Summary Assessment

Water Quality Survey for Kurunegala, Sri Lanka

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Introduction

This summary is one in a series of summaries written by the Wastewater Agriculture and Sanitation for Poverty Alleviation in Asia (WASPA Asia) project. The project aims to develop and test solutions for sanitation and wastewater management, to reduce the risks from wastewater use in agriculture. The approach involves the development of stakeholder coalitions at town and national level, called Learning Alliances, which will bring together the main stakeholders into a participatory process through which actions will be planned and implemented.

The WASPA Asia project is funded primarily under the EU Asia Pro Eco II Programme of the European Commission. It is being undertaken in Sri Lanka and Bangladesh by the International Water Management Institute (IWMI) and COSI in Sri Lanka; the International Water and Sanitation Centre in the Netherlands; NGO Forum for Drinking Water Supply and Sanitation in Bangladesh; and the Stockholm Environment Institute (SEI) in Sweden.

Conclusions and Recommendations

Most of the parameters tested in the water quality survey were within the proposed Sri Lankan standards for irrigation and agriculture, and the World Health Organization (WHO) guidelines for wastewater use in agriculture. Very low if any concentrations of heavy metals were recorded, and these were not therefore tested in future monitoring events. The most concerning finding was that biological quality parameters were not satisfied. It can be concluded that the major problem in using wastewater in agriculture in the project area is the high level of faecal contamination.

The wastewater is mainly used for growing paddy and the health risks are therefore predominantly to agricultural workers and their families; consumers are less likely to be at risk because rice is always cooked. However, vegetables are occasionally grown in small plots which could affect consumers.

Though above WHO guidelines, the total Coliform count was substantially lower in the agricultural area than further up-stream. This may be due to natural treatment processes in the 2 km stretch of the irrigation canal where there are very few additional sources of pollution. This needs to be studied further before any recommendations are made.

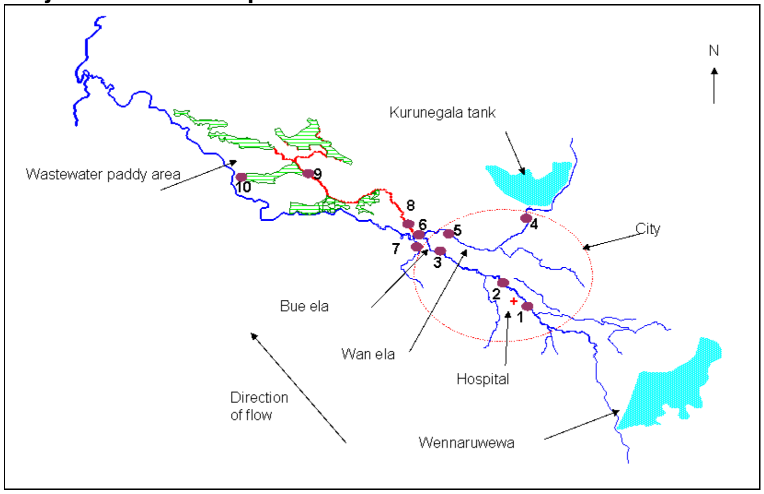
Main Findings

This section reviews the water quality results obtained in the baseline sampling and the single sampling event that has taken place since that. Samples were taken along the two water courses that flow through the city, the Wan Ela and the Beu Ela. Samples were also taken in the agricultural area and from one deep well and one shallow well.

Nitrogen

Nitrogen is a necessary primary macronutrient for plants that stimulates plant growth and is usually added as a fertilizer but can also be found in wastewater as nitrate, ammonia, organic nitrogen or nitrite (FAO 2006). The most important factor for plants is the total amount of nitrogen (N) regardless of whether it is in the form of nitrate-nitrogen (NO_3-N), ammonium-nitrogen (NH_4-N) or organic-nitrogen (Org-N). If excess nitrogen is applied to the crop it can result in: over-stimulation and excessive growth which attracts pests; delayed maturity; or a reduction in the quality of the crop (Ayres and Westcot 1994).

