Pergamon

Wat. Sci. Tech. Vol. 38, No. 11, pp. 77–85, 1998.

0273-1223/98 $19·00 + 0·00

PII: S0273-1223(98)00642-8

SYSTEMS APPROACH TO EFFECTIVE WATER QUALITY MANAGEMENT IN THE REPUBLIC OF SOUTH AFRICA, EXISTING SITUATION AND EXPECTED FUTURE DEVELOPMENTS

P. Marjanovic*, M. Miloradov** and F. van Zyl***

** Department of Civil Engineering, University of the Witwatersrand, P.O. Box 592, WITS 2050, South Africa*
*** University of Novi Sad, Faculty of Technical Sciencies, University of Novi Sad, Dositejev Trg 5, 21000 Novi Sad, Yugoslavia*
**** Department of Water Affairs and Forestry, Community Water Supply and Sanitation Directorate, Residence Building, Pretoria, South Africa*

ABSTRACT

The new National water policy will change the way water quality is managed in South Africa. The paper considers the water policy and the repercussions it will have for water quality management in South Africa and proposes a system that can be used to come up with optimum solutions for water quality management. The proposed solution integrates policy and institutional arrangements with the Cadastral system for point and non point sources of pollution and optimisation tools to ensure optimal management of water quality at any given time.

The water quality management functions catered for by the proposed system are: resource allocation for pollution discharge, water quality protection, water quality monitoring, planning, development and operation.

KEYWORDS

Water quality; water policy; integrated catchment management; government intervention; pollution.

INTRODUCTION

Like in many other spheres of social systems the role of the government in managing the environment, or better said controlling pollution, is a result of the nature of environmental problems.

Environmental pollution problems arise as a result of the common nature of the environment (environment is a resource but not a privately owned one) and are a direct consequence of the "Tragedy of the Commons" syndrome. Thus environmental problems fall into a class of problems known as "externality" problems.

It is widely accepted in modern democratic systems that in situations in which externality problems occur government intervention is justified. Thus modern Constitutions and Laws provide the means and

It is widely accepted in modern democratic systems that in situations in which externality problems occur government intervention is justified. Thus modern Constitutions and Laws provide the means and justification for the intervention of governments. The new Constitution of South Africa is no exception it provides the framework for the intervention of National Government in the sphere of environmental protection.

The recently published White Paper on National Water Policy for South Africa (DWAF, 1997) defines the scope of government intervention and specifies the principles on the basis of which water resource protection is to be achieved as well as the principles on which the government intervention will be based.

