Participant Questions from U.S. EPA Webcast

Keeping Your Cool:
How Communities Across the Country are Reducing the Heat Island Effect

June 26, 2014

Questions in bold were asked during the webcast.

Questions for Victoria Ludwig (U.S. EPA)

1. ***When you say that there are strategies that can be adopted by property owners to mitigate UHIs, are there any studies on the affordability of these tactics, and do you see policy/incentives ahead that will drive adoption of these tactics?***

   At the heat island program, we have tried to keep track of research that has been done and studies that have been done on the economic issues and also, we tried to keep track of where funding is available for these measures. And so, I do know that there has been some recent examination of this in many cities.

   In addition to what David mentioned, we do have rebates and tax credits, and there are—the ENERGY STAR program does have some information on their website (http://www.energystar.gov/index.cfm?c=tax_credits.tx_index) as well about cool roof products that are—that have tax credits applicable to them because they are energy efficient. So if you join our LISTSERV, you'll get information about the latest economic studies and things like that, that come out. But we are paying attention to that, it's an important question.

   In addition, EPA's *Reducing Urban Heat Islands: Compendium of Strategies* (http://www.epa.gov/heatislands/resources/compendium.htm) includes detailed cost-benefit information on each of the heat island mitigation strategies. It also includes a chapter on policies and incentives at the local level. More recent information on policies and incentives is available in EPA's Heat Island Community Actions Database, at http://yosemite.epa.gov/gw/heatisland.nsf/webpages/HIRI_Initiatives.html?openDocument.

2. ***Apart from learning what different communities are doing, is there information on which approaches have been most successful in practice?***

   Like I said, it depends on how you define success. We tried to collect the case studies, as I mentioned, and then we did these webinars as a way for the communities to talk to each other and learn about how they were successful and what that means. EPA doesn't—we try not to really promote one strategy over another.

   I would say each of those strategies that I mentioned as a mitigation option for the heat island effect has pros and cons. There are many—it's complicated in terms of estimating the economic

success, and it also depends, I think, on what your success could mean, what your main priority is.

For example, because Tucson has water issues, success for them is going to be different than maybe in Michigan where they have plenty of rain. And so, it depends on what your community's priorities are, but if you read the compendium of strategies, you will learn what has been successful for the communities that we mention in there, and that I think can give you an idea of which ones have been the most successful, because some communities also do measure their success. They quantify the temperature reductions that have occurred, although that is a complicated thing to do, but they do also measure success in terms of the reduction in electricity use and consequent GHG reductions. So I think if you look at those case studies, you'll get a good idea of what might be considered most successful in general.

That being said, we are not aware of any studies comparing the effectiveness or success of individual approaches.

3. *Is there a U.S. latitude above which the benefits of cool roofs are outweighed by the loss of heat absorption in the winter?*

The cost-benefit relationship is too complex to derive a simple latitude-based threshold, as it depends on factors such as snow cover, heating fuel costs, and electricity costs. We have pasted below some relevant text from the Cool Roofs chapter of EPA's *Reducing Urban Heat Islands: Compendium of Strategies* (http://www.epa.gov/heatislands/resources/pdf/CoolRoofsCompendium.pdf).

> Cool roofs can have a wintertime heating penalty because they reflect solar heat that would help warm the building. Although building owners must account for this penalty in assessing the overall benefits of cool roofing strategies, in most U.S. climates this penalty is not large enough to negate the summertime cooling savings because:
>
> - The amount of useful energy reflected by a cool roof in the winter tends to be less than the unwanted energy reflected in the summer. This difference occurs primarily because winter days are shorter, and the sun is lower in the sky. The sunlight strikes the Earth at a lower angle, spreading the energy out over a larger area and making it less intense. In mid-Atlantic and northern states with higher heating requirements, there also are more cloudy days during winter, which reduces the amount of sun reflected by a cool roof. Snow cover on roofs in these climates also can reduce the difference in solar reflectivity between cool and non-cool roofs.
> - Many buildings use electricity for cooling and natural gas for heating. Electricity has traditionally been more expensive than natural gas per unit of energy, so the net annual energy savings translate into overall annual utility bill savings. Note,

however, that natural gas and electricity prices have been volatile in some parts of the country, particularly since 2000.

