U.S. EPA State and Local Climate & Energy Webcast:
Improving Heat Health Resilience through Urban Infrastructure Planning and Design
August 19, 2015

Questions in bold were asked during the webcast.

Questions for All Speakers

1. **For the last 2 speakers. What does the speaker out of Atlanta think of the last speakers' thoughts on the negative co-benefits of green roofs?**

   Jason Vargo: Pierre, can you just describe some of those negative co-benefits quickly?

   Pierre Gosselin: Yes. Well, you have to read it – it's very dependent on where you are. What is your usual climate and what kind of stuff you need to do to improve your act regarding the urban heat island. What we did is for Montreal to take into account that context and see for each of these activities what was the impact in terms of production of greenhouse gases and the air pollutants and other impacts that you will bring with your project. So you can imagine that developing a very intensive green roof on an existing building somewhere probably means that if you're in a densely inhabited neighborhood that you'll need a big truck bringing soil. You'll need to import from somewhere the trees or any vegetation that you want to put on your – on your roof.

   And compared to that just planting a little tree has less impact to that's the kind of negative impact that you – that you can have from those green roofs. So that would not be my first choice. So, nonetheless, they are useful, they are effective and they bring greenery to the city. So if you're in a downtown area and building something new, it is going to be a very marginal negative impact compared to the rest of the building and in the long term, it could probably be positive. So it depends on each and every project but in general what I presented is if you are working on existing buildings in a densely inhabited area like a North American big city, it's more likely to be more negative to do a green roof instead of high albedo membranes.

   Sources:
   Life Cycle Assessment: https://www.inspq.qc.ca/en/publications/1532
   UHI Mitigation Measures: https://www.inspq.qc.ca/en/publications/1513

   Jason Vargo: I think that's very interesting because really when I've talked to people about dis-benefits of urban vegetation, I think I mentioned that in the presentation, we're often talking about sort of a suite of known health impacts related to vegetation in urban areas, be it aero-allergen production, asthma exacerbation, that type of thing. But also property losses, damages from falling trees or breaking trees or just people trying to keep trees longer maybe because of incentive programs than they should – that type of injury, those claims, I don't think are very

well understood. This is the first time I've heard about the lifecycle assessment of what's required to actually build or even maintain an intensive green roof.

So I think all of this is very necessary to sort of really accurately represent the sort of cost and benefit of these strategies. As I mentioned in the presentation, I think that's what's needed to really make the strong case and the convincing case to public and private partners that are going to be influential in sort of transforming urban areas into green or cooler places. They are going to want sort of comprehensive assessments of both the ills and the wins for their local neighborhood, the block and the metropolitan areas.

So, I think it's great that someone is doing that work and thought about green roofs in such a comprehensive way.

2. **Can any of the presenters recommend model zoning ordinance provisions for increasing tree cover as a method for reducing the urban heat island effect?**

   Jason Vargo: I have one that I would talk about. I mentioned that the work CULE is led by Dr. Brian Stone. He has a book called, "Cities in the Coming Climate." And there's a lot of examples in that book at the local level and it goes from around the U.S. but also internationally. And I will say that in Atlanta we have a particularly strong tree ordinance. And so that type of legislation is maybe not as important for increasing or adding new canopy but very important for sort of protecting the canopy that you have which is even cheaper.

   One thing that the ordinance does include is a recumbence fund so that trees that are taken down must store or sort of the money that property owners pay into the city's fund for new trees comes from – it's like a penalty for cutting down old trees. So in that way it's not only protects the existing vegetation but also sort of provides the mechanism to feed into the production of new urban greenery.

   Victoria Ludwig: The District of Columbia has a Green Area Ratio requirement in its zoning code. http://green.dc.gov/GAR

   Pierre Gosselin: We're beginning to see – one of the ordinances in this province is that for any new development a part of the land is to be converted to parks on private land. So there is between 10 and 30 percent of the land that needs to be conserved in parks. When it's not possible, well the equivalent in terms of the value of the land is to be paid by the promoter to the municipality for development. So it's at least between 10 and 30 percent.

3. Should the higher transpiration rates of trees give them highest priority for planting over other types of vegetation in lowering UHI temperatures?

   Jason Vargo: The answer likely varies by location. In limited cases in our CULE study in Atlanta, Philadelphia, and Phoenix we saw apparent temperatures increase with conversions of

grass to tree canopy. We believe this is due in part to result from an increase in leaf stomatal resistance with a shift from grass to tree canopy through this scenario, a physiological change that can decrease transpiration rates.

