

## KEY POINTS

- Heat can mitigate learning outcomes and cause damage to school children.
- Concrete roof tiles shows superior thermal performance compared to corrugated iron as a roofing material.
- Light coloured roof tiles can help cool down schools and protect children.

## BACKGROUND

The effects of climate change and manifestations of poor urban planning such as the Urban Heat Island (UHI) effect are becoming increasing concerns for the Australian public and urban policy planners. The UHI effect occurs when roofing materials such as corrugated iron causes urban areas to adversely heat up. This factsheet will look into the cause of high temperatures in the school environment, how they affect children, and roofing solutions that address this overheating issue.

To aid learning outcomes and the general wellbeing of school children, building materials with lower surface temperatures when exposed to the sun shall be used in schools.

To ensure school environments remain within comfortable and safe temperatures, the following strategies are recommended:

- Use cooler roofing materials with a higher solar reflectance.
- Mitigate heat fluctuations and extreme heat temperatures by selecting building materials with high thermal mass.

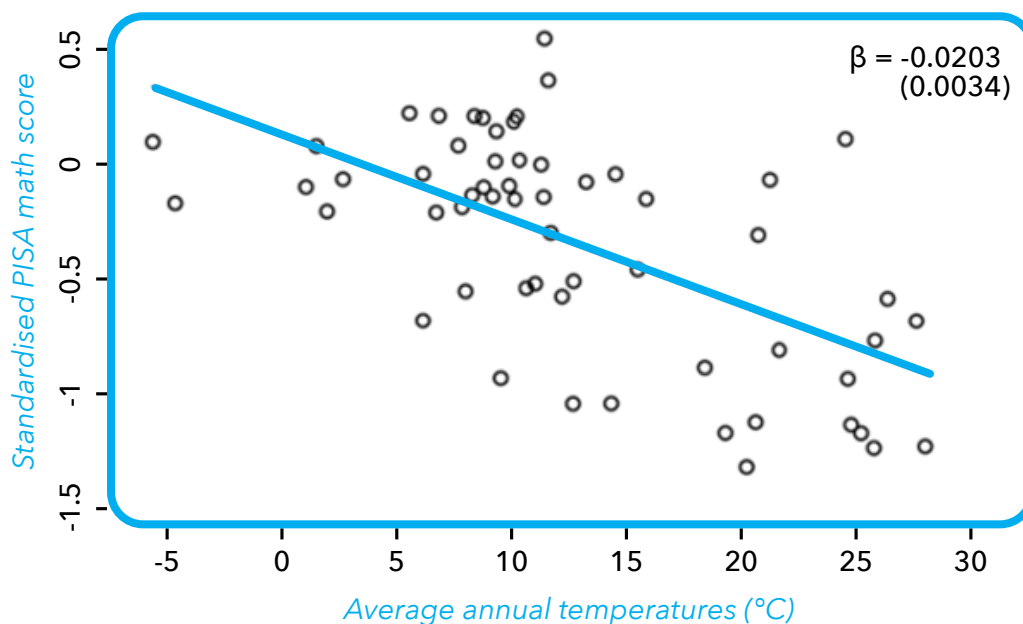
## HEAT IMPACT ON THE HUMAN BODY

Excessive heat is the most dangerous hazard in Australia, accounting for more deaths than the combination of all other natural hazards. The reason is that the human body can only adjust its temperature when the surrounding temperature is below 36-38 °C. Young children are at particular risk as they sweat less and have a weaker ability to adjust to the heatwaves commonly experienced in Australia.

## HEAT IMPACT ON LEARNING

Ambient air temperature and the learning outcomes of school children are negatively correlated; excessive heat can impact decision making, short-term cognition and work performance. The optimal classroom temperature is 22.5 °C in Australia, with each 1 °C increase mitigating 2% of the aforementioned learning outcomes.

Average Annual Temperatures Vs Standardised Math Scores



## RESEARCH – SCHOOL MICROCLIMATES (SEP 2020)

Conducted by Western Sydney University, Macquarie University and NSW Government as part of Western Sydney University's Cool Schools Initiative, this research documents the microclimate temperatures around an existing public primary school in Western Sydney. This report aims to provide town planners and developers with options to mitigate overheating issues, improve learning outcomes, and protect young children through developing passive cooling schools.

The research has provided evidence on the thermal performances of roofing materials. Among corrugated iron and concrete roof tiles, the research suggested that concrete roof tiles are the cooler option. Potential factors for this result include the higher solar reflectance and thermal mass value of concrete roof tiles.

During the summer holiday of 2019/2020, researchers recorded more than 100,000 temperature data points from 20 different locations within the school.

As the findings show, the average air temperature increases with time, with a maximum change of 10.75 °C and a minimum change of 6.5 °C in different locations.

Shading arrangement and roofing materials were major contributors to this overheating issue. For lighter coloured and higher reflectance materials, less solar energy will be absorbed, resulting in less turbulent temperatures.

## RESEARCH FINDINGS

- Air temperatures increased the most (by 10.0-11.0°C) where shade was provided by corrugated iron. This means that corrugated iron as a roofing material could lead to overheating issues in schools and should be avoided for the wellbeing and academic performance of the children.
- The cement shingles on the roof of the main administrative building were cooler (45°C) than those measured for green (50°C) or corrugated iron roofs. Compared with other roofing materials, concrete roof tiles remained cooler and contributed less to the overheating ambient air.



Mean warming of air temperature from 6:00-10:00am, Dec. 2019 to 26 Jan. 2020

## MATERIAL COMPARISONS

Compared to corrugated iron, concrete roof tiles provide better thermal insulation by reflecting solar radiation and resisting heat gain, which leads to a lower surface temperature and ambient heat.

## MITIGATING TEMPERATURE



Light Coloured Concrete/Terracotta Roofing Tiles

- Concrete and terracotta roof tiles have very similar thermal properties and offer a range of mottled light colors which have excellent performance in limiting solar radiation heat gain. Their high thermal mass will cause the surface temperature to rise more slowly under heat conditions when compared to other roofing materials.
- Light coloured tiles yield energy savings between **25-36%** compared to dark-colored surfacing materials.
- Shaped profiles can save an additional **11%** on cooling energy when compared with flat profiles.

## CONCLUSION

The research has confirmed that the type of roofing material makes an important contribution to the overall overheating issue. Corrugated iron roofs generate higher surface temperatures than concrete roof tiles. For strategies to cooler schools:

- Avoid corrugated iron roofings to protect school children from excessive heat and improve academic performance.
- Use suitable roofing products such as concrete and terracotta roof tiles in schools as primary roofing materials.

REFERENCES: Pfautsch S., Rouillard S., Wujeska-Krause A., Bae A., Vu L., Manea A., Tabassum S., Staas, L., Ossola A., Holmes, K. and Leishman M. (2020). School Microclimates. Western Sydney University, 56 p.  
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