4. *What impact do reflective windows and surfaces in and on high rise buildings have on the heat island effect?*

   Reflective windows and surfaces on high-rise buildings can contribute to heating in situations where light is reflected from one building onto heat-absorbing surfaces on another. However, we are not aware of any studies that have quantified this effect. To learn more, see section 2.3 (Urban Geometry) in the Urban Heat Island Basics chapter of EPA's report, *Reducing Urban Heat Islands: Compendium of Strategies*, available at http://epa.gov/heatisland/resources/pdf/BasicsCompendium.pdf.

5. *Are there free resources available to obtain Satt information of actual surface temps for our specific location? Such as the Kinetic Surface Map shown by Tucson?*

   Satellite data on surface temperatures (as opposed to air temperatures near the surface) are available from NASA's MODIS program (http://modis.gsfc.nasa.gov/data/ and https://lpdaac.usgs.gov/).

6. *Are there any Grant programs currently available to assist Non-Profits in deploying Pavement and/or Roof solutions to mitigate our heat island effect?*

   Rebates, tax credits, loans, and grants are sometimes offered at the state and local level for roofs that are "green" or energy-efficient. These are tracked by the Database of State Incentives for Renewables and Efficiency (www.dsireusa.org). In addition, pavement and roof initiatives may sometimes be eligible for support under broader sustainability or smart growth grant programs, such as the Partnership for Sustainable Communities grants at http://www.sustainablecommunities.gov/grants.html or the smart growth funding opportunities listed at http://www.epa.gov/livability/national_funding.htm and http://www.epa.gov/livability/state_funding.htm.

7. *Are there cities already applying local information on where the most vulnerable neighborhoods are, as a way to target and prioritize implementation of UHI interventions?*

   Some cities are doing this type of assessment. For example, New York City recently began developing a pilot study on strategies to protect vulnerable neighborhoods from extreme heat impacts. In addition, a study published in Environmental Health Perspectives in 2009 produced a map of the United States identifying areas vulnerability to extreme heat events (see http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2801183/ and a related study at http://www.ncbi.nlm.nih.gov/pubmed/17024398). This approach could be used to map and identify areas of vulnerability within specific cities and towns.

8. *What kind of research information do you have on the topic in tropical countries? What heat island mitigation techniques are more useful for tropical places?*

   Researchers have completed a number of studies on heat islands in the tropics; for just one example see this study from Malaysia: http://www.idosi.org/mejsr/mejsr11(11)12/19.pdf. The same mitigation techniques used in higher latitudes can be used in tropical cities..

9. *If you look at an air photo or Google, you see light and dark (colored) pavements. In general, are darker pavements more UHI than lighter, more reflective pavements?*

   Not always. During the webcast, you saw an example of a cool roof that looked no different from a standard asphalt-shingle roof; similar technologies exist for some types of cool pavements. Cool pavements do not necessarily have to appear light-colored to the eye in order to be effective. To learn more about cool pavement technologies, please see the Cool Pavements chapter of EPA's *Reducing Urban Heat Islands: Compendium of Strategies*, at http://epa.gov/heatisland/resources/pdf/CoolPavesCompendium.pdf.

Questions for Maria Koetter (Louisville, KY – Louisville Metro Government Office of Sustainability)

1. ***Was the tree canopy assessment a study of existing trees? If so, what metrics were collected? Tree species? Diameter? Or was it a plan on where to plant new trees?***

   So the tree canopy assessment is currently underway and it's an assessment of existing trees, but it's not an inventory, so it doesn't give us species, diameter or any of that but it includes planting scenarios to bring our canopy up to tree planting timelines and scenarios, as well as locations to get our canopy to 30 percent, 35, 40 and up to 45 percent. So it really is a plan to increase our canopies.

   We're right now around 27-ish. The central business district of downtown is only eight percent. So we have a long way to go.

2. ***Can you elaborate on the land cover assessment portion of the project? What resource(s) or tool(s) were used? Any involvement with the USDA iTree tool?***

   The land cover assessment is where Dr. Stone is using high-resolution imagery and data from our GIS Consortium here in town. So we're not using i-Tree in that way. I have heard that there's something out there that's commercially available or that's available that I've just recently heard about called i-Heat, but we're not really using that either. I thought that was interesting though.

