The cooking environment, technology and behavior as co-determinants of household air pollution and exposure

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Pathways to Clean Cooking 2050

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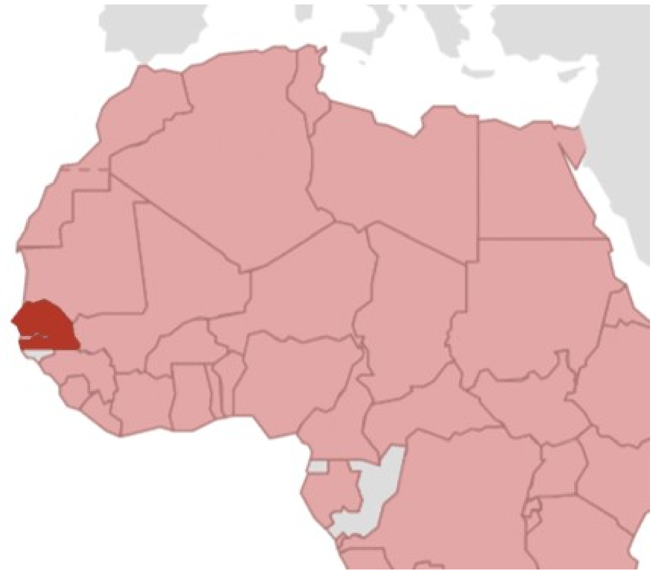
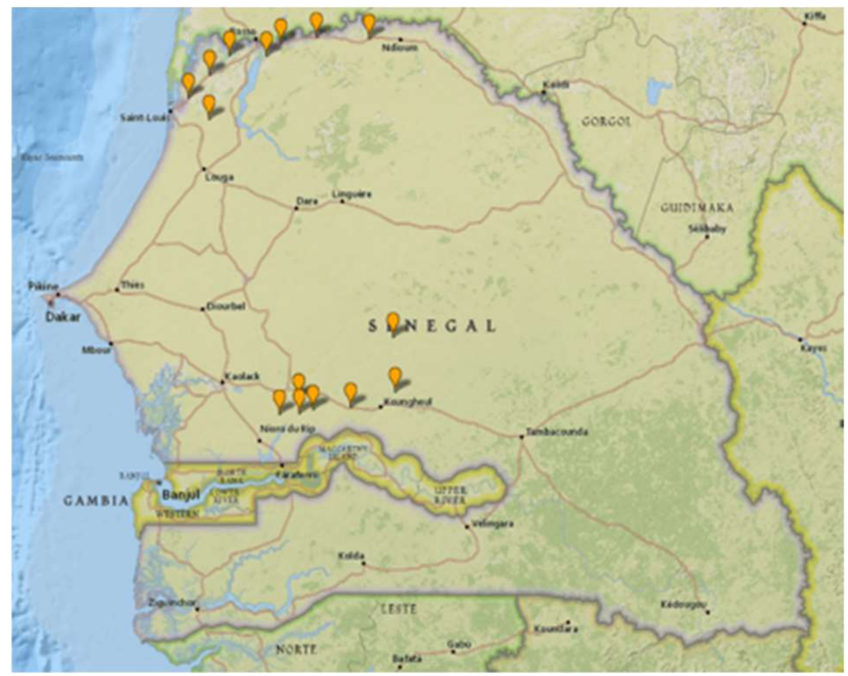
Motivation

- Many ill effects of cooking with traditional biomass technology…
- Increasing resources being deployed on a broad set of solutions
  - Growing evidence on (differentiated) benefits of diverse solutions
  - Commonly-voiced public health perspective: Need effort primarily on clean, and in fact, deployment of other solutions may be counterproductive
  - Alternative view: "Clean" solutions will not work in many places (e.g., rural places, much of Sub-Saharan Africa) for quite some time; transitional technologies have an important role
  - Many organizations (e.g., WHO, Clean Cooking Alliance) attempting to balance these perspectives
- Unfortunately, limited literature on the effects of cooking conditions
  - Ventilation, kitchen structure, behavior, etc. (Dasgupta et al. 2006; Yu 2011)
  - Either way, some see this as a distraction, except maybe for stacking
- Also, reaching those many difficult rural places with technologies that people like, meanwhile, is hard, despite economic gains (Pattanayak et al. 2019, Bensch & Peters 2016)

