Water, sanitation and health: South Africa's remaining and existing issues

Post-apartheid South Africa can lay claim to having substantially increased access to piped drinking water for all. Virtually all urban households and most rural households now have access to piped drinking water, with the remaining deprived communities located in more remote rural areas and in urban informal settlements. While drinking water may not necessarily be safe (or consistently available) in rural communities, there has been no recurrence of waterborne epidemics on the scale of the cholera epidemic of 2000–2001. However, child under-five diarrhoea case fatality rates indicate ongoing health issues in rural communities deprived of water services.

Water-related health issues are emerging due to conditions of water stress and climate change. Constraints on supply call for greater water re-use and better management of treatment plants to ensure river health and safe drinking water. The process of eutrophication is degrading water and habitat quality, and the results are difficult to treat. With climate change, existing microbial diseases could become more prevalent which is especially disturbing as water treatment plants are discharging insufficiently treated effluent into rivers. Contamination of groundwater and surface water from acid mine drainage requires specialised treatment. All of these factors indicate the need for improved water and health management, with greater surveillance of water quality and the delivery of universal water services to ensure health and prevent disease outbreaks.

The water-related Sustainable Development Goals extend the range of commitment beyond access to basic water services, and include improved water quality, enhanced water use and re-use and better water-related ecosystems. These commitments will demand a well-integrated approach and close public monitoring.

Introduction

South Africa has made considerable progress in providing water services, including both piped water and improved sanitation, to those who were previously deprived of such essential services during the apartheid era. This has resulted in significant benefits for rural populations, which now have improved access to greater volumes of water for domestic use, and some relief for women and girl children who bear the burden of collecting water from distant water sources. Although improved sanitation has not advanced to the same extent, increased levels of coverage have been achieved.

However, certain structural weaknesses persist; a proportion of the population either has no water services or due to uneven access to functioning systems, remain vulnerable to waterborne disease. In urban areas, households are disconnected when there is non-payment, and there can be ongoing challenges in the provision of water services to informal urban settlements. The current water crisis, with water constraints and limited supply in some areas, raises questions about the overall management of water resources and infrastructure to ensure water quality in sufficient quantity for health, particularly under the demanding conditions of climate change.

Safe drinking water is essential to life, and water services are crucial for personal health and hygiene. A health-sustaining living environment depends on access to water services supported by resilient water ecosystems that can provide water in sufficient quantity and quality for health and the enjoyment of life.

This chapter focuses on waterborne diseases rather than water washed diseases; these include diarrhoeal diseases such as cholera, typhoid fever and shigellosis, which can cause epidemics with high rates of mortality. Since 88% of these diseases are associated with unsafe water, inadequate sanitation or insufficient hygiene,1 the focus is on access to water services. While these diseases are widely understood, there is less public awareness of the transmission of viruses (such as hepatitis A and E, and influenza) through contaminated water or inadequate hygiene.2 In addition, non-communicable diseases are associated with harmful environmental pollutants found in water that can damage health, such as pesticides, nitrates and heavy metals.3

This chapter also discusses questions of access to and functionality of water systems and drinking water quality, with particular emphasis on conditions in rural areas, including an assessment of the 2000– 2001 cholera epidemic and its impact on water services, and the incidence of diarrhoea and other water-borne diseases. The current 2016 water crisis is reviewed in relation to increasingly varied weather conditions and emerging health challenges. Findings and conclusions are drawn on the issues of public health surveillance, prevention and promotion, water-quality reporting, and on the health impacts of environmental toxicants.

Access to safe drinking water and improved sanitation

Increased access to piped water by the majority of the population has been described as a “remarkable achievement”4 or even “one of the greatest feats in delivering on human rights”5 of the post-apartheid government. Improved access to piped water and improved sanitation mark a considerable advance in public health, particularly for those living in rural areas. Such access does more than reduce water related diseases, as improved hygiene also helps to reduce vulnerability to other infections, such as influenza.