   So yes, it's pretty much GIS information and data that we have, like I said, from our local Consortium and it's down to the two foot level resolution. So it's very accurate and it's very detailed.

3. *If you will require heat impact analysis for new developments, will there be certain tools or methods you will advise/require developers to use? If so, which ones?*

   There are no current plans to require a heat impact analysis; however the concept is that we would use the data from the Heat Mitigation Plan that is currently under development to guide the process.

4. *Who makes up the tree advisory committee?*

   The Tree Advisory Commission members were appointed by the Mayor and include a representative from each senatorial district; a representative from the Department of Economic Development; a member appointed by the Metro Council; and ex-officio members including the city arborist, a representative of the Air Pollution Control District, Department of Planning and Design Services, and the Department of Parks and Recreation.

5. *Is tree planting targeted? What are the most important areas to shade?*

   Tree plantings in 2013 were targeted in areas of need, primarily based on visual observation of areas lacking trees. The city has an Urban Tree Canopy Assessment underway right now and in combination with the Heat Management Plan data, all future tree planting will be based on the findings. The most important areas to shade are impervious surfaces because shading them creates a greater temperature reduction than shading a grassy area.

6. *Were ground-level ozone levels a consideration for implementation for your heat island effect program? Is so, what results are you expecting?*

   We did not consider ozone levels in this phase of the heat mitigation planning. We have discussed using the heat and air quality data to model ozone level increase/decrease during a future phase of the project.

Questions for Irene Ogata (Tucson, AZ – City of Tucson Office of Integrated Planning)

1. ***Tucson has planted 9,600 trees so far—have you done an assessment of the impacts? If not, are you planning to?***

   Right now, we have not done an assessment. One is because they're scattered pretty much around the city. Even though we've tried to identify the target neighborhoods, they don't always end up there and we don't have a metric to measure the effect of the increased canopy.

   We are looking at that right now on how to do that metric, and even looking at some of Dr. Sharon Harlan's data. Doing that assessment side could entail a lot of different types of equipment. So we're not quite sure about that one as yet.

2. ***Regarding the GIS tool that was used in Tucson, is this tool available for other areas and would it contain the data layers on census (i.e. vulnerable population) and tree cover?***

   The layers that are available here on Tucson are of course very specific to this region only, but I think the census information, other cities could definitely use the same sort of data because that's just census data, but you would have to create your own map utilizing your own resources.

   If you have a GIS person who would be able to link the census data to the mapping, that would probably really help. So on that one map of the Arizona Health Services, it has on there, the layers that they used from the census. And you may want to see whether or not those also apply in your community.

   The other one is that same slide also had Sharon Harlan's link on there and you can read her report to see which elements she found affected those heat neighborhoods, besides low income. And I think that, for us, helped to drive some of that social justice data collection. And I think the Arizona Health Services also were basing that map on some of her data.

3. *Given your low precipitation does your vegetation in your LID depend solely on rainfall harvesting or have you still installed a potable irrigation system for redundancy?*

   In urban areas, we still advise that there needs to be an irrigation system. Currently, there are very few commercial properties that have active harvesting (cisterns for collection and storage). There are no roadway networks that have active systems; they are all currently passive stormwater systems.

   Our rainfall occurs predominantly in two seasons. The summer 'monsoons' from July to August are short intense spurts of rain that lead to runoff more than a soaking rainfall. The gentler winter rains from December to February provide more beneficial rainfall. The hot months from April to June have little to no rain, so urban vegetation requires supplemental irrigation.

4. *Are there any other options than trees?*

   Yes, we also advocate any shade, such as shade structures with reflective properties to cover parking lots, including solar panels.

5. *Do you partner with the major universities or other partners on Urban Heat Island research?*

   The City of Tucson does collaborate with the University of Arizona, located in Tucson, and Arizona State University, located in Phoenix, whenever possible.

6. *The communities in the deserts – Sonoran, Great Basin, Mojave and Chihuahua, covering Arizona, Nevada, New Mexico, part of California, and Texas, have significant issues that are extremely different than the rest of the country. With vegetation and green rooftops a financial*

impossibility due to extreme heat (~90 days over 101F), dryness (<10" of rain/year and 70 – 90" of evaporation/year), and cost of water transport, are you aware of low cost options that are viable in the desert areas?