A number of factors should go into tree selection: variety, pollen production, growth rate, hardiness, etc. Close work between urban designers, public health officials, and arborists and urban foresters is likely to result in the best outcomes.

4. Is there any information on infant/child mortality related to heat in metropolitan areas?

   Jason Vargo: Much of the data on heat and health effects focuses on elderly, if it considers specific ages at all. For modeling the health impacts in our study we relied on three studies, which looked at the response in mortality to temperature among all age groups. Others have limited analyses to adults over 65. This is due to the decreased ability of older adults' bodies to thermoregulate. Seasonal differences in infant mortality have been observed but a robust relationship to temperature has not been demonstrated.

   Victoria Ludwig: Adding to Jason's response above on mortality data, there is more general evidence that children and infants are vulnerable to extreme heat. According to the Climate Change chapter (PDF) (7 pp, 421 K) of EPA's 2013 report, *America's Children and the Environment*, children's bodies are less effective at adapting to heat compared with those of adults. Children also may not feel the need to drink as urgently, which can lead to dehydration and electrolyte imbalance. Humidity can exacerbate heat stress in children. Infants may be especially vulnerable to extreme heat, in part because they depend on adults for care and are unable to communicate thirst and discomfort.

5. What do you see as the future opportunities for public health and environmental agencies to work together on this issue?

   Jason Vargo: For researchers there is increasing demand for finer scale analyses. The reliability, accuracy, and cost of new sensors for temperature and humidity is making more detailed monitoring of urban heat possible. Health data are usually a limiting factor for how fine studies can go. Novel and emerging sources of data like coded emergency and 311 calls may provide ways to improve these studies. Also, medication use that is connected to data, for example with inhaler usage (see Propeller Health), could provide time and location specific information about asthma and respiratory distress. Linking detailed environmental and health monitoring will reveal new findings about the environmental drivers of urban health issues.

   Victoria Ludwig: For policy makers and on-the-ground practitioners, climate change provides a significant opportunity to work together. Public health and environmental agencies are currently seeing the reduction of the heat island effect as a way to increase resiliency to climate change impacts. So as climate change impacts increase, the potential (and the urgency) for collaboration will only grow.

Questions for Victoria Ludwig (U.S. Environmental Protection Agency)

1. **Can green roofs also help moderate temperature? Your short slide just mentioned improved comfort (temperature? aesthetic?) and stormwater management.**

   Victoria Ludwig: Great question. And I forgot to mention that all of the mitigation strategies on the slide, green roofs, cool roofs, cool pavement, trees, and smart growth do reduce temperatures.

   The additional benefits that I mentioned were sort of – some of the different ones that aren't as commonly thought of. But in addition to temperature increase, all of the mitigation strategies have been shown to also save on energy use which can often reduce cost and they have reduced air pollution, reduced greenhouse gases.

   There are some studies on these aspects, temperature decreases and other things, so I'm happy to point you to some if you'll send me an e-mail. Thanks.

2. **How is the EPA State and Local Climate and Energy Program connecting with local public health departments, if at all?**

   Victoria Ludwig: Great question. I think we're connecting with them through this work that we've done to produce the webcast series. I think in general in the heat island realm, those two groups, environmental and EPA and the public health agencies have started to connect. They're connecting more and more. We do have relationships with the CDC, the American Public Health Association. With CDC, different parts of EPA have done research on the connection between climate change and health. And also with other groups like the American Public Health Association, we have – we work as partners and just understanding each other's work and helping to promote each other's work.

   But in general I would say, we hope to do more collaboration within that realm. And I think this webcast series is a great way to kick that off.

3. How has the state of Florida government been supportive in reducing climate change and sustainable communities?

   Victoria Ludwig: The state has produced a greenhouse gas inventory, and has developed a Climate Change Action Plan for the Florida Reef System. Several local governments are focusing on the issue. One example is the Southeast Florida Climate Impact, which involves four counties partnering to protect against the impacts of climate change.

4. You stated that cool roofs cool building interiors and the air. I believe it is incorrect to state that "cool roofs" actually cool anything. While they reduce build-up of heat in buildings, they do not actually cool the interior; and they certainly do not cool the air around buildings.

Victoria Ludwig: "Cooling" in this sense was used as a relative term: buildings with cool roofs are typically cooler than buildings with conventional roofs, because cool roofs transfer less heat to the building below. Cool roofs can result in lower air temperatures immediately above the roof, although the effect appears to be small. It would have been more precise to say that compared with conventional roofs, cool roofs result in cooler building interiors, cooler roof surface temperatures, and cooler air just above the roof.

