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Informal settlements - impact on water quality

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KEY WORDS

Informal settlements, water quality, bacteriology, pollution, health, sanitation.

INTRODUCTION

The influx of people to the areas surrounding towns and the resulting impact on water quality is of considerable importance to water authorities, and Umgeni Water, a regional water supply authority in Natal, South Africa (Figure 1) is no exception. In order to fulfil its objective of managing water services in response to the socio-economic needs of the population in its operational area, a water quality monitoring programme was set up to among other things provide management information. While it was widely recognised that the concentrated informal settlements in peri-urban areas result in significant water quality deterioration, it was considered necessary to characterise and quantify the pollution from such areas, together with that arising from low cost high density housing intended to replace such informal settlement.

This paper describes the impact of these developments using routine water quality monitoring data from four catchments of similar size but different land utilisation/settlement type within Umgeni Water's operational area. In addition, results from specific events within an informally settled area are presented and discussed.

As part of the requirement for management information, the consequences of some developments chosen to replace informal settlements have also been investigated, through surveys of catchments in which these have been implemented.

STUDY AREA

Four similar sized catchments with different land utilisation types were chosen for analysis of routine monitoring data (Figure 1). The Slangspruit catchment (52km²), has some dense informal settlements housing approximately 30 000 people, with no formal sanitation or refuse removal and limited water supplies. Some formal settlement (medium density, moderate income housing with full water borne sewage and a correspondingly low pollution threat) and also some subsistence agriculture exists in the catchment. The upper Umsunduzi catchment (52km²), possesses moderately dense informal settlement in some areas, with no formal services. Rural settlements with subsistence agriculture and pasturage occupy a significant portion of the area. Some commercial agriculture also takes place in the catchment. The Kwa Gqishi catchment (61km²), has mainly commercial agriculture with mixed crops, extensive cattle grazing, forestry and some dairy as the dominant land use types. Settlement is limited. The Mpushini catchment (79km²) land use is predominantly commercial agriculture with mixed crops and extensive cattle grazing. Some formal settlement with full services occupies part of the area.

A fifth catchment, that of the Kwa Pata river (Figures 1 and 2), was chosen for study as this catchment displays one of the management options for remediation of informal settlements. This catchment contains a recently developed high density low income settlement with services and ventilated pit latrines, and shows how poor planning of sanitation measures can impact on water quality. This formally developed area is situated upstream of an unserviced dense informal settlement.

1 KWAGQISHI
2 UMSUNDUZI
3 SLANGSPRUIT
4 MPUSHINI
5 KWA PATA

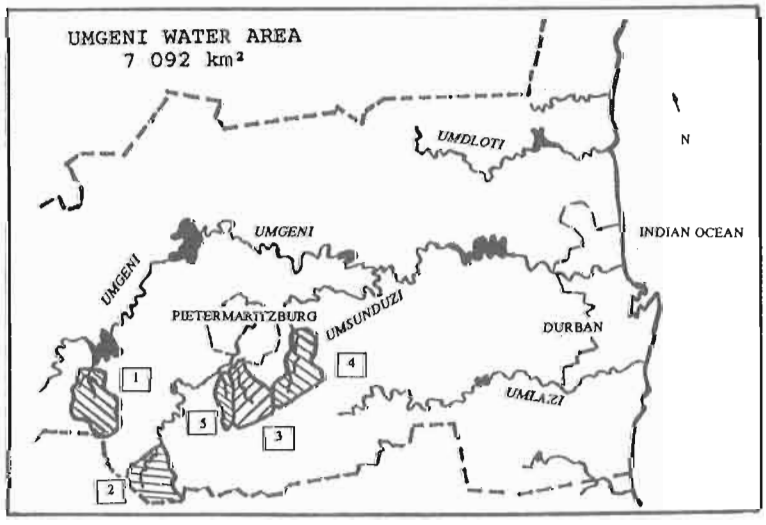

Figure 1 : Umgeni Water area.

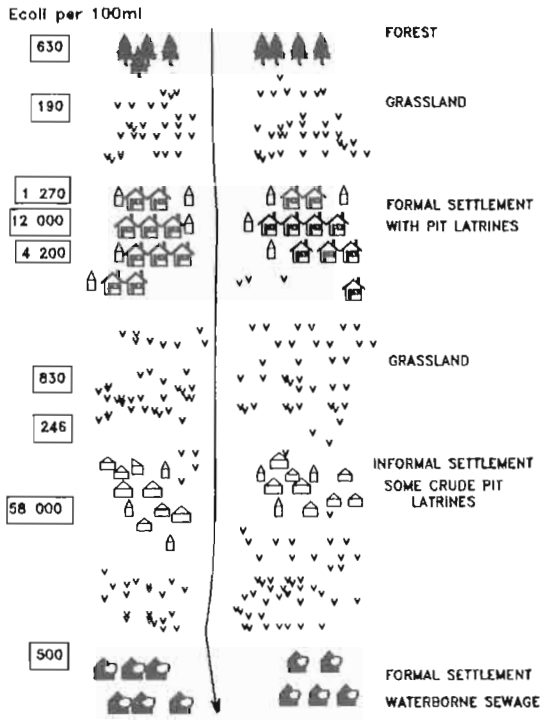

Figure 2 : Schematic of the Kwa Pata catchment showing formal settlement upstream of an unserviced informal area.

