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Evaluation of Temporal Stability of Dissolved Oxygen Conditions in a Small-Scale Phytodepuration System

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Index

Introduction

In recent years, the use of regenerated water has increased, and the phytodepuration becomes popular.

The operation principle of phytodepuration is: bacteria in the water under anaerobic and aerobiotic conditions transforms organic matter into nutrients.

Plants introduces small amounts of dissolved oxygen (DO) through their roots in the water + consume the excess of nutrients in the water.

Thus, the water quality is improved as the plant grows by absorbing these nutrients.

Introduction

Although several authors pointed out the relevance of DO in converting organic matter into nutrients, no one paper shows the evaluation of its variability (temporal nor spatial) and its range in those systems.

- the monitorisation of phytodepuration is still in an early development stage.

In this paper we will:

-evaluate its spatiotemporal variability for 6 points and 4 depth.

-compare the stability of conditions in each pond for two months to define if they are reaching nearly anoxic conditions.

-present the harvested biomass, which is growing over the water and injecting oxygen at the end of the study.

Related Work

Borges et al. studied the variability of several parameters on constructed wetland system. They do not found any extra relevant oxygenation by the macrophytes (the water was fully oxygenated from the beginning). Their data indicates a reduction of total suspended solids of 54.5%.

Caselles-Osorio et al. [7] evaluated the modification of studied parameters on a horizontal subsurface-flow constructed wetland using *Cyperus articulatus* L. The DO in the tanks with the plants reaches 2.1 (±1.2) mg/L. On the other hand, the tanks with the perforated pipes only went to 1.7(±1.2) mg/L. After finishing the experiment, the harvested biomass was 5 kg/m^2.

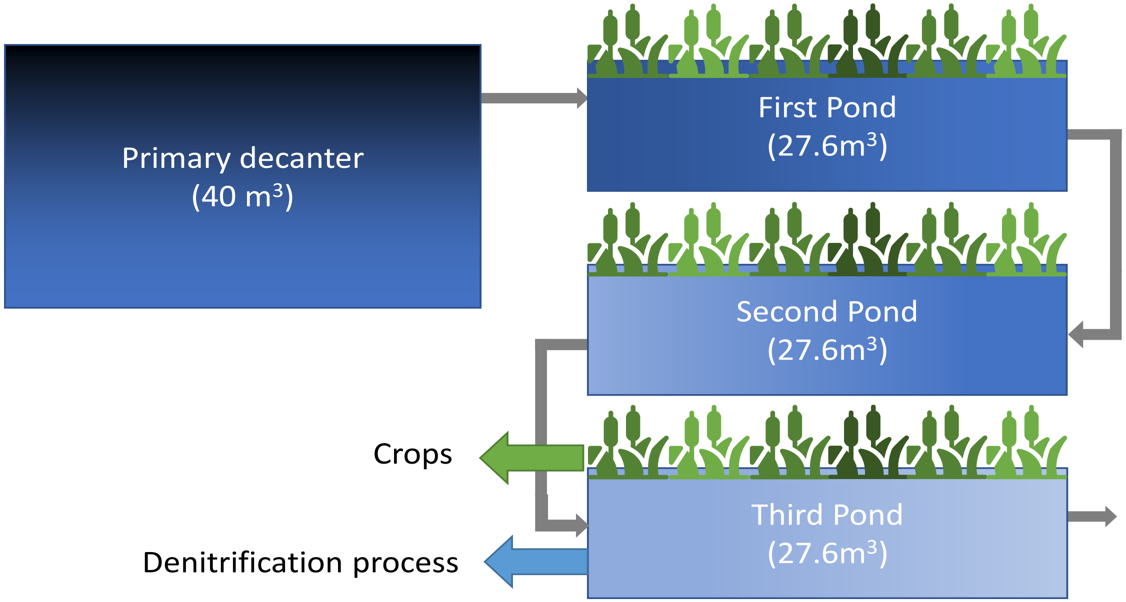
García-Perez et al. evaluated the temporal variability of DO in a recirculating vertical flow constructed wetland. Their results indicate that the wetland was in aerobic conditions with average values of 5.3 mg/L. Nonetheless, the authors do not specify precisely where are the water samples were taken.

