Republic of South Africa

NATIONAL WATER RESOURCE QUALITY STATUS REPORT:

INORGANIC CHEMICAL WATER QUALITY OF SURFACE WATER RESOURCES IN SA – THE BIG PICTURE

Department of Water Affairs and Forestry
Institute for Water Quality Studies

First Edition

June 2002

Published by

Department of Water Affairs and Forestry
Institute for Water Quality Studies
Private Bag X313
PRETORIA
0001

Republic of South Africa
Tel: (012) 808 0374

Co-ordinated by: Institute for Water Quality Studies

ISBN 0-621-32935-5

This document should be cited as:

Hohls, BC, Silberbauer, MJ, Kühn, AL, Kempster, PL and van Ginkel, CE (2002) *National Water Resource Quality Status Report: Inorganic Chemical Water Quality of Surface Water Resources in SA – The Big Picture.* Report No. N/0000/REQ0801. ISBN No. 0-621-32935-5. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

DOCUMENT INDEX

DOCUMENT STATUS AND APPROVAL

WORKING TITLE: NATIONAL WATER RESOURCE QUALITY STATUS REPORT: INORGANIC CHEMICAL WATER QUALITY OF SURFACE WATER RESOURCES IN SA – THE BIG PICTURE

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REPORT STATUS: Edition 1, Final

IWQS REPORT No.: N/0000/REQ0801

ISBN No.: 0-621-32935-5

DATE: June 2002

Approved for the Department of Water Affairs and Forestry:

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ACKNOWLEDGEMENTS

The following officials of the Department of Water Affairs and Forestry are specifically thanked for their written contributions towards the development of this document:

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The following officials of the Department of Water Affairs and Forestry are thanked for their inputs, comments and assistance towards the development of this document:

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EXTENDED EXECUTIVE SUMMARY

NATIONAL WATER RESOURCE QUALITY STATUS REPORT:

INORGANIC CHEMICAL WATER QUALITY OF SURFACE WATER RESOURCES IN SA - THE BIG PICTURE

1. PURPOSE OF THE REPORT

The aim of this report is to provide information on the major inorganic chemical water quality constituents of surface waters across South Africa to water resource managers, scientists, decision-makers, and the public. It is intended to provide an overview of the status of surface chemical water quality according to the water quality requirements of two water user sectors, namely, domestic water use and irrigated agriculture water use.

2. BACKGROUND

Water is an excellent solvent and transport medium for particulates, and as such it tends to become contaminated both by natural processes such as erosion, and dissolution of salts geologically present in soils, as well as by man-induced processes and wastes. The latter are both natural e.g. the contamination of runoff water with excreta, as well as artificial, such as the contamination of water with industrial effluents and synthetic chemicals such as pesticide residues.

Water can thus be contaminated by a whole host of substances including:

- Physical soil and clay particles and organic detritus from storm runoff
- Microorganisms, such as bacteria, viruses, and parasites, from the soil and environment and animal and human wastes.
- Chemical constituents, which can be subdivided into (a) major inorganic chemical salts (such as sodium, chloride, calcium, sulphate, etc.), (b) minor inorganic chemical salts (such as ammonia, fluoride, phosphate and trace metals such as iron, manganese, copper, etc.) and (c) organic substances such as pesticide residues, for example.
- Radioactive substances (which usually occur only in minute concentrations under natural conditions).

This report concentrates mainly on the status of water quality in South Africa, as reflected in predominantly the mineral salt composition. Mineral salts arise both naturally from soil erosion and washout of salts naturally present in the soil, as well as the contribution from human settlements and activities. Land use activities include both domestic (e.g. leading to nutrient enrichment or eutrophication) and industrial (e.g. the contamination of surface waters by acid mine drainage water containing constituents such as sulphate arising from the accelerated oxidation of sulphur bearing minerals in exposed rock consequent to mining operations).

In addition to the information on the major inorganic water quality constituents, information is also given in this report on the nutrient status of selected impoundments in South Africa as reflected by the so-called trophic status of the water bodies.

This report does not deal with the microbiological status of the water resources, as this information is not readily available yet. However, as a general rule, it must be assumed that all surface water has the potential for microbiological contamination, and needs to be disinfected before drinking.

