The direct components of light from the sky and the Sun remain constant across all combinations of reflectances, as the illumination received in this case is not influenced by the materials used on building façades.

In the South orientation, the values of direct sunlight were constant in all situations, as none of the VAOs were sufficient to obstruct this component. In the North orientation, direct sunlight values were also constant in the avenue and regular canyons; however, the 2nd floor of the deep canyon, T3-F2, received less direct sunlight, indicating obstruction, according to the analysis of the solar charts (Table 4).

The reflected components of the sky and the Sun show the highest variations. The deep canyon graphs show a tendency for the reflected components to be higher on the intermediate floors. Similarly, on the 4th and 6th floors, the greatest differences between the most extreme reflectance situations, MAOA and MBOB, are recorded.

Figure 7 presents the contributions of each component to the global AAI values for the South and North orientations.

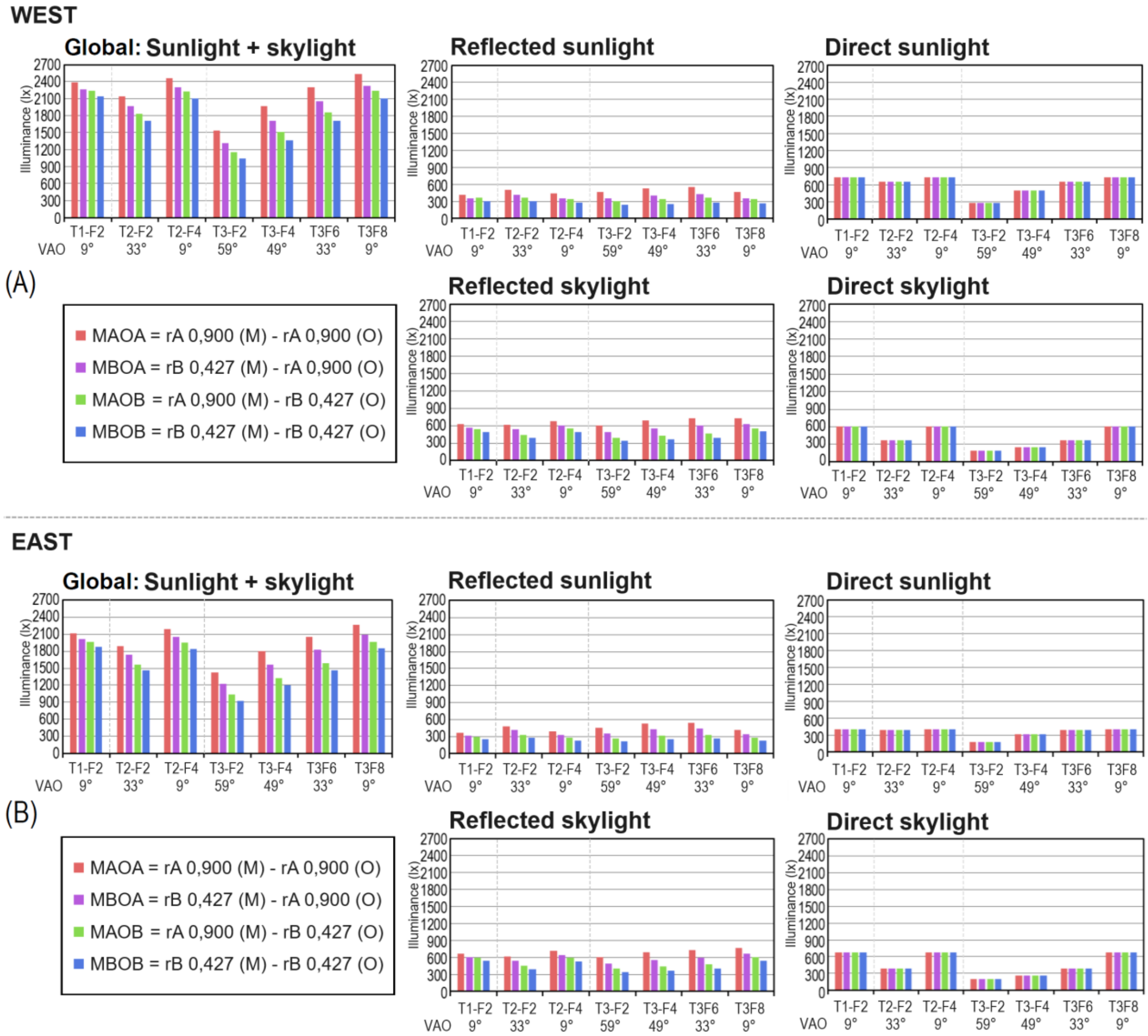
Figure 7: Percentage of AAI components for the South and North orientations.