Questions for Jason Vargo (Global Health Institute, University of Wisconsin-Madison)

1. **The graph showing the correlation between temperature and excess mortality seems to show a lag between the high temperature event and mortality. Could you please explain a bit more?**

   Jason Vargo: Yes. A number of studies have examined sort of the lag effect that temperature shows. We've been investigating that as well in the Madison area like I mentioned, the study we're doing with hospital admissions. The lag that we found for the zip code level temperature differences tend to be longer for lower temperatures and as the temperatures get higher like these extreme heat events, the lag is less. But it's sort of important to realize that the minimum temperature elevation that the heat island causes really is crucial for extending the time of exposure.

   So that's, I think, one reason that you see the lag is that, sure, high temperatures for, let's say, an hour will really only impact the most vulnerable people. But if you have high temperatures for a week and especially in urban areas when you don't see the temperature go below, let's say, 85 degrees even at night for a week, the exposure to those high temperatures is much longer. And so you start to see more and more people as that exposure gets longer and longer and longer. More people susceptible or sort of manifest the heat illness outcomes – heat outcomes.

2. **Can you give a little more detail about the hot block, cool block? What's the actual temperature difference? Surface or air?**

   Jason Vargo: Yes. Like I said that's very preliminary and sort of an anecdote that we've uncovered from a larger part of my Ph.D. work. And so we're just beginning to sort of dive into that. But I will say that we were using the satellite imagery to sort of approximate temperatures. And so when I mentioned the sort of 7 degree difference between the two, that's a difference in land surface temperature which as I mentioned is not always well correlated with air temperature. And that's one benefit of the network in Madison that we have is that the sensors actually measure the air temperature which is the metric that determines your exposure and the metric that is used in all of the epidemiological studies so that it's the metric that we know is associated with the health impacts.

3. **Do rooftop solar panels respond more like 'cool roofs' or 'hot roofs' where albedo is concerned?**

Jason Vargo: That's not something that I know a lot about so let me start my rambling with that disclaimer. I would like to see – Victoria, have you uncovered anything in the – in the compendium of strategies that talks about that?

Victoria Ludwig: Yes, I was just thinking about that. When we know that – we haven't covered that in our compendium but I do know that several cities have – when they have incentive programs for cool roofs or even laws that require cool roofs, some of them do allow credit for putting solar panels on the roof, meaning they don't have to install – have a cool roof per se on that section. So I'd be happy to maybe talk to some of those groups and find out if they've – if they looked into in. It would seem to me to be a very technical question that would require some good academic research which – yes, we haven't done that at EPA.

4. When you are referring to temperature, is that surface or air? Are you taking humidity into account?

   Jason Vargo: For most of the work I cited in the presentation, I was referring to air temperatures. In some cases we account for humidity and others we do not. In the CULE study where we used climate modeling outputs to estimate health effects, we matched the temperature metric with the epidemiology study which our estimates were based upon. For example, the Medina-Ramon and Schwartz study we used looked at the relationship between mortality and daily minimum absolute temperature, while others used daily mean apparent or daily mean absolute temperatures. The climate models can produce any of these metrics for the 2-meter air temperature, which is the standard for relating to health effects.

   One slide with the image of two Chicago neighborhoods discussed Land Surface Temperatures (LST) which are derived from satellite or aerial imagery. Researchers are beginning to develop better methods to approximate air temperature from LST, but there is no rigorously tested or proven conversion yet.

5. Is there a study that looks at buildings and transportation factors in reducing heat sinks?

   Jason Vargo: Waste heat from human activity in buildings and cars can be an important contributor to local temperatures and to the heat island. One example from Portland examined how temperatures above streets changed with commercial and traffic patterns. From the paper:

   > "Anthropogenic heat emissions may also be a major factor in the elevated temperatures experienced in commercial districts on weekday afternoons. Temperatures in these areas are up to 2°C cooler on weekend afternoons, often times when activity in commercial buildings is minimal.
   >
   > Temperatures in the downtown core of Portland experience a 1–2°C stronger UHI intensity on weekday afternoons than weekend afternoons, once again

this difference in UHI intensity can possibly be attributed to anthropogenic heat emissions, with emissions due to the building and transportation sector being less on weekends.

Temperatures along major roads during the daytime differ by up to 2°C on weekdays compared to weekends (Fig. 7a,b), with average UHI intensity for grid cells encompassing major arterial roads 1.9°C on weekdays and 0.6°C on weekends. This difference in UHI intensity is likely to be due to differences in anthropogenic activity on weekdays compared to week- ends, particularly within the vehicle sector."

Citation: Hart, M. A., & Sailor, D. J. (2009). Quantifying the influence of land-use and surface characteristics on spatial variability in the urban heat island. Theoretical and Applied Climatology, 95(3-4), 397-406.