3. ASSESSMENT METHODOLOGY

3.1 Assessment Basis

To simplify the assessment and to present the information in such a way that it would be useful for water resource management purposes, South Africa is divided into 19 Water Management Areas (WMAs).

Water quality is assessed on the basis of its fitness for use by the domestic and irrigated agriculture water user sectors. These are the two user groups that generally have the most stringent requirements for water quality (with the possible exception of the aquatic environment). Agriculture often does not have the opportunity to pretreat the water to the desired quality before using it. Industry either has similar requirements to those of the above two water users or has the ability to conduct the necessary treatment of the raw water for it to be suitable for their purposes (*e.g.* industries with specific water quality requirements).

The water quality constituents selected for this study are largely limited to those of relevance to domestic and irrigated agriculture water use. The two sets of water quality constituents used as indicators for these water user sectors are:

Table 3.1 Water quality constituents used in the assessment of fitness-for-use for domestic and irrigated agriculture water use

Domestic Use	Irrigated Agriculture Use
Nitrate +Nitrite as N (NO_3+NO_2 (as N))	Chloride (Cl)
Ammonia as N (NH_4 (as N))	Electrical Conductivity (EC)
pH	pH
Potassium (K)	Boron (B)
Total Dissolved Salts (TDS)	Sodium Adsorption Ratio (Ca; Na; Mg)
Fluoride (F)	
Turbidity	
Sodium (Na)	
Magnesium (Mg)	
Chloride (Cl)	
Calcium (Ca)	
Sulphate (SO_4)	

The assessment classification system used for the assessment of the suitability of water for domestic purposes is based on that described in the Assessment Guide for the quality of Domestic Water Supplies (DWAF, DOH and WRC, 1998) and the water quality guidelines presented in the South African Water Quality Guidelines (DWAF, 1996a and DWAF, 1996b, for irrigated agriculture).

Water quality guidelines or criteria are scientific and technical information provided for a particular water quality constituent in the form of numerical data and/or narrative descriptions of its effects on the fitness of water for a particular use or on the health of aquatic ecosystems.

3.2 Data Collection

The water quality data that were used in the assessment of the fitness for use of South Africa's surface water resources for domestic and irrigated agricultural use were collected as part of the so-called National Chemical or Salinity Monitoring Programme. This programme has been in operation since the early 1970's and samples are regularly collected at approximately 1 600 monitoring stations at a frequency that varies from weekly to monthly sampling. The samples

collected for this programme are analysed at the laboratories of the Institute for Water Quality Studies and the data is stored on DWAF's database and information management system, namely the Water Management System (WMS).

3.3 Sample Site Selection

As far as sample site selection for the status report is concerned, two levels of sampling sites were selected from the chemical water quality database, namely:

- a national level sample site set, and
- a more comprehensive site set selected for each WMA.

The national site set is comprised of sites ideally as close to the downstream end of each tertiary drainage region with a sufficient record length of relatively regular frequency.

The individual WMA sample site sets are based on the national set with the addition of all other sample sites within the WMAs that have sufficient record length and frequency, irrespective of their location within the WMA. Sites are only excluded when their sampling frequencies are too erratic or sparse, or where there are better sample sites geographically close to them. This was done to identify river reaches with sampling sites where water quality problems are prevalent.

3.4 Study Period

A study period of 5 years was used for assessing the water inorganic chemical quality status of surface water resources extending from the beginning of 1996 to the end of the year 2000. The median (the most commonly) observed concentration for each variable is used in comparison with the domestic and irrigation use guidelines.

3.5 Presentation of Results

The assessment results are presented in a series of Tables and Maps. The symbols used in the assessment maps are referred to as Guideline Compliance Pie Diagrams and illustrate the median concentrations for each of the constituents depicted over the study period. Median constituent concentrations are depicted in a "pie wedge" that only projects beyond the circular "pie" when the concentration falls outside of the *Very Good* range in the case of the domestic use guidelines or the Target Water Quality Range (TWQR) in the case of the agriculture guidelines. If it does project beyond the *Very Good* range then the colour and extent of the projection indicates the extent of exceedence of the median value.

