



# EDUCATION AND TRAINING OF WATER PRACTITIONERS IN SOUTH AFRICA: NEEDS AND PROGRAMMES

C. F. Schutte

*Water Utilisation Division, Department of Chemical Engineering, University of Pretoria, South Africa*

## ABSTRACT

South Africa is facing severe water supply and water quality problems as a result of its limited water resources and other complicating factors. Adequately educated and trained water practitioners are needed to address these problems to ensure economic prosperity and a reasonable standard of living for all South Africans. Training and education needs are analysed in this paper and available programmes and initiatives to deliver the water practitioners needed are discussed. The main areas where training and education is needed include education at community level to educate local water committee members and community support personnel; training of technical staff to operate and maintain water treatment and supply schemes; and education of high-level scientists and engineers to develop new technologies, to improve performance, design and management of processes, plant and projects. © 1998 IAWQ Published by Elsevier Science Ltd. All rights reserved

## KEYWORDS

Education needs; training programmes; water practitioners.

## INTRODUCTION

South Africa is a country with a unique combination of circumstances affecting its water supply situation. These circumstances are the limited availability of water; the concentration of economic activities in certain areas; and the legacy of a political system which resulted in large disadvantaged communities. This combination of circumstances places difficult demands on those responsible for the optimal utilisation and protection of the country's water resources while ensuring equitable distribution of the available water to all water demand sectors.

The experience gained in managing these demands and specifically the training and education of people at different levels and with different responsibilities should be valuable to other developing nations experiencing water supply difficulties.

South Africa is a relatively arid country with an average annual rainfall of only 500 mm, compared to a world average of 800 mm. In addition, rainfall is poorly distributed. Over most of the country the average annual potential evaporation which ranges from 1100 mm in the east to 3000 mm in the west is well in excess of the annual rainfall which reduces surface runoff greatly (Department of Water Affairs, 1986). This

means that the economically harvestable amount of water in the country is limited. Studies show that South Africa's water resources can support a total population of only 80 million people together with the economic activity required to ensure a reasonable standard of living. With a 1995 population of about 43.5 million, growing at an annual rate of 2.3% (Ministry of Welfare and Population Development, 1995) the demands on water resources and equitable distribution will continue to escalate. Projections show that if population growth continues at current levels the available water will be fully committed by the year 2020 (Department of Water Affairs, 1986). This means that demands on managers and engineers responsible for water supply will continue to increase and intensify in the following two decades, emphasising the need for quality education and training programmes in this field.

In addition to the limited availability of water, a compounding factor is that the economic development of the country has been concentrated in a few areas. The main economic development (with concomitant high demands for water) and the main concentration of people is on the central-eastern plateau area where most of the gold mines, many coal mines and the cities of Johannesburg and Pretoria are located. A number of water transfer schemes such as the Tugela-Vaal and the Lesotho Highlands have already been implemented or are under construction to quench the thirst of this area.

The third factor contributing to water supply problems is the historic political situation in South Africa which left a legacy of large disadvantaged communities with inadequate water supply and sanitation facilities. Large numbers of these people have moved since 1994 or are moving to the economically active areas such as Gauteng where large squatter communities are developing. This development increases the demand for water in these areas while at the same time causing large-scale pollution of water sources as a result of inadequate sanitation facilities. Diffuse pollution through stormwater runoff is causing severe problems which requires practitioners with knowledge and ingenuity to develop solutions for these problems.

This paper firstly considers the need for the different categories of trained and educated people to address the water supply and resource protection problems in South Africa. Following the consideration of training and education needs, an overview is given of training and education programmes to address these needs with specific attention to the programmes of the National Community Water and Sanitation Training Institute and the Water Utilisation Division of the Department of Chemical Engineering of the University of Pretoria.

## EDUCATION AND TRAINING NEEDS

The training and education needs discussed in this section are based on the main problem areas being experienced currently and those projected to become pressing in the near future. These problems can be grouped in three main categories: limited availability to meet total demands; equitable distribution to all users; preservation of water quality.