In some of the Urban Climate Lab's latest work they've attempted to model the waste heat contribution, and the health impacts of these interventions were found to be less than vegetation or albedo strategies.

Questions for Pierre Gosselin (Quebec Public Health Institute, Climate and Health Program)

1. **Which component would show the most bang for the buck, so that we could pilot a specific project to show a quick return on investment?**

Pierre Gosselin: Well, there was one slide from Jason about that, that said try to avoid cutting the remaining forests that are in town. That's number one and that's in itself difficult. It takes a lot of organized groups to do that. The next thing would be, from my point of view, projects going for better management of water in town. I mean, if you've got land where that water can remain, it's really effective in evaporating the energy accumulated in the soil.

After that I would say, of course, parkings and cars in the sense that you can promote bicycle paths and walking paths in town. And also public transit. And every time – every time you have one more bus it's usually the equivalent of 50 cars so you can reduce the size of the street accordingly. And these aren't difficult depending on what you define as a bus. There are some political bucks that are tough to implement. Others are easier. So it depends on the context. But of course it's beginning to be a serious problem. It's going to get only worst and eventually nothing can be solved only by air conditioning.

I mean, there are some real studies showing that heat actually increases when air conditioning is generalized in towns. It increases the heat density by several degrees. And not to mention power outages and several problems that can be linked to that. There's no simple answer to that. I believe the combinations are most effective, the projects having the combination of planting trees, ripping up asphalt, and white roofs, that kind of stuff done together in a – in a specific area.

2. **Where can I find the complete Life Cycle Assessment?**

   Pierre Gosselin: It's on the web on our institute website. Just type the full title into Google and you will find it easily.
   Sources:
   Life Cycle Assessment: https://www.inspq.qc.ca/en/publications/1532

3. **Does the rainwater harvesting help by promoting vegetation growth or is it some other impact?**

   Pierre Gosselin: Rainwater is important when it's in the soil, and after it gets there. When heat accumulates into soil, it can evaporate and then bring accumulated energy to the atmosphere. One of the things after this first step of evaporation, the water that has been incorporated into trees and vegetation, in the following days also evaporates but through the leaves of the trees. So it contributes also to evaporating some of the accumulated energy. So that's the way it works.

   There are some cities in Europe that I know that during heat waves use that rainwater that they've put in reservoirs on the streets. It was basically sprinkled the streets to decrease – to evaporate the energy. So that is the way it works as a simple way of using basic physics.

4. How are you going to connect existing parks? It looks like there are houses in-between them…

   Pierre Gosselin: The connection need not to be contiguous all over the place. Birds and bees fly, and grass snakes will find a way. ☺ The idea is to densify the tree cover, mix the species, re-create brooks (that often still exists in pipes underneath) and small wetlands areas, including in private backyards (also called water gardens, and very popular nowadays).

5. How can permeable surfaces and green strips be used in back streets and alleys that are also used for trash collection and garage access?

   Pierre Gosselin: See some ideas (like porous concrete paving stones or grids where you can grow vegetation yet support heavy loads) in:
   - UHI Mitigation Measures: https://www.inspq.qc.ca/en/publications/1513
   - United States Environmental Protection Agency (USEPA) (2008) Reducing urban heat islands: compendium of strategies, urban heat island basics. USEPA, Washington, DC, 19 p. Available at: http://www.epa.gov/heatisld/resources/compendium.htm

   Besides, many back alleys are or were already more permeable (dirt cover, fine gravel) than pavement, and can easily support trucks and cars. Most European urban parks have unpaved paths and roads.

6. 3.7 C degrees is 38 degrees F. That sounds like a dramatic amount of cooling. Is that normal?

Pierre Gosselin: Google gives the equivalent temperature, so 3.7° C is 38° F, which is close to freezing which happens at 0° C. To get the difference, you multiply C x 1.8 F, instead. So a cooling of 3.7°C is equivalent to a cooling of 6.7° F.

7. Do you have information on paved vs unpaved areas within the City?

   Pierre Gosselin: We have detailed mapping (Landsat images) for surface temperatures where the pixel is about 60x60m depending on the band of interest. So one can overlay this over any street plan and see the streets in detail.

8. What are you planning to do in the future?

   Pierre Gosselin: Promote walking, cycling and electric vehicles, not to mention gardening and parks. ☺

9. I am interested in learning more about Quebec and Canada's climate and public health programs and plans in general. Who would you suggest I could contact?

   Pierre Gosselin: You can send a more specific request to my email: pierre.gosselin@inspq.qc.ca