

Faecal indicator organisms in the Renoster Spruit system of the Modder-Riet River catchment and implications for human users of the water

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Abstract

The impact of a variety of urban discharges from Bloemfontein on the numbers of microbiological faecal indicator organisms in the water of the Renoster Spruit subcatchment was investigated using *E. coli*, *C. perfringens* and somatic coliphages as microbial indicators. The no-observed-adverse-effect-levels for the occurrence of these organisms in water intended for domestic purposes, for full-body contact recreation as well as irrigation of crops that may be eaten raw, were exceeded. The results indicated that the faecally polluted urban runoff, in combination with inadequately treated wastewater effluents, overcame the assimilation capacity of the Renoster Spruit in the immediate vicinity of the city to such an extent that it posed a possible risk of infection to potential water users for considerable distances downstream from the urban area. The high levels of faecal indicators in the Renoster Spruit diminished to such an extent downstream that the receiving Modder River, directly downstream from the confluence with the Renoster Spruit, posed an infection risk for domestic users only but not for recreational users of the water. Water at this point could also be used to irrigate crops eaten raw.

Introduction

Urbanisation generates increasing loads of faecal wastes discharged to natural water resources. In many cases, the extent of pollution causes increases in numbers of faecal indicator organisms to levels which exceed recommended limits for water to be used by humans for purposes such as drinking, recreation, or irrigation of crops eaten raw.

Surface water bodies have a natural capacity to assimilate microbiological contaminants without the quality of water deteriorating beyond its value for ecological sustainability and human use (DWAF, 1995). Usually in urban, peri-urban and adjacent rural areas, surface water bodies receive faecally polluted urban discharges that contain pathogenic micro-organisms in such high numbers that the assimilation capacity of the receiving water body is overcome. This results in an increase in the numbers of faecal indicator organisms in receiving water, which often becomes unfit for domestic purposes, recreation or irrigation of crops eaten raw (Jagals, 2000; Venter et al., 1996).

An impact, in the context of this study, was when faecal pollution, indicated by the numbers of microbiological indicator organisms released with the urban discharges, reached such high levels that the assimilation capacity of the receiving surface water failed to reduce these levels to within acceptable limits (Griesel, 2001; Jagals, 2000; Chapra, 1997). Acceptable limits for the occurrence of faecal indicator organisms in water are recommended in various national and international guidelines and standards such as the *South African Water Quality Guidelines* (DWAF, 1996a & b) and the *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture* (WHO, 1989).

Significant reduction of microbiological indicator organism levels would imply reduction of the numbers of pathogenic micro-organisms in these urban discharges, to levels where their occurrence in the receiving water intended for various human uses, is not expected or observed to have adverse effects on human health. This is referred to as the no-observed-adverse-effect-level (NOAEL) (Kindzierki and Jackson, 1998; Kolluru et al., 1996).

In the context of this study, domestic water use means water people take from the Renoster Spruit and its tributaries and use at home with limited (generally disinfection with products based on sodium hypochlorite as an active ingredient) or no treatment (Jagals, 2000). Recreational use refers to activities with full bodily contact of the water, such as swimming and water-skiing (DWAF, 1996b). Agricultural use means the irrigation of crops that may be eaten uncooked (Jagals, 2000; Shuval et al., 1997).

This study was done to determine the contribution of urban discharges from Bloemfontein City to numbers of faecal indicator organism numbers in rivers and streams in the Renoster Spruit subcatchment, which lies within the Modder-Riet River catchment in the Free State Province, South Africa.

The study area

The subcatchment

The study was conducted in the Renoster, Bloem, and Fontein Spruit systems as well as the sector of the Modder River receiving discharges from these tributaries (Fig. 1). The study area lies within the Middle Modder subcatchment of the Modder-Riet River catchment. The Renoster Spruit (spruit means stream or small river) flows past Bloemfontein and drains into the Modder River. The Renoster Spruit receives a variety of discharges from Bloemfontein City. Some discharges are treated effluents discharged directly from wastewater treatment facilities while other discharges are from surface water runoff from informal settlements on its banks. The Bloem Spruit, a tributary of the Renoster Spruit, runs

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