Project site and sample locations



The concentration of nitrogen required varies according to the crop. Most crops are relatively unaffected until nitrogen exceeds 30 mg l^{-1} but more sensitive crops can be affected by nitrogen concentrations above 5 mg/l. The sensitivity of crops also varies with the growth stage: high nitrogen levels may be beneficial during early growth stages but may cause yield losses during the later flowering and fruiting stages, consequently high nitrogen water, including domestic wastewater, can be used as a fertilizer early in the season but should ideally be reduced or blended with other sources of water later in the growth cycle (Ayres and Westcot 2004).

In general, the nitrogen levels in the surface water in the project area were fairly low and were all below 30 mg/l. However, six of the samples were above the 5 mg/l proposed for irrigation water for Sri Lanka. These results seem low for wastewater and further analysis is required.

The total nitrogen concentration of the ground water was among the highest of the samples but the NO_3-N was below the WHO Guidelines for Drinking Water Quality (1998).

Phosphorous

Phosphorus is also a primary macronutrient that is essential to the growth of plants and other biological organisms but quantities can be excessive and if the concentrations in water are too high noxious algal blooms can occur. In Sri Lanka there is currently no limit on phosphorus levels in wastewater but the proposed limit has been set at 0.7 mg l^{-1}**Error! Reference source not found.** for irrigation (CEA 2001). All the values reported exceed the this standard.

Salts and Conductivity

Electrical conductivity (EC) is a measure of the ions present in water and is also effectively a surrogate for total dissolved solids (TDS). It is a measure of the salinity of the water and although it does not identify the dissolved salts or the effects they may have on crops or soil, it does indicate fairly reliably the degree with which a salinity problem is likely to occur. Salinity restricts the availability of water to plants by lowering the total water potential in the soil. Salinity also has an impact on crop physiology and yield with visible injury occurring at high salinity levels.

The Food and Agriculture Organization (FAO; Ayres and Westcot 1994) has developed guidelines for the evaluation of water quality for irrigation and suggests that there need be:

- No restrictions on the use of irrigation water with an EC of 0.7 dS m^{-1} (700 µS cm^{-1}) or a TDS concentration of less than 450 mg l^{-1};
- Slight to moderate restrictions if concentrations are in the range 0.7 – 3.0 dS m^{-1} or a TDS concentration of 450 – 2000 mg l^{-1}; and
- Severe restrictions for irrigation water with an EC of greater than 3.0 dS m^{-1} or a TDS concentration of more than 2000 mg l^{-1}.

The proposed irrigation water quality standards for Inland Waters in Sri Lanka for EC and TDS are 0.7 dS m^{-1} (700 µS cm^{-1}) and 500 mg l^{-1} respectively.

The surface water samples were all within the FAO guidelines for TDS and EC.

Sodium Absorption Ratio

The relative proportion of sodium to other cations is determined by the Sodium Adsorption Ratio (SAR). This index quantifies the proportion of sodium (Na^+) to calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in a sample. Calcium will flocculate (hold together), while sodium disperses (pushes apart) soil particles. This dispersed soil will readily crust and have water infiltration and permeability problems. Any increase in the SAR in irrigation water increases the SAR of the soil solution, which ultimately increases the exchangeable sodium by the soil, leading to the loss of permeability.

SAR varied between 0.44 to 1.05 for locations 1 to 10 in the baseline survey and 0.70 to 1.25 in the second monitoring event. The variation within the irrigation canal is less at 0.78 to 1.05; and 1.25 to 1.17 for the respective sampling events. These values are far below the WHO (2006) restricted limits for irrigation water. The Proposed Ambient Water Quality Standard range for SAR for irrigation and agriculture in Sri Lanka is 6-15.

Iron

Excessive iron in wastewater can reduce the dissolved phosphorous component through precipitation; therefore, phosphorous might not be readily available for plant uptake in the presence of excessive iron. The concentration of iron ranged from 0.6 mg l^{-1} in one of the ground water samples to 2.5 mg l^{-1} in the in-flow to Beu Ela; however there was no clear pattern in the variability of iron concentrations. The WHO recommended maximum concentration of iron for crop production is 5 mg l^{-1}, which is above and the reported values for the project samples.

In the second sampling event, iron was tested only in ground water samples and the concentrations are within the proposed permissible maximum level for drinking of 1.0 mg l^{-1}.

