Implementation of a catchment-based national microbial water quality monitoring programme in prioritised high health risk areas

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Abstract

In order to provide for a healthy aquatic environment, water resource managers need water quality data and information on which to base water management actions and decisions. To ensure that such data and information are collected, it is important to establish national water quality monitoring systems. A catchment-based National Microbial Water Quality Monitoring Programme (NMMP) was developed to comply with the above requirement. Subsequently an implementation plan was produced as part of the monitoring programme design. The NMMP is currently being implemented incrementally. The newly designed implementation process is being executed in three main phases, namely a Demonstration Implementation Phase, an Assessment and Revision Phase, and the Full Implementation Phase. During the first two phases the implementation plan is being tested and revised. One of the main changes to the initial NMMP Implementation Plan will be the consolidation of the NMMP into nineteen sub-programmes, rather than having a sub-programme for each of the hundred and twenty identified potential high health risk areas. Each of the nineteen sub-programmes will cover one of the nineteen Water Management Areas (WMA) in South Africa. The main obstacle in the way of implementing the NMMP is a lack available monitoring capacity in these WMAs. In the revised plan, data from local monitoring programmes in the WMAs will be used to feed into the NMMP. Very little monitoring is, however, currently being done in the areas that have been identified, by the NMMP. New monitoring programmes designed to comply with the specifications of the NMMP will thus have to be implemented in those WMAs.
1 Introduction

The Department of Water Affairs and Forestry (DWAF) is the custodian of South Africa's (SA) scarce water resources [1] and is responsible for the coordination, organization, control and further development of national water resource quality monitoring programmes.

A number of national water resource quality monitoring programmes are already in place. The national chemical water quality monitoring programme has for example been operational for many years. A national biomonitoring programme is currently being implemented. The feasibility of a national eutrophication monitoring programme is currently being tested.

South Africa does, however, not have a central source of information for assessing the potential health risks associated with faecally polluted surface water [2]. To supplement the existing national water resource quality monitoring programmes DWAF commenced with the design of a national microbial water quality monitoring programme (NMMP). The programme addresses the acquisition, recording, assessment and dissemination of relevant microbial information on water resources. The implementation of this programme has become a high priority since South Africa's water resources are coming under increasing threat from faecal contamination. Despite the mammoth efforts of DWAF to provide water supply and sanitation services to a large number of poor communities, rapid demographic changes resulting in the establishment and growth of numerous new dense settlements without appropriate water supply and sanitation infrastructure are still leading to faecally polluted water resources. The recent, 2000/2001, cholera epidemic has also greatly increased the demand for such information.

The aim of this paper is to give an overview of the implementation process and discuss problems encountered during the implementation of the NMMP.

2 NMMP objectives

The aim of the NMMP is to assess, on a national scale, the potential health risks related to faecal pollution of South Africa's fresh water resources with respect to use for potable, recreational and irrigation purposes [3]. The specific objectives of the NMMP are as follows;

- To locate, assess and prioritise those areas in the country where potential health risks related to faecal pollution of surface water resources are highest.
- To provide information on the status and trends of faecal pollution, in terms of the microbial quality of surface water in the potential high risk areas.
- To provide information to help in assessing the potential health risk to humans associated with the possible use of faecally polluted water resources.
- To help assess the effectiveness of measures to protect water resources against faecal pollution in terms of trends in the microbial water quality.

It is important to note that the NMMP was designed to give a national perspective and not to do in-depth regional monitoring. The latter will be the responsibility of stakeholders in the specific regions.
3 Approach

To accomplish the aim of the NMMP, the implementation project was designed to be executed in three main phases, namely: the Demonstration Implementation Phase; Assessment and Revision Phase; and the Full Implementation Phase. The implementation project has also been designed to identify and correct as many problems as possible that may impede the effectiveness or viability of the NMMP. Sufficient time has, therefore, been allocated to the testing phase and the assessment and revision phase. This progressive phased implementation of the NMMP will ensure the efficiency, effectiveness and sustainability of the programme once it is fully implemented.