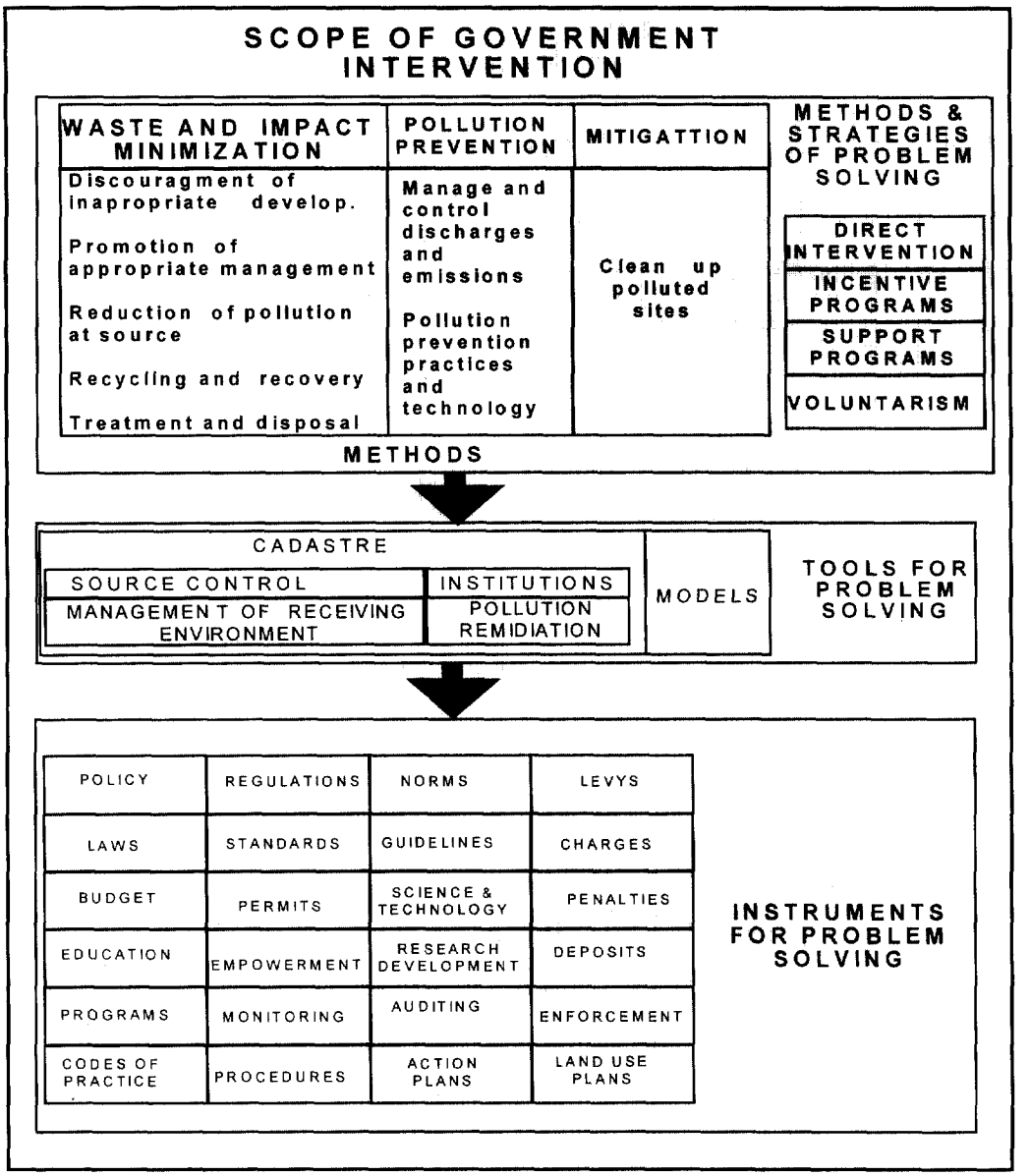

Figure 1. Scope of government intervention.

When interpreting the White Paper on National Water Policy (DWAF, 1997) from the conceptual point of view it is evident that government intervention will occur within the integrated catchment management and integrated pollution control framework and at a number of different levels (Figure 1).

The major levels at which intervention occurs are constitutional, legislative, policy, integration, system development, regulatory, institutional and implementation level.

How complex and far reaching government intervention can be is shown conceptually in Figure 2, (only the most obvious options are shown).

In defining the objectives of government intervention within the above framework the unique nature of the natural environment must be recognised and the inter relatedness of the receiving media must be acknowledged.

The pollution control mission of government therefore needs to be underpinned by three main sub-goals which provide the tangible targets against which performance of the government intervention system may be measured.