It is noticeable that when both buildings have a reflectance of 0.900, the reflected components are greater than when the obstructing building has a higher reflectance than the model building, clearly indicating the importance of choosing materials for both façades, as the reflections occur mutually and ad infinitum (3). The higher the VSF, the more noticeable the contribution of the direct skylight component. Direct sunlight has little influence on the South, less than 5%, while in the North orientation, it contributes approximately 30% to the global AAI. It is noted that on the 8th floor of the deep canyon with both buildings having a reflectance of 0.427 (T3-F8-MBOB), more than 80% of the received illumination comes from sky components in the South orientation, whereas in the North orientation, sky components represent 60% of the global AAI.

Figure 8 presents the AAI values for the West and East orientations.

Figure 8: AAI in the West (A) and East (B) orientations.



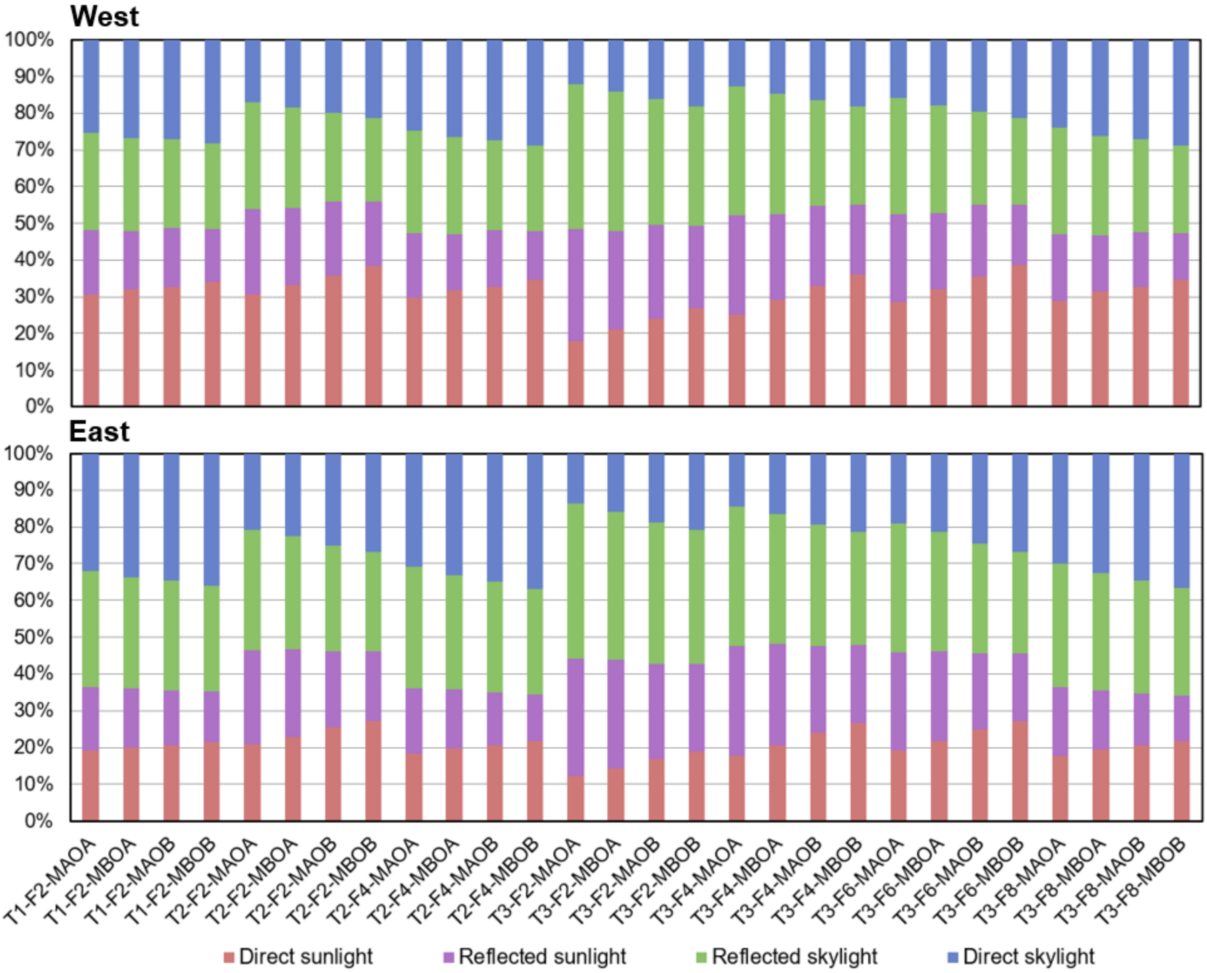
The behavior of the AAI in the West and East orientations is generally similar to that of the South and North. One particularity is that these orientations receive more daylight due to the low angles of incidence, making the global values considerably higher than the previously presented values, reaching approximately double in some situations.