South Africa’s post-apartheid government has set a higher standard of service in water and sanitation than that of international monitoring organisations. The Department of Water and Sanitation (DWS) defines basic water supply as access to piped water, rather than to a range of improved ‘rudimentary’ sources. The standard sets the minimum quantity of potable or safe drinking water at 25 litres per person per day (or six kilolitres per household per month), with flow of 10 litres/second to a facility within 200m from the household.6 Free basic water is available at this volume of consumption, although a rising tariff applies thereafter. Since the quality and safety of drinking water are not directly measured in household surveys, the government has adopted a proxy measure, namely access to piped water, based on the assumption that all piped water is safe. This follows the practice of international monitoring organisations in assessing progress.7 While national Regulations specify that water supply should be tested,6 this appears to be applied more in urban than rural water systems.

Access to piped water

Levels of access to piped water have improved nationally when compared with the deprivation of the past. Analysis of the data over time is difficult, largely because apartheid-era statistics did not include sections of the black population in 'independent' Bantustans as part of the national population. The baseline figures are therefore difficult to establish and the Joint Monitoring Project (JMP) data, which draw on South African surveys to model access data, are used here, although the JMP definition of improved access does not coincide with that of basic service.8

Over the period 1990–2015, access to piped water and other improved sources increased from 66% to 81% of the rural population, signifying an increase of 15%.8 Targets for universal access to water services were set by the post-apartheid government: all households were to receive piped water by 2008 and improved sanitation by 2010;9 these target dates were later modified to 2014.

More detailed analysis of access is available from the 2013 General

Household Survey,10 which indicates that 10 896 000 households, or 72.1% of the total number surveyed, access water from taps either with direct connections to the house or yard connections. Table 1 shows that a further 2 290 000 households, or 15.2% of the total surveyed, access public standpipes. Taken together, they represent the proportion of the total survey households included in the defined basic standard.

Table 1: Levels of access to water services and facilities

Water source	Households 000	Percent of national total
House connection	6845	45.3%
Site of yard access	4051	26.8%
Public tap	2290	15.2%
Other	1921	12.7%
Total	15107	100.0

Source: Statistics South Africa, 2014.10

These data further indicate that 1 921 000 households (or 12.7% of all households) accessed water from a range of water sources such as wells, dams, ponds, springs, rivers and streams, all of which represent types of sources that fall below the basic standard in South African water regulation.

There is a constitutional right to ‘sufficient’ water in South Africa; however, there are questions about the volume and affordability of the water and about water access when disconnections or flow restrictors are enforced. Although DWS Regulations specify a basic minimum standard of 25 litres per person per day, this has been assessed as insufficient to meet basic needs. One calculation puts the basic water requirement at 50 litres per person per day,11 but access at this amount is regarded as unaffordable.12

Functionality of rural water systems

Government regulations describe functionality as the continuous supply of piped water flowing at 10 litres/second.6 However, surveys have found uneven levels of functionality. For example, a review of 23 rural water systems in KwaZulu-Natal Province in 200313 found that 78% were working (as water was flowing), which implied a high level of functioning systems. However, 56% of these systems either did not meet the standards of basic service or did not work at all.

The shortcomings included gaps in accessibility, ineffective operation, incomplete construction and financial exclusion (some schemes did not provide for all sections of a community), water not flowing from some taps, and several systems that were operational but incomplete. At that time free basic water was unevenly available, thus excluding those who could not afford access to piped water. As municipal management has been comprehensively extended and has benefited from changes in the government allocation of revenue, some of these unsatisfactory features have been resolved, but there is evidence that issues of functionality and water quality remain.

A review of the data in national surveys14 found that the shortfalls in functionality were predominantly in rural provinces, some of which had high levels of interrupted supply.

In 2009/10, a high proportion of households in two rural provinces (78% in Mpumalanga Province and 69.5% in Limpopo Province) reported interrupted supply over the previous 12 months. Interruptions were caused mainly by burst pipes, water leaks, poor general maintenance and insufficient water, and were not always speedily resolved; for example, in 2010, 68% of interruptions in Mpumalanga lasted for more than 15 days.14

Water quality in rural systems

In addition to the problem of functionality, deficiencies have been reported in the quality of drinking water in rural water systems,15 with a proportion of plants not achieving the South African National Standard (SANS 241) for the quality of drinking water. On its own, access to piped water may not signify access to safe drinking water.