### Limited water resources

The biggest growth in water demand is in the Gauteng province and surrounding areas which are located on the central-eastern plateau. The available water within this region is very limited and already has to be supplemented by water transfer schemes from the Tugela river in Kwazulu Natal. Currently the massive Lesotho Highlands scheme is under construction to transfer water from Lesotho to Gauteng.

Other areas with high growth rates in water demand and with limited availability include Cape Town and the Western Cape, Port Elizabeth and East London areas in the Eastern Cape and the Bloemfontein area in the Free State.

The need is for skilled people to address high-technology problems, i.e. managers, engineers and scientists to do project planning and design and to do research and development on processes and programmes to increase the availability of water to meet demands. The skills that are required include those of process engineers to desalinate seawater and brackish water, to reclaim wastewater for reuse, to improve the

efficiency of utilising available sources and to prevent or minimise pollution by employing waste minimisation and clean technology. Furthermore, since large volumes of water are used (and lost) through evaporative cooling at power stations, skilled people to design, implement and operate dry cooling (non-evaporative) systems are needed.

South Africa has limited groundwater resources in terms of the volume contributed by groundwater to the total available volume. However, groundwater plays a most important role in the water supply to hundreds of small rural communities. Skills to explore groundwater resources, to improve understanding and determination of sustainable yields and to preserve groundwater therefore also need to be developed.

#### Equitable distribution to all users

The supply of water to the different use sectors in South Africa has not been equitable in the past. Water supply to the developed urban areas and to industry and mining has been of the highest quality and reliability. In contrast, most of the peri-urban or developing communities received a poor service. Rural communities suffered the most as they had to obtain water from unreliable hand pumps, untreated surface sources or standpipes.

Since assuming power in 1994 the new government has identified reliable water supply and adequate sanitation facilities to everyone as one of the priorities in terms of allocation of funds. (Department of Water Affairs and Forestry, 1994).

The provision of a reliable water supply to previously disadvantaged communities is an area where very large needs exist for education, training and capacity building to ensure successful and sustainable supply schemes. These needs cover a very wide spectrum including:

- Education at community level through awareness programmes to make them aware of how their water supply system functions, the need to protect their water sources from pollution, the need to pay for services such as water, etc. This is required in order for the community to assume "ownership" of their scheme. Without such ownership the success of water supply schemes, especially in rural areas, will be very much in doubt.
- Training and education at community level for development of administrative skills to manage rural water supply schemes. This would include skills such as general administration, financial control, communication skills, etc. These would typically be skills required by members of a local water committee or a similar group who will take the initiative and act as a communication channel between the community and a local or regional authority or other body responsible for water supply.
- Training and education of "pump operators" to run and maintain low technology water supply schemes such as diesel-driven engines to pump groundwater to reservoirs, operation of a basic distribution system and doing basic maintenance. The skills required to operate these types of rural schemes would include a basic knowledge of the operation and maintenance of diesel engines, solar powered pumps, the different types of pumps on such schemes, operation and maintenance of valves, reservoirs and pipelines.
- Training and education of maintenance teams to give support to pump operators. The skills required by these operators would be the same but higher level skills than those of the pump operators. They would provide back-up to a number of schemes to assist in those tasks which pump operators cannot carry out.
- Training and education of plant operators (or process controllers) for conventional treatment plants. These people would require a basic understanding of treatment processes and skills for process control and plant operation.

### Preservation of water quality

Because of the relatively small flows in South African rivers, return flows of purified sewage and industrial effluents make up a substantial fraction of total flows. This has resulted in a continuing deterioration in water quality of all major water resources. The main problems include eutrophication as a result of enrichment with plant nutrients in purified sewage effluents; salination due to irrigation return flows, industrial effluents and acid mine drainage, all of which carry high salt loads; pollution by micro-organisms and organic matter in surface runoff from squatter towns; specific problems in certain areas such as low pH levels as a result of acid mine drainage in mining areas. (Department of Water Affairs and Forestry, 1991).