3.1 Implementation schedule

The Demonstration implementation phase commenced in January 2000 and will extend to December 2001. During this phase the NMMP will be implemented in eight identified potential high health risk areas (see 3.2 below). The objective of this phase is to test the implementation and monitoring procedures as set out in the NMMP implementation plan.

The Assessment and revision phase will run over the period July 2001 to December 2002. The objectives of this phase are to revise implementation and monitoring procedures using information generated during the demonstration implementation phase. Another important objective is to secure financial commitment from stakeholders for ongoing monitoring.

The Full implementation phase will commence in January 2003. During this phase, which is expected to last for approximately four years, the NMMP will be implemented in at least 40 potential high health risk areas, depending on financial commitment by the stakeholders.

3.2 Identification and prioritisation of potential high health risk areas

The implication of the non-conservative behaviour of microbes (both pathogens and indicators of faecal pollution) is that it would be almost impossible, without large investments in resources, to sample at representative locations on a national “grid” to obtain an overall picture of the microbial quality of surface water resources in South Africa [4]. The NMMP was thus designed to focus on potential high risk areas where there would be a high possibility of the water being faecally polluted and where it would pose a major risk to the health of water users in that area [4]. For this reason the Institute for Water Quality Studies (IWQS) conducted a project to identify and prioritize areas of high health risk as a result of faecally polluted surface water. This project was done as a basis for the implementation of the NMMP. The project was completed in 1998 and 120 potential high health risk areas have been identified [2]. This exercise will be repeated after every 5 years as a result of changes in demography and better delivery of services such the provision of treated water and sanitation infrastructure to poor communities.
3.3 Responsibility structure

The NMMP has been designed to function mainly on two levels, namely, a national level and a local level. An NMMP sub-programme is established for each potential high health risk area, that then functions on a local level. Typical role players on a local level are the area manager, the person taking the samples, a laboratory and other local stakeholders. The area monitor is responsible for the initiation, implementation and management of the NMMP sub-programme in the identified high health risk area. General co-ordination of all the sub-programmes, data storage and information dissemination is done on a national level. The national co-ordinator is responsible for the general co-ordination of the NMMP and is the driving force behind initial and ongoing implementation [5]. Figure 1 gives a simplified view of the responsibility structure of the NMMP.

![Diagram of Responsibility Structure]

Figure 1: The simplified responsibility structure of the NMMP.

3.4 Data storage and information dissemination

One of the most important aspects of any water quality monitoring programme is data management and the generation and dissemination of information. The Department of Water Affairs and Forestry has created a national database for water quality data storage. All the NMMP data has to be stored on the national database. Data are currently being fed into the database manually, as the electronic data import facility is not yet functional.

The person responsible for the assessment and processing of data extracts data from the database on a regular basis. Bimonthly reports are then produced. These reports are then disseminated to the relevant NMMP sub-programmes. The bimonthly reports indicate the potential health risks during that period associated with water uses such as recreation, drinking of untreated water and the irrigation of crops that are to be eaten raw. A set of guidelines is used for the identification
The potential health risk. Figure 2 is an example of a time series graph (for one sampling site) as used in the bimonthly reports. General guidelines are also indicated on these graphs. Raw data and tables indicating potential risks are also included in the bimonthly reports.

![Time Series Graph](image)

Figure 2: Example of a time series graph (for a specific sampling site), indicating actual faecal coliform counts for each sampling date, as used in the bimonthly reports. General guidelines, above which the water should preferably not be used for specific use, are also indicated.

The National co-ordinator, together with the data assessor, produces annual and five yearly reports that reflect the potential health risks on a national scale. Unlike the bimonthly reports that are sent to the area managers and local stakeholders, these reports are also for the attention of stakeholders on a national level, such as the relevant ministers [5]. The aim of the annual report is to inform stakeholders on the potential health risks associated with surface waters in South Africa. This would enable them to put in place the necessary policies and distribute funds accordingly.
4 Current status and proposed changes

4.1 Current status

The NMMP is currently in the closing stages of the Demonstration Implementation Phase. NMMP sub-programmes have, as planned, already been implemented in eight potential high health risk areas. The NMMP is also in the beginning stages of the assessment and revision phase. During this phase experience gained from the demonstration implementation phase is used to revise the implementation and monitoring procedures. The problems identified during the demonstration implementation phase and the proposed changes are discussed in section 4.2 hereunder.