In 2006, uneven water quality was recorded in a study of 55 rural water treatment plants, with only 18% complying with the recommended limits in terms of microbiological quality specified in national water standards. The authors reported the major factors contributing to high bacterial readings as being due to ineffective water treatment, resulting in “high turbidity and inefficient chemical(coagulant and chlorine) dosing, which led to low chlorine residuals”15 Another study of rural groundwater systems found that the majority of those tested did not meet national water standards and that the groundwater systems were of inferior quality compared to surface water systems.16 A study of groundwater quality in Mpumalanga found similar conditions and concluded that some water tested "pose[s] a serious threat to the health of consumers".17 Such deficiencies in the qualitative aspects of water services indicate that reports of high levels of access may have to be moderated, as they may not signify access to continuous service or necessarily to safe drinking water in line with national water standards.

Sanitation

Access to improved sanitation – defined in water Regulations6 as access to a ventilated toilet facility or better – has also improved substantially during the post-apartheid period. The most recent data illustrate that the insanitary conditions that typified the apartheid era, during which most of the rural population had either inadequate or no facility, have been partially redressed. Over the period 1990–2015, access to improved sanitation (using JMP data including 'privy not ventilated') changed from 52% to 77% of the rural population – representing an increase of 29% over the past 25 years (Table 2).

Sanitation system	Number of households, 000	Percent of total
Flush toilets	9 418	62.3%
Ventilated privy	2 296	15.2%
Privy, not ventilated	2 456	16.3%
None	937	6.2%
	15107	100.0%

Source: Statistics South Africa, 2014.10

At the time of the General Household Survey conducted by Statistics South Africa in 2013, the two levels of access (which met or exceeded the basic standard of sanitation) amounted to 14 170 000 households, or 77.5% of all survey households. The remaining households either had unimproved privies (2 456 000, or 16.3%) or none (937 000, or 6.2% of all households). While 93.8% accessed some type of toilet facility, the 16.3% with 'unimproved' privies and the 6.2% with none represent the challenge in improving sanitation, particularly in rural areas.

Although there has been progress in the post-apartheid period, there has also been unevenness in the delivery of water services. South Africa has for instance met the Millennium Development Goal (MDG) target in water delivery but not in sanitation.7 Equally, the government's targets of universal access to piped water and improved sanitation by 2014 have not been met and a section of the population continues to experience uneven quality in terms of sanitation facilities and water services.7

Water services and waterborne disease

This section looks at the incidence of waterborne-disease outbreaks to determine whether advances in access to piped water and improved sanitation have resolved the issue of functionality and water quality, and thus succeeded in eliminating outbreaks of waterborne disease.

The cholera epidemic of 2000–2001 and outbreaks in waterborne disease illustrate the health risks resulting from shortfalls in achieving a health-sustaining environment. The cholera epidemic was unexpected, spread widely and led to 114 000 cases resulting in 260 deaths, the majority of which were in KwaZulu-Natal Province where the outbreak originated. Despite the high incidence, there was (using various comparative standards) a comparatively low level of mortality, estimated at 0.31% of those infected.18

The epidemic raised questions about access, functionality and water quality – questions that had been identified earlier in scientific studies and national surveys. The communities at the epicentre of the epidemic were found to have access to infrastructure but since piped water supply was at times irregular, and metered taps excluded households that were unable to pay a monthly fee, continuous access was compromised.19 Households excluded from access by constant interruptions and cost-recovery measures reverted to using traditional water sources which were often contaminated.

The rapid spread of cholera through northern KwaZulu-Natal to the Eastern Cape and beyond, highlighted gaps and weaknesses across the rural water and sanitation landscape. Expansion of the disease from 'epidemic hotbeds' to distant areas has been attributed to transport of the pathogen through hydrological networks along and upstream from coastal areas, and to the mobility of people, possibly without symptoms, across catchment areas who then transmit the bacteria faecally.20 While the primary route for the disease appears to have been along catchment areas, human mobility led to more extensive transmission across catchment areas. In both cases, inadequate water services may not have impeded hydrological transport or human transmission.