As mentioned in the analysis of the solar charts, the obstructing building blocked a portion of the direct sunlight for all VAOs in the West and East orientations. Thus, it is possible to observe that the values of this component differ from those in the previous orientations for almost all cases, except when they have the same VAO and VSF; in this situation, they remain the same.

Once again, there is a tendency for the values of the reflected components to be higher on the intermediate floors (4^{th} and 6^{th}), where the most significant differences between the reflectance combinations were also recorded.

Figure 9 presents the contributions of each component to the global AAI values for the West and East orientations.

Figure 9: Percentage of AAI components for the West and East orientations.



Analyzing the contributions to the global AAI, a balance is observed between the sum of the sky-related components and the Sun-related components in the West orientation, both contributing around 50% to the global value. In the East, the contributions of the sky components are slightly higher and direct sunlight is lower, altering this proportion. In both East and West orientations, in the T3-F2-MAOA situation, approximately 70% of the global illuminance comes from reflected light.

A comparison between Figures 7 and 9 shows that daylight behavior is strongly influenced by orientation. In the South, direct sunlight contributes less than 5% due to the solar path at the study latitude (9° 40' S), so daylight availability depends mainly on skylight and reflections. In the North, direct sunlight reaches about 30%, reducing the relative share of other components. East and West orientations present a more balanced distribution. Low solar angles in the morning and afternoon increase both direct exposure and reflection. In the West, skylight and sunlight contributed in similar proportions. In the East, skylight has a slight predominance. These differences can be explained by solar geometry, which defines the potential for direct sunlight incidence; by canyon geometry (VAO and VSF), which determines the level of obstruction; and by façade reflectances, which significantly affect the availability of daylight.

A statistical analysis was conducted to identify the influence of each studied variable on the AAI values. First, two hypothesis tests were applied to verify if the samples met the necessary assumptions for conducting the analysis of variance (ANOVA). The Shapiro-Wilk test was applied to check sample normality, considering the sample normal if the p-value was greater than the significance level of 5%. According to Table 5, all samples obtained p-values higher than 5%, indicating a normal distribution. Next, the Bartlett test was applied to verify homoscedasticity, considering that the samples met the homoscedasticity conditions when the p-value was higher than the significance level of 5%. Table 5 also presents the p-values obtained from the Bartlett test.