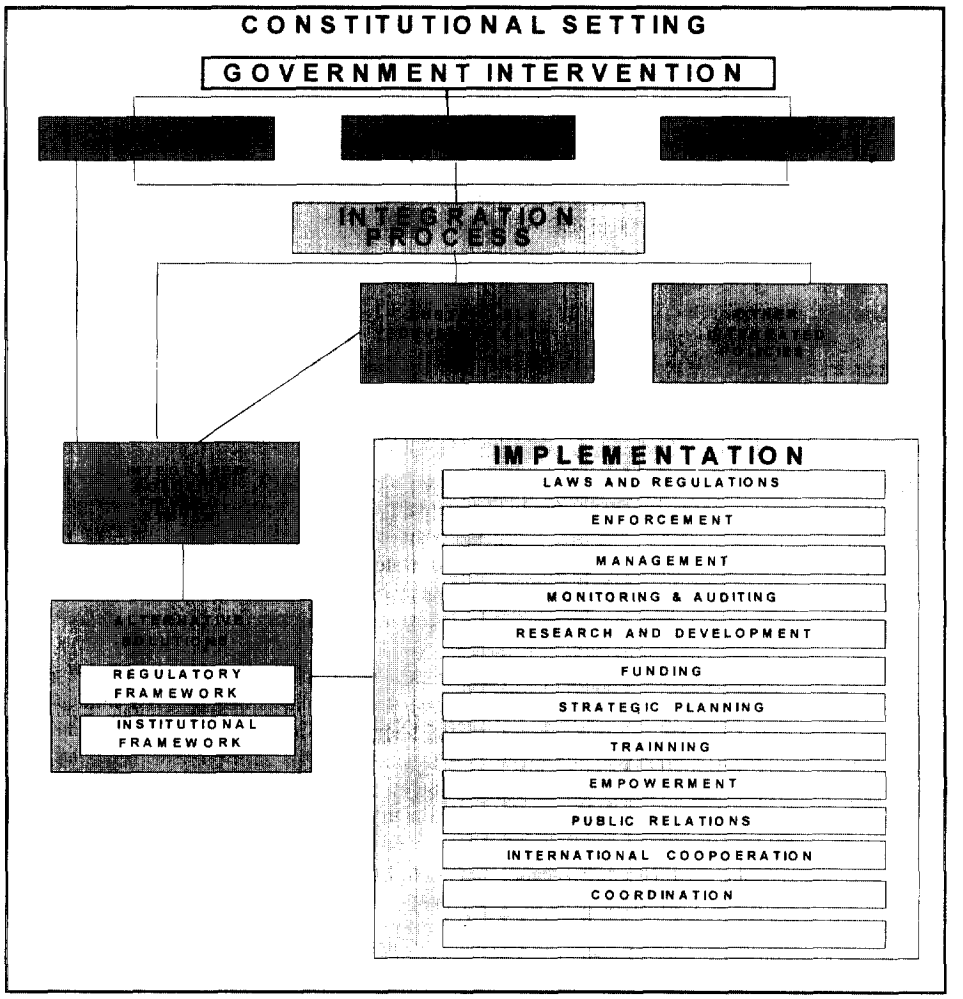

Figure 2. Levels at which government intervention occurs.

The following have been proposed for South Africa (Department of Environment and Tourism, 1996):

Waste minimisation: Discouragement of inappropriate development, reduction at source, recycling, reuse and recovery, treatment and disposal.

Pollution prevention: Manage discharges and emissions, promote the development of pollution prevention practices and technology, and identify remediation as may be necessary.

Remediation: given that a certain degree of damage has already been done, and might still be done despite our best efforts, it is necessary to implement remediation, where this is necessary.

The major reason behind Government intervention is thus to induce desirable behaviour by dischargers (polluters) in order to meet the stated policy objectives. The modes of intervention must take account of this "behavioural " requirement. The starting point is the recognition of the fact that:

'Polluters/dischargers are rational "economic entities" and behave accordingly'

As a result modes of government intervention suitable for pollution control may be grouped into three general categories: direct intervention, incentive programs and supportive programs.

Neither of these three categories nor the sub-categories within them are mutually exclusive and many existing programs in different countries have elements of more than one type of approach.

What is characteristic of all these categories is that all of them must rely on sufficient and adequate information to be implemented successfully. The information needs between different strategies do not differ significantly and all need information and data of the same kind.

The framework of integrated catchment management and the concept of integrated pollution control within which government intervention occurs require, as preconditions for successful pollution control, an efficient data collection, storage and retrieval system. This system should cater for different aspects of pollution and should contain a set of efficient tools to evaluate different alternative solutions and select the best one.

