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Hydrology and human behavior: two key factors of diarrhea incidence in montane tropical humid areas

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The global burden of diarrhea is a leading cause of morbidity and mortality worldwide. In montane areas of South-East Asia such as northern Laos, recent changes in land use have induced increased runoff, soil erosion and in-stream suspended sediment loads, and potential pathogen dissemination. In this study we hypothesized that climate factors combined with human behavior control diarrhea incidence, either because higher rainfall, leading to higher stream discharges, suspended sediment loads and Fecal Indicator Bacteria (FIB) counts, are associated with higher numbers of reported diarrhea cases during the rainy season, or because water shortage leads to the use of less safe water sources during the dry season. For this mixed methods approach, we conducted a retrospective time series analysis of meteorological variables (rainfall, air temperature), hydrological variables (discharge, suspended sediments, FIB counts, water temperature) at the outlet of 2 catchments in Northern Lao PDR, and the number of diarrheal disease cases reported in 6 health centers located in the Luang Prabang Province. We also examined the socio-behavioral factors potentially affecting vulnerability to the effect of the climate factors, such as drinking water sources and hygiene habits. We found the FIB Escherichia coli to be present all year long (100-1,000 MPN 100 mL-1) indicating that fecal contamination is ubiquitous and constant. We found that populations switch their water supply from wells to surface water during drought periods, the latter of which appear to be at higher risk of bacterial contamination than municipal water fountains. We thus found that water shortage in the Luang Prabang area triggers diarrhea peaks during the dry and hot season and that rainfall and aquifer refill ends the epidemic during the wet season. We thus found that anthropogenic drivers, such as hygiene practices, were at least as important as environmental drivers in determining the seasonal pattern of a diarrhea epidemic. For diarrheal disease risk monitoring, discharge or groundwater level can be considered as relevant proxies.