



Solutions for indoor air pollution during the herding season in Bumthang, Bhutan

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Tripod Fire



Bukhari

INTRODUCTION

- Domestic biomass burning is a major environmental health challenge in the Global South – and open tripod fires pose a considerable health risk
- Rural households in Bhutan predominantly burn biomass for heat and energy – and despite major national electrification efforts, many mountain communities do not have access to any infrastructure services during their nomadic seasons

OBJECTIVES

- Explore the indoor air pollutant (IAP) exposure profile of the nomad communities of Bumthang, Bhutan
- Conduct an IAP-relevant health assessment for these communities
- Meet a critical environmental health need expressed by these communities in the form of a stove distribution effort
- Further investigate the energy behaviors and environmental health needs of these communities

METHODS

- Low-cost 2.5-um particulate matter (PM_{2.5}) active sensors
- Passive air pollutant samplers
- Community questionnaires
- Clinical evaluations of community members

INNOVATIVE ASPECTS

- Use of FreshAir clips
- Use of low-cost air pollution sensing technology in a remote and resource-constrained setting
- Demonstrate real value of new low-cost sensors for community-based research

RESULTS

Table 1. Peak and average PM_{2.5} concentrations measured during field work burn scenarios.

Metric	Metric	Bukhari (n=4)	Tripod Fire (n=22)
Fine Particulate Matter Peak Concentration (ug/m ³)	Min	2.1	409.2
	Med	46.2	1318.6
	Mean	43.2	1263.3
	Max	78.2	2341.9
Fine Particulate Matter Average Concentration (ug/m ³)	Min	0.1	25.6
	Med	13.5	250.5
	Mean	11.7	344.6
	Max	19.7	1101.9

Table 2. Crude assessment of time-weighted average daily inhalation exposure to both total PM_{2.5} mass concentration and total PAH volumetric concentration

	Hour	Mean PM _{2.5} m.c. (bukhari)	Mean PM _{2.5} m.c. (fire)	Mean PAH v.c. (bukhari)	Mean PAH v.c. (fire)
Living space	11	11.77 ug/m ³	192.77ug/m ³	0.0876 mg/m ³	0.1229 mg/m ³
Non-living space	1.5	449.77 ug/m ³	449.77ug/m ³	0.8674 mg/m ³	0.8674 mg/m ³
TWA	24	33.4688 ug/m ³	116.4271 ug/m ³	0.0944 mg/m ³	0.1105 mg/m ³

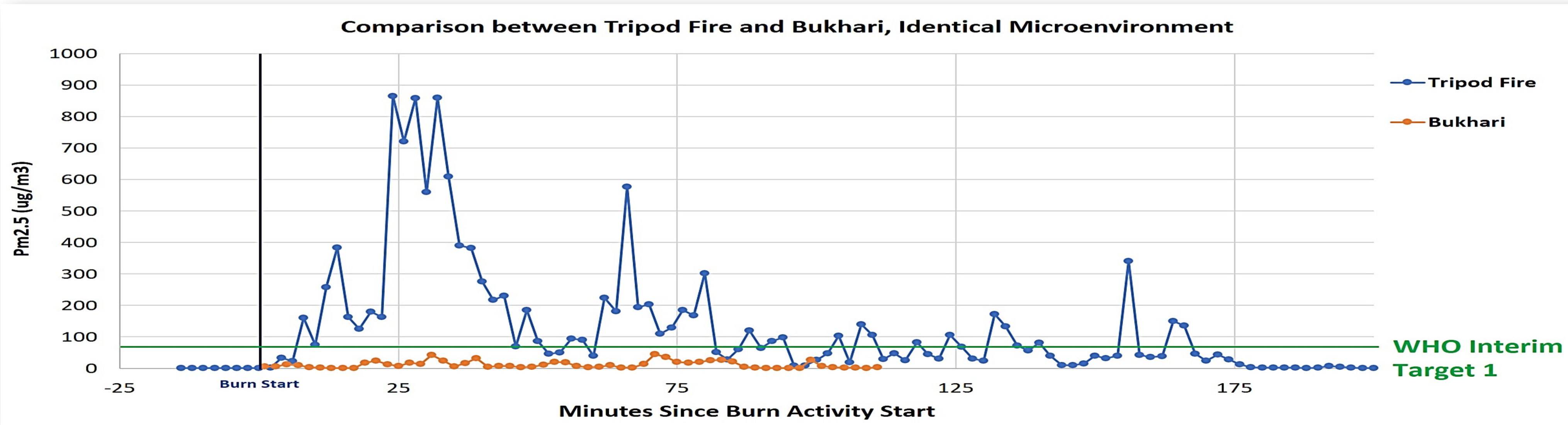


Figure 1. Comparison of real-time indoor fine particulate matter mass concentrations from an open fire and a *bukhari*.

CONCLUSIONS

- Bukhari* demonstrated vastly superior pollution performance than tripod fires, approaching WHO interim guidelines
- Community members have unacceptably high rates of IAP exposure and health problems possibly associated with IAP
- Community members were exposed to high levels of several priority pollutants, including PAHs as well as non-combustion-associated compounds such as pesticides, phthalates, and flame retardants.
- Preliminary data warrants a more rigorous, deeper, and broader environmental health risk assessment for these and similar communities
- Evidence of acceptability and effectiveness justifies broader stove distribution efforts
- Methodological abilities demonstrated in difficult research context; evidence in support of broader, systematized community IAP monitoring
- Good community and researcher partnerships built for future work

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