CURRENT POLLUTION MANAGEMENT IN SOUTH AFRICA

Water quality management has traditionally been more advanced than other areas of environmental management in South Africa. Until early 1990's water quality management was based on effluent control and minimum effluent standard. This has not given the desired results and the Department of Water Affairs and Forestry (DWAF) introduced a two tier system to water quality management in the mid nineties. Minimum effluent standard remains the main management tool but it is now also linked to receiving body water quality objectives. The system currently in place is essentially described in Figure 3, (DWAF, 1995)

The review of relevant literature, outputs from different workshops and discussions with government officials, professionals, students and layman over the last year indicate that environmental protection in South Africa is generally characterised by: uncoordinated approach with diverse and sometimes conflicting laws governing pollution. It is seen as being ineffective in protecting the environment, needs rationalisation of the current regulatory system, is based on an uncoordinated approach to pollution control and is perceived as obstructive to development. There is also a perception that the present system of pollution control is designed for big business and industry only and is thus ineffective in addressing problems at community level, (a controversial issue causing much debate), and is not capable of harnessing the potential contribution of communities and NGOs. The current system is thus incapable of integrating diverse efforts into the formal regulatory system and there is a need to align commitments to international treaties, protocols and conventions to national regulatory efforts.

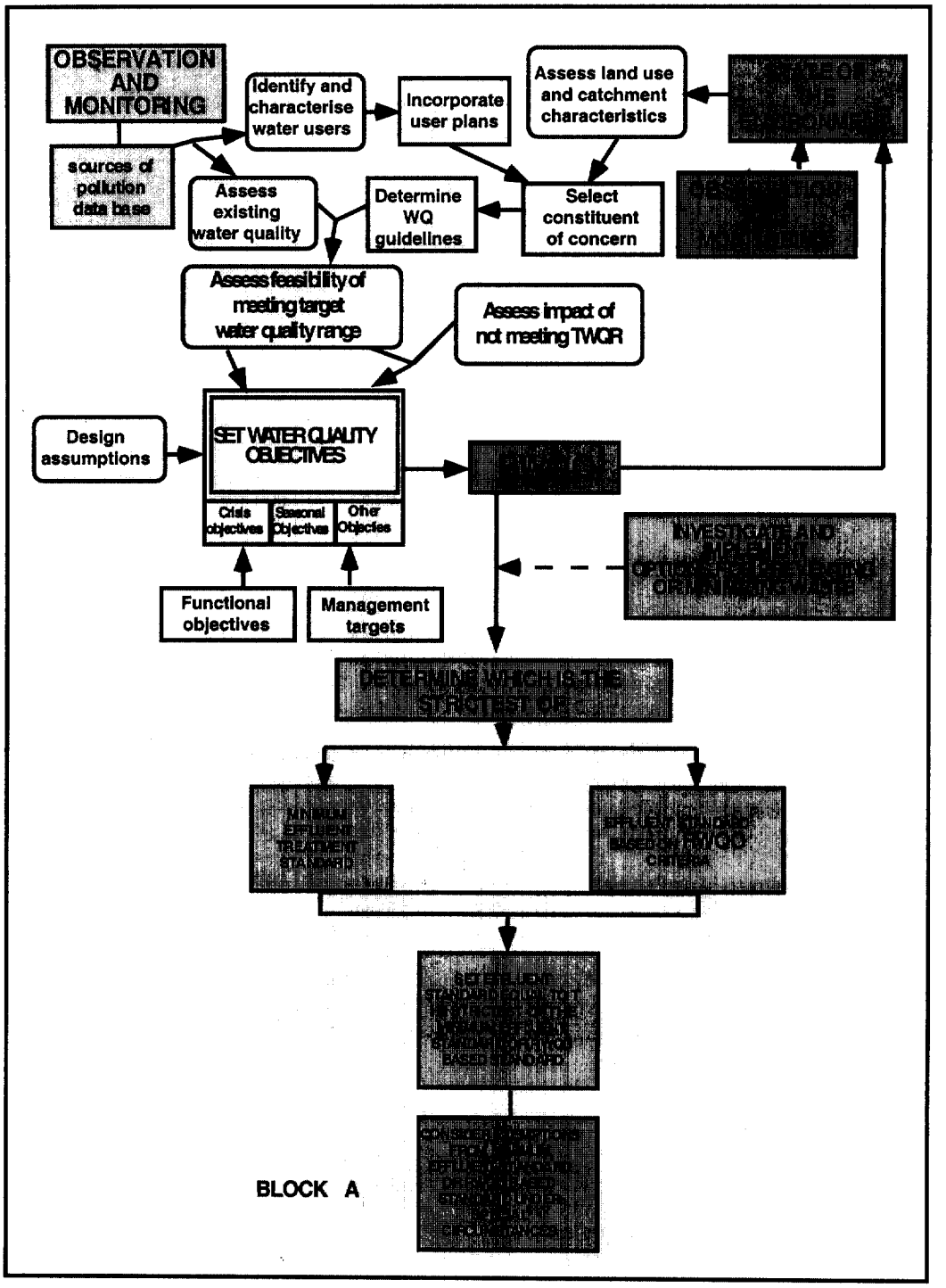

Figure 3. Existing system for water quality management in South Africa.

MAIN CHARACTERISTICS OF THE NEW SOUTH AFRICAN WATER POLICY

One of the ideas that emerged during the development of South Africa's Constitution was that of co-operative governance. While many governmental functions are undertaken in national, provincial or local spheres, there is a commitment to co-operation between each sphere. This sets the stage for water quality management in the country that is seen as a complex government function which includes regulatory, support and straightforward operational activities.

The range and variety of issues, which are seen to affect or to be affected by water quality management, call for an integrated approach. The new policy requires water quality management to be integrated with management of quantity and for economic considerations to be weighed together with social and environmental ones. The policy requires groundwater to be managed together with surface water. It calls for land use, human settle-ments, industrial activity and mines and other impact causing activities to be integrated into water quality management practice in an efficient manner and at the level of integration justified by the nature of the problem.

