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[1,2], [1,2]

(1. , 050018;2. , 050018)

**摘 要:** , , , 。 , 、 , (RQ)、AQUATOX 、 (SSD)、 (Igeo)、Hakanson , 。 , , 。

**关键词:** ; ; ; ;

**中图分类号:**X826 **文献标志码:**A

# Research progress on ecological risk assessment methods of pollutants in different environmental media at domestic

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**Abstract:** Ecological risk assessment of pollutants has been a focus of attention at home and abroad in recent years. Domestic and foreign scholars have put forward various methods and models for ecological risk assessment. The purpose is to evaluate the ecological risk of pollutants in environmental media by establishing different indicators, hoping to predict their adverse ecological impacts, as well as assess the potential for ecological changes caused by a certain factor in the past. This paper reviews the development of ecological risk assessment, summarizes the ecological risk assessment models and methods about pollutants in

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water, sediment and soil, summarizes the Risk Quotient (RQ), AQUATOX model, Species Sensitivity Distribution (SSD), Index of Geoaccumulation (Igeo), Hakanson potential ecological risk index to determine the level of ecological risk. According to the types and concentrations of pollutants in different environmental media, the appropriate method should be selected for ecological risk assessment. In the future, more research should be conducted on the ecological risk assessment method for the coexistence of multiple pollutants under different environmental media, riching ecological risk assessment method system, and providing a more appropriate assessment method for the ecological risk of various pollutants.

**Keywords**: environmental ecology; environmental media; ecological risk; evaluation method; research progress

[1] 。 , , 、

[2] 。

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, 。 , ; [3]

; [4]

;ZHANG [5] 。

, 、 [6], HOUBRAKEN

[7] RQ 。

, 。

## 1 生态风险评价发展概述

1992 [8], 1998 《 》,

、 , , 、

、 [2] 。

1995 ,

“ ” 。 , ,

[8] 。

1989 , ,

( ),

[8] 。

1996 《 》( 《 》), 2010—2012

, 《 》 , [9] 。

, 。 ,

, [2] 。

, 2003 《 》,

《 》[2] 。 ,

, 、 、 、

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## 2 生态风险评价方法与模型

### 2.1 水环境生态风险评价方法与模型

2.1.1 ( )

(risk quotient, *RQ*) (*MEC*) (*PNEC*)

, 。*PNEC* ($LC_{50}$ $EC_{50}$)

($f$) 。

$$RQ=\frac{MEC}{PNEC}=\frac{MEC}{\frac{E(L)C_{50}}{f}}。\quad(1)$$

，4

[10]，1。1

[11]

Tab.1 Division of ecological risk levels

| RQ |
|---|
| $RQ<1.00$ |
| $1.00\leqslant RQ<10.0$ |
| $10.0\leqslant RQ<100$ |
| $RQ\geqslant 100$ |

、

，

4 。[12] ，

，

，：

，2 ；

、 (2- ) ，

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2.1.2 AQUATOX

AQUATOX ，

，。

，($LC_{50}$ $EC_{50}$) ，

，

。AQUATOX [13-15]。

，[16] AQUATOX (PBDEs)

。，PBDEs 。

[17]，AQUATOX ，、、

。NIU [18] ，AQUATOX 、

。，、。

2.1.3

(species sensitivity distribution，SSD) STEPHAN

KOOIJMAN 20 70 ，，SSD

$PNEC$[19]。SSD ，

，，

。SSD ，

($HC_x$，$x$ 5)，$HC_5$ 5%，95%

[20]。，($HC_x$ ，)

($HC_x$ )。

[21] (SSD) DDT、、、8

95% ($HC_5$)。，8 SSD

$R2$ 0.96，。[22]

SSD ，95% 、

($HC_5$) ，。，

$HC_5$ 19.22 μg/L，($\rho(HC_5)=6\ 583.94$ μg/L) ($\rho(HC_5)=334.33$ μg/L)。

(SSD) ，[23]