Training and education needed to address these problems fall in two categories:

- Training of scientists and engineers at post-graduate level to do research and development of processes to treat wastewater to high levels of purity. Further, to design processes and treatment plants and to optimise operation.
- Training and education of scientists and technicians in the field of water quality management. The required skills would include knowledge and understanding to evaluate water quality, to do impact assessments, to evaluate the potential impacts of discharges and diffuse pollution, to develop water quality guidelines and standards and to evaluate hydrological and geohydrological information.

### TRAINING AND EDUCATION PROGRAMMES

This section gives an overview of existing training and education programmes and those under development and evaluates how the needs discussed in the previous section are being addressed by these programmes.

South African universities and technikons have a reputation for the high quality of training and education offered to scientists, engineers and technicians. Undergraduate training offers basic skills in science and engineering and does not offer specialised training on water-related subjects. For specialised training at the higher level students have to follow post-graduate courses offered by a number of universities. These courses cover a fairly wide spectrum of subjects including water sciences, hydrology, geohydrology and engineering. In many cases specialisation only takes place at the Master and PhD level where education and training result from research projects on water related subjects.

Training and education programmes can be grouped into the following categories:

#### **General water and sanitation awareness programmes at community level.**

These are not specific training programmes but rather general educational programmes providing information to communities through printed and electronic media such as pamphlets and radio and TV programmes as well as through verbal communication at community meetings, at clinics and at schools. The responsibility for these programmes does not lie with training institutions but rather with state departments such as the Departments of Health and Water Affairs and their agents.

#### **Training and education programmes to develop administrative skills to manage water supply schemes at community level.**

It is estimated that more than 10 000 communities do not have adequate water and sanitation services (Department of Water Affairs and Forestry, 1994). They also do not have the local government skills and structures to develop, implement and operate systems to provide these services. To build the capacity of such a large number of communities and to provide trained support staff is a massive undertaking that will require very substantial training inputs.

The programmes required are of a "capacity building" nature and are typically offered by community development consultants, by non-government organisations (NGO) and by international aid organisations.

In an attempt to address these needs a training institute was established in 1996 specifically to co-ordinate and facilitate the development of these capacity building types of programmes as well as other training programmes as discussed below. The National Community Water and Sanitation Training Institute (NCWSTI) was established in September 1996 as a non-profit non-government organisation within the framework of the International training Network (ITN) of the United Nations Development Programme (UNDP) and the World Bank Water and Sanitation Programme.

The aims and objectives of the NCWSTI are as follows (The National Community Water and Sanitation Training Institute, 1996):

- Developing and promoting appropriate training and capacity building for community based development in water supply and sanitation, on a national basis;
- developing curricula, models and material on a national basis, to work towards standardisation and accreditation of water supply and sanitation courses, ranging from community capacity building to technical and engineering aspects;
- supporting policy development to ensure an integrated development approach, improved methodologies and effective planning for targeted training and capacity building programmes for the water and sanitation sector;
- advocating improved water and sanitation training to be offered by other educational and training institutions and Local Government;
- providing support to enhance training capacity of governmental and non-governmental bodies;
- networking and linking with national and international training organisations and offering information support services based on research and data collection; and
- undertaking action centred research and piloting of curricula through workshops.

#### **Education and training programmes to develop technical skills for plant operators and process controllers**

Programmes in this category cover a wide spectrum from certificate programmes offering training in basic skills to tertiary diploma training at Technikon level and in-house training by larger water supply authorities and companies.

The curricula at tertiary institutions are typically compiled under direction from an "advisory board" while those offered as in-house training or by private organisations usually reflect the views of the programme leader.

In order to provide guidance on the suitability of training courses for specific purposes, the Water Institute of Southern Africa (WISA) decided recently to assume responsibility for the accreditation of training programmes in this field (Water Institute of Southern Africa, 1997). WISA is a national institute consisting of corporation and individual members representing the interests of the water industry (in both water and wastewater fields) in South Africa and providing a forum for the exchange of information to improve water resources management in Southern Africa.

