经验交流

质量衡算模型计算太湖底泥磷的交换量

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摘要　太湖水体中底泥和湖水之间磷的交换主要取决于温度和溶解氧．它对底泥磷释放速率的影响与其氧化还原电位有关，当温度升高时，溶解氧的氧化还原电位降低，底泥磷的释放速率加大，当超过其沉积速率时，呈现出底泥磷的释放过程，反之为沉积过程．

关键词　质量衡算模型，太湖，底泥，磷．

太湖底泥中营养物质相当丰富，湖区底泥总磷含量平均为 0.52g/kg，最大值为 0.67g/kg，远远大于湖水中总磷量的平均值 0.020mg/L 和最大值 0.039mg/L[1]，底泥已成为湖泊水体潜在的内源性污染源．本文根据水文资料，监测数据，利用质量衡算模型计算 1980 年每月太湖底泥磷的交换量，从而解释太湖湖水中磷含量的周期性变化规律．

一、太湖水体总磷的质量衡算

Kelderman 博士在研究荷兰境内 Grevelingen 湖的富营养化问题，曾利用质量衡算模型对该湖水体的总磷进行质量衡算，公式如下[2]，

$$v_b \cdot c_b + L \cdot c_L \cdot \Delta t + I \cdot c_i \cdot \Delta t + N \cdot c_n \cdot \Delta t = v_e \cdot c_e + u \cdot c_u \cdot \Delta t + F \cdot \Delta t$$

式中，v_b，c_b 为时间段初贮水量（m^3）及总磷浓度（mg/L）；L，c_L 为时间段内地表径流和废水量（m^3/d）及其总磷浓度；I，c_i 为时间段内入湖径流水量（m^3/d）及其总磷浓度；N，c_n 为时间段内湖面降水量（m^3/d）及其总磷浓度；v_e，c_e 为时间段末贮水量（m^3）及其总磷浓度；u，c_u 为时间段内出湖径流水量及其总磷浓度，$c_u = \frac{c_b + c_e}{2}$；$F$ 为时间段内底泥磷的交换量（kg）；Δt 为选取的时间段．

假设太湖为全混型湖泊，蒸发水中不含磷，L 省略不计（实际上已并入 I）．那么，以月为时间段，逐月计算 1980 年太湖总磷的收支平衡项，从而求出每月的底泥和湖水总磷的交换量 F，详见表 1．有关太湖的水文资料和总磷的监测数据取自有关文献资料*．湖面降水中总磷浓度 c_n 是由年降水总磷量/年降水量求得为 0.020mg/L，与文献[3]值 0.013—0.087mg/L 大致相符．入湖径流的总磷浓度 c_i 是由（年入湖总磷量－年降水总磷量）/（年入湖总水量－年降水总量）求得为 0.027mg/L．

二、底泥磷的交换量和湖水总磷变化关系

如果把太湖水总磷浓度逐月变化曲线和底泥磷交换量逐月变化曲线放在一起对照（见图1），可以找

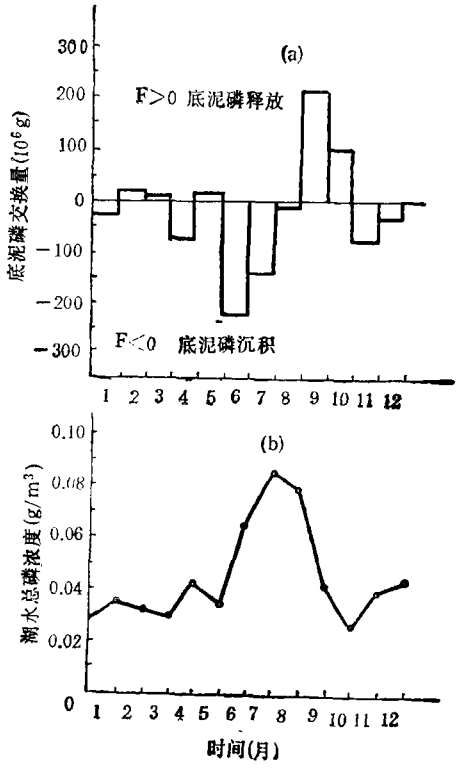

图 1　(a)太湖底泥磷释放量逐月变化曲线（1980 年）．
(b)太湖水总磷浓度逐月变化曲线（1980 年）．

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* 江苏省太湖渔业管理委员会，太湖渔业史，25—27（1986）．