The Regulations published in April 2001 requiring a defined volume of free basic water6 were undoubtedly influenced by the cholera epidemic and have led to improved access. Further, the incidence of water-related diseases in subsequent years has not reached the same scale as in the early 2000s. However, there have been at least two subsequent outbreaks of waterborne disease since the cholera outbreak in 2000. The first was an outbreak of diarrhoea and typhoid in the town of Delmas in 2005,21 when the lack of well-managed water treatment, particularly chlorination, was identified as a significant causative factor. The second outbreak, in uKhahlamba District in 2008, involved the contamination of drinking water with E. coli following the breakdown of the local waste-water treatment plant; the outbreak was reported to have led to the death of 78 infants.22

The report of such outbreaks appears episodic. While the incidence of diarrhoea in under-five-year-olds is recorded in the District Health Barometer,23 reporting of the specific types of waterborne diseases appears to be dependent on whether or not there is an outbreak. Despite the reporting of a lower occurrence of outbreaks in recent years, analysis of the data indicates ongoing high levels of diarrhoeal infection in vulnerable rural areas (even if these infections do not necessarily constitute an outbreak), with incidence spreading across geographical areas.

Areas of high risk for waterborne disease

Given that access to water services has improved, an attempt was made to determine the extent to which populations are still vulnerable to waterborne disease; in this regard, the number and proportion of households deprived of water services in all district municipalities was examined and then compared with the under-five year diarrhoea case fatality rate.

Figure 1 shows the number of households deprived of water services, i.e. deprived of both piped water and improved sanitation, in the six district municipalities surveyed. The majority of the district municipalities with lower numbers of deprived households and lower percentages of these as a proportion of total population are reflected in the lower left quadrant, indicating that many of the district municipalities are approaching universal access to water services.

The district municipalities with the greatest numbers and the highest percentages of vulnerable households are reflected in the upper right hand quadrant and appear as a smaller set of scattered outliers. In these municipalities the number of households without water services ranged downwards from 100 000 to 40 000 as follows (with the percentage of the total population shown in brackets): OR Tambo (Eastern Cape) 34%, Alfred Nzo (Eastern Cape) 33%, Amatole (Eastern Cape) (25%), Greater Sekhukhune (Limpopo)(22%), Ehlanzeni (Mpumalanga) 16%, and Bojanala (Limpopo) 8%.

Figure 2 shows the data for the child under-five-years diarrhoea case fatality rate in relation to data on water services for four district municipalities. The number (rather than the proportion) of households without water services was used to highlight the extent of deprivation in areas of concern.

While it would have been preferable to use data on the incidence of severe diarrhoea, there was greater confidence in the under-five diarrhoea case fatality rate data. However, the graph is illustrative rather than indicative of correlation, as the under-five case fatality rate reflects not only the level of access to water services but also the accessibility and quality of health services in the district municipality.

For instance, a high fatality rate could be interpreted as indicating district municipalities with (a) sanitation conditions leading to high levels of dehydration from severe diarrhoea among under-five-year old, or (b) poor accessibility and quality of care in local hospital services.

Again, most the municipalities are reflected in the lower left quadrant of the graph, indicating lower numbers of deprived households and lower under-five case fatality rates. In contrast, municipalities with higher numbers of deprived households are reflected in the right hand quadrant of the scatterplot.

The trend line illustrates the relationship between deprivation (in the poor quality of water and health services) and disease; district municipalities with the highest number of deprived households are generally (but not consistently) associated with higher child under-five-year diarrhoea case fatality rates. Municipalities with high concentrations of households without water services (in a downwards range from 100 000 to 40 000 and with the under-five case fatality rates for diarrhoea in brackets) include OR Tambo (173 per 1 000), Ehlanzeni (95 per 1 000), Mopani (86 per 1 000) and Alfred Nzo (57 per 1 000).

Since the redistributive element in the division of revenue and local government funding prioritises funds for water and sanitation and other essential services (including funding for free basic services), it seems that capacity issues are associated with continuing high levels of deprivation. Rural councils often lack human resources and local sources of revenue, and are more dependent on intergovernmental transfers.25 They are also found to lack experienced staff and well established procedures to access and manage these funds effectively.

Surveillance and predictive analysis

The broad association between patterns of disease and service levels in water and sanitation, plus the cholera epidemic of 2000– 2001 and the concern to prepare adequately for such outbreaks, stimulated two studies that systematically examine risk of waterborne disease in rural populations.

The first study was undertaken in 2000, prior to the cholera epidemic, by a unit in the Department of Water and Sanitation,26 and the second study was conducted after the cholera epidemic, by an independent group of researchers.20 The first study employed a method of weighting risk factors (such as level of access to water services and other indicators) to identify and prioritise areas of high risk for waterborne disease. The second study developed a model of cholera transmission from available epidemiological records and a range of demographic, service-level and mobility data. The modelling of the pathways of a cholera epidemic was tested against the historic data to provide a predictive planning tool.

