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The Relationship between Hydroclimatic Variables and Faecal Indicator Bacteria in River Basins in Pakistan and Bangladesh

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Water contaminated with pathogenic bacteria causing diarrhoea poses a health risk to the population. Worldwide, diarrhoea is the 3rd leading cause of death. A changing climate may increase the concentration of pathogens in surface water. Increased temperature will mostly increase the inactivation of pathogens and therefore decrease the surface water concentration. Increased precipitation may dilute contaminated water, but may also increase the runoff of pathogens into the surface water. Decreased precipitation may have the opposite effect. Moreover, increased chance of extreme precipitation events and increased risk of floods may also increase the runoff of pathogens into the surface water. The net balance of these effects is uncertain. The objective of our study is to quantify the relationship between hydroclimatic variables (surface air and water temperature, precipitation and runoff) and faecal indicator bacteria (FIB, E. coli and Enterococci) in two rivers in Pakistan and Bangladesh. In these countries health problems are large, particularly in annual periods of flood. We studied FIB instead of pathogens, because of the costs associated with pathogen measurements. The relationship between FIB and hydroclimatic variables is expected to be comparable to the relationship between pathogens and hydroclimatic variables.

For both regions the FIB concentrations have been monitored for two years between 2013 and 2015 at several points in the rivers. Concentrations of FIB in Kabul (Pakistan) and Betna (Bangladesh) river basins are very high (up to 5.2 log10 cfu/100ml). Due to a broken waste water treatment system of the city of Peshawar, concentrations are higher in Kabul than in the Betna river. All hydroclimatic variables positively correlate with FIB. An unexpected positive relation with temperature can be explained by the fact that temperature and discharge increase at the same time and possibly FIB growth. The positive relation with precipitation and discharge shows that not the dilution, but the increased runoff of FIB is more important. Regression models for each of the measurement locations in Kabul river show that water temperature, discharge and precipitation together explain a large part of the variance (R2 equals 0.72-0.94) for E. coli. The regression model for Betna river comprises water temperature and discharge and for E. coli R2=0.47 and for Enterococci R2=0.49. We can conclude that FIB concentrations increase with increasing temperature and particularly precipitation and discharge. We expect pathogen concentrationss to increase in a similar way and would therefore expect increased health risk due to climate change in Kabul and Betna river basins.