Main water quality management functions, which should be approached in an inte-grated manner according to the new National water policy, are: resource allocation, resource protection, resource use and conservation, monitoring, planning, development and operation.

The new management approach and organisational arrangements will be designed to provide for integration across a number of dimensions. The main dimensions are: vertically (between spheres of authority and levels of organisation in water management), horizontally (between authorities and organisations with common interests or competing needs for water resources), co-operatively (within water use sectors with a joint interest in particular resources, coherently between organisations active in the development, management and use of scarce resources) and geographically, (in a way which reflects the interactions of the water cycle and the web of human life and activity).

The complexity of an integrated approach to water quality management, as defined in the new policy, requires **optimum** rather than simply beneficial solutions and practices. This National water policy requirement for an **optimum solution** will have a profound and far reaching consequence for South Africa and how water quality is managed in the future.

The other consequence of the National water policy is that water quality management will be implemented on the catchment level but will remain subject to national authority. An institutional framework will thus reflect the central responsibility of the National Government as custodian of the nation's water resources.

Apart from the clearly governmental functions of policy formulation and regulation, certain water quality management functions will continue to be performed by Government at national level, including strategic and technical planning, overall management of catchments on a national basis and water quality information services.

Since water and water-related services which people use are dependent not only on the physical and chemical characteristics of the water itself, but on the healthy functioning of whole ecosystem the National water policy introduces the concept of "resource quality" to include the health of all of the parts of a water resource which together make up an "ecosystem", including plant and animal communities and their habitats. This allows for the retention of the receiving water quality objectives approach as the basis for water quality management in the future also.

The national water policy requires two separate sets of measures for water quality management. The first are resource-directed measures which set clear objectives for the desired level of protection for each resource. The second are source-directed controls that aim to control what is done to the water resources so that the

resource protection objectives are achieved. These include source reduction measures that aim to reduce or eliminate the production of potential pollutants that could harm our water resources.

