Parametric Modeling in the Coastal Brazilian Cityscapes: Case Study of Balneario Camburio, Santa Catarina, Brazil

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Abstract: The Paramedic Modeling research group from the Federal University of Minas Gerais (UFMG), in cooperation with the Geo-processing Laboratory group from the State University of Santa Catarina, among other collaborators, seeks to analyze and graphically decode the urban landscape proposed by different, but converging, Brazilian municipalities' urban laws. Throughout the years, the former research group has concentrated its interests and research efforts into applying parametric modeling to simulate the impact of the urban laws in multiple Brazilian cityscapes using ESRI®'s software *CityEngine*. In this series of case studies, the emphasis was placed in middle to large-sized coastal cities. Recife, Fortaleza and Balneario Camboriu were chosen for their local and regional relevance and, as well as, for the rapid changes currently unfolding in their coastal skylines. Furthermore, the presence of group representatives in direct contact with the urban reality in those municipalities and the ease in acquiring geo-referencing data for analysis were also taken into consideration when choosing those towns. This article, however, will only concern itself with the case study of Balneario Camboriu, since the other cases will be presented in parallel articles.

The municipality, at stake, is located at the northern shore of the state of Santa Catarina and 80km from Florianopolis, the capital and most preeminent city in the state. Recognized nationally and internationally as a touristic hotspot in the region, Balneario Camboriu has seen a surge in demand for vacation housing, which in turn has increased real estate speculation. In combination with a perfunctory and complacent urban planning to market demands, the central coastal cityscape of Balneario Camboriu is rapidly verticalizing, imposing a burden on the native inhabitants and the municipality's natural environment; the latter is the major responsible for the touristic allure of the place. One of the direct consequences of this increase in verticalization can be felt by tourists and natives alike when the clock tick 14 o'clock and the tall buildings cast their invasive shade upon the beachfront and beachgoers. Considering this alarming situation, the group developed a rule for *CityEngine* with the purpose of aiding locals to better visualize and comprehend the future impacts the new developments will bring to their cityscape and shorefront if the current urban laws is left in place.

The urban region chosen for analysis is located two blocks inland from Praia Central, the main stretch of beachfront in this touristic city, between Atlantica Avenue and Brasil Avenue, extending across the following secondary streets: 2200 St, 2018 St, 2206 St., 2300 St, 2308 Str, 2400 St., 2450 St., 2480 St., 2414 St., 2412 St. And 2500 St. The selection of this parcel of land was motivated by its rapid redeveloped and verticalization, which is impacting natural ventilation, saturating its street network and permanently shading large portions of the beach right across from it.

Before simulating the cityscape being encouraged by the current urban laws, it was necessary to grasp the nuances of the existing built environment. For that, local parcel data, as well as the projected shape of the already built superstructures, were collected with city authorities. An algorithm was developed which primary read the height for each building feature from its attribute table in other to generate the built landscape. Therefore, the rule to graphically recreate this built environment is relatively simple and straightforward, making it easy to replicate for other municipalities with up-to-date cadastral registry.

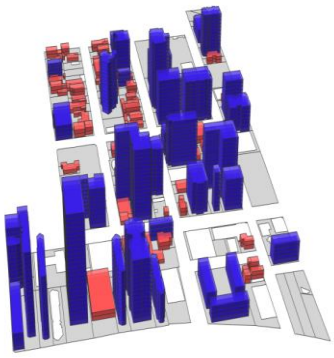

Figure 1. Simulation of the built environment according to data from 2010 (Balneario Camboriu, Santa Catarina, Brazil).

In order, however, to visualize the future cityscape proposed for the aforementioned seafront, it was paramount to first comprehend the local urban law and its legal tools and parameters. Once the team mastered the intricate zoning and urban parameters in place, a more complex algorithm was developed. The aim with this *CityEngine* rule was to once again be effortlessly replicable in other case studies, given that one of the broad research goals of the group is to explore mechanisms upon which ordinary citizens can rely to visualize the diverse cityscapes being proposed around the country. With those mechanisms the group hopes to facilitate ordinary people's comprehension of these intricate urban laws in order to be able to critically and politically evaluate them.

Nevertheless, interpreting the law and its parameters was anything but simple, which hindered at first the group's capacity to translate the scope of the law to a all-encompassing *CityEngine* rule. The difficulty emerged from the lack of a parametric logic in the city's defined parameters – a sorrowful oxymoron. As an example, instead of basing its front setbacks on a street hierarchy, the municipality chose, against all odds, to base those setbacks according to the specific streets a lot is facing. In other words, the city has compiled a list of all the streets comprising its urban area to which it has assigned varying degrees of setbacks without a formal logic to it. Thus, it is not possible to deduce a correlation between street sections, or for that matter, any other street characteristic, and the setbacks

required.

