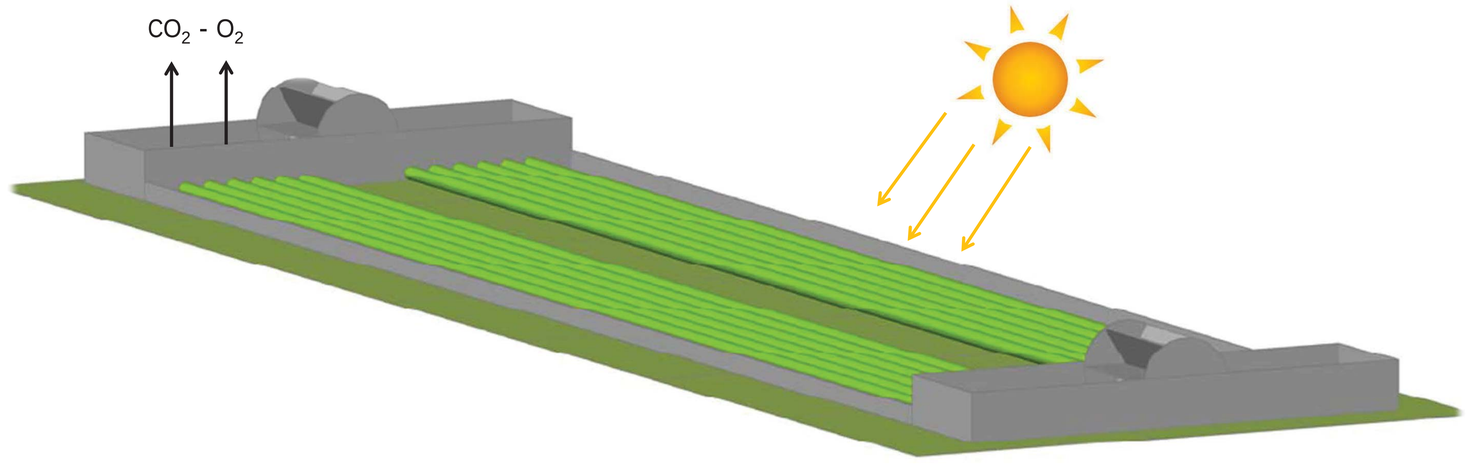
UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Group of Environmental Engineering and Microbiology

CALIBRATION OF A BIO-KINETIC MODEL TO SIMULATE MICROALGAE GROWTH

Alessandro Solimeno, Joan García
Environmental Engineering and Microbiology, Universitat Politècnica de Catalunya, Barcelona, Spain

OBJECTIVE

To develop a mathematical model able to describe algae growth due to irradiance and photosynthetic processes. This model is the starting point for a more complex system with algae and bacteria treating wastewaters.