Such models utilising data on climate, living environment and incidence of waterborne disease should be updated if they are to serve as tools for contemporary analysis and disease management. The most useful output from renewed exercises of this kind would be the development of maps of vulnerable areas so that national and local government officials can visualise the most vulnerable areas and prioritise interventions.

Water crisis, climate change and health

The 2016 water crisis, precipitated by the worst drought since 1933, has resulted in widespread water shortages that are increasing stress on an already challenged infrastructure. Although South Africa's annual rainfall is below the world average, water consumption is above the world average. This has resulted in a water demand–supply gap. Population growth and greater urbanisation will increase the demand for water supply in the future and require that greater attention be given to improving the overall quality of readily available water supply. Demand is therefore anticipated to rise over the next 20 years, while the country's water resources are considered to be almost fully allocated – leading to an ongoing critical period in water management.27

Climate change is leading to rising temperatures, particularly in the interior of the country, and is anticipated to bring changes in rainfall patterns and increased droughts and floods. The net effect for water resources is likely to be greater water scarcity resulting from longer dry seasons and increased evaporation from dams.28 While these effects will be uneven geographically and accompanied by larger rainfall variances, there may be greater contamination of rivers and other water sources because of a reduced dilution effect.27 A study of the ecological consequences of climate change finds that water quality is likely to be affected by the mobilisation of pollutants such as metals, as well as the increased transport of dissolved pollutants, including pathogens.29

Under these conditions, greater care and improvement in the management of hydrological flows, waste-water treatment and drinking water purification are needed to achieve and maintain resilient water systems and sustain water services. At the municipal level, a persistent issue is the reduction of water loss which requires socio-political as well as technical management.

There is evidence of growing public concern about the quality of water, and increased sensitivity to service issues. General household surveys report lower levels of satisfaction over time; for example, less than two-thirds of households rated their water services as ‘good’ in 2013.10 Deterioration in levels of satisfaction is associated with a decline in the percentage of households that feel that their water is clean, clear, tastes good and is free of unpleasant odours.

Waste-water treatment and acid mine drainage

There are many elements in the potential deterioration of water quality including sanitation, eutrophication, the presence of micro pollutants, microbiological pollutants and sedimentation. Some of these factors are associated with the extensive re-use of water in South Africa through the release of waste-water effluent of uneven quality into rivers, which has implications for river health and downstream water treatment.

There has been considerable discussion about the types of contamination that could pose the most immediate threats to health, particularly eutrophication, and microbial pollution from poorly managed waste-water treatment. Turton30 has persistently raised the question of eutrophication, which leads to the growth of blue-green algae (cyanobacteria) and results from the presence of nutrients existing in sewage effluent. Cyanobacteria are difficult to treat and eliminate, and threaten the health of humans and livestock, in addition to damaging the ecosystem. The DWS acknowledges this threat and has a monitoring system in place28 although the planned regular reporting does not appear to be evident.

There is also ongoing concern about the direct health impact of the presence of microbial pathogens in the effluent from water treatment works. A study of pond systems in rural hospitals in northern KwaZulu-Natal, for instance, found that the effluent was being used to water crops and even, indirectly, for domestic purposes.31

The researchers concluded that they “consistently found that such effluents were either inadequately disinfected or not disinfected at all”. These researchers traced the existence of Vibrio cholera in raw sewage months before the cholera outbreak in October 2000.

Municipal waste-water treatment plants are discharging effluent that has not been properly treated. South Africa has 986 municipal water-treatment facilities currently in operation, which discharge 2.1km3 (or 2 100 million kl) of treated water into river systems, although the quality is uncertain,27 and inadequate treatment is responsible for the existence of high levels of faecal coliforms in effluent entering rivers. Drawing from the Green Drop (waste-water) monitoring reports, Turton concludes that only 26% of sewage is adequately treated before being discharged into rivers.30 Apart from the additional cost of water treatment downstream, high levels of contaminants in rivers and streams pose a direct health risk to populations potentially drawing on these surface-water sources.

The Green Drop monitoring programme, which reports on the quality of waste-water treatment, involves a complex assessment of management practices and skills as well as effluent quality microbiological compliance. The reports provide the resulting risk profile, which for reasons of simplicity is selected for reference.