The Education and Training Division of WISA is currently in the process of developing the necessary protocols for accreditation of education and training programmes in South Africa. A further objective is to

facilitate the development of new courses to fill gaps in order to cover all education and training needs in this field.

### **Education and training to develop high-level science and engineering expertise**

Programmes to develop high-level expertise in the water field are offered at post-graduate level by a number of South African Universities. The programmes may consist of specific courses leading to an honours degree; or courses and a research project leading to a masters degree; or a research project only leading to a masters or doctors degree.

The type of training offered depends on the focus of the university or department. This may, for example, be hydrology, geohydrology, water chemistry, treatment processes, membrane processes, etc.

The courses offered by the Water Utilisation Division, Department of Chemical Engineering, University of Pretoria, have been developed over more than two decades to educate and train scientists and engineers to address South Africa's water quality problems. Graduates from this division should therefore fill the needs indicated above for high-technology scientists and engineers.

The honours courses (water utilisation engineering and water utilisation technology) are presented over a period of two years part time study. Eight subjects are presented over this cycle in two modules. The first module consists of the following subjects with the focus on the water environment and treatment of drinking water: Water Chemistry, Water Quality Management, Water Purification and Water Treatment.

The second module also consists of four subjects with the focus on wastewater treatment: Unit Processes, Water Microbiology, Sewage Treatment and Industrial Wastewater.

The masters degree requirements include the eight subjects listed above together with a thesis based on a research project.

The PhD is awarded for a thesis of the required standard.

Over the past two decades the Water Utilisation Division has produced more than 200 graduates at honours, masters and doctorate level, many of whom are in senior positions in the different sectors of the water industry.

In addition to the formal degree courses, the Division also offers specialised certificate courses for water practitioners on specific subjects. These are typically one-week courses, the presentation of which is demand driven. Examples of the certificate courses offered are: Water Quality Management, Operation of Activated Sludge Plants, Treatment of Industrial and Cooling Water, Operation of Small-Scale Water and Wastewater Treatment Plants. These courses are compact and intensive and are very popular as they are designed to meet specific industry needs. A total of more than 350 students have successfully completed certificate courses over the last three years.

## **CONCLUSIONS**

South Africa is facing severe water supply and water quality problems as a result of limited resources and rapidly growing demands. A large number of well educated and trained practitioners is needed to solve problems, in particular those related to the supply of water and sanitation services to disadvantaged communities. The newly established National Community Water and Sanitation Training Institute has an enormous challenge as the driving force to meet these education, training and empowerment needs.

On the tertiary level there are well established programmes in place which should be able to meet the education and training needs for scientists and engineers.

## REFERENCES

- Department of Water Affairs (1986). *Management of Water Resources of South Africa*. Pretoria.
- Department of Water Affairs and Forestry (1991). *Water Quality Management Policies and Strategies in the Republic of South Africa*. Pretoria.
- Department of Water Affairs and Forestry (1994). *Water Supply and Sanitation Policy. White Paper*. Cape Town.
- Ministry for Welfare and Population Development (1985). *A Green Paper for Public Discussion. Population Policy for South Africa?* Pretoria.
- The National Community Water and Sanitation Training Institute (1996). *Information Brochure*. Pietersburg.
- University of Pretoria (1997). *Post-graduate Training in Water Utilisation. Information Brochure*. Pretoria.
- Water Institute of South Africa (1997). *Report on Strategic Planning Conference*. Johannesburg.

Note:

Since submission of this paper (June 1997) a mission consisting of representatives of the Department of Water Affairs and Forestry of South Africa, UNESCO and the World Meteorology Organisation conducted a study on "Education and Training Needs of the Water Resources Management Services of South Africa". This study took place during the period November 1997 to May 1998 and culminated in a national workshop on 14 May 1998. A report on this mission will be available towards the middle of 1998.