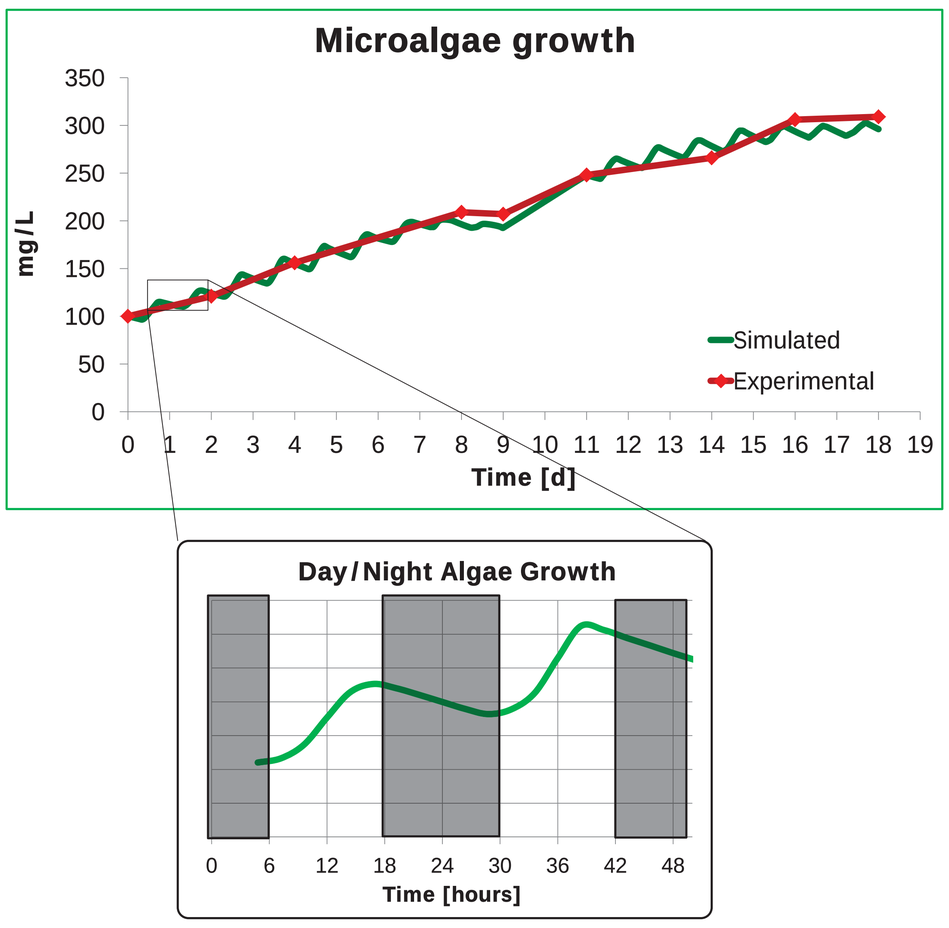
MODEL DESCRIPTION

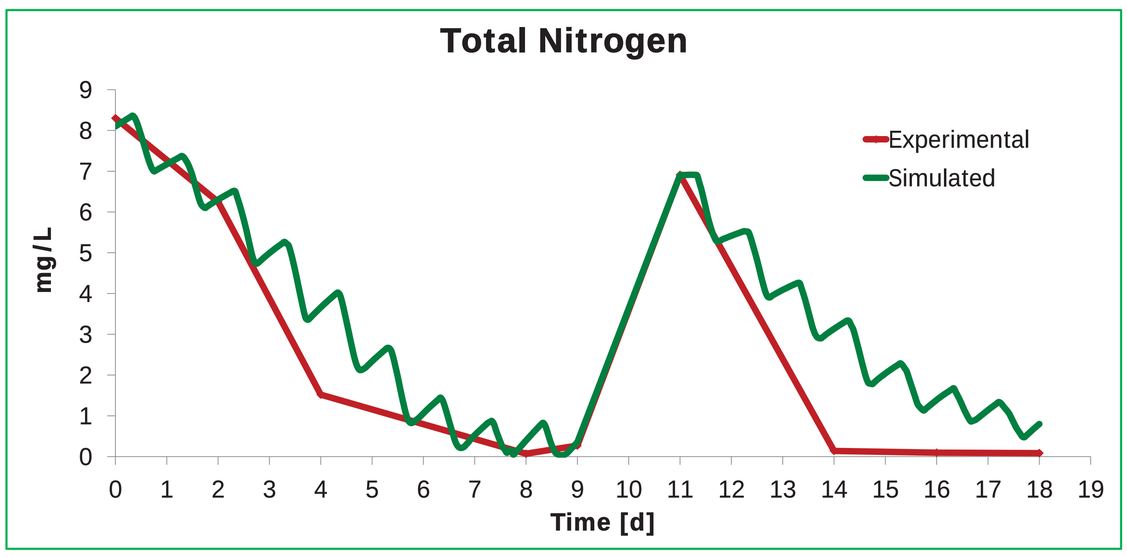
Due to the complexity of the algae and bacteria systems the model is initially developed zero-dimensional, which considers only the biokinetic reactions of algae. Algae processes correspond to growth, endogenous respiration and inactivation of microalgae (X_{ALG}).
The equations related to algae growth were adapted from the IWA RWQM1 through the incorporation of inorganic carbon as limiting factor, the inhibitory effect of an excess of carbon dioxide and thermal efficiency.

