POLICY BRIEF

August 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.

Environmental water temperature: A manual for setting temperature targets for perennial rivers in South Africa

Temperature exerts a major influence on biological activity and growth. Temperature governs the kinds of organisms that can live in rivers and lakes. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. Setting temperature ranges forms part of the ecological Reserve process as described in the National Water Act of 1998. Over the last 20 years, the Department of Water and Sanitation has developed several methods and models for Reserve determination, however water temperature and/or the effects of climate change have traditionally been omitted, mainly due to a lack of data. A recently completed Water Research Commission (WRC) project developed and tested water temperature guidelines on how to set and incorporate temperature in reserve determination, Resource Quality Objectives and in licensing processes or source directed measures.

Background

Freshwater ecosystems are among the most vulnerable in the world with respect to global climate change, with climate driven by radiation from the sun, by heat and by water, and there is thus an urgency to manage these systems appropriately.

Climate change has a significant impact on freshwater systems and their management, since water is a key resource and is the critical way that climate change impacts are felt (droughts, floods, storms, melting glaciers and sea level rise).

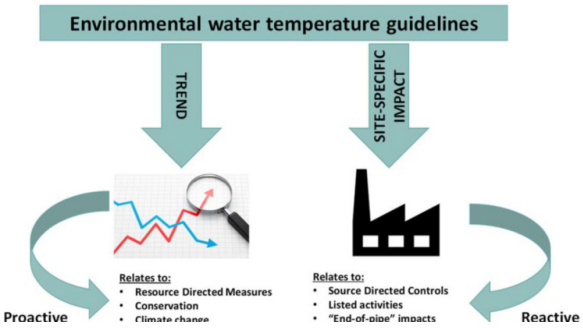
Within South Africa's National Water Act, water temperature is a bridging variable between the water quality and water quantity. Key thermal impacts and their prevalence in South African rivers have been tabulated, and management and mitigation options outlined. These impacts include both point and non-point source.

This information will assist water resource practitioners to assess risk of thermal impacts and formulate management and mitigation options and plans. Biological effects of changes in water temperature (and flow) on river organisms are described and categorised as physiological, metabolic, phenological, reproductive, behavioural or ecological.

Effects range from individual- to population-level modifications such as alteration of individual life history patterns, increases in the number and spread of invasive and pest species (such as blackfly), increase in waterborne and vector-borne diseases (cholera, malaria, etc.), extinction of vulnerable species, shifts in species distribution and range, and changes in communities and aquatic biodiversity.

This information will assist water resource practitioners to understand the likely ecological consequences of thermal stress, at multiple scales. For some effects, societal costs of altered thermal regimes need to be factored into the cost-benefit equations of catchment changes, which typically manifest in economic sectors and/or communities that don't directly reap the benefits.

The use of environmental water temperature guidelines may be both pro-active and reactive. The former relates to the establishment of guidelines to serve as a benchmark for future evaluation of thermal change and may include an assessment of trend; while the latter may be the direct response to an existing thermal impact or proposed thermal impact for which a user has, for example, submitted a water use licence application, see below.



Approaches and main results

Extensive consultation with water resource practitioners via questionnaires, workshops and individually informed the drafting and final product, the manual for setting target water temperature ranges. The technical manual produced serves as a roadmap for practitioners needing to incorporate water temperature into Resource Directed Measures, including Ecological Reserves and Resource Quality Objectives; and Source Directed Controls.

It speaks directly to several tools, packaged into a toolbox, developed for establishing environmental water temperature guidelines. The protocol was informed by the end-user requirements workshops, particularly the need for a screening process. The protocol comprises two processes that need to be followed for establishing environmental water temperature guidelines, namely a 1) Screening Process, and a 2) Evaluation Process.

The **Screening Process** allows water resource practitioners to evaluate whether water temperature should be considered at a particular site, be it for setting an environmental water temperature guideline or evaluating the potential effect of a thermal impact.

Three key questions are asked: 1) how resilient is the site, reach or river to changes in water temperature? 2) are there other hydrological, physico-chemical (water quality) or habitat considerations that could magnify or diminish thermal impacts? and 3) how sensitive are the river organisms?

The final stage of the screening process is an assessment of thermal stress in terms of risk using a thermal risk assessment matrix, which enables practitioners to assess the likely risk of thermal impact in the case of existing stressors and/or proposed stressors. This informs whether water temperature needs to be further examined at a site, in which case the water resource practitioner continues with the Evaluation Process.

The **Evaluation Process** is sub-divided into two components: 1) establishing Reference Indicators of Thermal Alteration (thermal metrics) and a Reference Thermograph, and 2); evaluating deviation of water temperature monitoring data from Reference Thermal metrics and Reference Thermograph, including the determination of the ecological category (A to F).

This allows water resource practitioners to set thermal targets for specific reference sites, reaches or rivers; using either logged water temperature data or modelled water temperature data; and to evaluate changes in water temperature at comparable monitoring sites, reaches or rivers. A prototype Thermal Sensitivity Index (TSI) based on aquatic macroinvertebrates has been developed, whereby each taxon is assigned a Thermal Sensitivity Weighting based on a combination of an estimate of thermophily and thermal limits determined experimentally.

These Thermal Sensitivity Weightings have been applied to most taxa in the South African Scoring System making it relatively easy for a water resource practitioner to determine if highly and/or moderately thermally sensitive taxa are present at a site.

Conclusions and recommendations

The products and protocols developed in this project provide water resource practitioners with the necessary knowledge and tools for incorporating water temperature into Resource Directed Measures, including Ecological Reserves and Resource Quality Objectives; and Source Directed Controls. These serve the local, regional and national context; and lays the foundation for the establishment of a national water temperature monitoring programme embraced by multiple end-user organisations and stakeholders.

This will need to be driven by DHSWS but will require co-ordination and support of multiple organisations that have a vested interest in tracking long-term change in water temperature. Water and freshwater ecosystems are an integral component of SDG: 3030, especially, SDG 6, SDG

13 (Take urgent action to combat climate change and its impacts), SDG:14 and SDG 15.

Policy recommendations

Water temperature urgently needs to be routinely monitored in South African rivers as required by Chapters 3 and 14 of the NWA. This needs to be done on an hourly basis to enable long-term trends to be established, as well as at site-specific impacts, where appropriate.

Focus needs to be on selecting a set of strategic national sites, aligned with the outcomes of the National Water Resources Monitoring Network Project's final set of monitoring site (DWS 2017), and potentially linked to existing River Ecostatus Monitoring Programme and the Ecological Water Requirements sites.

Cooperation between institutions and organisations to establish long-term water temperature monitoring sites is strongly recommended, such as the Protected Area Networks and conservation organisations (including SANParks, CapeNature, Forums, etc.). Such a spread of sites will add value in modelling climate change and impacts. Citizen scientists are key in sourcing data across the country, especially through Schools. This would be especially valuable for determination of thermal reference envelopes and would serve as benchmark for monitoring the long-term effect of global climate change on river systems.

Strategic Water Source Areas, which are source areas often regarded as natural 'water factories' since they support growth and develop needs that are often far away, should also be monitored.

Associated project:
Developing a manual on how to set water temperature targets and their incorporation into reserve monitoring and in licensing conditions (**WRC Project No. 2537**). For more information, contact WRC Research Manager Bonani Madikizela at Tel: (012) 761 9300 or Email: bonanim@wrc.org.za.