Municipalities in the Eastern Cape that have been previously identified as having deficits in water and sanitation delivery often also have a high Green Drop risk profile: for instance, OR Tambo District Municipality has a risk profile of 98.4% and Alfred Nzo District Municipality has a risk profile of 89.8%. None of the municipalities had more than 50% compliance for a single treatment plant.

Ehlanzeni District Municipality (Mpumalanga) has a greater range of risk profile scores for the five component local municipalities than OR Tambo and Alfred Nzo Municipalities in the Eastern Cape. The Ehlanzeni risk profiles ranged from Bushbuckridge with a high of 83.3%, to Mbombela with a low of 42.5%. In comparison to the Eastern Cape municipalities mentioned, Mpumalanga had a generally lower risk profile, with Umjindi, Mbombela and Nkomazi Local Municipalities recording some plants with more than 50% compliance.

Those municipalities associated with high levels of under-five diarrhoea case fatality rates also tend to have high risk profiles for the management of waste-water treatment. Other threats of contamination to surface and underground water are posed by acid mine drainage (AMD), which is the outflow of acidic water after mines are closed and tailing dams are decommissioned. AMD is characterised by high salinity levels, elevated concentrations of sulphate, iron, aluminium and manganese, and raised levels of toxic heavy metals such as cadmium, cobalt, copper, molybdenum, zinc and radionuclides.32 Specialised treatment has been researched and developed but not yet generally applied; it appears that much of the AMD leaches into rivers, resulting in the dilution of contaminants.27 There is a considerable range of potential impacts associated with AMD, including on health. For instance, high levels of uranium have been found in surface water at the Wonderfontein Spruit33which if consumed untreated, can have serious health implications, in particular kidney toxicity. It appears that the health impacts of many environmental toxicants in water are internationally known but should be grounded in the local context.

Anticipated trends in water a nd health

Water-related health issues resulting from climate change may be evidenced in the worsening of existing health outcomes rather than in unexpected diseases.34 The risk of adverse health impacts can be expected to follow the anticipated results of climate change; changes in temperature and precipitation, for example, may provide more favourable conditions for the concentration of microbial pathogens.

Reviews of likely health impacts from climate change in South Africa conclude that enteric (intestinal) waterborne diseases will be more likely,35 and extreme events associated with changing climate conditions may precipitate outbreaks of waterborne disease. E.coli, types of which are pathogenic, reproduce optimally in dark, warm, moist environments found in warmer conditions in coastal areas. Growth of the bacterium Vibrio cholera is affected by water salinity, water temperature and changes in rainfall patterns. Studies of the impact of climate change on waterborne pathogen concentrations in surface water indicate varying results, although extreme precipitation events (which will become more prevalent) are found to increase such concentrations.36

Whether incidence develops into an epidemic may be determined as much by the quality of governance (which can ensure quality water services) as by environmental and climate factors; the evidence27 is that good access to water services can constitute an effective barrier to incidence becoming a large-scale disease outbreak.

Maintaining public health under these changing conditions will demand improved management of waste-water facilities, closer surveillance of water quality, and improved interventions to ensure that water services are accessible and affordable to all. Effective primary health care services should also ensure safe drinking water.

The Sustainable Development Goals

The water-related Sustainable Development Goals (SDGs) adopted internationally in 2015 help to focus national and local government attention on key objectives to improve integrated water resource management and to strengthen adaptation strategies to climate change.37 these objectives include:

➢➢ Universal access to safe drinking water and improved sanitation;

➢➢ improved water quality and wastewater management;

➢➢ water-use efficiency;

➢➢ integrated water resources management on a wide scale;

➢➢ Public participation of local communities; and

➢➢ Interventions to reduce the impact of water-related disasters.

While none of these objectives is unfamiliar in the South African policy landscape, as a collective, they set a higher standard than previous individual commitments and policies, and draw attention to the central importance of sustainable management of water resources to maintain public health. Table 1 sets out the water-related SDGs and the necessary policy response.

The wide range of the SDGs will place greater demands on integrated governance, as they go well beyond the provision of basic services to improve the quality and accessibility of services, and include the environmentally associated issues of water re-use and ecological commitments. Objectives such as the protection and restoration of water-related ecosystems will require extensive interdepartmental co-operation and co-ordination across multiple tiers of government.