Palta-Prado and Morales-Velasco used different Poaceae for domestic wastewater phytodepuration [9]. The authors pumped the wastewater from a reduced region into 4 treatments. The wastewater had an average DO of 5.67 mg/L. Average DO values for each treatment were 5.5 to 5.16 mg/L.

As far as we know, no one paper has analysed the distribution of DO in the phytodepuration system and their trend along with the system or depth.

Materials and Methods

Description of the phytodepuration system



Materials and Methods

Description of the phytodepuration system

18/05/2020

09/07/2020

02/09/2020.

Materials and Methods

Measurement of DO in the ponds

Measurements of DO had been taken at two points per pond, one at the entrance and one at the exit of each pond.

A total of 6 measurement points.

In each point, DO was measured at four depth (6, 25, 50 and 75 cm).

DO was measured with a probe HI98198 optical meter (HANNA).

Results

General overview of DO and its temporal distribution

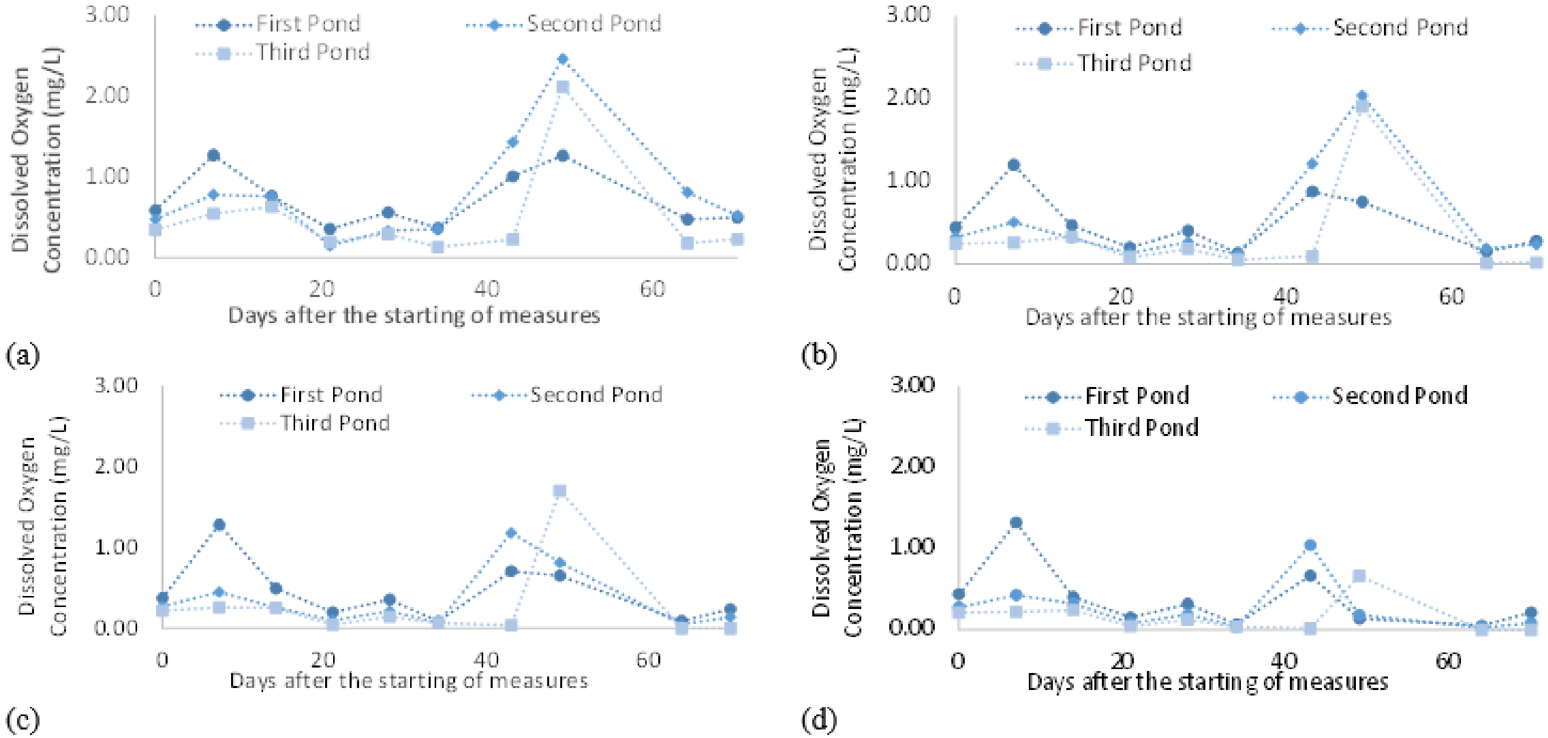


Figure 3. Overview of DO concentration at different depths (a) 6 cm, (b) 25 cm, (c) 50 cm, and (d) 75 cm.

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Results

Spatial distribution of DO in the ponds and their depth

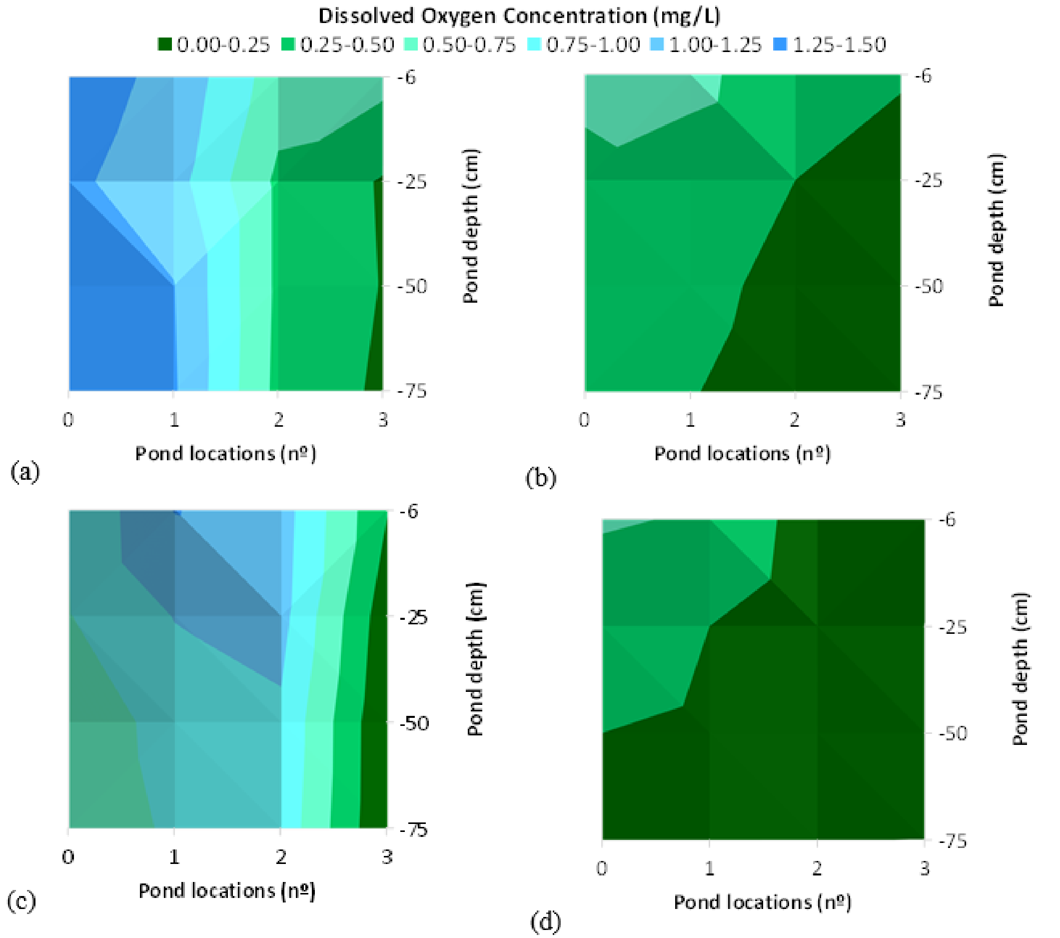

Figure 4. Spatial distribution of DO in different days, (a) 09/092020, (b) 30/09/2021, (c) 15/10/2020, and (d) 11/11/2021

