Improving water security for the poor

POLICY BRIEF, APRIL 2017

Identifying water quality risks and modelling intervention strategies

There is a serious problem of water pollution in central Dhaka, in the Turag-Tongi-Balu River System. Dissolved Oxygen is close to zero in the dry season, there is very high organic pollution loading, as well as high ammonia and large numbers of pathogens in the water. Factories along the river discharge pollutants with dangerous contaminants, runoff from waste tips is a serious problem and there is agricultural nutrient pollution from the upper reaches of the river. People using the water for drinking, washing clothes, bathing and vegetable production face different and varying health risks. In this study, a baseline survey of water chemistry and pathogens has been undertaken and mathematical models of the rivers set up. The models are being used to assess hydrochemical processes in the river and also evaluate alternative strategies for policy and the management of the pollution issues.

Introduction

Pollution in large rapidly developing cities is a major problem responsible for many premature deaths and serious illnesses, especially to women and children. High population numbers, insanitary conditions, poorly regulated industrial discharges and untreated domestic effluents has ensured that such rivers are highly polluted, and pose a significant threat to people using the rivers, groundwaters and associated water supply systems. There is wide-scale evidence of high levels of disease, skin infections and more serious illnesses impacting local people.

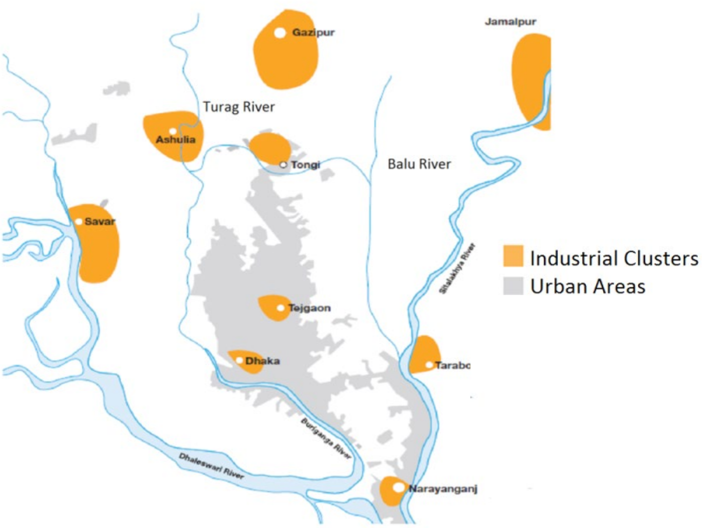


Figure 1. The Turag-Tongi-Balu system and major areas of industry

The Turag-Balu River system in north-eastern Dhaka (in central Bangladesh) is highly polluted with thousands of factories discharging waste into the river system and 12 million people contributing waste with minimal effluent treatment, in addition to agricultural pollution from upstream areas (Figure 1).

The Turag originates from the Bangshi River, the latter an important tributary of the Dhaleshwari River, and flows through Gazipur and joins the Buriganga at Aminbazar in Dhaka District. The Turag receives a huge waste load of industrial effluent from Konabari and Kashimpur of Gazipur. At Rustompur (near Mirpur of Dhaka) it is connected with Tongi Khal which flows eastward to join with Balu. The reach downstream from Rustompur to Amin Bazar is hydrologically known as the Lower Turag and has no major industries along its banks. The Tongi industrial area located on the banks of Tongi Khal has been polluting the river for over four decades. The rivers also receive domestic waste loads from numerous sources along the banks (Figure 1). Industrial and municipal wastes are the major sources of pollution due to the growing industrial development and the poor state of sewerage and sanitation system not only around Turag-Tongi-Balu but also in whole of Dhaka city.

A methodology is required to quantify pollution, assess the pollution and health impacts, and evaluate alternative pollution reduction measures including effluent treatment, flow augmentation and dredging.

Approach and results

The first phase of this work has been to establish a comprehensive set of surveys, taking samples from the river at many locations (Figure 2) and analysing the samples for a range of chemicals and pathogens. Figure 3 shows an example of a profile of water quality for ammonia concentrations. Most rivers have ammonia concentrations of about 0.2 mg/l but at Tongi the effluents increase ammonia to over 10 mg/l in the low flow period and this level is sustained down the river, with even bigger spikes further downstream. This pattern is repeated for many chemicals and pathogens (eg E.coli) along the river system. Meanwhile Dissolved Oxygen falls to zero in the dry season as the ammonia and organic pollution levels rise downstream of Tongi. Anoxic conditions release hydrogen sulphide gases from the sediments and also remobilise metals and organic contaminants from the sediments.