5% ($HC_5$)，，

。$HC_5$ ，Burr Ⅲ ，$HC_5$

0.37 μg/L；，，

，，。[24] SSD ，

A(BPA) , BPA SSD 。 ,BPA $HC_5$ 806 μg/L。

### 2.2 沉积物和土壤中重金属的生态风险评价方法与模型

2.2.1

(index of geoaccumulation, Igeo) MÜLLER [25] 1969 , *Igeo* [26]。 :

$$Igeo=\log_2\left(\frac{C_n}{k\times B_n}\right)。 \quad (2)$$

:*Igeo* ;$C_n$ *n* ;$B_n$ *n* ;*k* , 、 。

[27] 122 Ti,Cr,Mn,Co,Ni,Cu,Zn,As,Pb Fe 10 , 。[28] 51 Cu,Pb,Cr,Hg,As,Cd , 。

2.2.2 Hakanson

Hakanson HAKANSON 1980 。 , , , [29]。

$$E_r^i=T_r^i\times C_f^i, \quad (3)$$

$$C_d=\sum C_f^i, \quad (4)$$

(*RI* ) ($E_r^i$) ,

$$RI=\sum E_r^i=\sum T_r^i C_f^i, \quad (5)$$

:$E_r^i$ ,$T_r^i$ ; , ;$C_f^i$ , $C_n^i$ $C^i$ ;$C_d$ 。*RI* 2。

2

Tab.2 Different levels of ecological risk

| $E_r^i$ | *RI* |
|---|---|
| $E_r^i<10$ | $RI<30$ |
| $10\leqslant E_r^i<20$ | $30\leqslant RI<60$ |
| $20\leqslant E_r^i<40$ | $60\leqslant RI<120$ |
| $40\leqslant E_r^i<80$ | $RI\geqslant 120$ |
| $E_r^i\geqslant 80$ | |

Hakanson , 。 [30] Hakanson 、 、 8 , 43.01, ,Co 。[31] , 6 Cr,Cu,

Cd,Pb,Zn,Ni , 。 ,
, Cd , Cu,Pb Zn,
, [32] 。
。 , Hg,As,Cu,Pb,Zn,Cd,Cr,Ni,Co,Mn
, *RI* , Cd
, , Cd Hg ,
。 [33] , ,
。 ,
, 。

2.2.3

[34], ,
SSD 。 , ,
[35], , SSD [36-37],
SSD , 。
[38] SSD 21 ,
, ,
。 (log-logistic distribution)
SSD , [39] 2 Zn , 8 -
Zn 。 , Zn
, Zn , Zn ,
Zn 。

## 3 结 语

, , , 、AQUATOX
, , ,
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, 。 、 ,
, 。
AQUATOX ,
。 、 、
。 , 。
(SSD) ,
。 SSD ,
, 。
(Iego) ,
, 。Hakanson
, 、 , 。
Iego , Hakanson
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## 参考文献/References:


[1] , , , . [J]. ,2007,18(8):1869-1876.
YANG Wenrui, WANG Rusong, HUANG Jinlou, et al. Ecological risk assessment and its research progress[J]. Chinese Journal of Applied Ecology, 2007,18(8): 1869-1876.

[2] , . [J]. ,2009,27(12):33-35.
WANG Debao, HU Ying. An overview of ecological risk assessment procedures[J]. China Resources Comprehensive Utilization, 2009,27(12):33-35.

[3] , , , . [J]. ,2014,34(9):2417-2425.
ZHAO Chen, DONG Shikui, LIU Shiliang, et al. Distribution and environmental risk assessment of heavy metals and nutrients in sediments of upstream and downstream of Manwan Dam[J]. Acta Scientiae Circumstantiae, 2014,34(9):2417-2425.

[4] , , , . [J]. ,2013,33(12):3324-3333.
QIAO Minmin, JI Hongbing, ZHU Xianfang, et al. Fraction distribution and risk assessment of heavy metals in sediments of inflow rivers of Miyun Reservoir[J]. Acta Scientiae Circumstantiae, 2013,33(12):3324-3333.

