Webinar: ASHES Science to Achieve Results (STAR) Webinar Series #3: Linking cooking and trash burning to urban air quality in Ghana

Date/Time: March 24, 2021, 8:00-9:30 Mountain Time

Unasked/answered Panelist Questions

1. Assuming the advanced stoves were used and worked, did your data show whether there was decreased biomass used to generate the same number of meals?

Mike H:
For both the REACCTING and P3 studies, we did not directly measure fuel use. During REACCTING, we did several uncontrolled cooking tests and measured the heat transfer efficiency and found that there was not significant differences between the improved and traditional stoves. Since the heat transfer efficiency is one approach for assessing fuel use per unit of cooking energy service, we would say that no, there was a decrease in biomass use. For the P3 LPG study, we measured the total time that a household spent cooking. We did see that some of the LPG intervention groups cooked for less time than the control arm. This would amount to less biomass use.

2. Do you have any ongoing or future projects where you can add a group that places a rock bed in their three stone cookstoves? Lab and field testing (SNV) indicates that small rocks under the firewood improve three stone efficiency by 30%.

Mike H:
We do not have planned cook stove intervention studies. This is an interesting idea. We had some students at CU that looked at the impact of lifting the fuel off the ground (using a 3 stone cookstove) and found efficiency improvements. They use an old grill grate but rocks would probably have the same effect. We will keep this in mind as it is a great low cost, robust stove improvement and, if it reduced the CO and PM emission factors, then it would be well worth pushing on.

3. Have you looked at any health issues affecting the highest trash burning side in Ghana?

David P:
To my knowledge, no formal health study has been performed in the Accra area - but this brings up an interesting topic. Agbogbloshie is a very famous e-waste and general waste burning site within the city of Accra - from what I've heard from the folks at EPA Ghana, it's very difficult to conduct and research in that area or with the workers at the waste site because the operations are technically illegal. There's a large economy surrounding the informal e-waste industry, and there's general animosity between the workers there and any form of government employees or researchers.

In regards to general waste burning, a paper by Heidi Vreeland (Vreeland et al. 2016) performed toxicity estimates from emissions from open waste burning - definitely check that paper out if you're interested in the some of the potential health issues associated with the burning of common trash.

4. You highlight proximity stoves and stove choice. Do you have any insights on proximity to stove type vs types of meals being prepared?

Mike H:
We are finalizing the cooking behavior and stove choices papers now so we do not have finalized results yet. We hope to submit this paper by the start of summer.

5. How was wearing compliance monitored?

Response:
We assessed compliance by using the GPS watch signal, bluetooth beacon signal noise and the motion sensor built into the PM sensor, so these tools were embedded into our existing exposure monitoring tools and were not problematic. However, the exposure monitoring itself is onerous to wear as it is bulky and certainly impacted the lower than hoped for compliance.

6. As we look to the future of household energy systems, where should we put our efforts to keep the health impacts of household and urban air quality in check?

Mike H:
I am a fan of the studies that are looking at broader energy interventions where we can assess the unforeseen links between different energy systems as an energy user shifts from one conversion technology to another. Additionally, I am interested in seeing more exploration of energy system use paired with analyses of factors that impact use and dis-use. Some of the important factors may be non-technical and as such our field needs to work closely with social scientists, local governments, and policy makers.

7. Those new emission factors for open waste burning seemed to make a very large difference to the bottom up estimates for carbon monoxide and Organic carbon - what are some of the uncertainties associated with those values and how can they inform future emission factor calculations?

David P:
Excellent question - as I mentioned during the seminar Q&A portion, the way we calculate emission factors with our instrumentation requires us to know an average carbon content to the fuel we are measuring as it combusts. The current value for open waste burning makes the assumption that the carbon content is 45%. I personally think that this is a decent estimate to apply to a broad number of samples. But if you wanted to get as accurate as possible, you would want to know the waste composition as closely as possible, and then apply known carbon

contents to each material component to find some effective carbon content… This would be very intensive, of course.

Another large uncertainty lies in just how much mass is combusted during the flaming stage vs the smoldering stage of these fires. The large difference in Organic Carbon PM release between efficient and non-efficient combustion conditions may have a significant impact on the final estimates of OC release. Knowing how much mass on average is combusted during the different stages of combustion would allow for an effective Emission Factor to be calculated and better applied to activity data.

8. How applicable are the source profiles or molecular markers for waste burning in other countries or parts of the world?

David P:
At this point, emission factors for open waste burning calculated in Mexico City, Nepal, and Ghana are all fairly different - and this is to be expected. Different regions of the world will have different wastes and different materials going into the waste stream. Additionally, different levels of waste management infrastructure may leave certain materials burned but others recycled. I can imagine that these kinds of differences across countries or continents would have a large impact on the emission factors - as I mentioned in the presentation, it's probably one of the more complicated combustion events currently out there. Having a unified method for measuring these emissions, and then ample detail related to waste composition and combustion conditions might be able to tease apart how the different factors affect the ultimate emission rates of different pollutants - but I believe that kind of research would require a large collective effort or initiative.

