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Preliminary ecological risk assessment of copper on the Japanese coast

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Introduction

- Potential ecological risk of copper (Cu) in marine environment become an issue worldwide.
- Cu is among the target for setting Environmental Quality Standard for aquatic life in Japan.
- Little is known about potential ecological risk of Cu in Japanese marine environment.

Objectives

To conduct preliminary screening-level aquatic ecological risk assessment of copper using the Hazard Quotient method(HQ) on coastal area in Japan.

Method

	Technique Ⅰ	Technique Ⅱ
Exposure	Observed Environmental Concentration	
Hazard PNEC	EU report $\frac{HC5}{Assessment\ Factor}$	The Ministry of Environment in Japan $\frac{Minimum\ of\ 3\ groups}{Assessment\ Factor}$
Risk characterization	The Hazard Quotient $HQ = \frac{OEC}{PNEC}$	

OEC：observed environment concentration
PNEC: Predicted No-Effect Concentration
HC5: 5% hazardous concentration
HQ: Hazard Quotient

Exposure Assessment :

- Measured Cu concentration data for Japanese coastal areas reported in literature were collected, compiled and expressed as the Observed Environmental Concentration (OEC).
- 9 resources containing 29 sites were obtained and used for risk characterization.

List of resources:

- Japan Coast Guard, Marine pollution survey results, 1991~1994
- The Ministry of the Environment, Marine environment monitoring survey results, 2003~2012
- Yamaguchi et al., Copper monitoring in the Tokyo Bay seawater using the stripping voltammetry method, 2012
- Hyoe Takata et al., Distribution of trace metals Co, Cu and Cd in nothern Sagami Bay, Japan and their relationship to estuarine variables, 2012
- Nakashima et al., Metal concentration in Tokyo Bay seawater, 2007

Hazard Assessment :

- Two techniques were used to determine the Predicted Non-Effect Concentration (PNEC) for risk characterization.
- Saltwater chronic ecotoxicity data (22 data, 22 species) reported in the EU risk assessment report were used to estimate the PNEC.

Technique I: SSD-HC5 approach. Species Sensitivity Distribution (SSD) was used to calculate 5th percentile value (HC5). Assessment factor of 2 was applied to determine the $PNEC_l$.

Technique II: Assessment Factor approach. Depending on the availability of ecotoxicity data, assessment factors are used to adjust the NOEC and to estimate the PNEC. In this study, the assessment factor of 10 was applied to 34 test data and to derive the PNEC.

Risk Characterization : A Hazard Quotient (OEC/PNEC) was used to characterize ecological risk of copper for Japanese coastal waters.

Results

Exposure Assessment :

- The reported Cu concentrations ranged from ND to above 5 μg/L for Kure, Hiroshima (Fig. 1).
- Although it is difficult to assess the Cu temporal trends due to the limited data, the compiled exposure data showed that Cu concentrations seem to be comparable or, in some sites, increased after year 2000 beyond (Fig. 2).

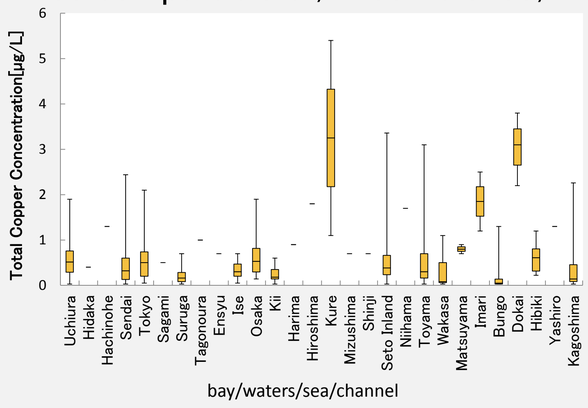
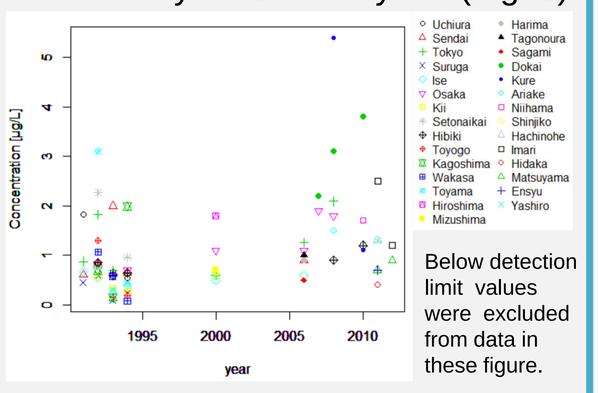