[5] ZHANG Daolai, LIU Jinqing, JIANG Xuejun, et al. Distribution, sources and ecological risk assessment of PAHs in surface sediments from the Luan River Estuary, China[J]. Marine Pollution Bulletin, 2016, 102(1):223-229.

[6] , , . [J]. ,2013(12):110.

[7] HOUBRAKEN M, HABIMANA V, SENAEVE D, et al. Multi-residue determination and ecological risk assessment of pesticides in the lakes of Rwanda[J]. Science of the Total Environment, 2017, 576:888-894.

[8] . [J]. ,2012,25(1):61-63.

[9] , , , . [J]. ,2015,28(1):17-21.
ZHU Yanjing, ZHANG Yan, GAO Si, et al. Progress of ecological risk assessment methodology and choice of assessment models[J]. Urban Environment & Urban Ecology, 2015,28(1):17-21.

[10] WENTSEL R S, LAPOINT T W, SIMINI M, et al. Tri-service Procedural Guidelines for Ecological Risk Assessment[R]. Aberdeen: US Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, MD, 1996.

[11] , , , . [J]. ,2016,11(2):421-435.
ZHANG Lulu, LIU Jingling, HE Jianzong, et al. The occurrence and ecological risk assessment of phthalate esters (PAEs) in urban aquatic environments of China[J]. Asian Journal of Ecotoxicology, 2016,11(2):421-435.

[12] . PAEs [D]. : ,2015.
XU Kai. Pollution Monitor and Ecological Security Assessment of PAEs in the River Basins of Main Districts and Drinking Water of Guiyang City[D].Guiyang: Guizhou Normal University, 2015.

[13] United States Environmental Protection Agency Office of Water. AQUATOX for Windows: A Modular Fate and Effects Model for Aquatic Ecosystems - Release 1-Volume 1: Users Mannual[M].Washington DC : USEPA, 2004.

[14] United States Environmental Protection Agency Office of Water. AQUATOX for Windows: A Modular Fate and Effects Model for Aquatic Ecosystems-Release 1-Volume 2: Technical Documentation[M].Washington DC : USEPA, 2004.

[15] United States Environmental Protection Agency Office of Water. AQUATOX for Windows: A Modular Fate and Effects Model for Aquatic Ecosystems Release 1 - Volume 3: Model Varification Reports Addendum [M].Washington DC : USEPA, 2004.

[16] , , , . AQUATOX (PB-DEs) [J]. ,2014,9(6):1156-1172.
ZHANG Lulu, LIU Jingling, ZHANG Shaowei, et al. AQUATOX model for ecological threshold and ecosystem risk assessment of polybrominated diphenyl ethers (PB-DEs) in Baiyangdian lake ecosystems[J]. Asian Journal of Ecotoxicology, 2014,9(6):1156-1172.

[17] , , . AQUATOX [J]. ,2016,34(3):44-48.
WEI Xingyao, WANG Chao, WANG Peifang. AQUATOX model for study of eutrophication of tributaries[J]. Water Resources and Power, 2016,34(3):44-48.

[18] NIU Zhiguang, GOU Qianq

GC

CHEN Jin, LIU Yimei, ZHANG Jianying. Aquatic ecological risk assessment of microcystins and nitrogen pollution based on species sensitivity distribution[J]. Chinese Journal of Applied Ecology, 2014,25(4):1171-1180.

[23] , , , . [J]. ,2016,11(2):531-538.

LIU Yali, XIE Yuwei, ZHANG Xiaowei, et al. Assessing ecological risks of dichlorvos to freshwater organisms by species sensitivity distribution[J]. Asian Journal of Ecotoxicology, 2016,11(2):531-538.

[24] , , . BPA [J]. ,2013,34(2):166-172.

YANG Jianjun, GUAN Weisheng, LU Ping. Study on quality criteria of environmental endocrine disruption chemicals BPA in Weihe River in Shaanxi Province[J]. Journal of Hebei University of Science and Technology, 2013,34(2):166-172.

[25] MÜLLER G. Index of geoaccumulation in sediments of the Rhine Rive

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