Context: Senegal

- 95% of rural population relies on biomass for cooking, growing fuel scarcity
  - Fuel collection exceeds 10 hours per week in many places
- Deforestation and desertification a major concern (Brandt et al. 2014)
- Study focus determined through iterative process working with 3ie, Government (Ministry of Energy), other key stakeholders
- Most successful ICS program is FASEN, supported by ENDEV/GIZ
  - Supports supply ecosystem: Production, distribution, marketing
  - Flagship product: Jambaar stove – most successful in urban Senegal; advances non-health objectives (esp. fuel conservation)
  - Diffusion to rural areas has been a problem
- **But is the Jambaar is clean enough?**





Our study: In progress…

- We know that ICS can reduce exposure to PM, but health impacts are often elusive (even for cleaner tech)
- Is this because the cooking environment is simply too dirty in low-income settings? (Stacking, poor ventilation, ambient air quality, etc.)
- Design:
  - Three groups (randomized at household level): Control, basic firewood Jambar ICS, more efficient jumbo Zama-Zama ICS

Firewood Jambar

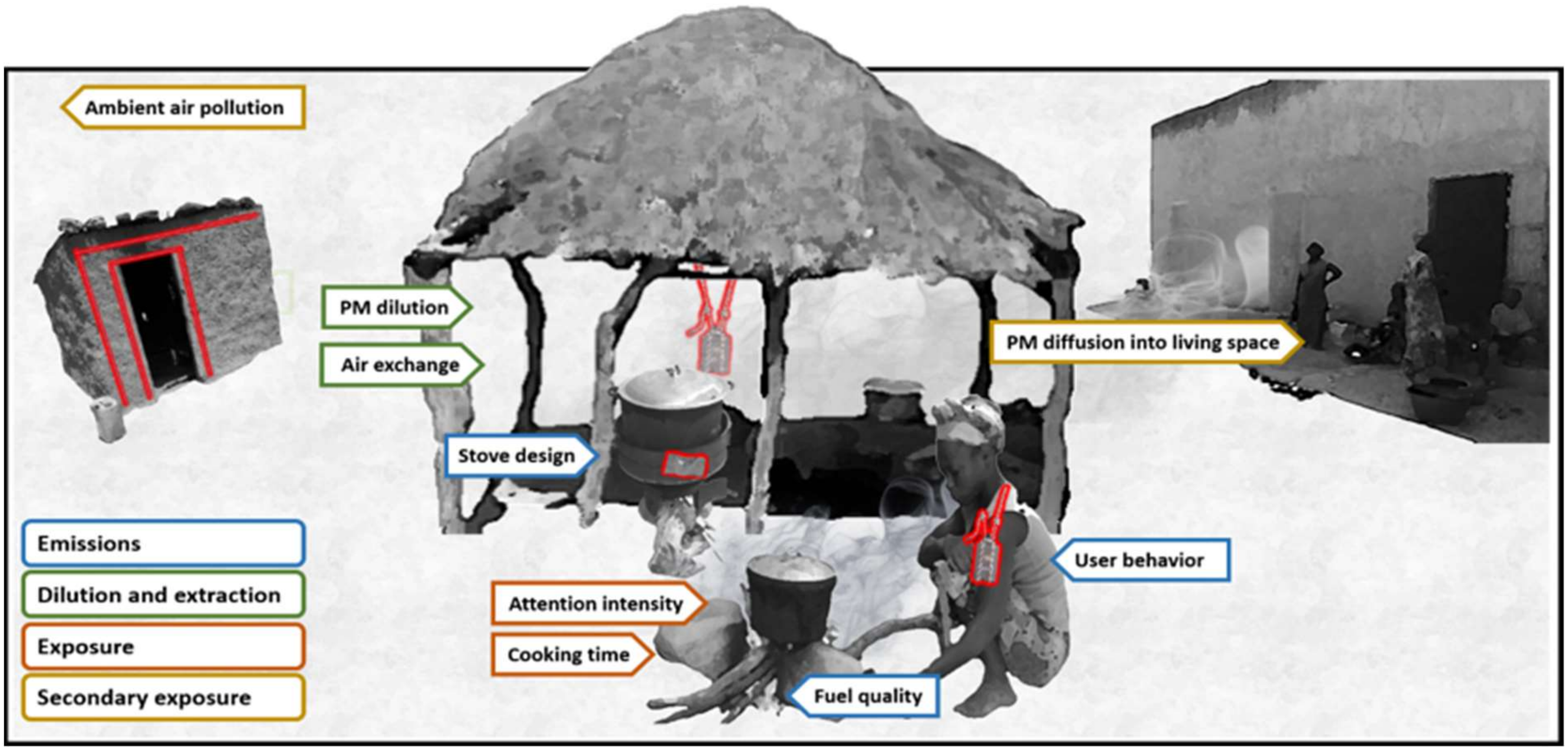
Produced locally

Zama Zama

Produced in South Africa

  - Stratied randomization of ICS according to the nature of the cooking environment: Thus, cleaner stoves in cleaner/dirtier environments, and vice versa

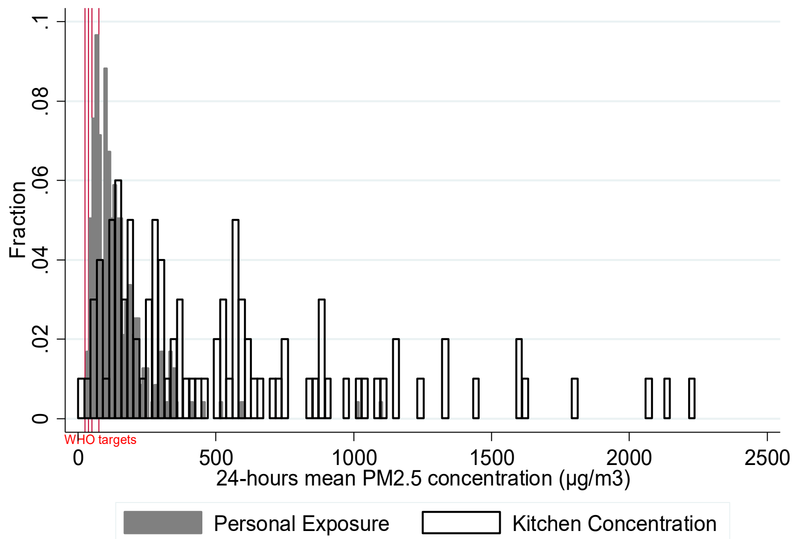
How do we characterize the cooking energy system concept?



Use these concepts (from EnDev) to create indices of cleanliness of the CES using statistical methods, for comparison with alternative weighting approaches

