POLICY BRIEF

June 2019
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Development of risk-based and site-specific recreational water quality guidelines

The South African Water Quality Guideline series of 1996 are one of the most widely-used tools in water quality management in South Africa. These guidelines are, to some extent, based on a risk philosophy, that is, based on available dose-response data, however, are not explicitly expressed in terms of risk. Recommendations from a review study initiated by the Department of Water and Sanitation (then Department of Water Affairs) highlighted the need to revise the guidelines so that they are risk-based, reflect current risk science, and are aligned to the prescripts of the National Water Act (Act no. 36 of 1998).

Based on these recommendations, a Water Research Commission (WRC) study, aimed at developing a risk-based and site-specific approach for the recreational water use, for the revision of the 1996 South African Water Quality Guidelines for Recreational Use (Volume 2), was initiated. In this context, the calculation of risk is a technical/scientific process, where the likelihood of the subject being exposed to the hazard, and the likelihood that the effect will be expressed if the subject is exposed to the hazard is considered in order to provide an estimation of the risk. Compared to the 1996 series, the use of the Daily-Adjusted Life Year (DALY) metric to propose what could be considered as the acceptable health-related risk in the context of setting water quality targets/ objectives (water resources management) and judging fitness for use is progressive. From a water resources management perspective, adoption of both the generic and context-specific (user and site-specific) risk assessment concepts help define the scope for the risk management process. Considering the water context in South Africa, this approach allows the user to set realistic criteria against which the risks will be assessed, without compromising public health. This important improvement of the guidelines is enabled through a software-based decision support system (DSS).

Background

The use of water for recreational purposes is common to all consumers. The 1996 South African Water Quality Guidelines (SAWQGs) for Recreational Use (Volume 2) has been one of the most widely used tools for water quality management and fitness-for-use decision-making in South Africa. These guidelines only concern the use of inland freshwater resources, such as dams, rivers and streams, or from groundwater via boreholes (i.e. excludes swimming pools and marine waters). In 2008, the Department of Water and Sanitation (then the Department of Water Affairs) conducted a review of these SAWQGs.

The main recommendation from this assessment was the need to revise all the 1996 South African Water Quality Guidelines so that they reflect current and international best practice on risk and align to the prescripts of the National Water Act (Act 36 of 1998). The 1996 version of the SAWQG were, to some extent, based on a risk philosophy, that is, were based on available dose-response data, however, were not explicitly expressed in terms of risk. The distribution was interpreted to determine the values at which the "Target Water Quality Range" would be ensured at a high level of confidence, whereas descriptors of effects at other levels were also provided.

A basic risk-based approach for health-based water quality targets setting was first adopted by the World Health Organisation (WHO) as part of the Stockholm Framework, providing a conceptual approach for assessing water quality hazards and managing the associated risks in 2001. Thus, a risk-based approach was one of the requirements for

the revised SAWQGs and, as such, the current approach considers the likelihood of exposure by taking into account the exposure distributions and the likelihood of an effect through dose-response distributions.

The resultant risk is then expressed as a probability between 0 and 1 (or as a percentage), that the specified effect will be expressed, given a certain distribution of exposure. While the scope of the 1996 guidelines was applicable to a limited number of recreational uses, the definition of 'recreational water activities' has been expanded to include social, cultural and religious uses of water resources and an understanding of the associated hazard and exposure details. One other important improvement of the revised guidelines is the incorporation of site-specific and user-specifi criteria in the estimation of risk, allowing greater input and context-specific decision-making and management of water quality risks. This feature is enabled through a software-based decision support system (DSS).

Risk and user/site-specificity in the context of recreational water use

"Risk based" water quality guidelines simply allow the suitability of the water to be interpreted in terms of risk of specific adverse effects. In this context, risk refers to the probability of adverse effects to the identified immediate user of the water for recreational activities.

The WHO defines risk as the likelihood of identified hazards causing harm in exposed populations in a specified timeframe, including the magnitude of that harm and their consequences. In short, risk consists of answers to three questions: (i). What can happen? (i.e. what can go wrong or hazard identification?); (ii). How likely is it that that will happen? and (iii). If it does happen, what are the consequences? In the case where a certain level of risk (the likelihood that an undesired effect may occur) has been identified, as may be the case considering the current state and quality of most of the freshwater resources in South Africa, decision-making on the fitness of the resource for a particular recreational activity should be guided by first defining the acceptable risk and tolerable burdens of disease.

