

ANEXO IV

Material suplementario metodológico

1. Método de la edad del agua

Para calcular la distribución de la edad del agua, se utilizó un trazador pasivo, así las ecuaciones de transporte para calcular el trazador y la concentración de la edad se escriben de acuerdo a (Delhez et al. 1999):

$$\frac{\partial c(t, \vec{x})}{\partial t} + \nabla(u c(t, \vec{x}) - K \nabla c(t, \vec{x})) = 0 \quad (1)$$

$$\frac{\partial \alpha(t, \vec{x})}{\partial t} + \nabla(u \alpha(t, \vec{x}) - K \nabla \alpha(t, \vec{x})) = c(t, \vec{x}) \quad (2)$$

Donde, c es la concentración del trazador, α es la concentración de la edad, u es el campo de velocidad, K es el tensor de difusividad, t es el tiempo y x la distancia. La edad media “ a ” entonces puede calculada como:

$$a(t, \vec{x}) = \frac{\alpha(t, \vec{x})}{c(t, \vec{x})} \quad (3)$$

Sin embargo, si no hay mezcla con agua no originaria de la fuente, el único constituyente es el agua de la propia fuente y entonces la concentración de edad es casi igual a la edad media ($\alpha \sim a$). Luego, puede ser directamente evaluada como:

$$\frac{\partial a(t, \vec{x})}{\partial t} + \nabla(u a(t, \vec{x}) - K \nabla a(t, \vec{x})) = 1 \quad (4)$$

2. Modelo biogeoquímico columna de agua

2.1 Variables de estado

ID	Name	Description	Transport	Spatial variation	Unit
1	BOD	BOD	AD	3D	mg/l
2	DO	Dissolved oxygen	AD	3D	mg/l
3	CHL	Chlorophyll-a	AD	3D	mg/l
4	NH4	Ammonia	AD	3D	mg/l
5	NO2	Nitrite	AD	3D	mg/l
6	NO3	Nitrate	AD	3D	mg/l
7	PO4	Phosphate	AD	3D	mg/l

2.2 Condiciones iniciales

State variable	Value/Item	Unit
BOD	Value: 1	mg/l
Dissolved oxygen	Value: 10	mg/l
Chlorophyll-a	Value: 0.003	mg/l
Ammonia	Value: 0.02	mg/l
Nitrite	Value: 0.005	mg/l
Nitrate	Value: 0.3	mg/l
Phosphate	Value: 0.01	mg/l

2.3 Constantes utilizadas en el modelo biogeoquímico

No.	Description	Type	Value
1	Latitude	Built-in	
2	BOD Processes: 1st order decay rate at 20 deg. celcius (dissolved)	Constant	0.5 /d
3	BOD processes: Temperature coefficient for decay rate (dissolved)	Constant	1.07 dimensionless
4	BOD Processes: Half-saturation oxygen concentration	Constant	2 mg/l
5	Oxygen processes: Secchi disk depths	Constant	0.4 m
6	Oxygen processes: Maximum oxygen production at noon, m2	Constant	2 /d
7	Oxygen processes: Time correction for at noon	Constant	-3 hour
8	Oxygen processes: Respiration rate of plants, m2	Constant	0.5 /d
9	Oxygen processes: Temperature coefficient, respiration	Constant	1.08 dimensionless
10	Oxygen processes: Half-saturation conc. for respiration	Constant	2 mg/l
11	Oxygen processes: Sediment Oxygen Demand per m2	Constant	0.5 /d
12	Oxygen processes: Temperature coefficient for SOD	Constant	1.07 dimensionless
13	Oxygen processes: Half-saturation conc. for SOD	Constant	2 mg/l
14	Nitrification: 1st order decay rate at 20 deg. C	Constant	0.05 /d
15	Nitrification: 1st order decay rate at 20 deg. C	Constant	1 /d
16	Nitrification: Temperature coefficient for decay rate, ammonia to nitrite	Constant	1.088 dimensionless
17	Nitrification: Temperature coefficient for decay rate, nitrite to nitrate	Constant	1.088 dimensionless
18	Nitrification: Oxygen demand by nitrification, NH4 to NO2	Constant	3.42 g O2/g NH4-N
19	Nitrification: Oxygen demand by nitrification, NO2 to NO3	Constant	1.14 g O2/g NO2-N
20	Nitrification: Half-saturation oxygen concentration	Constant	2 mg/l
21	Ammonia processes: Ratio of ammonium released by BOD decay (dissolved)	Constant	0.3 g NH4-N/g BOD
22	Ammonia processes: Amount of NH3-N taken up by plants	Constant	0.066 g N/g DO
23	Ammonia processes: Amount of NH3-N taken up by bacteria	Constant	0.109 g N/g DO
24	Ammonia processes: Halfsaturation conc. for N-uptake	Constant	0.05 mg/l
25	Nitrate processes: 1 st order denitrification rate at 20 deg. C	Constant	0.1 /d
26	Nitrate processes: temperature coefficient for denitrification rate	Constant	1.16 dimensionless
27	Phosphorus processes: Phosphorus content in dissolved BOD	Constant	0.06 g P/g BOD
28	Phosphorous processes: Amount of PO4-P taken up by plants	Constant	0.0091 g P/g DO
29	Phosphorous processes: Amount of PO4-P taken up by bacteria	Constant	0.015 g P/g DO
30	Phosphorus processes: Halfsaturation conc. for P-uptake	Constant	0.005 mg/l
31	Chlorophyll processes: Halfsaturation conc. for nitrogen, limitation for photosy	Constant	0.05
32	Chlorophyll processes: Halfsaturation conc. for phosphorus, limitation for pho	Constant	0.01
33	Chlorophyll processes: Chlorophyll-a to carbon ratio	Constant	0.025 mg CHL/mg C
34	Chlorophyll processes: Carbon to oxygen ration at primary production	Constant	0.2857 mg C/ mg O
35	Chlorophyll processes: Death rate of chlorophyll-a	Constant	0.005 /d
36	Chlorophyll processes: Settling rate of chlorophyll-a	Constant	0.15 m/day