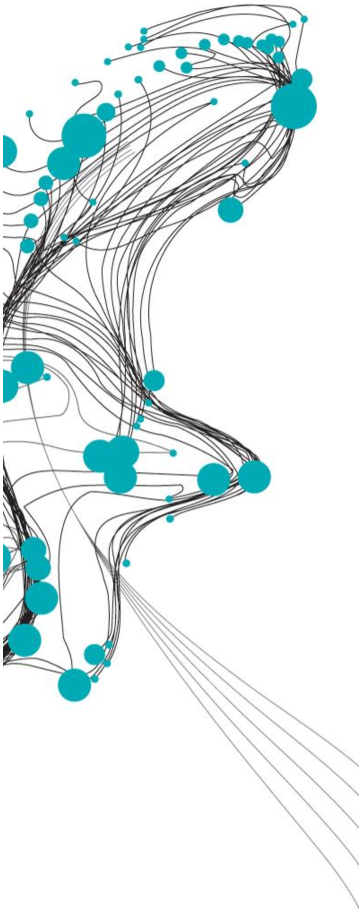
The role of water in cholera diffusion

Improvements of a cholera diffusion model for Kumasi, Ghana



Cholera is still one of the most feared infection diseases, especially in those countries where clean drinking water is not available to the local people. In order to develop an effective strategy against the spread of cholera it is important to understand the underlying spreading mechanisms. Therefore, Useya (2011) developed an agent based model that simulates the spread of cholera for the outbreak of 2005 in Kumasi, Ghana. Although the developed cholera model was able to reproduce the epidemic curve of cholera, it contained some parts, particularly the hydrological part, that should be improved before it can be used for practical purposes. Therefore the objective of this study was to improve the hydrological part of this model and use it to evaluate different scenarios.

Water flow is now modelled based on Mannings equation and resembles more realistic velocities. The hydrological procedures was calibrated and validated against discharges calculated by the Curve Number method which gave good results (Nash-Sutcliffe > 0.92 and Relative Volume Error within ±0.3%).

The modelled area was enlarged to the size of the catchment which is more suitable for hydrological modelling and provides the opportunity to compare the results to cholera cases from different communities. The model was calibrated on the relative contribution of each community to the distributed pattern of cholera rather than the absolute incidence. The calibration of the model resulted in a r^2 of 0.87 (figure 1). This means that the model was able to reproduce the geographical distribution well. The epidemic curve was comparable to results reported in literature.

Analysis of the model results shows that water plays an in important role in the diffusion of cholera: 75% of the cholera cases were infected via river water that is contaminated by runoff from the dump site. Due to the Environment-to-Human (EH) transmission procedure the model clearly shows a random spatial pattern of the diffusion process while this is not expected from literature. The model results appear to be quite sensitive to the scheduling of the daily activities and the survival time of V. cholerae.

The scenario analyses show that there is a strong relation between the epidemic curve and the rainfall. Crucial for the model performance to simulate the geographical distribution well is a process where the probability to get infected with cholera depends on the living location within the study area. Removing dump sites that are situated close to the river resulted in a decrease in the number of cholera cases.

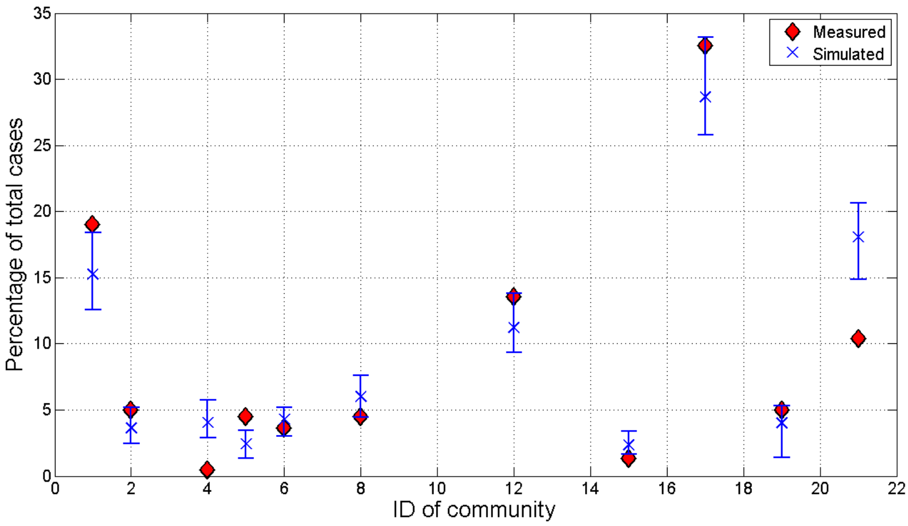


Figure 1: The geographical distribution of the relative number of cholera cases measured and simulated for each community (r^2=0.87). The error bars represent variability in simulated outcomes of the same input caused by the probabilistic character of the model.

Useya, J. (2011). Simulating diffusion of cholera in Ghana. Master thesis, University of Twente, ITC, Enschede.

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