As a result a national resource protection classification system will be introduced. Water resources will be grouped into a number of protection classes, with each class representing a certain level of protection. Where a high level of protection is required, the objectives will be strict, demanding a low risk of damage and the use of great caution. In other cases, the need for short to medium term use may be more pressing and the need for protection lower. Source controls will be strengthened, through permits and standards, and through changes in technologies and land-use, with the final aim of getting as close as possible to a situation in which there is no discharge of pollutants into natural waters. Protection of water quality will be enforced through a system of source-directed measures, including the registration of sources of impact, standards for waste discharges, best management practices, permits and impact assessments.

SYSTEMS VIEW OF FUTURE WATER QUALITY MANAGEMENT

On the basis of the new national water policy discussed previously the general conceptual system diagram of the future water quality management in South Africa as proposed by the authors is given in Figure 4. This diagram is a result of analysis carried out during 1996 as a part of a research project on point and non point sources of pollution and a Cadastral system to aid water quality management in South Africa (Marjanovic, Miloradov, 1997)

As outlined in Figure 4, the system allows government intervention to be permanently optimised. The system approach allows all the elements of the existing DWAF approaches to water quality management that found their way into the new national water policy to be retained and adds to it elements that the new policy establishes such as optimisation, transparency, public participation and right to information.

As can be seen it would be necessary to establish a national Cadastre of polluters if all functions of the government are to be fulfilled. Note that there is a differentiation between a Cadastral system and Inventory systems as used in USA, Canada and Australia. A Cadastral system is a dynamic category and is a "public record", much like a title deed for the land and has attached to it legal rights and responsibilities as any ownership does. An inventory on the other hand is purely a static category and has no legal meaning like the Cadastral system has.

The Cadastral system for sources of pollution would play a major role in the implementation of the water quality management in South Africa if it gets established, as is expected, on the basis of a National water policy.

The most suitable manner to form the Cadastre of point sources of pollution for South Africa is to collect the data on the level of a Polluter which may or may not consist of more than one production unit and to account for point discharges into the receiving environment. The production unit is defined as an independent technological process engaged in the production of goods and/or services and operating as a whole under normal conditions without any dependence upon other technological processes and or units. The discharge point is defined as a point at which the production unit discharges its emissions to one of the receiving environments.

For non point sources of pollution (NPS) the basic approach centres on the NPS unit area (NPSUA). NPSUA is defined as an area with known boundaries and fairly uniform characteristics to allow the estimation of pollutant export coefficients from it. Since pollution of the environment is characterised by three basic parameters (quantity, quality and location) the Cadastral system must be designed to allow for reporting and analysis with respect to all these parameters.

