Supplementary material. Mmag model description

Phase I. Water–soil interaction

The phosphorus concentration is determined by the Danish Model [59]. The model has only two state variables: total phosphorus in the lagoon water (P_w) and exchangeable total phosphorus in the sediment (P_s). The driving variables are the monthly inlet concentration of total phosphorus (P_i), the monthly water discharge Q, and the lagoon water temperature (T).

$$\frac{dP_w}{dt} = \frac{Q}{V} \cdot (k \cdot P_i - P_w) - P_{SED} + P_{REL}$$

where P_w = Lagoon water total phosphorus concentration (mgP/L); P_i = Inlet total phosphorus concentration (mgP/L); P_{SED} = Gross sedimentation of total phosphorus from the lagoon water to the sediment (gP/m^2/day); P_{REL} = Release of total phosphorus from the lagoon water to the sediment (gP/m^2/day); Q = Water discharge (m^3/day); V = Lagoon volume (m^3); k = fraction of phosphorus to water; and *1-k* = fraction of total phosphorus to the sediment, which is defined as,

$$k = \frac{1}{1 + \sqrt{\frac{V}{365 \cdot Q}}}$$

Gross sedimentation is obtained as,

$$P_{SED} = bS \cdot (1 + tS)^{T-Tl} \cdot \frac{P_w}{Z}$$

where bS =Sedimentation rate of total phosphorus (dimensionless). The original value of the Danish Model = 0.047; tS = Temperature correction for bS

(dimensionless). The original value = 0; *Tl* = threshold temperature (ºC). The original value 20ºC; *T* = lagoon water temperature (ºC); and *Z* =mean water depth (m).

The phosphorus release is obtained as,

$$P_{REL} = bF \cdot (1 + tF)^{T-Tl} \cdot P_s$$

Where *bS* =Release rate of total phosphorus (dimensionless). Original value = 0.000595; *tS* = Temperature correction for *bF* (dimensionless). Original value = 0.08

The nitrogen concentration in water is determined considering the nitrogen sedimentation as follows,

$$\frac{dN_w}{dt} = \frac{Q}{V} \cdot (N_i - N_w) - N_{SED}$$

Where N_{SED} = Gross sedimentation of total nitrogen from the lagoon water to the sediment (gN/m^2/day)

$$N_{SED} = k \cdot N_w \quad \text{and} \quad k = k' \cdot e^{-\gamma \cdot Z}$$

Where k' = Sedimentation rate (year^{-1}). Original value = 2.6 year^{-1}; γ = coefficient related to the water depth (m^{-1}). Original value = 0.2 (m^{-1})

Phase II. Water–soil interaction

The deep water plants' density, *DP* (kg/m^2) is obtained as follows,

$$\frac{dDP}{dt} = (RGR - M) \cdot DP$$

where *RGR* is the Relative Growth Rate (mg/g/day) that depends on the water temperature as a linear function defined by the values for 20ºC (RGR20ºC) and 30ºC (RGR30º); *M* is the mortality rate of deep water plants (day^{-1}) that also depends on the filamentous algae density and chlorophyll concentration in the upper layer, increasing the mortality rate when the density or chlorophyll concentration are higher.

Return P and Return N are respectively the percentage of phosphorus and nitrogen available again in soil for the deep water plant growth from the dead deep water plants. The rest of nitrogen and phosphorus are eliminated via the trophic chain or are deposited in soil in a non-available reservoir.

Phase III. Upper layer algal growth

Includes two processes also based in the RGR: the first one for the filamentous algae growth and after, and the second one if for the algae growth determining the chlorophyll level in water. Both processes use the same formulation for deep water plants, changing only the parameter values.