Since the frontal setback varies according to the street facing the plot, the group regarded as necessary that manipulations be made to the data acquired with the municipality; the changes made allowed *CityEngine* to be able to apply different frontal setbacks for the same plot of land. Since the decoding of the law proceeded that way, some generalizations were required, which not only rendered the rule more replicable, but also reduced the high number of street cases to just three. Thus, the streets were reclassified in three categories, with the two major roads (Atlantica Av. and Brasil Av.) retaining its significance, and the rest being categorized into the broad category of local roads.

With the parameterization of frontal setbacks dealt with, the next step consisted of defining the plots of land suitable for building. According to the law, the lots must have areas bigger or equal to 250m^2 to meet that criterion.

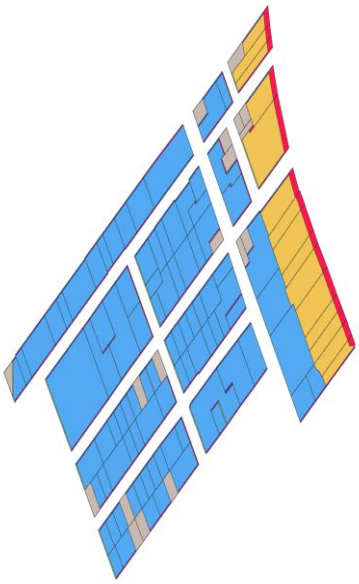

Figure 2. Areas suitable for building represented in gold (Zone ZACC_I_A) and (Zone ZACC_I_B). Areas not suitable for building in grey (plots with area less than 250m^2).

While Balneario Camboriu also defines multiple land uses in the area – among them single-unit residential use, multi-unit vertical semi-isolate residential use, mixed use development etc –, each with its respective urban parameters, it was necessary to universalize the land use in the analyzed area, for the final goal was to represent the maximum built envelop allowed by law in each plot. Multi-unit vertical semi-isolate residential was the land use selected for this analysis since it enables the construction of twenty-floor residential towers – urban parameter in place until 2016 – with a basic density coefficient of 3.5. Here it is worth mentioning that the 16m-height plinth the law allows developers to build is not computed in the total constructed built volume defined by multiplying the lot area by the aforesaid basic density coefficient.

With the necessary generalizations already considered and the exclusion of the plots not suitable for building, the following step was to comprehend how to model the stepped slabs to represent the towers. In addition, those stepped were to be present only on the facade facing the back and sides of the plot. According to the laws the back and side setbacks were to start at 1.5m and increase by 20cm for each additional floor above the ground floor, until it reaches a maximum distance of 5m. From there, all the additional floors are to be set back 5m. The frontal setback, however, is uniform and changes according to the road facing the plot. Thus, when dealing with a corner plot, this one could have up to three different frontal setbacks, thus, three uniform facades and only one stepped facade.

Although the local urban laws call for stepped facades, the built environment that proceeded never reflected that standard. Nonetheless, since the intent is to simulate the cityscape proposed by the legal acts, the group opted to graphically produce the built landscape intended and not the one actually disseminated by the market.

In order to generate this volume, each floor had to be regarded individually and an iterative algorithm applied. Despites Balneario Camboriu's singularities and complexities, the decoding of the urban law was once again done considering the convenience in reusing the bulk of this rule for other municipalities with similar urban parameters.

Still, given that the law also discriminates between two groups of plots in order to assign different land quota, which will result in difference in density – 50% of land quota for plots with area up to 750m^2, and 40% for plots with area above 750m^2 –, the research group has yet to explore how to include the usable area of the plot in relation to the land quota without leaving behind the rule for the stepped facade iteration already created. For that, the group must guarantee that the floor area of the first and biggest allowed floor does not extend beyond the maximum percentage that it can occupy of the plot, which is given by the land quota. Every attempt made so far did not prove successful in presenting within the scope of *CityEngine* an adequate graphical solution to the problem here introduced.

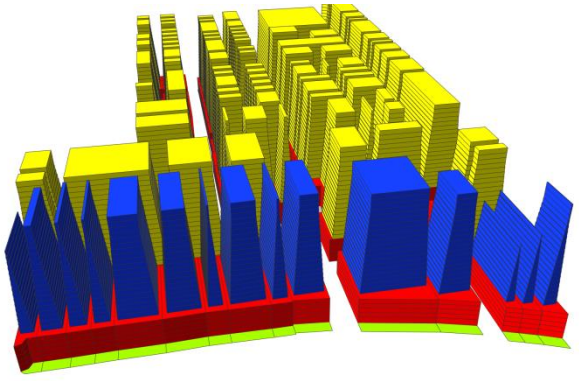

Figure 3. Lateral and back stepped facades.