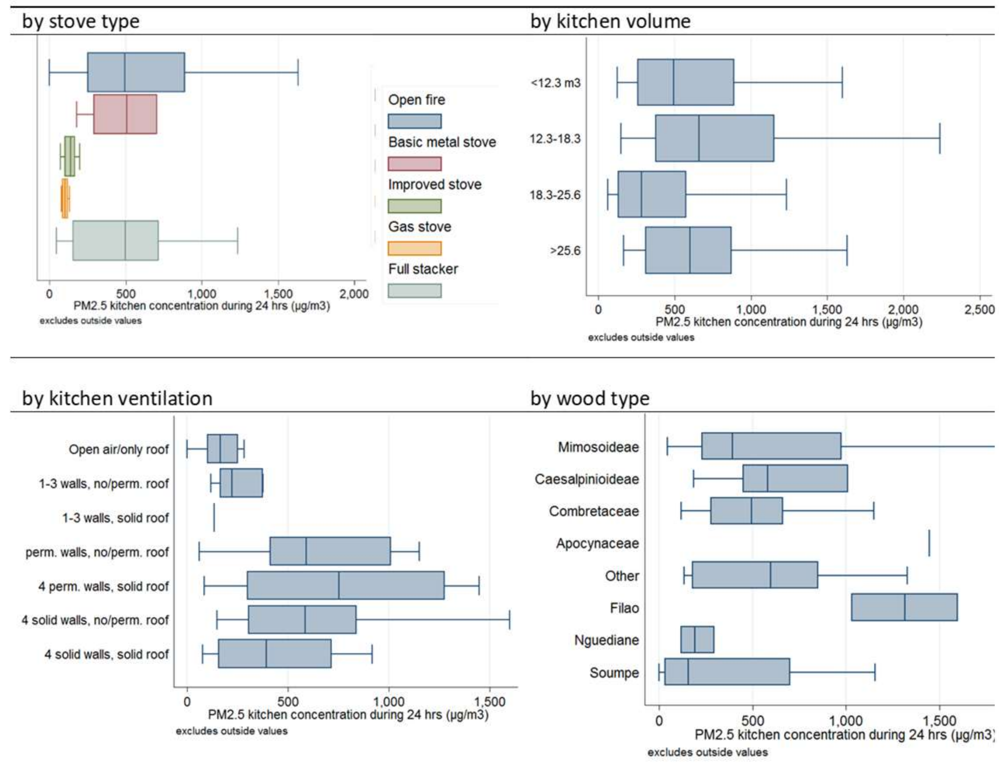
Two major principal components: 1) Ventilation; 2) More commercial fuels & cooking

Baseline data patterns

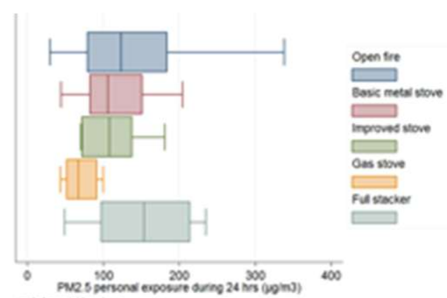


Note: Red lines indicate the WHO target of 25 µg/m³, and interim targets of 37.5, 50, and 75 µg/m³