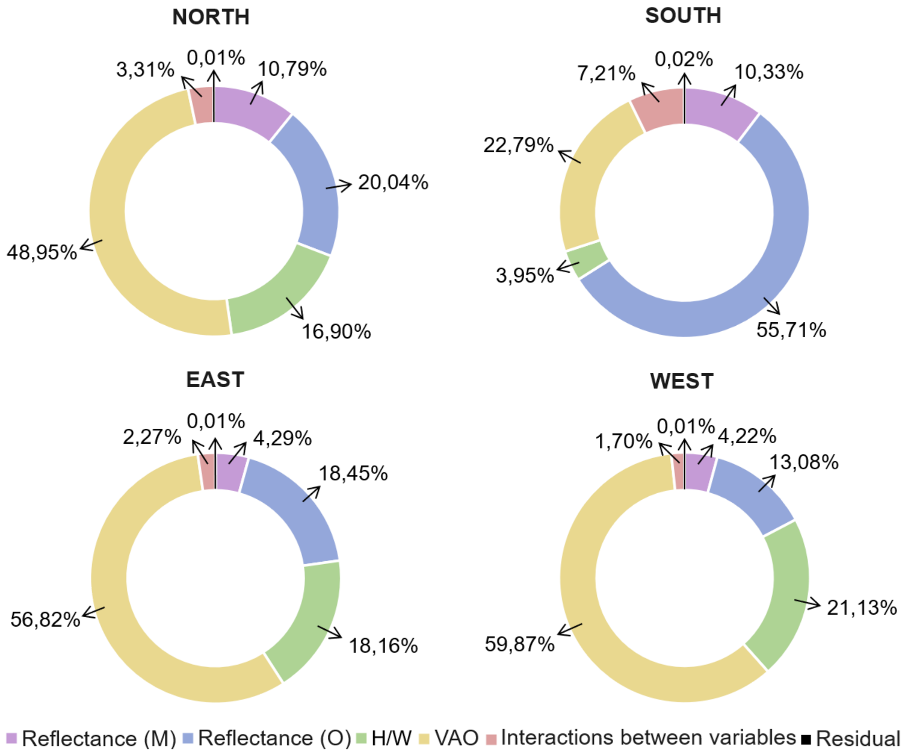
Table 5: Results of normality (Shapiro-Wilk) and homoscedasticity (Bartlett) tests.

Orientation	Normality (p-value)	Homoscedasticity (p-value)			
		Reflectance (M)	Reflectance O)	H/W	VAO
North	0.28	0.96	0.57	0.08	0.37
South	0.62	0.72	0.39	0.20	0.31
East	0.17	0.97	0.60	0.05	0.38
West	0.08	1.00	0.66	0.02	0.40

Of the sixteen hypothesis tests for the homoscedasticity of the samples, only the H/W variable in the West orientation showed a p-value less than 0.05. According to Lix, Keselman, and Keselman (27), it is possible to obtain a valid null hypothesis test in ANOVA when the degree of variance heterogeneity is small and the group sizes are equal. Thus, it was decided to proceed with the application of ANOVA.

ANOVA revealed that all variables considered in this study were significant, and the percentage contribution of each variable to the values of AAI can be seen in Figure 10. These values were calculated by dividing the sum of squares of each source of variation in the ANOVA by the total sum of squares.

Figure 10: Contribution of each variable to the AAI.



In the North, East, and West orientations, the variable that most influenced the AAI values was the VAO, followed by the reflectance of the obstruction in the North and East, and the H/W ratio in the West, as shown in Figure 10. This behavior can be explained by the significant proportion of direct sunlight in the AAI values in these orientations (Figures 7 and 9). The obstruction of part of the sky by the obstructing building directly impacts the amount of direct light, especially direct sunlight, which is more available in these orientations due to solar geometry reasons (Table 4).

On the other hand, in the South orientation, the variable that most influenced the AAI values was the reflectance of the obstruction, followed by the VAO, as shown in Figure 10. In this orientation, the portion of direct sunlight is small, with the direct sky and reflected components being more significant (Figure 7). The results of the contribution of each variable indicated that reflectances accounted for approximately 66.04% of the variation in AAI values.

Spatial Daylight Autonomy (sDA)

All studied situations presented sDA = 100%, a result considered favorable or preferable according to the classification stipulated by LM 83-12 (26). This unanimous result indicates that even in the situation with the higher influence of obstruction — the deep canyon — the analyzed room achieved the recommended autonomy.

