**Comparison of different methods to estimate sky openness   
in built environment from orthoimage:   
a case study in NTU campus**

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Recently, more and more studies are trying to investigate how the microenvironment in the urban area is influenced under the impacts of environmental change and human activities. In order to examine the physical processes, it is crucial to quantify different urban morphological parameters. Among these factors, sky openness is determined by the properties of the surroundings, and play important roles to affect wind profile, temperature, and radiation in the street scale. However, the traditional method to quantify the sky openness from fisheye lenes usually needs lots of labors and computing resources. To resolve this issue, this study propose an alternative to calculate the sky openness from the orthoimage and compare the results from different assumptions and data sources.

This study used the fisheye lenes image collected from the locations of newly developed NTU4AQ sensors in the NTU campus as the sample to compare with the proposed method. By using the orthoimage from UAV and GIS software, this study classified the land types into 6 classifications, including building, tree, grass, lake, ground, and no type (none). In the calculation, this study found that the buffer distance 35 m is most appropriate.

This research estimates the sky openness under 3 situations of data availability and proposed 3 different corresponding solutions for each situation. The situation includes S1: orthoimage only, S2: orthoimage and assumed height for buildings and trees, and S3 orthoimage and the actual digital surface model (DSM) data of buildings and trees. The results showed that the methods of S2 and S3 performed better than S1, but there is no significant statistical difference on the performance between S2 and S3. However, the demands for resource for the method of S2 is much less that S3. The findings from this study provides important quantitative reference for the estimation of sky openness in the urban area in the future.