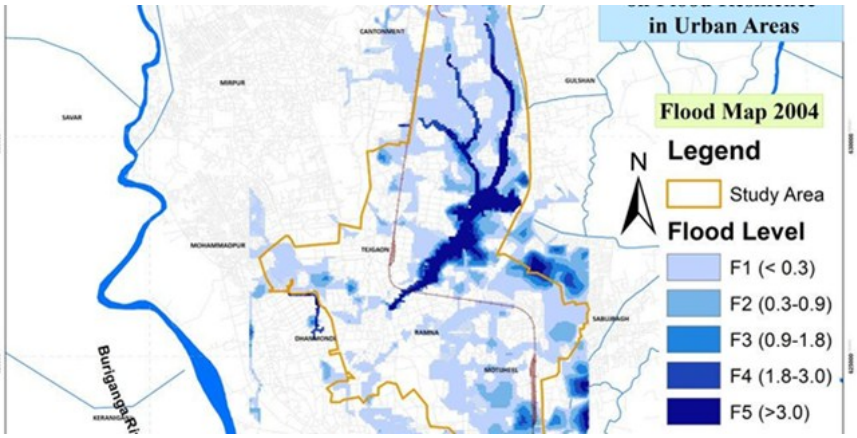
IMPROVING PUBLIC HEALTH

Intelligent water management to control urban water borne infectious disease

Diarrheal diseases such as cholera, typhoid, rotavirus and *E. coli* (ETEC) cause two million deaths – or 5% of the global mortality – every year. For children under five years old, this number 1.2 million deaths (9% of global mortality). There is an urgent need to reduce the burden of diarrheal diseases, particularly for children under the age of five. Waterborne diarrheal diseases are transferred via drinking water or direct exposure to surface waters such as flood water or recreational water. These diseases are generally seen in developing countries, particularly in slum areas that flood more frequently. Even in countries with fully developed water infrastructure, water borne infectious diseases are still transmitted via these same sources. With climate changes, the health risks for both developed and developing water infrastructures will become more evident.

DISEASE CONTROL THROUGH INTELLIGENT WATER MANAGEMENT

We have developed a concept for intelligent water management to reduce water borne infectious diarrheal diseases that are caused by contact with surface waters. Our concept identifies locations and situations with the highest risk. This allows water managers to prioritise and intervene in the most economically optimal way that result in the highest impact on the public health. We combine the use of one-dimensional drainage and sewer models with two-dimensional surface models to estimate flood levels and the concentration of wastewater and pathogenic microorganisms. The results of the flood model are used as input to assess human exposure to the pathogens and quantitative microbial risks in order to determine the burden of disease on the population when cities flood.



Model simulated flooding of Dhaka, Bangladesh, September 2004. © DHI

CLIENT

- Municipalities
- Water and sanitation utilities
- Local and national authorities
- Universities and research institutions
- Aid and donor organisations

CHALLENGE

- Need to manage the increased risk to water infrastructure as a result of climate change in developed and developing countries
- Need for climate change adaptation solutions that take into account health-related risks

SOLUTION

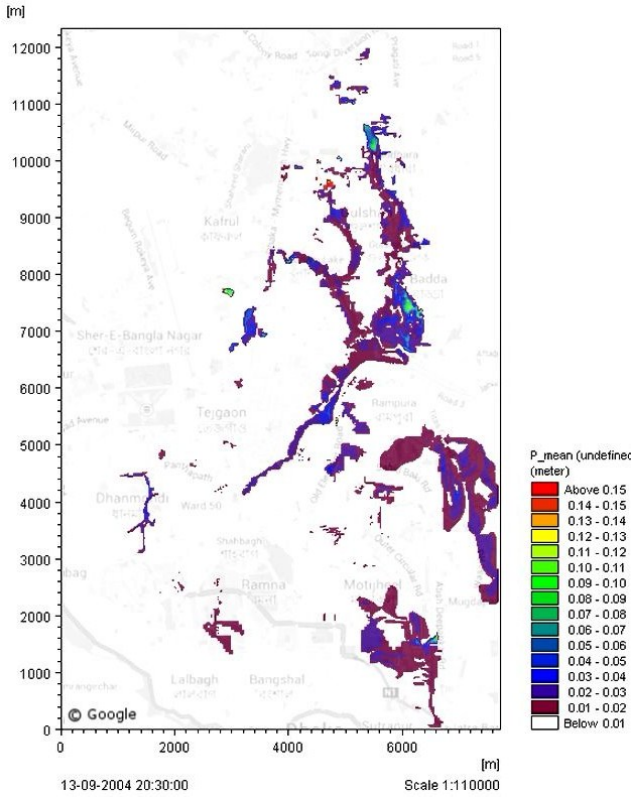
Combining classic hydraulic sewer network modelling and surface modelling with quantitative microbial risk assessment to allow for holistic water planning that takes into account health risk aspects

VALUE

- Enables health-based prioritisation of water management interventions
- Ensures optimal value for investments in water infrastructure

The model identifies critical control points for interventions to reduce disease burden. The interventions may be diverse and include, among other things, strategies such as:

- intelligent pumping strategies
- structural changes of the sewer/drainage systems
- improved distribution systems and sanitation
- restriction of access
- risk communication
- vaccination in high risk areas



Model simulation of the average risk of cholera infection per day for children below the age of 5 years old living in slum areas in Dhaka (Bangladesh). A dynamic version covering three days during a flood event in September 2004 can be seen here on our YouTube channel here: http://youtu.be/oJIDThnYweQ. © DHI

EVIDENCE-BASED RISK MANAGEMENT

Investments in water infrastructures to decrease water borne infectious diarrheal diseases and to increase resilience against climate change is expensive. In order to attract the necessary funds and to achieve the highest effects of the investments possible, a thorough planning and analysis of scenarios is necessary. At the same time, authorities must ensure that the investments themselves do not create a health risk.

Human health and diarrheal diseases are important parameters to take into account during the planning process. Our intelligent water management concept provides water managers with the best available information to identify the most critical points and support decisions regarding interventions by:

- mapping water infrastructure
- setting up models for the area of concern
- determining and/or estimating surface water qualities
- determining drinking water qualities
- estimating infection risks and disease burden
- determining critical disease control points in time and space
- analysing scenarios to estimate the effects of interventions

The scenarios may include future climate scenarios with increased frequency of heavy rain.

MULTIPLE USES AND USAGE REQUIREMENTS

The hydraulic model can be used for other purposes, including daily operation of sewer systems, urban development, and climate change adaptation. Our approach introduces a new understanding and awareness of the importance of risk management. By applying the described concept, water managers will increase the possibilities of attracting the necessary funds to intervene by providing credible scenario analyses and estimations of the effects of interventions.

To use this tool, a sewer and a surface model must be available or in the process of being set up. Our tool uses the deterministic model MIKE FLOOD, which integrates the one -dimensional hydraulic Advection-Dispersion module (A/D) sewer network model in MIKE+ and the two-dimensional hydraulic surface A/D model MIKE 21.

REFERENCE

Our concept has been applied to the City of Dhaka, Bangladesh in the Collaborative research on flood resilience in urban areas (CORFU) project. It was funded by European Union Seventh Framework Programme for Research (FP7) grant number 244047 and the Danish Agency for Science, Technology and Innovation.

The results of cholera risk assessment in Dhaka has been accepted for publication in the Journal of Flood Risk Management: Mark, O., Jørgensen, C., Hammond, M., Khan, M.D. Tjener, R., Erichsen, A., and Helwigh, B. (2015). A new methodology for modelling of health risk from urban flooding exemplified by cholera - Case: Dhaka, Bangladesh.

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