Cooking energy system aspects



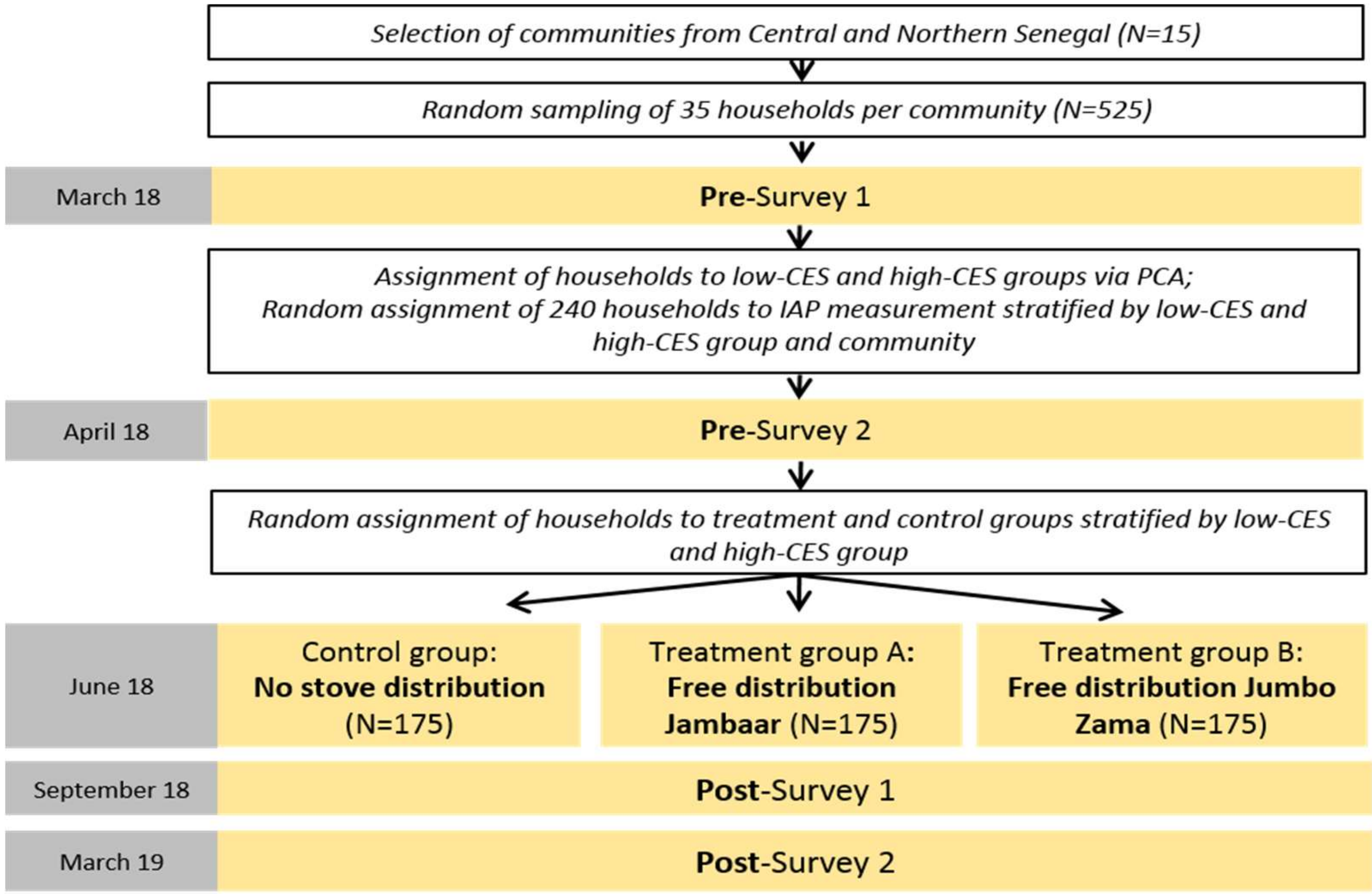
Note: Differences in cook exposure are much less pronounced → **Behavior!**
Same is true for other aspects as well!



Take home results from baseline

- Cleaner CES system (by ventilation stratum): Lower kitchen concentrations, **but not lower exposure** for cooks
- Cleaner fuels: Lower kitchen concentrations and exposure, **but differences are much greater for kitchen concentration**
- Counter-intuitively perhaps, healthier people (lower blood pressure, higher blood oxygenation) are more likely to be cooking in **worse** conditions (poor ventilation)
- Further analysis with underlying CES variables:
  - Mostly, significance decreases on individual underlying variables relative to principal components that account for correlations between them – **the confluence of factors is more important than individual ones alone**
  - For example, clean fuel does not consistently explain differences in concentrations and exposure, controlling for other factors
- Stay tuned for intervention results! (Will cooking environment / behavior reinforce or negate the benefits of cleaner technology?)

Moving forward: Experimental design & timeline



Baseline/Endline measurements: PM (kitchen and personal cook; Micro-PEMs); Stove use (SUMs); Fuel weighing; Health measures (Blood pressure, pulse, blood oxygenation, biomarkers of inflammation (not analyzed yet), self-reported illness

Midline survey (Post 1): Self-reports, fuel use only