Using the water quality data and rainfall data for the catchment, we have set up a dynamic flow and quality model for the whole system. The hydrology of the system is highly complex and special attention needs to be paid to the additional flood flows and runoff coming from the upstream Turag. However, we can model the hydrological cycle in the river systems and then, by making various assumptions about effluent discharge rates and quality, we can simulate the profiles of water quality (Figure 3).

Having established the model, we have evaluated a series of management alternatives to assess pollution clean-up (Figure 3). Three management strategies have been considered initially, namely, the introduction of effluent clean up technologies for key discharges along the river plus the alteration of water flows in the upper Turag so as to increase the flows of water in low flow conditions. Figure 3 shows the effects of these 2 strategies plus what would happen if both these were implemented together. The results show that clean-up of the effluents will significantly improve the water quality, and that also the dilution effects of extra flows in low flow months will also improve the water quality. The best solution is to combine these policies, and this would reduce the ammonia levels to safe concentrations (see Figure 4).

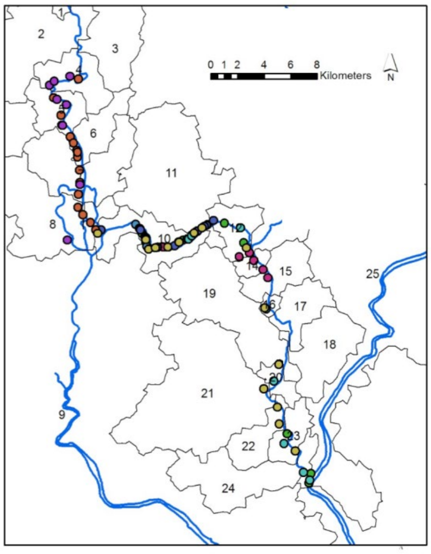


Figure 2. Sampling sites along the river system

Conclusions and recommendations

The combined strategy to reduce pollution and enhance the low flows is recommended and these also align with government policy. However the costs of new Sewage Treatment Works (STWs) plus the cost of canals or diversions to enhance summer flows upstream will be high. The model can be used to evaluate alternative designs such as the number, efficiency and location of STWs, the flows required by the canal, and hence canal size etc, to evaluate the most cost effective solution. Improving water quality is a key priority for the government and a stronger evidence base can help target the most beneficial investments for people, ecosystems and industry. Plus the model can be used to evaluate the Pathogens and Dissolved Oxygen balance to ensure Pathogen levels are reduced and that Dissolved Oxygen is above the acceptable limit for ecosystem health.

Figure 3. Observed Ammonia along the river

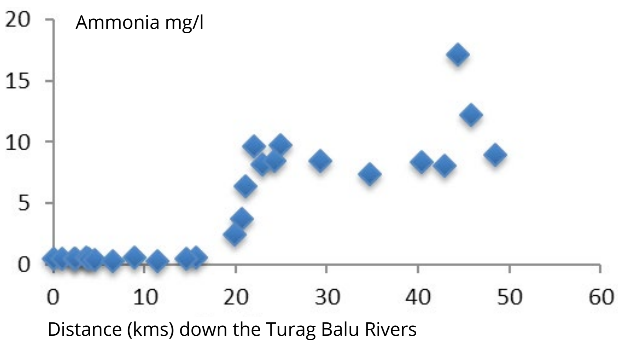
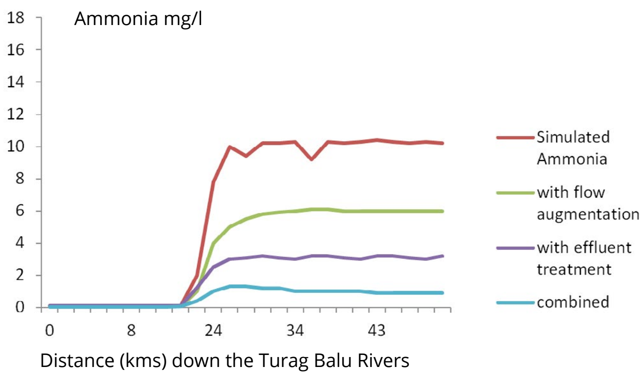


Figure 4. Simulated Ammonia along Turag-Balu River system and three policy initiatives



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