

TITLE: THE USE OF *Escherichia coli* AND *Bacteroides thetaiotaomicron* AS FECAL CONTAMINATION MARKERS IN GROUNDWATER AFFECTED BY INADEQUATE SANITATION

AUTHORS: GAUTHIER, C.¹; ALVES, T. S.²; LEITE, D. S.²

INSTITUTIONS: ¹ENTER FOR GLOBAL CHANGE AND EARTH OBSERVATIONS AND DEPARTMENT OF GEOGRAPHY, ENVIRONMENT, AND SPATIAL SCIENCE, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI, USA (Harrison Road, Suite 218, East Lansing, MI 48823, USA).

²INSTITUTO DE BIOLOGIA, UNIVERSIDADE ESTADUAL DE CAMPINAS - CAMPINAS, SP, BRAZIL (CAIXA POSTAL 6109, CEP 13083-862, CAMPINAS, SP, BRAZIL).

ABSTRACT:

In the Brazilian Amazon States, provision of basic sanitation services lags behind with 55.4 percent of residents having potable water from a distribution network and only 10.5 percent having sewer service. As population density increases in the region, greater volumes of contaminants enter the shallow groundwater resources through septic tanks. Watersheds with high septic tanks densities exhibit increased concentrations of fecal indicators and septic systems seem to be the primary driver of the increased fecal bacteria levels. Higher septic system densities are associated with endemic diarrheal illnesses making areas with a lack of sanitary infrastructure and limited access to clean drinking water particularly vulnerable to diseases. We investigate the use of *Bacteroides thetaiotaomicron* (hereafter *B. theta*) as a robust human fecal contamination marker for groundwater resources. Thirty household wells within urban Altamira, Pará, were sampled and analyzed for fecal coliform indicators *Escherichia coli* and *B. theta* to determine the presence and magnitude of human fecal contamination in the local groundwater resources. We used *Aquagenxx's Compartmental Bag Test*, a most probable number (MPN) chromogenic method for *E. coli* in drinking water. Since *E. coli* can be found in tropical soils and in the feces of warm-blooded animals, we used microbial source tracking (MST) and quantitative Polymerase Chain Reaction (qPCR) assays targeting the *B. theta* α -1–6 mannanase gene, which has high human specificity. Nineteen of the homes sampled tested positive for *E. coli* with concentrations ranging from 1.1 to greater than 100 MPN/100mL and the geometric mean of 10.13 MPN/100mL. Thirteen of homes sampled tested positive for *B. theta* ranging from 37.02 to 43460.58 copies/mL and geometric mean of 4132.69 copies/mL. Only eight of the homes tested positive for both fecal coliform markers. Based on these results, we conclude that the presence of *E. coli* in 63% of the sample demonstrates the existence of fecal contaminants in the local groundwater resources. The presence of *B. theta* in 43% of the homes demonstrates that not all of the fecal contaminants reaching local groundwater resources are human in nature. Considering sanitation both an important societal and environmental issue that affects water quality, and public health and safety, *B. theta* can be a useful indicator for the likelihood of contaminant intrusion from septic tanks to water wells in the region.

Keywords: septic tanks, qPCR, potability, coliforms, public health