The formal approach of the SDGs is intentionally top-down, but there are other possibilities that could encourage bottom-up approaches. Public participation, which has been formally instituted at the local government planning level and in other ways, will be important in achieving water efficiency as well as environmental and other objectives. Such focus could be the positive basis for discussion with municipalities and be part of a wider debate about efficiency in water use and public concern about water quality.

Conclusion

The relationship between water and health has been explored in relation to the provision of water services, which serve to protect populations from waterborne disease. Climate change will place demands on the resilience of water systems, demands that go well beyond the delivery and management of basic water services. The following points are instructive in this context.

➢➢ ongoing deficits in rural water services. Despite government commitment to provide universal access to water and sanitation by 2014, a proportion of the population, particularly in the rural areas, remains unserved and vulnerable to waterborne disease. Substantially incomplete water services, possibly combined with inadequate health services in identified rural areas, have left poor rural populations with under-five diarrhoea case fatality rates that are much higher than that of populations with virtually universal access to piped water.

➢➢ Health-risk modelling is possible. The two types of mapping of the potential vulnerability of populations to water-related diseases demonstrate that the areas for priority intervention can be identified and that the likely pathways of cholera and other water-related diseases can be tracked. Under conditions of climate change, which will be associated with a greater number of extreme events with potential for waterborne epidemics, priority-setting for intervention should be guided by greater surveillance of the epidemiological and environmental data.

➢➢ Climate change impacts require improved management of water services. The current water crisis shows that the supply of water in sufficient quantity and quality is a challenge to water governance; this focuses attention on the need for improved management of infrastructure and water ecosystems. The deteriorating quality of available water requires diligent water treatment. There appear to be two main areas for improved management of river water quality, firstly poorly treated effluent from waste-water plants, and secondly contamination from acid mine drainage, both of which are reducing the quantity of readily available water of reasonable quality and complicating treatment.

Environmental toxicants transported in water are linked to non-communicable diseases. Environmental toxicants contaminating drinking water can lead to early-life exposures that can have developmental health impacts.43 Lapses in water-quality monitoring for such contaminants can have wide-ranging effects on child development and adult health.

Recommendations

➢➢ Improved public health surveillance in vulnerable communities is needed. Mapped outputs from an appropriate model would provide the information to focus attention on vulnerable populations particularly at the district municipality level.

This will provide early warning of outbreaks, and serve as an important planning tool for health and water service interventions.

➢➢ Disease prevention and health promotion should be focused where they are most needed. The re-engineering of primary health care through Ward-based Outreach Teams should lead to improved disease prevention and health promotion in vulnerable populations without water services. Environmental Health Practitioners trained in water-related disease prevention should be involved to support such interventions. In key areas of identified need, interventions to achieve disease prevention and health promotion should be substantially improved.

➢➢ The Department of Water and Sanitation and the Department of Health should regularly review and publicly report on the conditions of the unserved population. Despite the previous government commitment to achieve universal access to piped water by 2014, substantial numbers of the unserved population still have to access potentially contaminated natural water sources and suffer higher rates of waterborne disease. The modelling and mapping of public health should provide an instrument to track water system delivery and provide appropriate health system support. These interventions, and hospital access and treatment in district municipalities with high under-five diarrhoea case fatality rates should be reviewed and reported for further action.

➢➢ Make reporting of water quality management more readily and publicly accessible. The Green and Blue Drop monitoring and reporting systems include a well-established annual review of changes in municipal water management. Despite this, reports may be delayed and the reporting format is complex for ordinary citizens to review. For this form of incentive-based regulation to function properly, reports should be publicly available soon after completion to facilitate critical public review in various ways, including through public meetings, particularly at local level.

Further research is needed into the development and sustainability of sanitation services. Existing systems face two challenges: the best-designed pit latrines will eventually be filled to capacity and need replacement, and existing sewage systems are drawing large volumes of quality water during a time of water constraint. More sustainable sanitation technologies should be developed.

Given the existing high burden of disease in South Africa, additional water-related negative health impacts (exacerbated by climate change) will strain public health systems. In order for water and sanitation to have their full health impact, there is a need for capable management of water resources, improved rural local government, and a well-prepared primary health care system. Such an integrated approach should be set within a programme to end the poverty of large sections of the population.

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