Calculation of the Drinking Water Quality Index

Essentially, the WQI model consists of three measures of variance from selected water quality objectives (Scope; Frequency; Amplitude). The "Scope (F_1)" represents the extent of water quality guideline non-compliance over the time period of interest. The "Frequency (F_2)" represents the percentage of individual tests that do not meet objectives. The "Amplitude (F_3)" represents the amount by which failed tests do not meet their objectives. These three factors combine to produce a value between 0 and 100 that represents the overall water quality. The formulation of the WQI as described in the Canadian Water Quality Index 1.0 – Technical Report is as follows (CCME 2001):

The measure for scope is F_1. This represents the extent of water quality guideline non-compliance over the time period of interest.

$$F_1 = \left(\frac{\text{Number of failed variables}}{\text{Total number of variables}} \right) \text{X } 100 \qquad (1)$$

The measure for frequency is F_2. This represents the percentage of individual tests that do not meet objectives ("failed tests").

$$F_2 = \left(\frac{\text{Number of failed tests}}{\text{Total number of tests}} \right) \text{X } 100 \qquad (2)$$

The measure for amplitude is F_3. This represents the amount by which failed test values do not meet their objectives. This is calculated in three steps:

Step 1- Calculation of Excursion

Excursion is the number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective.

When the test value must not exceed the objective:

$$\text{excursion}_i = \left(\frac{\text{Failed Test Value}_i}{\text{Objective}_j} \right) - 1 \qquad (3)$$

When the test value must not fall below the objective:

$$\text{excursion}_i = \left(\frac{\text{Objective}_j}{\text{Failed Test Value}_i} \right) - 1 \qquad (4)$$

Step 2- Calculation of Normalized Sum of Excursions

The normalized sum of excursions, *nse*, is the collective amount by which individual tests are out of compliance. This is calculated by summing the excursions of individual tests from their objectives and dividing by the total number of tests (both those meeting objectives and those not meeting objectives).

$$nse = \frac{\sum_{i=1}^{n} \text{excursion}_i}{\text{Number of tests}} \qquad (5)$$

Step 3-Calculation of F_3

F_3 is calculated by an asymptotic function that scales the normalized sum of the excursions from objectives to yield a range from 0 to 100.

$$F_3 = \left(\frac{nse}{0.01nse + 0.01} \right) \qquad (6)$$

The WQI is then calculated as:

$$WQI = 100 - \left(\frac{\sqrt{F_1^{\,2} + F_2^{\,2} + F_3^{\,2}}}{1.732} \right) \qquad (7)$$

This score is then ranked into one of the following five categories:

Excellent: (WQI Value 95-100) - Water quality is protected with a virtual absence of impairment; conditions are very close to pristine levels; these index values can only be obtained if all measurements meet recommended guidelines virtually all of the time.

Very Good: (WQI Value 89-94) - Water quality is protected with a slight presence of impairment; conditions are close to pristine levels.

Good: (CWQI Value 80-88) - Water quality is protected with only a minor degree of impairment; conditions rarely depart from desirable levels.

Fair: (WQI Value 65-79) - Water quality is usually protected but occasionally impaired; conditions sometimes depart from desirable levels.

Marginal: (WQI Value 45-64) - Water quality is frequently impaired; conditions often depart from desirable levels.

Poor: (WQI Value 0-44) - Water quality is almost always impaired; conditions usually depart from desirable levels.

References

CCME. **2001. Canadian water quality guidelines for the protection of aquatic life: Canadian Water Quality Index 1.0 Technical Report. *In* Canadian environmental quality guidelines. 1999. Winnipeg.**