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APPLICATION OF WATER QUALITY INDEX FOR EVALUATING WATER TREATMENT PLANTS IN SRI LANKA

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INTRODUCTION

A Person's existence depends upon clean water. Even though the two thirds of the earth's surface are covered by water, all of them are not being able to consume directly by human. There are only 1% of the world's water is usable to us. About 97% is salty sea water, and 2% is frozen in glaciers and polar ice caps. Thus that 1% of the world's water supply is a precious commodity necessary for our survival.

In Sri Lanka, the water treatment plants that are belong to National Water Supply and Drainage Board (NWS&DB), which follows SLS standards to check their treated water quality in the acceptable range. The treated water quality depends on the processes and the maintenance of the water treatment plants. If there are number of water treatment plants in Sri Lanka their processes are different to each other. However, there is no reliable tool to monitor the performance of these water treatment plants. Therefore, it is difficult to identify well-suited processes and maintenance procedures for water treatment.

The index is a numeric expression used to transform large quantities of water characterization data into a single number, which represents the level of water quality (Sanchez *et al.* 2007; Bordalo *et al.* 2006). The water quality index (WQI) can be considered as one criterion for drinking water classification based on the use of standard parameters for water characterization, as well as a monitoring factor. Further, drinking water quality has become a critical issue in many countries, especially due to concern that fresh water will be a scarce resource in the future. In order to close observation of water resources, water quality monitoring is necessary for protection of fresh water resources (Pesce & Wunderlin 2000). Therefore, this study was carried out with collaboration of Research and Development Division of NWS&DB to develop WQI and to apply for water treatment plant in order to evaluate the process of water treatment.

METHODOLOGY

Questionnaire survey was carried out to select the intervening parameters to be included WQI with their respective weights. Thirty professionals with expertise in water treatments were involved to questionnaire survey and monthly water quality records of raw and treated water of twenty five treatment plants were selected based on mainly Nilwala ganga, Kalu ganga, Ging ganga, Kelani Ganga and Kalatuwawa and Labugama reservoirs. Assigned weight of each parameter according to relative importance of water for drinking purposes and the number of parameters were considered to determine the relative weight.

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The WQI equation was generated based on the relative weight and the quality rating scale basically the index equation generates a number initiate from 0, with 0 being the excellent and indicating best water quality. Within this range designations have been set by as excellent, good, poor, very poor and unsuitable for drinking.

Fifteen water quality parameters were analyzed, namely, turbidity, color, electrical conductivity, alkalinity, nitrate, nitrite, coliform, e-coli, chloride, residual chlorine, fluoride, phosphate, total iron, total hardness and sulphate. Raw and treated water quality records were taken monthly from each treatment plant from January 2006 to January 2009 for WQI analysis. The Indian water quality index formula was used to calculate the raw and treated WQI of all water treatment plants.

Development of Water Quality Index

Indian Water Quality Index formula (Ramakrishnaiah *et al.* 2009) was used with modifications appropriate to Sri Lankan situations to calculate the raw and treated WQI of all water treatment plants.

Relative Weight (W_i)

Assigned weight of each parameter according to relative importance of water for drinking purposes and the number of parameters were considered to determine the relative weight.

$$W_i = \frac{wi}{\sum_{i}^{n} wi} \quad \text{...(1)}$$

W_i- Relative Weight

w_i- Weight of each parameter

n- Number of Parameters

Quality Rating Scale (*qi*)

A quality rating scale for each parameter was assigned by dividing its concentration in each water sample by its respective standard according to the standards SLS 614-1 (1983) and the results had to multiply by 100.

$$q_i = C_i/S_i * 100 \quad \text{...(2)}$$

q_i - Quality Rating Scale

c_i - Concentration of each chemical parameter in each water sample in mg/L

s_i - Sri Lankan Drinking water standards for each chemical parameter in mg/L

Sub Index of each parameter (SI_i)

The sub index of each parameter can be developed by the multiplying of relative weight and the quality rating scale.

$$SI_i = W_i . q_i \quad \text{...(3)}$$

SI_i - Sub index of i th parameter

Water Quality Index (WQI)

By considering the summation of each parameter the WQI can be developed.

