Assessing the Retroreflectivity of White HDPE-sprinkled Roof Sheets in a Tropical Climate

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Background

One effect of climate variations is the Urban Heat Island (UHI), where a metropolitan area has higher temperature levels than surrounding suburban areas. Due to the UHI, the demand for cooling technologies in urban areas has increased (Lickley, et al. 2020). Previous studies have confirmed that light-colored paint,and glass beads have retroreflective properties capable of lowering the surface temperature, cooling indoor temperatures, and producing thermal comfort (Romeo & Zinzi, 2013).

Moreover, high-density polyethylene (HDPE) microplastics are waste polymers that deposit GHGs. It shares similar properties with retroreflective glass beads, thus recycling it to produce retroreflectors may show promise (Lin et al. 2019).

Research Aim

The research aims to accomplish the following objectives:

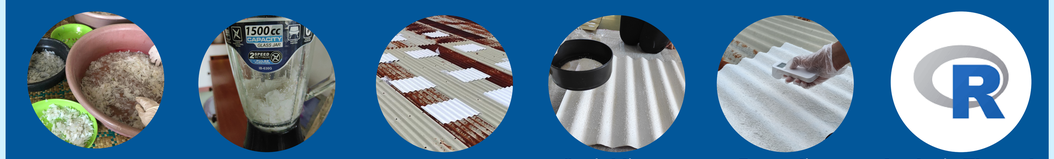
1. To determine and compare the surface temperatures of roof sheets with and without applied HDPE microplastics over a period of time.
2. To determine and compare the proportions of solar radiation (albedo values) reflected by roof sheets with and without applied HDPE microplastics.

Significance

The key findings of this research may be used to combat climate change by:

1. decreasing the demand for air conditioning and cooling systems that deposit CFCs and GHGs in areas with UHI
2. recycling potentially-polluting HDPE microplastic wastes into environment-friendly retroreflectors.

Methods



Results & Discussion

GLOBE Data

The researchers assessed GLOBE cloud data to describe the weather conditions during the data gathering. The high cloud cover was shown to be overcast, and only few middle clouds were observed.

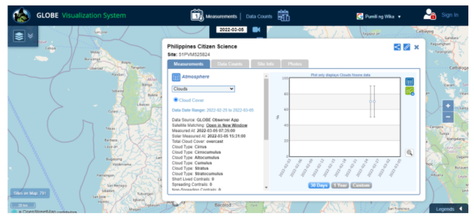


Figure 1. GLOBE visualization page showing the submitted cloud data to GLOBE.

Albedo

For the albedo, the one-way ANOVA results show that the albedo of the samples is not significantly different, with a p-value of 0.386.

Surface Temperature Difference

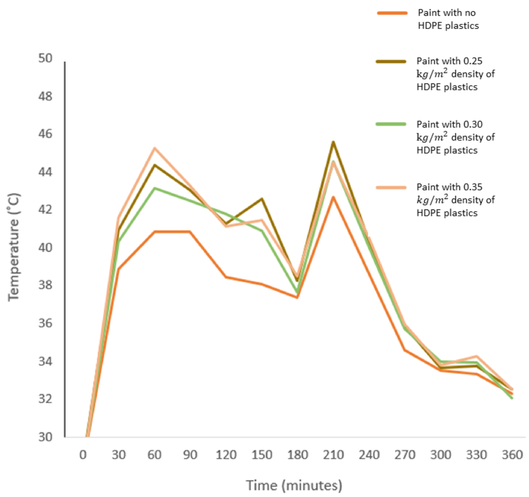


Figure 2. Graph showing the change in the average surface temperatures of the roof sheets over time.

The average surface temperature of the roof sheets with no HDPE plastics is lower compared to the samples with HDPE plastics.

The one-way ANOVA results show that the difference between the initial surface temperature and the temperature measured every 30-minute interval of each density is statistically significant, except during the 150-minute and 270-minute onwards timeslot.

Furthermore, the Tukey post hoc test revealed that for the 0-time interval, the temperature difference of the samples with 0.25 kg/m2 and 0.35 kg/m2 densities of HDPE plastics is significantly higher compared to the 0 g/m2 sample. For the other time intervals, the temperature difference of the 0.25 kg/m2, 0.30 kg/m2, and 0.35 kg/m2 samples is significantly higher than the 0 g/m2 sample.

Methods

Preparation

Pre-shredded chunks of HDPE plastics were washed and sun-dried for a day. The plastics were pulverized with a blender and sieved through a size 10 mesh (2.0 mm). The determined amounts of HDPE powder were prepared for all samples. Store-bought roof sheets were cut into the desired size and were initially coated with water-based acrylic paint. After drying, it was coated again with the same paint and the powder was sprinkled evenly on the roof sheets. All samples were left to dry overnight prior to data gathering.

Data Gathering

Samples were situated on a building roof at equal distances. The temperature of each sample was taken at 30-minute intervals from 10:00 AM to 4:00 PM the following day.

Data Analysis

One-way ANOVA and the post hoc test were used to analyze the results.

Conclusion

HDPE plastics do not possess retroreflective properties capable of lowering surface temperature and reflecting solar radiation. In contrast, HDPE acts as an absorber of solar radiation, which increases the temperature of a roof sheet. Applying HDPE microplastics on roofing is not a feasible alternative to cooling technologies. Future studies may also consider using HDPE as alternatives to heating technologies, instead of cooling systems.

References

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