Best practices currently are to:

- harvest rainwater—with development, 75% to 80% of rainwater is designed to flow away from the property;
- divert stormwater for public landscaping—since over 60% of our cities have impermeable surfaces, pavement, and roofs, cities create more run-off than what would have flowed pre-development; and
- use as much native or drought-tolerant/low water-use vegetation as possible—desert-adapted trees have green bark to photosynthesize sunlight, smaller leaves to prevent excessive evapotranspiration, and spreading root systems to capture what little rainfall does fall on bare earth.

Questions for David Fink (Climate Resolve, Los Angeles, CA)

1. ***How cost-competitive are the products and materials, construction, etc. for cool roofs, cool pavement, etc.?***

   Well, I guess in terms of the cool roofs, they're very cost competitive. You know I can mention, if you go to the Cool Roof Rating Council's website (http://coolroofs.org/), you'll see that there are well over 1,000 products that are available and in terms of pricing, you'll see that clay tiles, shingles are right in line with most traditional products.

   There are some—sort of your cheapest asphalt shingles—you can get slightly below what the cheapest or lowest cost cool roof materials are out there but that's about it. It's a very small percentage. So it is very cost competitive.

   In terms of cool pavement, this is sort of a new area. The materials we're working on, we don't have a cost estimate yet. We should actually have that within the next week. So I don't have a definitive answer on that but you know, it is like I said, sort of a new developing area and there aren't a lot of products available right now.

2. ***How does a city promote residential cool roofs in areas where historic preservation requires dark shingles or metal roofing?***

   I guess there are sort of two things. One if a city felt like there were a number of historic buildings, where that was a concern, that could be an exemption in the ordinance. And the other thing I would say is that because there are so many products now, that shouldn't be too much of a problem.

3. ***Are there any practical studies on use of cool roofs to mitigate UHI? I know of one study in Spain on greenhouses, but the rest of these studies seem to be computer modeled. Any real life studies now? Any up and coming?***

   Yes, I would point to work that's being done by a Dr. Larry Kalkstein out of the University of Miami. He's a synoptic climatologist and he's looked at several aspects and some of that data, or some of that research, is on how cool roofs or cool surfaces and tree canopies can reduce the number of mortalities during extreme heat events.

   So he's done some really important work in this area and I think his work would be the best place to go to see that data.

4. *Green spaces in highly urbanized areas help to cool cities, but there is increasing pressure to use artificial turf—with arguments that there is a lower carbon footprint overall. The research is spotty and dubious... and the heat produced is still there... can you comment on if you know of any policies or studies regarding restricting the addition of heat producing artificial turf surfaces?*
   Artificial turf has become quite popular in the last ten years as an alternative to grass on sports fields. The contribution to the Urban Heat Island effect however is as negative as black asphalt. Ground rubber tires are used as in-fill to surface the synthetic (plastic) blades of grass. There is usually a 2-3 inch layer of the ground tires that make up around 90% (by weight) of the field. The combination of crumb rubber tires and synthetic grass has a very low solar reflectance meaning they heat up significantly. Furthermore, there are public health concerns over the release of carcinogenic, volatile organic compounds (VOCs) as well as leaching of chemicals into groundwater from the crushed, used tires. However, I don't currently know of any local or regional policies that discourage the use of these types of artificial turfs.

Questions for All Speakers

1. ***Have any of the speakers done, or know of scientific research showing/proving the air quality benefits of urban trees and vegetation? Also have any of you dealt with the issue of trees that actually negatively contribute to ground-level ozone formation?***

   Irene Ogata: Yes, so I know the one about air quality and the negative benefits. You know I was just reading that this morning. Although the study itself, even from the i-Tree, has come out that some trees do emit volatile organic chemicals, and that when the VOCs interact with the nitrogen in the atmosphere and the UV light, that it does turn into that smog, so it's bad air quality.

   Some of those trees are oaks and eucalyptus and other trees. I think ash and something else are lower emitters, so they're much cleaner and they do not emit that VOC into the air. But I always say, because we have a lot of oaks downtown, that you have to weigh the benefits of everything, it's not just the air quality but the shade, the heat. And even this one article was saying, you don't get rid of those high emitters, but just be more careful where you plant them.

