CAI 334 IRRIGATION WATER QUALITY AND WASTE WATER MANAGEMENT

UNIT V NOTES

Water quality indices

Water quality indices are numerical tools used to express the overall quality of water based on multiple water quality parameters. These indices provide a concise and understandable representation of water quality, facilitating communication with the public, policymakers, and scientists. Various indices have been developed globally, each tailored to specific geographical regions, water uses, or regulatory frameworks. Here are details about water quality indices:

1. **Components of Water Quality Indices:** □ Physical Parameters: Temperature, turbidity, color. □ Chemical Parameters: Nutrients (nitrogen, phosphorus), dissolved oxygen, pH, heavy metals. □ Biological Parameters: Biotic indices based on the health and diversity of aquatic organisms.

2. **Calculation Methods**: □ Weighting Factors: Different parameters may be assigned different weights based on their significance to the overall water quality. □ Normalization: Parameters are often normalized to a scale (e.g., 0 to 100) for ease of interpretation. □ Aggregate Score: The overall water quality index is usually calculated by aggregating individual scores for each parameter.

3. Commonly Used Water Quality Indices: • Water Quality Index (WQI):

A composite index that combines multiple parameters into a single value, providing an overall assessment of water quality. □ Canadian Council of Ministers of the Environment (CCME) Water Quality Index: Used in Canada, it considers physical, chemical, and biological parameters, providing an integrated assessment. □ Aggregate Pollution Index (API): Used in India, it considers parameters like biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solids (TDS). □ National Sanitation Foundation Water Quality Index (NSF WQI): Used in the United States, it includes parameters such as total coliform bacteria, turbidity, and pH.

4. **Interpretation of Index Values:** □ Ranges: Indices often have predefined ranges or categories indicating water quality status, such as excellent, good, fair, poor, and very poor. □ Thresholds: Specific threshold values for individual parameters may trigger changes in water quality classification.

5. **Advantages:** □ Simplicity: Indices simplify complex water quality data into a single value, making it accessible to a broad audience. □ Communication: Facilitates communication between scientists, policymakers, and the public about water quality conditions.

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5. **Advantages:** Simplicity: Indices simplify complex water quality data into a single value, making it accessible to a broad audience. Communication: Facilitates communication between scientists, policymakers, and the public about water quality conditions.

6. **Limitations:** Sensitivity to Parameter Selection: The choice of parameters and their weights can influence index values. Temporal and Spatial Variability: Indices may not fully capture temporal and spatial variations in water quality.

7. **Applications:** Monitoring Programs: Regular assessment of water quality trends over time. Policy and Management: Informing policy decisions and management strategies. Public Awareness: Communicating water quality conditions to the public.

8. **Considerations for Development:** Regional Specificity: Indices may need to be regionally specific to account for local water quality standards and conditions. Data Availability: The selection of parameters should consider the availability of reliable data.

9. **Emerging Trends:** Integration with Remote Sensing: Incorporating satellite and remote sensing data for real-time monitoring. Machine Learning Applications: Utilizing machine learning algorithms to improve the accuracy and reliability of indices. Water quality indices are valuable tools for summarizing complex water quality information. However, their application should be guided by an understanding of the specific context, regulatory frameworks, and the goals of water management programs. Continuous research and development aim to enhance the accuracy and applicability of these indices in diverse environmental settings.

WQI	Rating
0-45	Good
45-60	Fair
>60	Poor

Calculations

The WQI is calculated by averaging the individual index values of some or all of the parameters within five water quality parameter categories:

1. Water clarity: turbidity (NTU*) and/or Secchi disk depth (meters or feet);
2. Dissolved oxygen: Dissolved oxygen concentration (mg/l);
3. Oxygen demand: biochemical oxygen demand (mg/l), chemical oxygen demand (mg/l) and/or total organic carbon (mg/l);
4. Nutrients: total nitrogen (mg/l), and/or total phosphorus (mg/l);
5. Bacteria: total coliform (# per mg/l) and/or fecal coliform (# per mg/l).

Quality Rating (Qn) = 100* [Vn – Vo] / [Sn – Vo] **…….**

Where, Qn = Quality rating for the nth water quality parameter.

Vn = Estimated value of the nth parameter at a given sampling stations.

Sn = Standard permissible value of the nth parameter.

Vo = Ideal value of nth parameter in a pure water. Ideal values in the most cases Vo = 0 except in some parameters such as pH. Calculation of quality rating for pH is 7.0 for natural water.

Calculation of quality rating for pH

For pH the ideal value is 7.0 (for natural water) and the permissible value is 8.5

Therefore, the quality rating for pH is calculated with help of the following equation:

Qn = 100 [Vn (pH) – 7.0] / [8.5 – 7.0] **…….. (ii)**

Where, (Vn pH) = observed value of pH

Calculation of Relative weight or Unit weight (Wn)

Unit weight has been calculated by a value inversely proportional to the recommended standards values Sn of the corresponding parameters.

Unit weight (Wn) k/Sn **……...…… (iii)**

Where, Wn = Unit weight of the nth parameter. Sn = Standard value of the nth parameter. K = Constant for proportionality (K = 2.5)

The overall quality index (WQI) has been calculated by aggregating the quality rating with the unit weight linearly.

$$\textbf{Water Quality Index (WQI)} = \sum Wn\ Qn / \sum Wn$$

Where, WQI = Water quality index Wn = Unit weight of the nth parameters. Qn Quality Rating of the nth parameter.

Table : Water Quality Status based on WQI.

S. No.	Water Quality Index	Status of Water Quality
1	0 – 25	Excellent Water Quality
2	26 – 50	Good Water Quality
3	51 – 75	Poor Water Quality
4	76 – 100	Very Poor Water Quality
5	> 100	Unfit for Drinking

Source: WHO, 2004.