Heavy metals

The results of the water quality analysis showed that nickel, cadmium, arsenic, lead and mercury were not detected in any of the samples. All samples except that from point 9 were found to contain some Chromium but it ranged from 0.05 to 0.06 mg l^{-1} and was therefore below the national limit for Sri Lanka of 0.1 mg l^{-1} for effluents disposed of to surface water and below the limit of 1.0 mg l^{-1} for effluents disposed of to irrigated land. Copper (Cu) was only found to be present in the ground water and only at a concentration of 0.01 mg l^{-1} which is the minimum quality standard proposed by the CEA. Standards are not proposed for copper for irrigation. The WHO (2006) recommended maximum concentration is 0.2 mg l^{-1}, and Cu is toxic to a number of plants at 0.1-1.0 mg l^{-1} in nutrient solutions.

Biochemical Oxygen Demand

The most widely used parameter to measure water quality is 5-day biochemical oxygen demand (BOD_5). In the analysis the method used for BOD_5 determination had a detection limit of 15 mg l^{-1} because the water was deemed to be wastewater. The results of the analysis were that all samples were below the limits of detection for the method used. This was not expected and further sampling events must consider why such low BOD values are being obtained. Research by the National Water Supply and Drainage Board and the University of Peradeniya found the range to be 90-160 mg l^{-1}. The current maximum limit for BOD_5 for industrial effluent discharged to agricultural land is 250 mg l^{-1} but this is high; the limit for discharge to open water bodies is only 30 mg l^{-1} and the proposed limits for ambient water quality are in the range of 3-5 mg l^{-1}.

Chemical Oxygen Demand

Chemical oxygen demand (COD) is often measured in addition to or instead of BOD_5. There is no maximum permissible COD level defined for Sri Lanka for irrigation water but there is a proposed minimum quality criterion of 40 mg l^{-1} for Class III waters (general waters). All the samples were within this limit in the baseline survey, although higher values were expected.

Microbiological Characteristics

The microbiological characteristics of water and wastewater are of fundamental importance to human health. Untreated wastewater that includes faecal waste contains a variety of excreted organisms including pathogens at very high concentrations. The most common indicator organisms used when monitoring water quality are Coliforms and Faecal Coliforms.

Guidelines set by WHO for wastewater used in agriculture originally had a maximum Faecal Coliform count of less than 1000 Faecal Coliform Units (FCU) per 100 ml for crops likely to be eaten raw, but no standard for irrigation of cereal crops (Pescod 1992). The high level of total and Faecal Coliforms in samples tested in the baseline survey does not comply with the proposed water quality standards for irrigation and agriculture in Sri Lanka or the WHO guidelines for use of wastewater in agriculture (CEA 2001; WHO 2006). The Coliform count was highest as the wastewater exits the city, near Wilgoda. The water in the canal which takes water from the *anicut* to the paddy fields was found to have 5×10^5 most probable number (MPN) of Coliforms/100ml. The water in the irrigation canal at the entry point to the paddy fields had 16×10^4 MPN of coliforms/100ml, which is above the limits set by the WHO for wastewater used in agriculture.

The groundwater samples analyzed also showed high faecal contamination. One well is used for bathing but the water quality does not comply with the bathing water standards for Coliforms given in the CEA proposed water quality standards.

Nematode Eggs

Of the three sample locations tested, only Wilgoda Anicut was positive for parasite eggs. The eggs found were pin worm eggs (*Enterobius vermicularis*), indicating faecal contamination of the storage water. The water quality in the anicut did not satisfy the WHO quality criterion for irrigation.

Implications for WASPA

The water quality testing has some important implications that need to be shared with the Learning Alliance members. The most important are:

- Use of wastewater poses a health risk to farmers.
- Microbial contamination is the main concern, suggesting that interventions to reduce the quantity of domestic waste entering the drainage channels could be beneficial.
- Parasites may be entering through wastewater or open defecation which is known to take place in Wilgoda.
- Since microbial contamination is the main problem, on-farm practices and post-harvest activities could reduce the risk for farmers, their families, and consumers of the produce.
- The use of wastewater for irrigation may have positive impacts for short term productivity because of the presence of nutrients but might have negative consequences in the long term.
- Heavy metal concentrations do not appear to be high.
- There is the possibility that natural treatment processes are taking place along the system might be effective, further investigation should establish this and if it is proven to be the case could offer an opportunity to improve the water quality by enhancing natural processes.

References

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