

**ASAP**  
EAST AFRICA



# Briefing Note: Household air pollution in charcoal fuel households in Kigali, Rwanda

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ASAP brings together leading UK and East African researchers in air pollution, urban planning, economic geography, public health, social sciences and development studies to provide a framework for improved air quality management in three East African cities: Addis Ababa (Ethiopia), Kampala (Uganda) and Nairobi (Kenya).

This timely and responsive programme of activity will enhance local decision-making abilities to improve urban air quality, reduce the effects of air pollution upon human health, and allow for sustainable development to proceed without further deterioration in air quality.

Central to the project's aims are strengthening research capabilities and technological expertise in East Africa, with local stakeholders and experts involved in the conception, implementation, and uptake of the programme and its outcomes.

## Summary

- Exposure to household air pollution associated with solid biomass cooking fuels is known to be harmful to human health from conception to old age.<sup>1</sup>
- In Kigali, charcoal biomass fuel is estimated to be used by 65% of households, followed by wood (32%). Use of electricity and LPG remains low (0.9% and 1.4%, respectively).<sup>2</sup>
- To understand cooking patterns and household air pollutant levels we undertook a study among biomass fuel-burning households in Nyarugenge District, Kigali in July – August 2018.<sup>3</sup>
- In 18/20 households (90%) key pollutant concentrations were in the hazardous range for human health, exceeding World Health Organisation (WHO) Air Quality Standards.
- We strongly recommend policy actions are taken to change household energy usage towards cleaner cooking fuels (e.g. LPG) to mitigate the harms from more polluting fuels (e.g. wood).

**Policy Issue:** Solid biomass cooking fuels (e.g. *charcoal, wood, crop residues*) are widely used in low- and middle-income countries worldwide as a primary source of domestic energy. Cooking with biomass fuel using traditional open stoves in poorly ventilated kitchens is known to produce high levels of toxic air pollutants, including Particulate Matter (PM) and Carbon Monoxide (CO). Fine particulate Matter (PM<sub>2.5</sub>)<sup>1</sup> is recognised to be particularly harmful to health because it can penetrate the lungs and enter the circulatory system, with exposure associated with an increased risk of acute and chronic respiratory, cancer and cardiovascular diseases. Carbon Monoxide (CO) is a gas which may be fatal at high concentrations and exposure over long periods is associated with adverse pregnancy outcomes, including low birth weight and impaired foetal development.<sup>1</sup> The World Health Organisation (WHO) sets recommended health-based limits for harmful concentrations of indoor air pollutants (including PM<sub>2.5</sub> and CO), based on a global synthesis of scientific evidence.<sup>4</sup> Biomass fuel production is also associated with wider environmental degradation, through deforestation and fuel processing activities, contributing to carbon emissions and risk of natural disasters such as flooding.<sup>5</sup>

**Research Context:** There exists very limited information concerning household and ambient air pollutant levels in Rwanda. Kalisa and colleagues reported outdoor (ambient) PM<sub>2.5</sub> levels in Kigali<sup>6</sup> and Das identified elevated household air pollution levels among biomass fuel households in Ribavu.<sup>7</sup> We now report the first scientific investigation of PM<sub>2.5</sub> and CO measurements among biomass fuel households in Kigali, thereby providing novel insight regarding public health risks associated with charcoal and wood fuel cooking in this setting.

**Research Activities:** We undertook an investigation among 40 charcoal fuel households in the villages of Kabeza cell in Muhima sector, Kigali during the dry season (July and August 2018). All selected households had a female resident of childbearing age (18-55 years) and a child aged 5 years or below. We performed two data collection

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<sup>1</sup> Particulate matter (PM) is a term used to describe the mixture of solid particles and liquid droplets in the air which have a diameter of less than 2.5 micrometers (µm).

stages: (i) household cooking activity and survey (40 households); (ii) 24-hour pollutant concentration assessment (20 households). All pollutant monitoring was performed in the kitchen at a fixed location from the cooking stove.

## Key Research Findings

### (1) Household and cooking activity survey (40 households)

- Charcoal was the most common cooking fuel used in 85% of study households.
- Almost half of families (47.5%) cooked outdoors.
- Almost two-thirds (62.5%) of families cooked two or three times each day.
- Most households (85%) spent more than 5000 Rwandan Francs (RWF) each month on cooking fuel.

### (2) Indoor air quality study (20 households)

- Average 24-hour pollutant concentrations were 93  $\mu\text{g m}^{-3}$  (range 15 - 1604  $\mu\text{g m}^{-3}$ ) and 35.1 ppm (range 0 - 503 ppm) for  $\text{PM}_{2.5}$  and CO respectively.
- Higher average concentrations were associated with cooking two or more times daily.
- Pollutant concentrations were significantly higher among those households using wood and charcoal fuel, compared to those only using charcoal fuel.

## Recommendations

The present study is the first of its kind undertaken in Kigali, Rwanda. Our findings suggest that those living in households using charcoal and/or wood as the primary cooking fuel are exposed to high levels of CO and  $\text{PM}_{2.5}$ , with concentrations typically in the hazardous range for human health.

Based on the findings and existing evidence base, we recommend the following actions:

- Implement a household energy policy which prioritises and incentivises access and usage of cleaner fuels (e.g. LPG, electricity) rather than solid biomass cooking fuels.
- Undertake activities to increase awareness of the health risks associated with household air pollution, particularly among vulnerable groups (e.g. pregnant women).
- Develop integrated policy initiatives to identify and mitigate the potential unintended consequences associated with household fuel policy interventions, including risk of fuel substitution for more accessible but more polluting biomass cooking fuels (e.g. wood).

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<sup>1</sup> Ezzati, M. and Kammen, D.M., 2002, The health impacts of exposure to indoor air pollution from solid fuels in developing countries: Knowledge, gaps, and data needs. *Environmental Health Perspectives* 110, 1057–1068. doi: 10.1289/ehp.021101057

<sup>2</sup> EWSA, 2012, Biomass use survey in urban and rural areas in Rwanda. Unpublished report.

<sup>3</sup> Telesphore Kabera, Suzanne Bartington, Clement Uwanyirigira, Pacifique Abimana & Francis Pope (2020) Indoor  $\text{PM}_{2.5}$  characteristics and CO concentration in households using biomass fuel in Kigali, Rwanda, *International Journal of Environmental Studies*, DOI: 10.1080/00207233.2020.1732067

<sup>4</sup> WHO Guidelines for indoor air quality (2014) Available at: <https://www.who.int/airpollution/guidelines/en/>

<sup>5</sup> Fullerton, D.G., Bruce, N., and Gordon, S.B., 2008, Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. *Transactions of the Royal Society of Tropical Medicine & Hygiene* 102, 843e851. doi: 10.1016/j.trstmh.2008.05.028.

<sup>6</sup> Kalisa, E., Nagato, E.G., Bizuru, E., Lee, K.C., Tang, N., Pointing, S.B., Hayakawa, K., Archer, S.D.J., and Lacap-Bugler, D.C., 2018, Characterization and risk assessment of atmospheric  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$  particulate-bound PAHs and NPAHs in Rwanda, Central- East Africa. *Environmental Science & Technology* 52(21), 12179–12187.

<sup>7</sup> Das, I., Pedit, J., Handa, S., and Jagger, P., 2018, Household air pollution (HAP), microenvironment and child health: Strategies for mitigating HAP exposure in urban Rwanda. *Environmental Research Letters* 13, 045011. doi: 10.1088/1748-9326/aab047.

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