$$WQI = \sum SI_i \quad \text{...(4)}$$

WQI – Water Quality Index

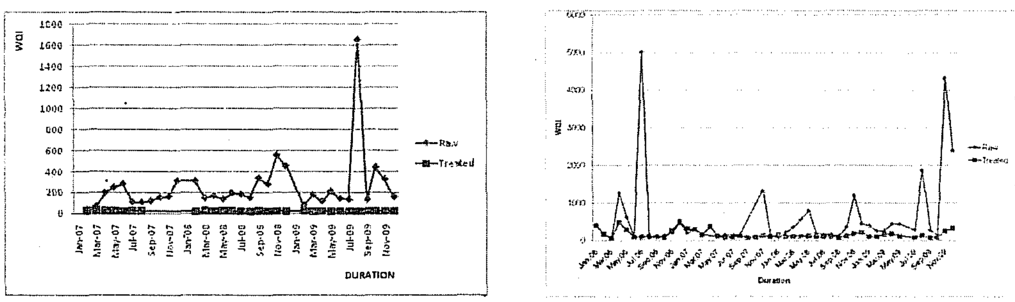
RESULTS AND DISCUSSION

The Study shows the values of most parameters in treated water in number of selected water treatment plants are in desirable limit. But the water quality parameters such as pH, colour and turbidity were the most variable parameters which show drastic changes during the study period. According to the above Indian Formula the computed treated WQI values for selected 25 treatment plants are varied from 23 to 170. This can be included into three categories as"excellent water ", "good water" and "poor water". Table 1 shows number of treatment plants that falls under different quality. Based on these analysis, it has been noted that most of treatment plants are in excellent category. Few of treatment plants exceeded WQI of 50 which belong to "good water" category. One treatment plants indicates its treated water quality is poor and has to improve the performance.

WQI value	Water Quality Classification	No. of WTPs	Percentage (%)
<50	Excellent	19	76
50-100	Good water	05	20
100-200	Poor water	01	4
200-300	Very poor water	-	0
>300	Water unsuitable for drinking	-	0

Table 1. Water Quality Classification based on treated WQI value

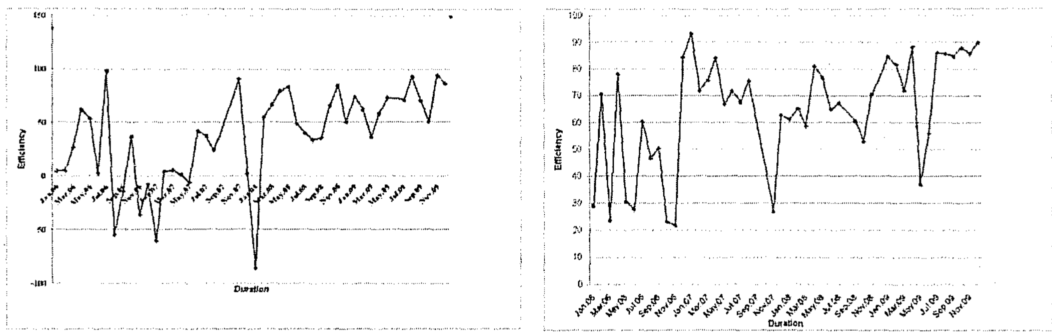
The variation in treated WQI in selected treatment plants during the study period indicated that whether the treated water quality in each treatment plant is of good quality or not. Figure 1 shows the developed raw and treated WQI of some treatment plants.



(a) (b)

Figure1: The variation of treated and raw WQI vs time of some selected treatment plants
(a) Kandana (b) Katharagama

The calculated water treatment efficiency of each treatment plants according to the water quality index also show a better variation of treatment plants. The monthly calculated water quality index values in some treatment plants shows negative values in some months. The variations of efficiency of some treatment plants are shown in Figure 2.



(a) (b)

Figure 2: The variation of efficiency vs time of some selected treatment plants
(a) Katharagama (b) Kurunagala

CONCLUSIONS

The computed treated WQI are varied from 23 to 170. Katharagama treatment plant has showed the highest WQI 170 that is poorest water quality while Kandana has showed the lowest value as 23 that is the excellent water quality. According to the water quality classification 76% of NWS&DB water treatment plants distribute excellent water while 20% distributes good water. The most important parameters to develop the WQI are pH, turbidity, colour, electrical conductivity, nitrate, fluoride, total iron, total hardness, sulphate, alkalinity, phosphate. Turbidity was observed as the most sensitive parameter which shows the better correlation with the treated water quality index of the treatment plants. The developed WQI can apply for other water treatment plants in Sri Lanka and it will contribute towards increased awareness and knowledge of water quality issues by the public, and a more integrated management of water resources.

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