METHOD

Routine monitoring of river water quality was conducted on a weekly grab sample basis, this being conducted at the lowest drainage point of the catchments of interest. Statistical analysis of Total Phosphorous (TP) and Esherichia coli data for a two year period was used to generate box and whisker plots, which summarise the quality characteristics of the data. *E coli* data is presented in the Log_{10} form. All Phosphorus and *E coli* data reported on here were analyzed according to Standard Methods (Ref 1)

A rainfall event (October 1989) in the Slangspruit catchment (Figure 1) was intensively monitored at the catchment discharge point to determine the runoff/water quality relationship and to quantify the total load entering the receiving water. Intensive monitoring of flow and determinand concentrations were undertaken during the period immediately following the rainfall/runoff event.

Surveys were conducted of the Kwa Pata catchment in order to assess the extent and variation in bacteriological pollution along the length of the river. A survey methodology was considered necessary because of the need to relate quality to land use in different areas of the catchment.

RESULTS AND DISCUSSION

Total Phosphorous and *E coli* have been used here as being indicative of the problems in water quality which are faced by water authorities. High TP loads in surface waters result in eutrophication of downstream impoundments, with resulting water quality problems (eg. excessive algal growth, deoxygenation). The *E coli* concentrations are taken as being indicative of the extent of faecal pollution and hence the water borne disease threat to the health of communities that make use of surface water downstream. This is considered to be of significant importance in the area, as diseases such as bilharzia, dysentery and gastroenteritis are known to be endemic, and the potential exists for outbreaks of these and other more dangerous water borne diseases (Ref 2).

The impact of the dominant catchment utilisation on water quality can be clearly seen in the statistical analysis of routine monitoring TP and *E coli* data from the four catchments (Figures 3 and 4). It is noticeable that the Mpushini and Kwa Gqishi catchments, with formal settlement and/or predominantly large scale commercial agriculture, produce the lowest indications of pollution. The upper Umsunduzi catchment, with some informal settlement and agricultural land use problems produces significantly higher concentrations. However, it is the Slangspruit catchment, with its dense informal settlement, which generates significantly higher average TP and *E coli* concentrations than all the other catchments. The lack of formal services in this area is undoubtedly the major contributing factor to the generation of these high mean concentrations and hence high loads derived from these areas.

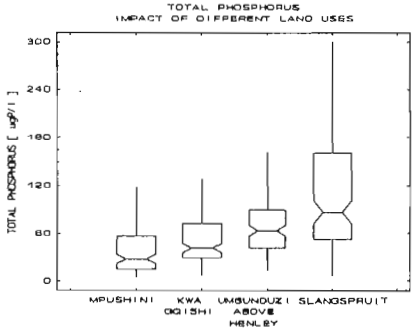

Figure 3 : Box-and-whisker plot showing total phosphorus concentrations for different land utilisation types.

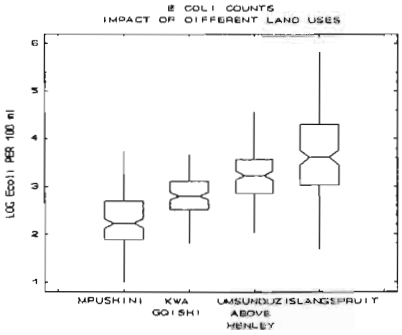

Figure 4 : Box-and-whisker plot showing *E coli* results for different land utilisation types.

The data from the Slangspruit rainfall/runoff monitoring indicate that much of the pollutants from informal settlements accumulate on land and enter the water course during rainfall events. Results indicated that *E coli* concentrations increased 200-fold and total phosphorus 14-fold during the event (Figures 5 and 6). The event monitored was one of 16 similar sized events that occurred in 1989; 10 events of twice the magnitude and one event 6 times the magnitude occurred. Assuming similar processes occurred with all these rainfall events, the total load of phosphorus entering the receiving water from the Slangspruit in 1989 was estimated as 3 tons. This is considered to be very high for an area of only 52 km². The problem is compounded by the fact that numerous other areas within the major river catchments possess such informal settlements, most of which are expanding considerably with time. The load from these non-point sources thus represent a significant portion of the total load to the river system, in a form which is not readily affected by pollution control measures.

