Rethinking the Link **Between Pavement Albedo and the Urban Heat Island Effect**

Dark-colored surfaces attract heat, and light-colored surfaces reflect it. Some claim, this easily observed phenomenon contributes to the urban heat island effect (UHI), which is the tendency for urban areas to become warmer than nearby rural areas due to a built environment that absorbs more solar energy than grass and trees.

The search for ways to mitigate the UHI effect has led some to suggest that the construction of reflective pavements could alleviate its impact. The thought process is that lighter pavements would reflect solar energy into the atmosphere, dispersing excess heat, especially during warmer seasons. However, existing published pavement research does not support this tactic as a best practice for UHI mitigation.

UHI is a serious issue affecting many cities around the world. Green construction codes and green building rating systems try to address it by offering credits for porous paving systems and vegetative and structural shading of hardscapes. Many, but not all, encourage the use of lighter, concrete pavements because they have a higher initial albedo than darker asphalt pavements without regard for the fact that pavement albedo changes over time.[1]

Effective UHI mitigation requires close consideration of the science and ensuring the intended goals are met without unintended consequences. However, most of the published studies on the issue focus on high-albedo rooftops or the combined effect of rooftops and hardscapes. These are the studies often used to support ground-level albedo modification — even though they don't assess albedo at the ground level.

Recently, researchers have begun to look at the actual impact of reflective pavements on UHI.

One study concluded that, "Reflective pavements seem to have been the least effective methods of cooling urban temperatures."[2]

Part of this is due to complicated urban geometry. Buildings often cast shadows on the pavements, limiting their ability to reflect energy.[3]

The studies of reflective pavements are also finding significant unintended consequences as a result of their use, including an increase in building cooling loads due to reflected solar radiation and increased human discomfort. For example:

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- Increasing pavement solar reflectivity from 0.1 to 0.5 increased annual building cooling loads up to 11%.[4]
- Increasing pavement solar reflectivity from 0.15 to 0.5 substantially impacts the comfort of people standing or walking on the more reflective pavement, and increases the temperature they feel by 3°C to 6°C.[5]
- Infrared satellite imagery (Figure 1) demonstrates that darker pavements can be as cool or even cooler than reflective pavements.[6,7]
- Reflective pavements can increase upward light scatter, adding to nighttime light pollution.[8]
- Widespread albedo modification has the potential to negatively impact regional hydroclimates and to reduce summertime precipitation.[9]

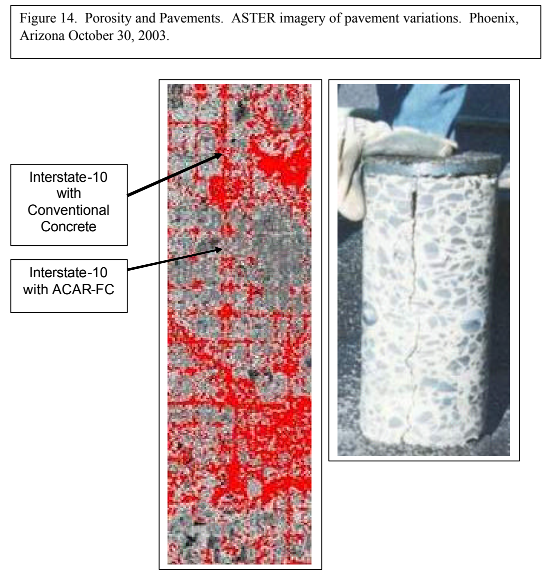

Figure 1: ASTER Imagery of Pavement Variations. Phoenix, Arizona, October 30, 2003.[7]

Yang et al. (2015) provides a solid overview of these and other unintended consequences of reliance on albedo modification as a UHI mitigation strategy.[10]

Even if we disregard the unintended consequences, a key question remains: Does albedo modification help address anthropogenic climate change or does it simply mask the problem? A recent National Academy of Sciences study, *Climate Intervention: Reflecting Sunlight to Cool Earth*, says it's the latter. The authors write: "Albedo modification techniques mask the effects of greenhouse warming; they do not reduce greenhouse gas concentrations," and "It is far easier to modify Earth's albedo than to determine whether it should be done or what the consequences might be of such an action."[11]

Similarly, a U.S. Department of Energy report on UHI research found that "the challenges faced in measuring cool pavements as opposed to cool roofs are significant simply due to the complexity of measuring the pavement's influence upon building energy demand — this implies that there still remain significant challenges to be overcome in establishing such estimates."[12]

While using reflective pavements may seem a simple solution to the UHI problem, the science does not support its widespread adoption, and the identified unintended consequences could create additional problems as our urban areas seek to address climate change.

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