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GIS-based management of a campus tree inventory for assessing optimal shade tree locations: a case study of National Cheng Kung University, Taiwan

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Abstract:

The presence of a healthy and continuous tree canopy offers significant cooling effects to both natural and built environments. This study describes the use of participatory mapping, geographical technology and an updated campus tree inventory to assess tree locations for the optimization of shade canopy coverage. The study area is located on the Cheng Kung Campus of National Cheng Kung University, as shown in figure 1. The study area climate is characterized as sub-tropical, dominated by hot and humid weather through-out the year.

Figure 1. Aerial and side view of the study are, the new Hydraulic and Ocean Engineering building, National Cheng Kung University, Tainan, Taiwan.

Using a campus living lab approach, participatory mapping activities were conducted by GIS students over one academic semester. Students were tasked with using GNSS receivers to obtain the coordinates of trees to develop an updated campus inventory. A GIS-based site characterisation work identified the quantity, tree species type and land cover of the study site. The field results show a total of 5 species identified, with a total of 35 trees georeferenced and added to the updated inventory data set (figure 2). The 5 species include

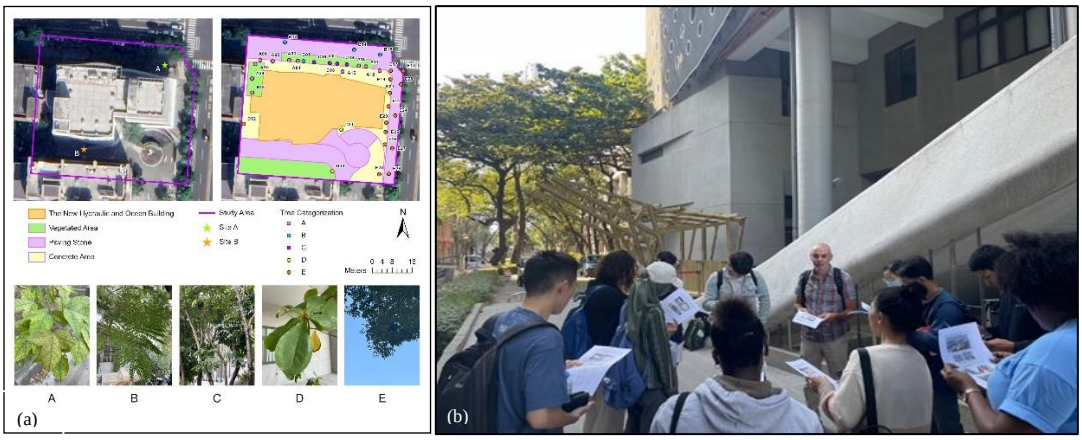

Figure 2. (a) Map of study areas, study sites, botanic shading sources and land cover types, (b) participatory mapping exercise.

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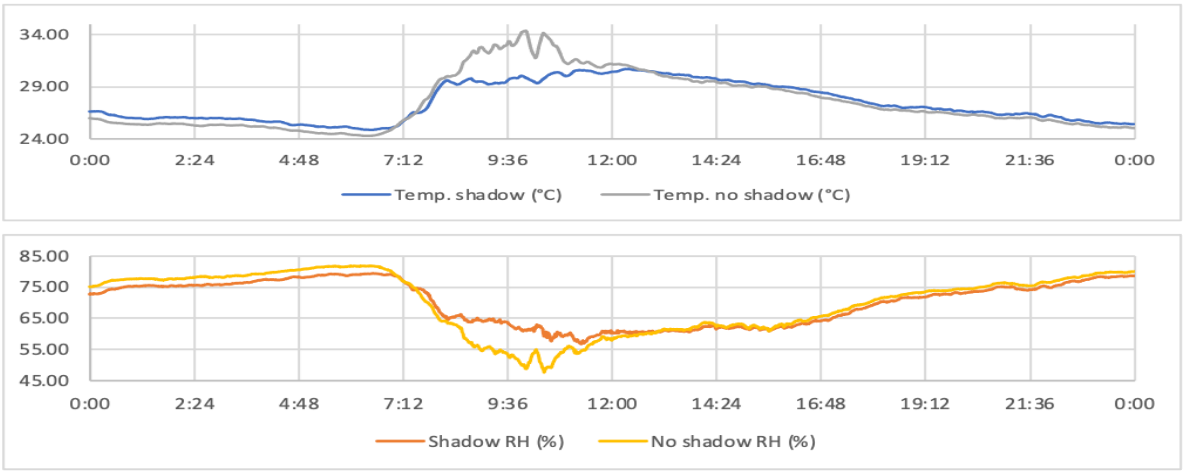

Figure 3. Averaged temperature and relative humidity measures for two control points under and without shadow cover, recorded during a period of five continuous days.

To further validate the cooling effect of shade trees, temperature and relative humidity dataloggers were used to collect the microclimate conditions of the study site (figure 3). The results show that shade can have a cooling effect of 3 degrees Celsius during, while increasing the humidity of shaded areas by 8%.

Grounded based photos were taken of each species of tree located in the study site. A fish eye lens enabled the canopy coverage to be mapped and assessed. To test the relationship between trees which offer good shave coverage, a shade tree index is proposed. The index ranks each of the five species on the study site. A rank of one offers less than 20% shade canopy coverage during the sunniest period of the day, while a rank of 5 provides over 80% shade canopy coverage.

Figure 4. Example results of tree locations with a high area of influence (Rank 5 – white color), and low ranked value trees (orang and green color).

A high rank value result indicates (figure 4 – white coloured zones) a full canopy, with optimal shade coverage. High area of influence zones offer continuous shade corridors for pedestrians. Low ranking locations are lacking shade coverage and shade gaps are identified. The shade gaps are then prioritized as optimal tree planting locations. Future work aims to scale up the study area site for the entire campus, and further validate the shade tree index values for by increasing the sample number of trees used to represent a specific species.

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