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Title: Linking cooking and trash burning to urban air quality in Ghana

Academic Publications:

1. Piedrahita, R, Coffey, ER, Hagar, Y, Kanyomse, E, Wiedinmyer, C, Dickinson, KL, Oduro, A, Hannigan, MP. Exposures to carbon monoxide in a cookstove intervention in northern Ghana. Atmosphere, 2019, 10:402.
2. Piedrahita, R, Coffey, ER, Hagar, Y, Kanyomse, E, Verploeg, K, Wiedinmyer, C, Dickinson, KL, Oduro, A, Hannigan, MP. Attributing air pollutant exposure to emission sources with proximity sensing. Atmosphere, 2019, 10:395.
3. Coffey, ER, Pfotenhauer, D, Mukherjee, A, Agao, D, Moro, A, Dalaba, M, Begay, T, Banacos, N, Oduro, A, Dickinson, KL, Hannigan, MP. Kitchen area air quality measurements in northern Ghana: evaluating the performance of a low-cost particulate sensor within a household energy study. Atmosphere, 2019, 10:400.
4. Dickinson, KL, Piedrahita, R, Coffey, E, Kanyomse, E, Alirigia, R, Molnar, T, Hagar, Y, Hannigan, MP, Oduro, A, Wiedinmyer, C. Adoption of improved biomass stoves and stove/fuel stacking in the REACCTING intervention study in Northern Ghana. Energy Policy, 2019, 130:361-374.
5. Pfotenhauer, D, Coffey, E, Piedrahita, R, Agao, D, Alirigia, R, Muvandimwe, D, Lacey, F, Wiedinmyer, C, Dickinson, KL, Dalaba, M, Kanyomse, E, Oduro, A, Hannigan, MP. Updated emission factors from diffuse combustion sources in sub-Saharan Africa and their effect on regional emission estimates. Environmental Science & Technology, 2019, 53: 6392-6401.
6. Dickinson, KL, Dalaba, M, Brown, Z, Alirigia, R, Coffey, E, Mesenbring, E, Achazanaga, M, Agao, D, Kanyomse, E, Awaregya, J, Adagenera, A, Aburiya, JB, Gubilla, B, Oduro, A, Hannigan, M. Prices, Peers, and Perceptions (P3): Study protocol for improved biomass cookstove project in northern Ghana. BMC Public Health, 2018, 18:1209.
7. Dalaba, M, Alirigia, R, Mesenbring, E, Coffey, E, Brown, Z, Hannigan, M, Wiedinmyer, C, Oduro, A, Dickinson, KL. Liquified petroleum gas supply and demand for cooking in northern Ghana. EcoHealth, 2018, 15:716-728.
8. Coffey, E, Muvandimwe, D, Hagar, Y, Wiedinmyer, C, Kanyomse, E, Piedrahita, R, Dickinson, K, Oduro, A, Hannigan, MP. New emission factors and efficiencies from in-field measurements of traditional and improved cookstoves and their potential implications. Environmental Science & Technology, 2017, 12508-12517.
9. Lacey, FG, Marais, EA, Henze, DK, Lee, CJ, van Donkelaar, A, Martin, RV, Hannigan, MP, Wiedinmyer, C. Improving estimates of anthropogenic emissions and the resulting air quality impacts in Africa. Faraday Discussions, 2017, 200:397-412.
10. Wiedinmyer, C, Dickinson, K, Piedrahita, R, Kanyomse, E, Coffey, E, Hannigan, MP, Alirigia, R, Oduro, A. Rural-urban differences in cooking practices and exposures in Northern Ghana. Environmental Research Letters, 2017, 12:065009.
11. Piedrahita, R, Kanyomse, E, Coffey, E, Xie, M, Hagar, Y, Alirigia, R, Agyei, F, Wiedinmyer, C, Dickinson, KL, Oduro, A, Hannigan, MP. Exposures to and the origins of

carbonaceous PM2.5 in a cookstove intervention in Northern Ghana. Science of the Total Environment, 2017, 576:178-192.
12. Piedrahita, R, Dickinson, KL, Kanyomse, E, Coffey, E, Alirigia,R, Hagar, Y, Rivera, I, Oduro, A, Dukic, V, Wiedinmyer, C, Hannigan, M. Assessment of cookstove stacking in Northern Ghana using surveys and stove use monitors. Energy for Sustainable Development, 2016, 34:67-76. doi:10.1016/j.esd.2016.07.007
13. Dickinson, KL, Kanyomse, E, Piedrahita R, Coffey, E, Rivera, I, Adoctor, J, Aligiria, R, Muvandimwe, D, Dove, M, Dukic, V, Hayden, M, Diaz-Sanchez, D, Adoctor, V, Anaseba, D, Slichter, Y, Masson, N Monaghan, A, Titati, A, Steinhoff, D, Hsu, Y-Y, Kaspar, R, Brooks, B, Hodgson, A, Hannig**a**n, MP, Oduro, A