NUMERICAL AND FIELD STUDY OF OXYGEN EXCHANGE AT THE SEDIMENT/WATER INTERFACE OF SHALLOW FLOW IN SALT LAKE OF NORTHERN CHILE

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Field experiments and numerical models have been applied to study the uptake/production of DO at the sediment/water interface of a surface aquatic system located within Salar Punta Negra, a salt lake located in northern Chile (latitude: 24.5°S, altitude: 2950 m above sea level). This salt lake presents a series of interesting aquatic systems with unique ecosystems. They consist of a marshland recharged by saline groundwater, a rather shallow channel flow, a couple of kilometers long, and an evaporation/infiltration lagoon extending one or two hundred meters into the dry bed of the salt lake. The Andean Flamingo uses these systems to build their nests (on the lagoons) and to feed (usually on microphytobenthos growing on the channel bed). The balance of this system is delicate and depends heavily on the amount of water available as wells as on its salinity. Questions arise about how these systems behave under reduced water input. A study is being conducted on many aspects of this problem. In this paper, results of a field campaign to measure oxygen uptake/production at the sediment/water interface in one of these systems, called VCL2, are reported, together with results of numerical simulations of transport and biogeochemical processes affecting DO in the water column and sediments.

Dissolved oxygen uptake at a sediment/water interface (SOD) is controlled by mass transport and/or biochemical reactions in two adjacent boundary layers: the diffusive boundary layer in the water and the penetration depth in the sediment. An existing model for the unsteady response of SOD and DO profiles near the sediment/water interface was adapted in this study. The adapted model uses Michaelis-Menten kinetics to represent the decay of organic matter, an improved representation of turbulent diffusion within the wall boundary layer using a suitable eddy viscosity model, and incorporates a zero order model to take in account DO production and consumption associated with microphytobenthic photosynthesis and respiration.

Field data obtained with benthic chambers show that photosynthetic production of DO by microphytobenthos is the dominant process in the oxygen exchange at the sediment/water interface of the channel reach of VCL2 (Fig. 1). A layer-averaged model was used to calibrate parameters representing biogeochemical processes within the sediments using the field data. The same was done with the 1D vertical model, and a coherent set of calibrated parameters was obtained from both models. 1D vertical simulations are able to adequately reproduce the observed behavior of DO in the studied system and provide a reasonable account of transport and biogeochemical processes in the sediments and water column (Fig. 2). A more mechanistic model that considers the dynamics of microphytobenthic biomass is currently being developed.

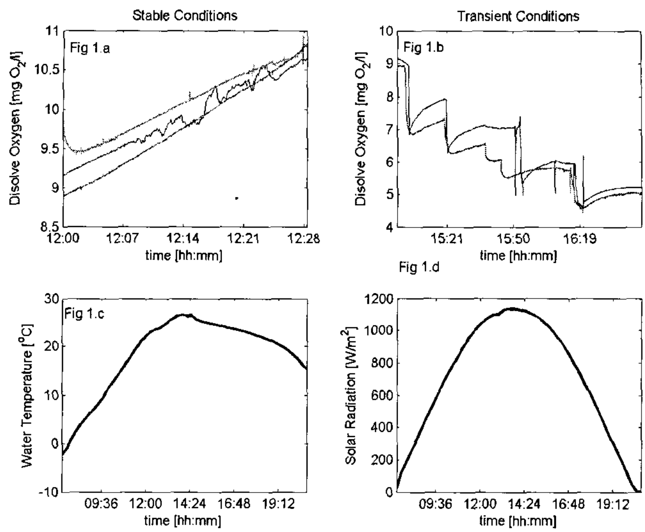

Fig. 1 Field data collected: a) Experiments under steady conditions; b) Experiments under transient conditions; c) Water temperature; d) Solar radiation.

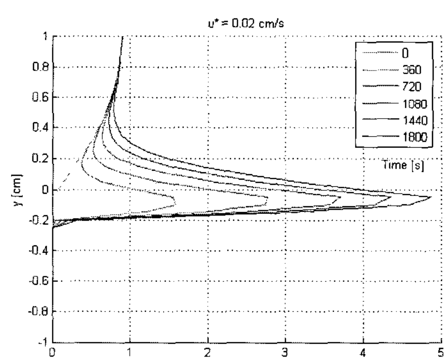

Fig. 2 Time evolution of DO profiles due to photosynthetic activity and oxidation of organic matter (varying from initial steady state without phytoplankton photosynthesis and respiration). (μ = 0.106 mg/l/s; *Pr–Re* = 0.0226 mg/l/s; *U* = 0.31 cm/s).