Computation of the Pollutant Standards Index (PSI)

The PSI is based on six pollutants particulate matter (PM$_{10}$), fine particulate matter (PM$_{2.5}$), sulphur dioxide (SO$_2$), carbon monoxide (CO), ozone (O$_3$) and nitrogen dioxide (NO$_2$). For each pollutant, a sub-index is calculated from a segmented linear function that transforms ambient concentrations onto a scale extending from 0 through 500.

The breakpoints used in defining each of the six pollutant sub-indices are listed as follows:

<table>
<thead>
<tr>
<th>Index Category</th>
<th>PSI</th>
<th>24-hr PM$_{2.5}$ (µg/m$^3$)</th>
<th>24-hr PM$_{10}$ (µg/m$^3$)</th>
<th>24-hr SO$_2$ (µg/m$^3$)</th>
<th>8-hr CO (mg/m$^3$)</th>
<th>8-hr O$_3$ (µg/m$^3$)</th>
<th>1-hr NO$_2$ (µg/m$^3$)$^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>0 – 50</td>
<td>0 – 12</td>
<td>0 – 50</td>
<td>0 – 80</td>
<td>0 – 5.0</td>
<td>0 – 118</td>
<td>-</td>
</tr>
<tr>
<td>Moderate</td>
<td>51 – 100</td>
<td>13 – 55</td>
<td>51 – 150</td>
<td>81 – 365</td>
<td>5.1 – 10.0</td>
<td>119 – 157</td>
<td>-</td>
</tr>
<tr>
<td>Very Unhealthy</td>
<td>201 – 300</td>
<td>151 – 250</td>
<td>351 – 420</td>
<td>801 – 1600</td>
<td>17.1 – 34.0</td>
<td>236 – 785$^*$</td>
<td>1131 – 2260</td>
</tr>
<tr>
<td>Hazardous</td>
<td>301 – 400</td>
<td>251 – 350</td>
<td>421 – 500</td>
<td>1601 – 2100</td>
<td>34.1 – 46.0</td>
<td>786 – 980$^*$</td>
<td>2261 – 3000</td>
</tr>
<tr>
<td>Hazardous</td>
<td>401 – 500</td>
<td>351 – 500</td>
<td>501 – 600</td>
<td>2101 – 2620</td>
<td>46.1 – 57.5</td>
<td>981 – 1180$^*$</td>
<td>3001 – 3750</td>
</tr>
</tbody>
</table>

(Note: $^*$When 8-hour ozone concentration exceeds 785µg/m$^3$, the PSI sub-index is calculated using the 1-hour concentration; $^*$Sub-index for nitrogen dioxide is reported only when the 1-hour concentration equals or exceeds 1130 µg/m$^3$.)

Each sub-index $i$, is calculated by using a segmented linear function that relates pollutant concentration, $X_i$, to sub-index value, $I_i$. A segmented linear function consists of straight-line segments joining discrete co-ordinates (i.e. breakpoints). For pollutant i and segment j, the co-ordinates of the j$^{th}$ breakpoints are represented by sub-index value $I_{ij}$ and the concentration $X_{ij}$ giving the ordered pair ($X_{ij}$, $I_{ij}$). If the observed concentration is $X_i$ the corresponding sub-index value $I_i$ is calculated using the following equation over the concentration range:

**Equation 1:**

$$I_i = I_{ij+1} \frac{X_i - X_{ij}}{X_{ij+1} - X_{ij}} + I_{ij}$$

for $X_{ij} \leq X_i \leq X_{ij+1}$
where \( X_i = \) Observed concentration for the \( i^{th} \) pollutant
\( I_{ij} = \) PSI value for the \( i^{th} \) pollutant and the \( j^{th} \) breakpoint as given in the table
\( I_{ij+1} = \) PSI value for the \( i^{th} \) pollutant and the \((j+1)^{th}\) breakpoint as given in the table
\( X_{ij} = \) Concentration for the \( i^{th} \) pollutant and \( j^{th} \) breakpoint as given in the table
\( X_{ij+1} = \) Concentration for the \( i^{th} \) pollutant and \((j+1)^{th}\) breakpoint as given in the table

Finally, the overall index is calculated as the maximum of sub-indices:

\[
PSI = \text{maximum} (I_1, I_2, I_3, I_4, I_5, I_6)
\]

**Example of computation**

Suppose a 24-hr PM\(_{2.5}\) concentration of 40 µg/m\(^3\) is observed. Based on the table, the observed concentration of \( X_i = 40 \) µg/m\(^3\) lies between 12 and 55 µg/m\(^3\). Therefore, the computation is carried out for the first segment (\( j = 1 \)). For this segment, \( X_{1,1} = 12 \) µg/m\(^3\) and \( X_{1,2} = 55 \) µg/m\(^3\) with corresponding sub-index values of \( I_{1,1} = 50 \) and \( I_{1,2} = 100 \). The computation is as follows:

\[
I_i = \frac{I_{ij+1} - I_{ij}}{X_{ij+1} - X_{ij}} (X_i - X_{ij}) + I_{ij}
\]

\[
= \frac{100 - 50 (40 - 12) + 50}{55 - 12}
\]

\[
= 83
\]

Therefore, the PM\(_{2.5}\) sub-index is 83. If the five other pollutant sub-indices calculated in a similar manner from concentrations were \( I_2 (\text{PM10}) = 48 \), \( I_3 (\text{SO2}) = 46 \), \( I_4 (\text{CO}) = 15 \), \( I_5 (\text{O3}) = 45 \), \( I_6 (\text{NO2}) = -^* \), then the overall index is reported as the maximum of these values as follows:

\[
PSI = \text{maximum} (83, 48, 46, 15, 46, -^*) = 83
\]

*Note: Sub-index for nitrogen dioxide is reported only when the 1-hour concentration equals or exceeds 1130 µg/m\(^3\), which corresponds to sub-index of 200.*

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