So you don't want to plant a whole mass of oaks along the roadways where cars are also emitting the VOCs. Just be more cognizant. As our research and our data comes up and we're learning more, we just have to start figuring out how to work with that.

Maria Koetter: Well, here in Louisville, we are in and out of attainment with our air quality constituents of concern. So I know that we have a direct correlation between heat (the temperature in the summer) and our ozone alert days.

It's proven that obviously, heat is a precursor and contributes to the formation of ozone. So, last year was not so bad of a summer here. So we were really lucky with our ozone alert days. We had fewer than usual. So we definitely keep an eye on that as it relates to air quality.

Irene Ogata: I'm just going to add another thing. I know there was that question about i-Tree. So if you do an assessment of your trees and you know species and size of the trees, the i-Tree does have a model in which it does generate the air quality benefits. So if your community wants to take that on, and i-Tree—the software itself—is through the USDA. So it's a free software that any community can use, you just have to learn how to use it.

a. *Follow up question, I am told there is no 'real' evidence that trees improve AQ. If you know of any, please share it.*

   Irene Ogata: The US Forest Service Pacific Southwest Research Station, at UC Davis, has a number of researchers addressing ecosystem processes (http://www.fs.fed.us/psw/topics/).

2. ***Are your cities looking at how a future, climate-resilient palette of tree species might differ from what has traditionally been appropriate?***

Irene Ogata: I would say that it will change only because our climate zone is changing—we are getting warmer. One, as I had said earlier about the VOC emitting trees, that we'll probably start looking at that, which ones are higher and how will we figure out on planting them. But also, some of the – because we're hot and cold sort of determines the viability of a tree, that we may have less trees that we have today that are a little bit more cold tolerant.

Well, they may change. The heat is marching upward from the South. So yes, the palette would change. But it may take a while to do that.

Maria Koetter: Yes, we're definitely seeing that in Louisville as well where our hardiness zone recently shifted and we are incorporating those trees that you know 10, 20 years ago wouldn't tolerate our harsh winters. So yes, we are really trying to include that in the mix of our resourcing plans for sure.

3. *Have any of the cities established a performance metric, e.g. reducing UHI by x degrees or keeping it below x degrees through coordinated implementation of strategies? Or has anyone modeled what effects their strategies would have?*

   Maria Koetter: The Heat Management Plan that is currently being prepared will include this exact information. I am happy to share the findings once the plan is complete in May 2015.

   David Fink: I'm not aware of any sort of modeling / index that tracks coordinated UHI mitigation strategies and results. California EPA has contracted with a climate modeling firm to develop a UHI Index which will be able to track daily increases in temperature due to UHI which will be ready later this year. It won't incorporate mitigation strategies, however.

   Victoria Ludwig: EPA's Urban Heat Island Pilot Project, which ran from 1998–2002, included modeling analyses of the impacts of hypothetical heat island mitigation measures on energy use, greenhouse gas emissions, and air quality in the five pilot cities (Baton Rouge, Chicago, Houston, Sacramento, and Salt Lake City). For more information, visit http://epa.gov/heatisland/pilot/index.htm.

4. *What are your thoughts of the paper out of ASU regarding unintended consequences of highly reflective materials?*

   Irene Ogata: As research and science delve into the issues, findings will unveil conflicting issues (i.e. trees emitting VOCs). Not being a researcher or knowing the nuances of the modeling methodology, I will continue to follow the trail of research (i.e., ASU researcher Dr. Matei Georgescu regarding roofs and precipitation), and weigh the potential for reflective roofs to divert precipitation around core heat island areas in the arid Southwest. As Dr. Georgescu discusses, there are regional differences and adaptation strategies need to be weighed accordingly from your regional perspective.

   Maria Koetter: The ASU paper is a good summary of the pros and cons associated with high SRI materials. It is important to consider all the issues raised while planning a cool coating or roofing project. It is not a once size fits all solution.

   David Fink: The ASU paper has dozens of factual errors, has not been peer reviewed, and was paid for by a grant from the National Asphalt Paving Association and other related industry groups which all have a vested interest in seeding doubt about the benefits of cool materials. See the link to the Global Cool Cities Alliance response to the paper for a more specific look at why the claims made in the ASU document are questionable: http://www.coolrooftoolkit.org/knowledgebase/gcca-responds-to-asu-paper-unintended-consequences/