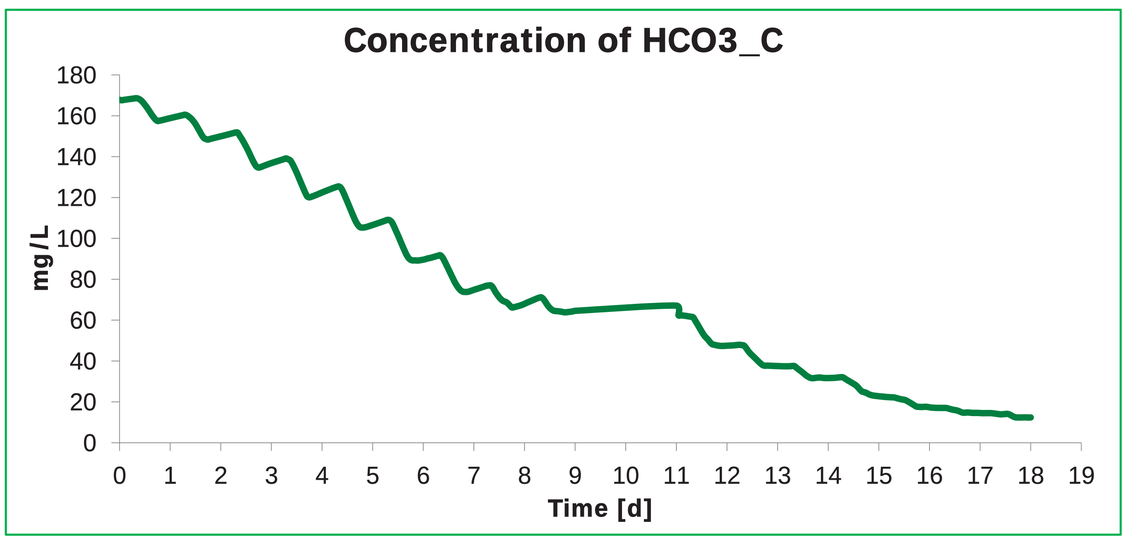
Growth of algae on NH_4 and NH_3	$\rho_{1a} = \mu_{ALG} * f_{T,FS}(T) * \eta_{PS}(I, S_{O2}) * \frac{S_{CO2} + S_{HCO3}}{K_{C,ALG} + S_{CO2} + S_{HCO3} + \frac{S_{CO2}^2}{I_{CO2,ALG}}} * \frac{S_{NH3} + S_{NH4}}{K_{N,ALG} + S_{NH3} + S_{NH4}} * X_{ALG}$
Endogenous respiration	$\rho_2 = k_{resp,ALG} * f_{T,FS}(T) * \frac{S_{O2}}{K_{O2,ALG} + S_{O2}} * X_{ALG}$
Death of algae	$\rho_3 = k_{death,ALG} * f_{T,FS}(T) * X_{ALG}$
Photosynthetic thermal factor	$f_{T,FS}(T) = e^{-\beta(T-Topt)}$
Photosynthetic performance	$\eta_{PS}(I, S_{O2}) = f_L(I) * f_{PR}(S_{O2})$

EXPERIMENTAL SETUP

We used the COMSOL Multiphysics® to model the biokinetic process of microalgae growth. The model was calibrated thought a case study based on the cultivation of few microalgae species in a synthetic water.







CONCLUSION

The model is able to describe:
- Algae growth as a function of irradiance, nutrients and inhibitory effects
- Complex system of photosynthetic growth with simultaneous photoinhibition and photolimitation
- Death of algae in the absence of nutrients NH_3-NH_4 and HCO_3

ACKNOWLEDGEMENTS

COMSOL CONFERENCE 2014 CAMBRIDGE
GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Excerpt from the Proceedings of the 2014 COMSOL Conference in Cambridge