4.2 Problems and proposed changes

During the demonstration implementation phase three issues that might compromise the functionality and sustainability of the NMMP were identified. The issues are: i) the delineation of boundaries for the NMMP sub-programmes, ii) a lack of monitoring capacity on a local level and iii) an interim lack of data management capacity on the national level. These issues and proposed changes are discussed below.

4.2.1 Delineation of boundaries for NMMP sub-programmes

According to the current NMMP implementation plan, sub-programmes would be established for each potential high risk area [5]. This means that there will eventually be almost a hundred sub-programmes. Such a large number of sub-programmes would be extremely difficult to manage from a national perspective and it would be difficult to find such a large number of reliable area managers.

However, the recently revised National Water Resource Strategy provides the framework for the protection, use, development, conservation, management and control of water resources for the country as a whole. It also provides the framework within which water will be managed at regional or catchment level, in defined Water Management Areas (WMA). A catchment management agency (CMA) will be established for each WMA. The function of CMAs will be to protect, develop, conserve, manage and control the water resources in the specific WMA. Nineteen catchment-based WMAs have been identified [6]. It would, therefore, make more sense to align the programme to the National Resource Strategy and to establish an NMMP sub-programme for each WMA, rather than establish a sub-programme for each of the hundred and twenty identified potential high health risk areas. The CMA's would thus eventually take over the responsibility of the area manager.

4.2.2 Lack of monitoring capacity on a local level

The NMMP was designed to make use of local resources in each high risk area [5]. Stakeholders in the high risk areas are expected to provide all the resources for monitoring in their area. No funds for ongoing monitoring were thus allocated (on a national level) to the NMMP.
Monitoring for the NMMP is expensive. The two main factors contributing to the high cost of monitoring are the high sampling frequency (initially weekly). Most of the identified high risk areas are also in rural areas, far from suitable laboratories.

Statistical analyses of test data (faecal coliform counts) have shown that, due to the non-conservative behaviour of microbes in water, averages derived from data collected on a weekly basis are more representative than averages derived from data collected on a two-weekly basis [3]. However, during the demonstration implementation phase it was shown that the cost associated with this high sampling frequency might compromise the sustainability of the NMMP. It has, therefore, been decided to allow two-weekly sampling and, if necessary, monthly sampling.

National funding (to cover at least the cost of analyses) to help relieve the financial burden on the local stakeholders will have to be negotiated.

4.2.3 A lack in data management capacity
A major shortcoming that was identified during the demonstration implementation phase was the temporary lack in data management capacity at a national level. DWAF is currently developing a national database that is already partly functional. Functions, such as electronic data import and automatic reporting that are needed by the NMMP are, however, not yet active. During the demonstration implementation phase data had to be fed manually into the database, a time-consuming activity. The generation of bimonthly reports is also time consuming.

As soon as the NMMP has been fully implemented, a large amount of data will be generated. To avoid a data bottleneck, it has been decided to develop a simple data capture system specifically for the NMMP. This will be an interim measure until the national database can fully accommodate the data capturing and processing needs of the NMMP.

5 Conclusion
The South African Government is placing major emphasis on the provision of water and sanitation services to poor communities. The NMMP has a specific role to play in measuring the impact of such initiatives on the countries water resources. It is, therefore, of great significance that the process of implementing the NMMP is going ahead as planned.

The effort to upgrade the countries water supply and sanitation infrastructure also goes hand in hand with wider initiatives to build skills at local level so than an awareness is created of the need for monitoring of water quality at local level, and the initiative needed for maintenance of created infrastructures may be promoted.

The demonstration implementation phase has successfully identified a number of problems that will be rectified in the revision of the implementation plan. Lessons learned from the implementation of the NMMP can be used to avoid pitfalls in the development of other envisaged national monitoring programmes such as the national eutrophication monitoring programme [7] and the national radioactivity monitoring programme.
6 References