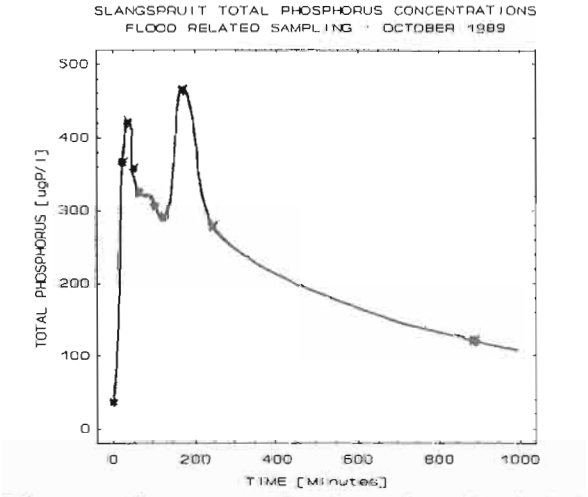

Figure 5 : Flood related total phosphorus concentrations in the Slangspruit catchment.

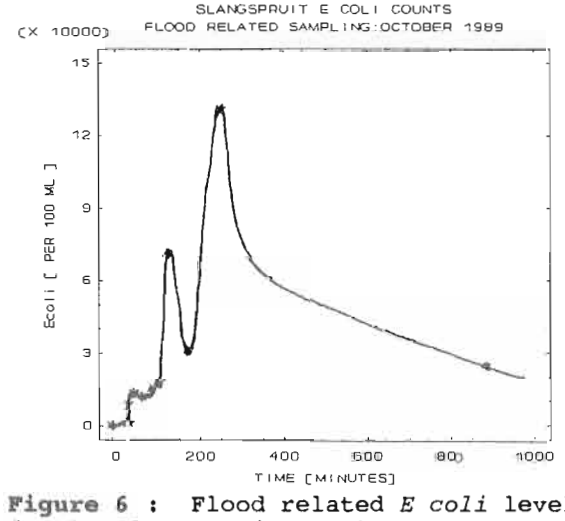

Figure 6 : Flood related *E coli* levels in the Slangspruit catchment.

Sources of pollution from informal settlements include human, livestock, domestic animal waste and household refuse dumped in the water course. It is not as yet fully understood by rural people that unpurified water supplies are the source of the majority of their health problems, particularly those of young children. On the contrary, overcrowding and limited access to formal supplies or limited disposable incomes force households to rely on rivers and other natural resources for their water.

The investigation of Slangspruit runoff indicates a significant problem for managing water quality, in that although the water quality impact of informal settlement areas is clearly indicated by the routine monitoring of rivers, such data significantly under represents the total impact of an area over time. The problem lies in the discontinuous nature of grab sampling, in which the true extent of water quality problems may not be disclosed. This is of particular importance in using such data on which management decisions are based.

An obviously desirable management option is the upgrading of such informal areas and the provision of services. However, correct management is required. In addition to pollution from informal areas, the uncontrolled siting of pit latrines in formally developed areas are also a serious threat (Ref 3). This has been observed in the Kwa Pata catchment where ventilated pit latrines were sited incorrectly in the floodplain of the Kwa Pata stream. These were also placed on the river banks by developers unaware of potential problems related to the water table, proximity to the river and soil type, resulting in seepage into the water course. The results of surveys (Figure 2) indicate high occurrence of faecal bacteria in the vicinity of this formal development. The requirement for correct decision making and planning is obvious.

In a study of the health profile in certain communities in Natal a strong correlation was found between the availability of water and sanitation and the incidence of acute diseases, (Ref 4). It is therefore essential that the rural and informal communities be given access to potable water supply and appropriate sanitation technology. However, major initiatives are required if any substantial improvement is to be made. The treatment and disposal of human waste poses enormous problems for the responsible agencies. Umgeni Water has however identified that potable water supply and sanitation go hand in hand, and is of central importance in the control of diseases and pollution loads. Investing in water supply and sanitation measures would lead to better health and be of social and economic benefit to all. Consequently Umgeni Water has embarked on an ambitious programme that aims to supply rural and informal communities living in its supply area with potable water by the year 2005. Details of this scheme are given by Wilson (Ref 5). The issue of sanitation will also be addressed and various types of sanitation technology will be tried out. In addition, the programme will address educational needs

which are viewed as crucial in the development of water supply and sanitation systems.

CONCLUSION

Informal and rural areas represent a form of large-scale non point source pollution of water resources. The total load from such areas could be under represented if water quality monitoring is not comprehensive, and management can suffer as a result.

Inadequate planning of settlements intended to replace informal areas may not result in the desired and necessary improvements. The uncontrolled siting of pit latrines and the use of inappropriate technology leads to dangerous health situations.

Owing to the lack of knowledge with regard to the siting of pit latrines, the availability of upgraded sanitation systems and the link between poor sanitation, water contamination and disease, there is a need for educational and health awareness programmes amongst informal and rural communities.

The Umgeni Water rural areas water and sanitation plan aims to address the problems of water supply, sanitation and education, in rural and informal areas and when implemented will result in a positive impact on the quality of water resources which would be of benefit to all.

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