Information from the Trophic Status Project is also included in the report. The trophic status on a national scale of selected impoundments across South Africa, specifically those impoundments managed by DWAF, is reflected in a Table. Information is also given on a priority ranking for the 49 selected impoundments indicating the relative need for eutrophication management.

4. RESULTS AND CONCLUSIONS

Various land uses, notably mining and agriculture and the degradation of land, modify the water quality in many parts of the country. At a national scale, however, land cover and geology influence water quality predominantly. Since the bulk of the country is still in a moderately natural state, it is only on proceeding to a finer level of detail, such as the WMA level, that problem areas become more easily apparent.

4.1 Water Quality Status for Domestic Use

The main water quality problems throughout the country for domestic use relate to the widespread elevated salt levels (high TDS values) and elevated fluoride (F) levels in certain locations.

Water with elevated TDS tastes salty and does not slake thirst. The elevated salt levels (as expressed by TDS concentrations) also decrease the aesthetic value of water. Consumption of the water may not produce adverse health effects in the short-term, but there is a slight possibility of salt overload in sensitive individuals in the long term. TDS levels were especially elevated in the Lower Orange, Fish to Tsitsikamma and Gouritz WMAs. It would appear that these elevated levels are due to natural reasons. The Breede and Berg WMAs have elevated TDS levels when considering the individual WMA sample sites.

High F levels were evident in the lower Olifants WMA. Health effects and tooth staining can be expected at the concentrations evident at selected sample sites.

At a WMA scale, pH values were also seen to deviate in various parts of the country. The pH was low in the Klip Spruit (of the Olifants WMA) and would likely result in irritation of the mucous membranes of water users in this area. It is likely that the source of the low pH is the acid mine drainage from the coalmines and mine dumps in the area. A notable effect of the low pH would be "burning eyes" with the use of the water for recreational purposes.

Magnesium (Mg), sulphate (SO_4), chloride (Cl), sodium (Na) and potassium (K) were also elevated in various parts of the country.

4.2 Water Quality Status for Irrigation Use

From an irrigated agriculture use perspective, the sodium adsorption ratio (SAR), electrical conductivity (EC), pH and chloride (Cl) were elevated in various regions of the country.

There were high pH levels in the Luvuvhu and Letaba, Crocodile (West) and Marico, Olifants, Usutu to Mhlatuze, Mzimvubu to Keiskamma, Upper Orange and Lower Orange WMAs.

The Fish to Tsitsikamma and Gouritz WMAs had low pH values and high SAR, EC and Cl values; making irrigated agriculture in these WMAs more challenging, and limiting crop selection to more salt tolerant crops.

The Thukela WMA had high pH values, with the Upper and Middle Vaal WMAs having high EC values.

The South Western Cape (Breede and Berg WMAs) had low pH values evident in some cases and elevated SAR, EC and Cl concentrations, again limiting the potential for growing salt sensitive crops.

4.3 Trophic Status of Selected Impoundments

South Africa has disturbingly high levels of nutrient enrichment in many of its impoundments. This is something that requires urgent attention. The most enriched impoundments are often those that have the greatest concentration of humans in their catchment areas.

Apart from the aesthetic aspects of water with a "pea-soup" appearance, eutrophication leads to the frequent occurrence of toxic algal blooms, with the danger of fish and cattle deaths, and the induction of gastro-enteritis in humans.

5. RECOMMENDATIONS

The following recommendations are proposed:

- Revision of the existing monitoring network is necessary to terminate sampling at unnecessary sites and expand the network to cover more adequately the sensitive problem areas or those areas with insufficient sampling sites.

- Role players must be informed of the impact of land uses that result in deterioration in the water quality. This is especially important for mining and agriculture.

- Ways to improve the water quality at those negatively impacted sites must be investigated.

- Water users at sites where the water that could be detrimental to their health should be informed to take appropriate precautions. Safe water should be provided to those domestic users who have no access to a safe and healthy water supply.

- Water resources should be protected, in particular the more pristine water sources, in order that their quality does not deteriorate as a result of a change in land use or management practice.

- The trophic status monitoring and assessment programme should be expanded to include more of the impoundments throughout the country and appropriate land use management practises should be encouraged to prevent or minimise large loads of nutrients entering the aquatic environment.

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