PROPOSAL OF THE ENVIRONMENTAL QUALITY INDEX IN NORTHEAST ASIA PORT

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1. Introduction

Back ground

・As the growing of globalization, vessel traffic across borders has been intensively activated.
・Environmental connection across the countries will also become tighter and we need to share the common standard concerning harbor environmental management.
・In the case of using their own national standards, it was impossible to compare harbor environment management with neighboring countries.

Objective

・Suggesting the harbor environment standards (Air quality index(AQI), Water quality index (WQI), Sediment quality index(SQI)), which have been evaluated and managed at different standards, methods, and grades, as one common standard agreed by the three countries.

2. Computation method for environment indices

Water quality index (WQI)

・WQI tells the how clean or polluted water is, protect marine ecosystem from pollution and degradation, and show the acceptable levels of various items to maintain a healthy and balanced port.

How to calculate WQI

$$WQI = 10DO_{score} + 6COD_{score} + 2(DIN_{score} + DIP_{score})$$

where, each score (DO_{score}, COD_{score}, DIN_{score}, DIP_{score}) is estimated from R_v(reference value) and method (Table 4)

Table 1 Reference values of the water quality parameters for common WQI computation

	Bottom DO saturation ratio (%)	Surface DIN (mg/L)	Surface DIP(mg/L)	COD (mg/L)
R_v (Ref. value)	90	230	25	2.0

Table 2 Scores of the WQ parameters based on the reference concentrations

Scores	WQ parameters	
	DIN(mg/L), DIP(mg/L), COD(mg/L)	DO (saturation ratio)
1	Below reference value (R_v)	Above reference value (R_v)
2	$< R_v + 0.10R_v$	$> R_v - 0.10R_v$
3	$< R_v + 0.25R_v$	$> R_v - 0.25R_v$
4	$< R_v + 0.50R_v$	$> R_v - 0.50R_v$
5	$>= R_v + 0.50R_v$	$<= R_v - 0.50R_v$

For example, observed DIN is less than R_v (=230μg/L), the DIN_{score} become 1. When observed DIN is ranged from R_v to $1.1R_v$, the DIN_{score} become 2. Other scores are estimated in the same manner above. Finally, substituting the estimated scores to equation (3) and then estimating WQI from Table 5.

Air quality index (AQI)

・AQI tells the public how clean or polluted the air is, and what associated health effects might be a concern for the public.

$$IAQIp = (IAQI_{HI} - IAQI_{LO})/(BP_{HI} - BP_{LO}) \times (Cp - BP_{LO}) + IAQI_{LO}$$

$$AQI = (IAQI_1 + IAQI_2 + IAQI_3 + IAQI_4 + IAQI_5)/5$$

Table 3 The variables required in calculating AQI

Break Point of pollutant Concentration	0	50	100	150	200	300	400	500
SO2 (ppm)	0	0.019	0.057	0.181	0.305	0.611	0.802	1.000
NO2 (ppm)	0	0.021	0.043	0.096	0.149	0.300	0.399	0.500
CO (ppm)	0	1.75	3.492	12.221	20.950	31.425	41.900	52.374
PM10 (μg/ m3)	0	50	150	250	350	420	500	600
PM2.5 (μg/ m3)	0	35	75	115	150	250	350	500

where, $IAQIp$ = the air quality index for each target pollutant; Cp = the rounded concentration of each target pollutant; BP_{HI} = the breakpoint that is greater than or equal to Cp ; BP_{LO} = the breakpoint that is less than or equal to Cp ; $IAQI_{HI}$ = the index value corresponding to BP_{HI}; and $IAQI_{LO}$ = the index value corresponding to BP_{LO}.

Sediment quality index (SQI)

・SQI is the quantitative tool to assess and rate contaminated site.
・SQI can applied to compare the sites before and after remediation and to see if the jurisdictional requirements have been met for particular site.

$$SQI = \frac{\sqrt{F1^2 + F2^2 + F3^3}}{1.732}$$

The factor $F1$ (Scope) represents the percentage of contaminants that do not meet their respective guidelines (failed contaminants) relative to the total number of contaminants that were measures (and selected for inclusion in SQI calculation) at the site. The factor $F2$ (Frequency) represents the percentage of individual tests that do not meet their respective guidelines (failed tests). The factor $F3$ (Amplitude) represents the amount by which failed test values do not meet their respective guidelines (excursion from the guideline value)

Table 4 Evaluation of WQI, AQI, and SQI

WQI and SQI	Very Good	Good	Normal	Poor	Very poor
AQI	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy
WQI Value	0～23	24～33	34～46	47～59	60～
AQI Value	0～50	51～100	101～150	151～200	201～300
SQI Value	0～10	10～30	30～50	50～70	70～

3. Discussion

Difference between Korean WQI and present WQI

In this study, the present WQI is based on Korean WQI. In Korea, water quality is evaluating for Korean WQI[1, 2]. Therefore, we think both of the methods should show the similar results. However, these results weren't similar (Figure 1). This is because the R_v is fixed in the present WQI. R_v must be vary depending on the place[3]. In future study, we will study how to determine the R_v in the arbitrary location.

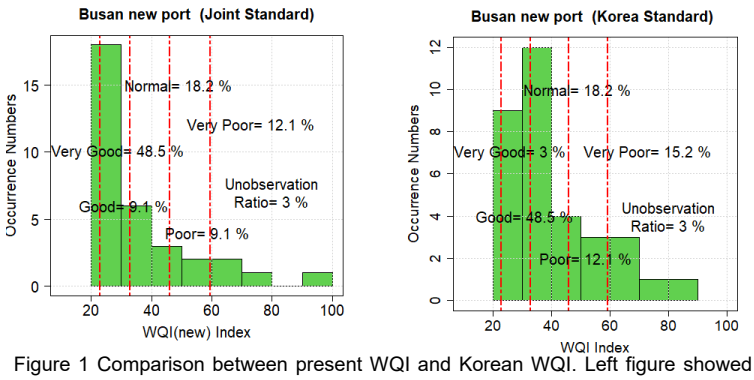

Figure 1 Comparison between present WQI and Korean WQI. Left figure showed the result from present WQI. Right figure showed the one from Korean WQI. The left region from the first left dashed line is very good water quality. Good water quality region is between first and second from the left dashed line. Normal water quality region is between second and third, Poor water quality is between third and fourth, and very poor water quality is right region from the right dashed line.

4. Conclusion

A common index, which is expressing overall environmental conditions in harbor area in China, Korea, and Japan, was introduced.
This is the first step aiming to the common understanding and united management of the Northeast Asian harbor environment and some progresses will be required.
For example, employed monitoring items are not enough and more items are expected to be monitored in the same manner (frequency, analytical method, etc.) among the countries.

References

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