表 1 1980 年太湖底泥和湖水总磷交换量的计算

月份	v_b (10^8m^3)	c_b (g/m^3)	f (10^8m^3/月)	c_i (g/m^3)	N (10^8m^3/月)	c_n (g/m^3)	U (10^8m^3/月)	c_u (g/m^3)	v_e (10^8m^3)	c_e (g/m^3)	F (10^6g)
1	48.7	0.030	3.71	0.027	1.89	0.020	51.3	0.035	2.99	0.033	−29.4
2	51.3	0.035	2.72	0.027	0.66	0.020	49.6	0.031	3.01	0.033	+24.5
3	49.6	0.031	3.13	0.027	2.67	0.020	50.4	0.030	2.73	0.031	+7.67
4	50.4	0.030	6.99	0.027	4.30	0.020	57.2	0.042	2.86	0.036	−71.7
5	57.2	0.042	16.7	0.027	5.05	0.020	67.1	0.035	10.3	0.039	+20.5
6	67.1	0.035	5.84	0.027	2.63	0.020	65.2	0.065	11.1	0.050	−224
7	65.2	0.065	3.39	0.027	3.95	0.020	60.4	0.086	8.35	0.076	−140
8	60.4	0.086	6.69	0.027	3.07	0.020	65.0	0.080	4.65	0.083	−15.1
9	65.0	0.080	20.0	0.027	6.24	0.020	75.6	0.042	9.26	0.061	+214
10	75.6	0.042	1.58	0.027	1.18	0.020	64.3	0.026	15.4	0.034	+105
11	64.3	0.026	3.06	0.027	0.87	0.020	56.5	0.039	10.0	0.033	−76.1
12	56.5	0.039	0.95	0.027	1.41	0.020	53.8	0.043	6.13	0.041	−30.9

到两者之间的相关性. 当底泥磷释放量($F<0$)增大时,湖水中总磷浓度也相应增高,反之亦然. 这种现象在夏、秋二季较为明显. 这是因为夏季阳光充足,气温很高,湖水表层水藻的光合作用非常旺盛,大量繁殖的结果阻挡了阳光透射,抑制了深层湖水处的光合作用,减弱了溶解氧的补充,使溶解氧降低,从而促进了底泥磷的释放,如果湖底出现厌氧状态,磷的释放量会大大提高. 另一方面,底泥磷的释放又为藻类的生长提供了充足的营养,秋季大量死亡的藻类尸骸沉积到底泥中成为底泥磷的积累. 冬季,这些生物尸骸腐烂分解,消耗了大量溶解氧,又引起底泥磷的释放,为来年春夏藻类的生长提供营养物质磷.

三、讨 论

1. 底泥和湖水之间磷交换量季节变化的主要影响因素是溶解氧,它对底泥磷释放速率的影响与其氧化还原电位有关[4]. 底泥有氧层是很薄的一层,约几毫米. 它的存在取决于水体的溶解氧,当它降到零时,底泥有氧层随之消失,就破坏了底泥对磷的吸附,使磷酸铁大量还原为磷酸亚铁,导致磷的大量释放.

2. 温度对底泥磷释放的影响,主要表现在对溶解氧浓度及其氧化还原电位的影响. 根据能斯脱方程,当温度升高时,溶解氧的氧化还原电位降低,从而削弱了它的氧化能力,使底泥磷的释放速率加大,当它超过底泥磷的沉积速率时,呈现出底泥磷的释放过程;反之,表现为底泥磷的沉积过程.

3. 通过质量衡算模型计算得到 1980 年全年底泥磷的释放量为 205 吨,略低于外源性磷全年入湖量 240 吨,占全年进入太湖水体总磷量的 46.2%. 底泥作为内源性磷对于湖泊富营养化已起到举足轻重作用. 所以,内源性磷的去除在湖泊富营养化防治过程中应受到足够的重视.

参 考 文 献

[1] 太湖环境质量研究协作组,上海师范学院学报(自然科学版,环境保护专辑),149(1983).

[2] Kelderman, P., Neth., *J. Sea. Res.*, **14**,229 (1980).