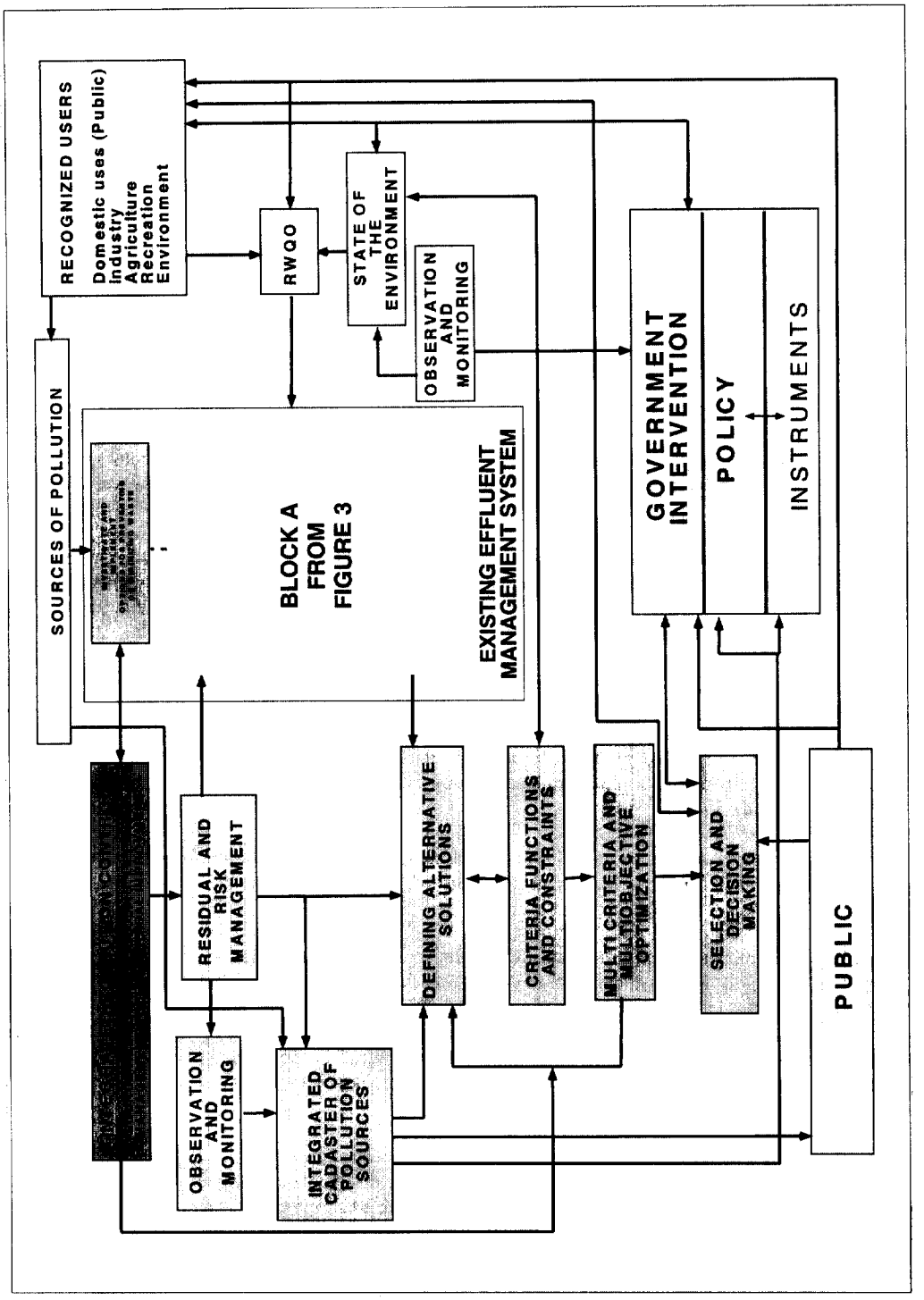

Figure 4. Proposed system for water quality management in South Africa.

CONCLUSIONS

The new National water policy and the new Water Act to be based on it will change the way water quality is managed in South Africa. The new approach will be based on an efficient, transparent, integrated and state of the art water quality management system at the centre of which is a dual approach to effluent control based on effluent standards and receiving river water quality objectives. To allow for this integration it is necessary to develop and implement a Cadastral system for point and non point sources of pollution and a set of optimisation tools.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to the South African Water Research Commission and the Federal Ministry for Development, Science and Environment of Yugoslavia who jointly funded a research project on the basis of which the proposed system for water quality management is based.

REFERENCES

Department of Water Affairs and Forestry (1997). *White paper on a National Water Policy for South Africa*, Department of Water Affairs and Forestry, Pretoria, South Africa

Department of Water Affairs and Forestry (1995). *Procedures to Assess Effluent Discharge Impacts*, South African Water Quality Management Series, Water Research Commission, Pretoria, South Africa

Department of Environment and Tourism (1996). *Integrated Pollution Control Project*, Working reports and discussion documents, Department of Environment and Tourism, Pretoria, South Africa

Marjanovic, P., Miloradov M. (1997). *The Cadastral system for point and non point sources of pollution*, Water Research Commission, Pretoria, South Africa, *In print.*