Such decisions are complex and need to take account both the probability and severity of impact, over and above the environmental, social, cultural, economic and political dimensions that play important roles in decision-making. Definitions of reference levels of risk and tolerable burdens of disease are required to provide a baseline for the development of health-based targets. The calculation of risk needs to be a technical/scientific process, where the likelihood of the subject being exposed to the hazard, and the likelihood that the effect will be expressed if the subject is exposed to the hazard is considered in order to provide an estimation of the risk. In other words, risk is dependent on an agent causing the effect (the hazard), and the subject experiencing the effect (the response).

The decision of whether a particular level of risk is acceptable or unacceptable and if it warrants an action, is a value-based decision, which belongs in the policy and management domains. Disability-Adjusted Life Years (DALYs) have been widely used to quantify the population health burden of diseases and to prioritise and evaluate the impact of specific public health interventions. DALYs are the sum of years of life lost (YLL) due to premature death and years lost due to disability (YLD) for incident cases of the particular health condition in a population (DALY=YLL+YLD).

Calculation of YLL requires information on the number of people who died from the disease and their life expectancy at age of death. YLD incorporates the number of incident cases, symptom duration, and symptom severity. Thus, from a policy perspective, the use of the DALY metric to propose what could be considered as the acceptable health-related risk in the context of setting water quality targets/objectives (water resources management) and judging fitness for use is progressive.

From a management perspective, the concept of establishing and defining acceptable risk in both generic terms and within a specific context (user and site-specificity) has been adopted as means to aid water quality decision making. Context-specific risk estimation helps define the scope for the risk management process and sets the criteria against which the risks will be assessed. As such a three-tiered approach, to cater for both generic and user- and site-specific water quality risk assessment guidance, has been adopted for the estimation of risk in the revised guidelines.

These tiers are as follows:

- *Tier 1:* This tier communicates the minimum water quality requirements for different recreational uses to the user taking the most sensitive user into account, highlighting potential problems if these are not met. It closely resembles the 1996 generic guidelines, but has been revised to reflect the current risk science.
- *Tier 2:* The process for water quality risk estimation in this tier allows for user, site and scenario specific inputs, that influence the fitness for use of a particular water quality constituent. The calculations for site/scenario specific considerations include one or combinations of the following:
  - Refined exposure parameters – higher or lower exposure or dose situations based on the recreational activity may differ from that described in Tier 1
  - Sensitivity or acclimatisation of users to a particular constituent(s) – for example, some pathogens that may be naturally present in the environment may be able to cause disease in certain subpopulations and not others.
  - Others – such as location from point source water quality impacts e.g., wastewater treatment works or mining activities; user density; recreational use during or after large rainfall or flood events, etc.
- *Tier 3* allows for more detailed site-specific input, and allows for modifications to the approaches used for risk estimation.

A decision support system for assessing fitness for use / water quality requirements

The decision support system (DSS) developed as part of the WRC project is an engineered computational software system that provides a structured approach for assessing the water quality requirements and fitness for use for different recreational uses. The DSS incorporates different exposure scenarios (how the water is contacted and used) i.e. ingestion, dermal contact and inhalation, the risk estimation (the consideration of the water quality constituent and the user) and the two-level functionality (generic or site-specific) that is run through a calculation methodology (mathematical calculations) to provide risk-based guidance on water quality.

Most illnesses resulting from exposure during recreational activities is result of the accidental ingestion of contaminated water. Therefore, the high priority public health risk associated with recreational water activities is due to exposure to acute contaminants, particularly, pathogenic microorganisms. However, the tiered approach also allows for the estimation of risk due to exposure to contaminants that cause health effects after continuous long-term exposure at levels greater than the allowable concentrations.

Based on a number of international studies, there is now consensus on rates of water ingestion for different recreational activities. These range depending on the type of contact, from full contact to partial contact activities, each with differing exposure details. Context-specific exposure assessment is very important here as different levels, frequency of contact and events determine the possible risk.

In addition, aspects such as vulnerable sub-populations are able to be included in the DSS at a tier III level if new data becomes available relating to area specific susceptibilities of the population. A four-class classification system based on the current DWS practice is used to depict the fitness for water for a specific recreational use. The "Ideal" fitness for use class for recreational water use for example describes a class where water quality would not impair the fitness of water for its intended purpose. Both the fitness-for-use classification and the risk-based water quality assessment are represented in the DSS output screens depicting an assessment of water quality.

Conclusion

The risk-based and context specific approach for setting health-based water quality targets for recreational use serves as an important water resources and related risk management tool. Considering the water context in South Africa, this approach provides a systematic generic and context-specific risk-based decision-making framework, to help water resource managers and the user refine guideline trigger values for local, regional and or catchment uses, and inform actions to address water quality risks and assess performance.

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