[3] 日本机械工业联合会等,水域的富营养化及其防治对策,第 118 页,中国环境科学出版社,北京,1987 年.

[4] 彭迈新等,水质富营养化与防治,第 114 页,中国环境科学出版社,北京,1988 年.

Abstracts

Key words: SO_2 pollution, air pollution, sulphur content in plants, assessment of air pollution, plant indicator.

Study on Optimal Station Setting forM onitoring of Atmospheric Environment in Anyang Urban Area. Fu Jinsheng, Liu Ansheng, Chen Yafen. (Anyang Environment Protection Monitoring Station, Anyang): Chin. J. Environ. Sci., 13 (1), 1992, PP.

A model of optimal station setting for the monitoring of atmospheric pollution was developed based on the trait of local environment, the weblike check monitoring and the analysis of historical environmental data. The number of optimal stations was decided by variable factor method of sampling theory. The locations of the optimal stations were decided by correlation analysis method. The outputs of the model can depict the environmental trait of middle cities in plain areas.

Key words: atmospheric pollution monitoring, optimization of monitoring, model of optimal setting stations, number of optimal stations,situations of optimal stations.

Rapid Determination of COD_{Mn} in Environmental Water Samples Using Microwave-Heating Digestion Method. Gao Xiangyang (Henan Agricultural University, Zhengzhou), Guan Di (Southwest Jiaotong University, Chengdu): Chin. J. Environ. Sci. 13(1), 1992, PP.

A new microwave-heating digestion method was developed for the rapid determination of COD of water samples taken from Xiliu lake, Yellow river as well as a standard water sample (CW82: Environmental Monitoring Station of China). Water samples were dispelled in a closed-vessel with potassium permanganate under the action of microwave and as many as 14 samples could be treated each time. High Cl^- content (up to 1000 mg/L) did not interfere with the determination. The detection range of COD was found between 0.26 mg/L and 15.0mg/L, relative standard deviation less than 4.0%(n=5 or 6), recovery ranging from 97.0% to 105.6%, and relative error 0.3% for the determination of CW82 standard water sample. Compared to the classical method, this method proved to be simple, rapid, accurate and suitable for the determination of COD_{Mn} of lightly polluted water.

Key words: microwave-heating digestion, COD_{Mn} determination.

Sediment-Water Exchange Capacity of Total Phosphorus in Taihu Lake Calculated by Mass Budget Model. Huang Shaoji (Department of Environmental Protection, Suzhou Institute of Urban Construction & Environmental Protection, Suzhou), Zhao Haizhou, Fang Manping (Jiaozuo Municipal Pollution Management Station, Henan Province): Chin. J. Environ. Sci. 13(1), 1992, PP.

Sediment is a source or sink of micropollutants. Mass budget model is used to calculate the total phosphorus mobilization monthly in 1980 from the sediment in Taihu Lake. The mobilization is found to obviously affect the total concentration change in water body.

Kew words: mass budget model, taihu lake, sediment, phosphorus.

Introduction to Risk Assessment and Risk Management. Zhao Zhenhua (Beijing Municipal Research Institute of Environmental Protection): Chin. J. Environ. Sci., 13(1), 1992. PP.

In this paper, a brief introduction is given to the concept, main content, procedure and interface of risk assessment and risk management. Risk assessment is gaining increasing importance to the regulatory decision—making bodies in the process of formulatign policies intending to minimize health risks resulting from exposure to hazardous substances. Recent trends of risk assessment of environmental hazards are also reviewed.

Key words: risk assessment, risk management, hazardous chemical.

Statistics of Directional Data in Environmental Meteorology. Zhuang Shijian (Xiamen Municipal Research Institute of Environmental Protection): Chin. J. Environ. Sci., 13(1), 1992, PP.

There are many problems in environmental meteorology in which only angles are concerned. Directional data have specific features resulting in the apparent differences between statistics of directional data and general mathematical statistics. In this paper, statistics of directional data is applied to the ennvironmental science. By means of direct-viewing wind rose, wind direction data is naturally expressed. The concept and calculation of average wind direction is introduced, and the reasonable calculation of wind direction standard deviation is also illuminated. As an example, the wind directions in xiamen was studied.

Key words: wind direction data, statistics of directional data.