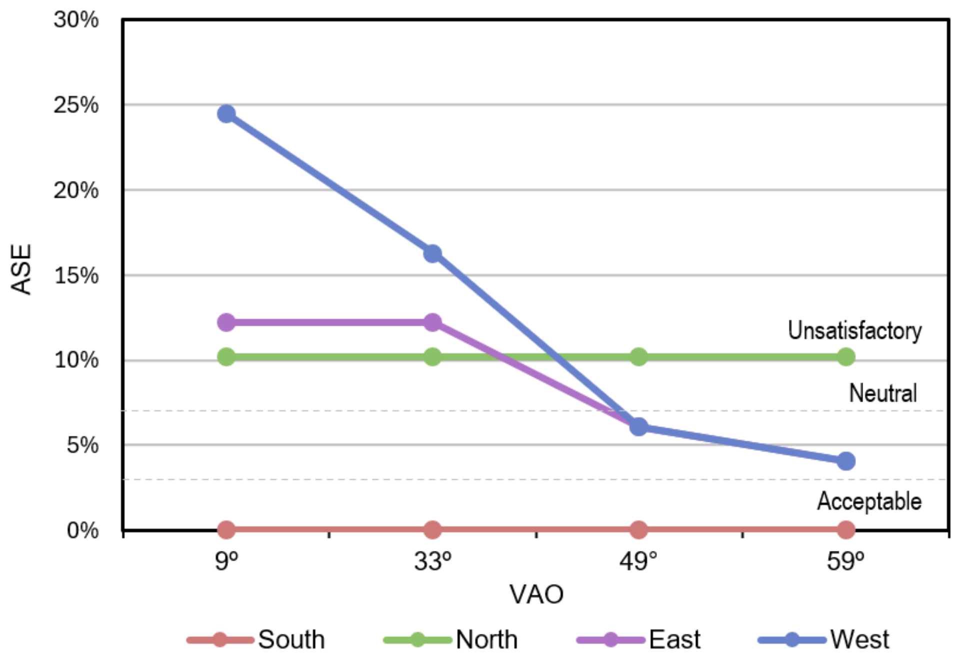
However, evaluating autonomy alone is not enough to indicate that the room will meet the needs of its users. Despite the favorable sDA, it is possible that autonomy is being achieved with excessive incident light levels, potentially causing discomfort. For this reason, it is also relevant to evaluate the ASE.

Annual Solar Exposure (ASE)

ASE, which evaluates only the direct sunlight component, is not influenced by reflectances; therefore, the values are the same for all combinations of reflectances. What directly affects its values are the obstructions, which are directly related to the analyzed floor level, VSF, and VAO, so that for equal VAO values, ASE is equal. Accordingly, all top floors present identical values, as their VAO values are the same — as do the 2nd floor of the regular canyon and the 6th floor of the deep canyon.

Except for the South orientation, some excess direct sunlight was observed in all other situations. According to Figure 11, in the North orientation, the unsatisfactory result (greater than 10%) occurred in all scenarios. The behavior for the East and West orientations is quite similar: for VAO values of 49º and 59º, the levels are below the neutral limit (less than 7%), while on the higher floors (VAO values of 9º and 33º), both orientations showed unsatisfactory results — with the highest percentages in the West orientation. The results indicate that in the deep canyon situation, the 2nd and 4th floors were somewhat protected from excessive direct sunlight exposure by the geometric configuration itself, in which the obstructing building partially blocks direct sunlight from reaching these floors.

Figure 11: ASE in all orientations.



FINAL CONSIDERATIONS

Regarding the evaluation of daylight availability influenced by urban canyons, it was expected that daylight availability would decrease due to building obstructions. This initial hypothesis was confirmed by the results obtained in the AAI, which showed the influence of canyon depth on the availability of daylight inside the building.

However, a quite interesting phenomenon occurred when reflectances were also considered in the analyses. It is noted that this property can be used as a mechanism to control the resulting daylighting inside buildings. The results show that increases of up to 50% occurred in the reflected component when varying the reflectance of façade materials. It was also observed that the influence of the obstructing building's façade material is greater than that of the model building's material, although both are important. This reinforces the importance of material choices not only for aesthetic reasons but also for considering the surroundings and specificities of each project from the perspective of daylighting.

Furthermore, the results of the statistical analysis indicated that, among the variables studied, the one that most influenced the AAI values for the North, East, and West orientations was the VAO. In the South orientation, the variable with the greatest influence was the reflectance of the obstruction.

For the tropical scenario studied, the sDA results indicate that daylight autonomy was achieved according to LM-83-12 (26) criteria. However, the ASE shows an excess of direct solar illumination in most situations. Thus, not only did the deep canyon configuration achieve the minimum required illumination even on lower floors, but there was also an excess of light in the North, East, and West orientations — indicating the need to protect openings by reducing direct solar incidence in the studied room.

Similar analyses with specular reflectances are a suggestion for future work, as well as studies on deeper canyons, higher VAOs, in different locations, and other solar orientations. The importance of the results from this and similar studies lies primarily in their contributions to guiding future design decisions, not only optimizing the use of daylighting but also mitigating its negative effects — both at the level of individual urban units and across entire cities — through the application of findings in the development of urban design regulatory instruments.

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