Fig.1. Total cooper concentration on several site in Japan

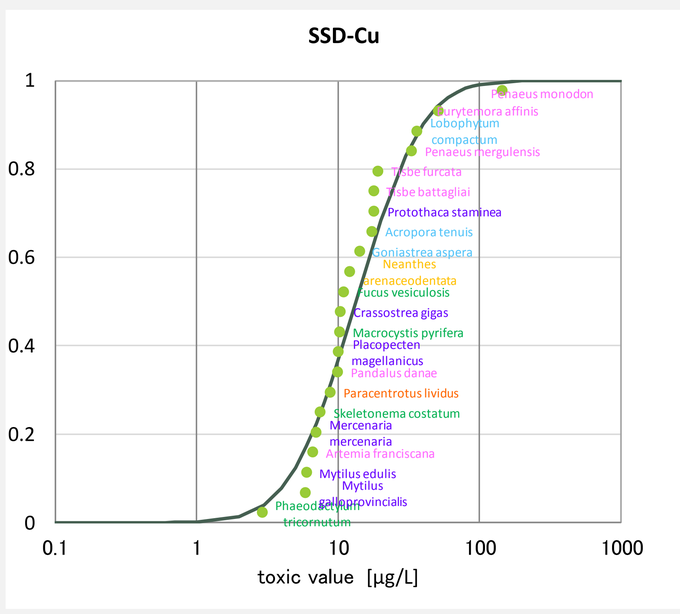


Below detection limit values were excluded from data in these figure.

Fig.2. Secular change for copper concentration

Hazard Assessment :

- The saltwater ecotoxicity data (22 data) from the EU report were fitted to develop the Cu-SSD and the 5th percentile for the Cu-SSD was calculated to be 3.31 μg/L. Applying an assessment factor of 2, PNEC was calculated to be 1.66 (PNEC-1)
- For the MOE method, the toxicity value of 2.9 μg/L for algae, *Phaeodactylum tricornutum,* was used and the PNEC was calculated to be 0.3 μg/L applying an assessment factor of 10 (PNEC-2).



- This SSD was draw up by using Q1 data
- Assessment factor＝2

HC5=3.31 μg/L
PNEC=1.66 μg/L

Under HC5 species is *Phaeodactylum tricornutum (algae)*

Fig.3. Cu-SSD

Risk Characterization :

- The HQs ranged from 0.018 to 1.3 with PNEC-1 and from 0.10 to 7.3 with PNEC-2.
- Higher HQ values were observed in Uchiura, Sendai, Tokyo, Osaka, Kure, Seto inland, Niihama, Wakasa, Toyama, Imari, Dokai, and Kagoshima bay with PNEC-1. Moreover, HQ greater than one were all sites with PNEC-2.

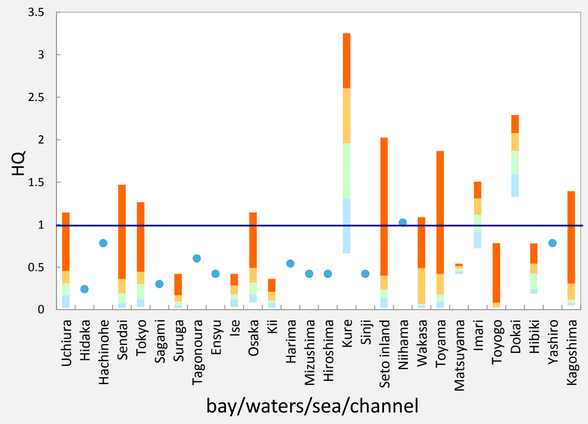


Fig.4. HQ with PNEC-1

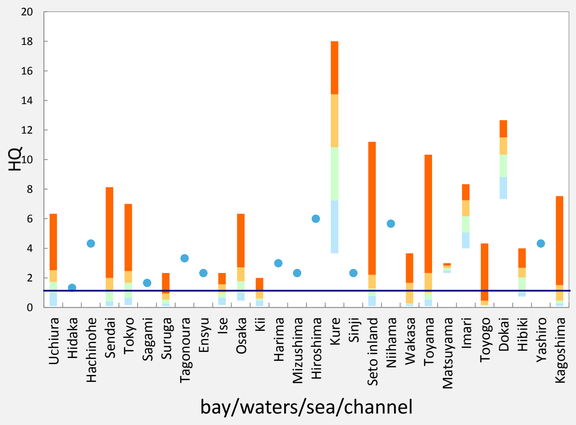


Fig.5. HQ with PNEC-2

Conclusions

- This study demonstrated that the screening-level risk estimates were influenced by the assessment approach applied.
- The screening-level ecological risk assessment of Cu for Japanese coastal waters using the conventional approach suggested that a more refined risk assessment is needed for not all but some sites.
- The bioavailability-based RA of copper will be conducted.