Results

Temporal variability in each measured point

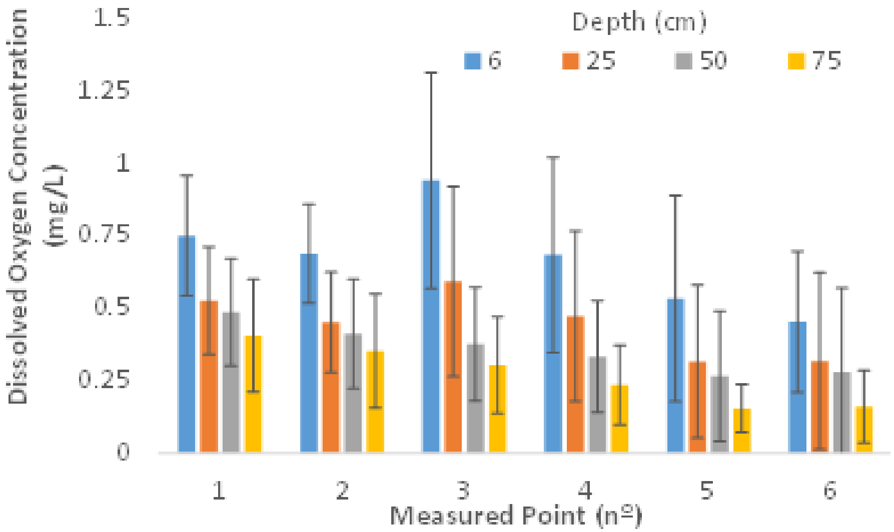

Figure 5. Mean and standard deviation of measured DO concentration along with the ponds.

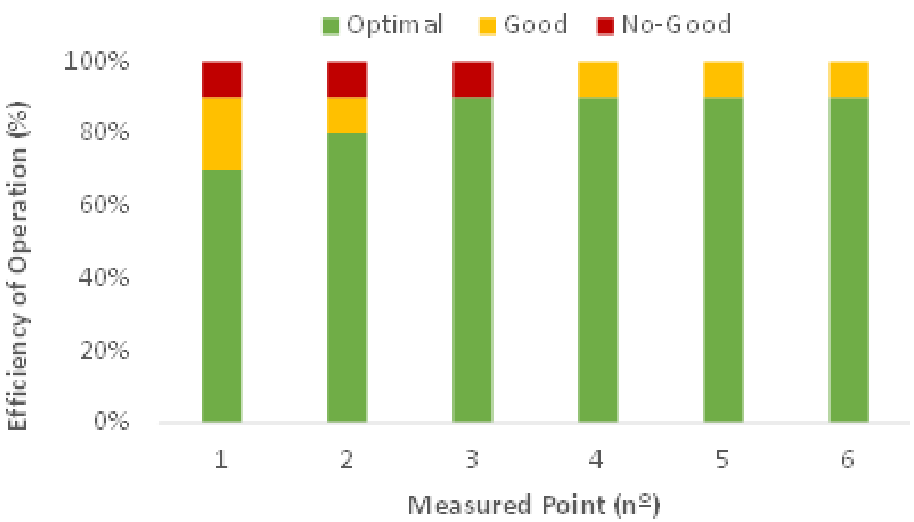

Figure 6. Operational conditions of the ponds in the studied period.

Results

Evaluation of phytodepuration performance

The data of total suspended solids confirms that there is a reduction of 80% as average.

However, CDO values are relatively low (at the entrance and exit), and the effect of phytodepuration on the reduction or increase of CDO is not yet apparent.

Concerning the system's productivity, a total of 187.88 kg of typha biomass was harvested on 11/11/2020. It supposes average productivity of 1.8 kg/m^2.

Conclusion

The DO is low in the three ponds in general terms, mainly due to the water input and a decreasing DO concentration along with the ponds.

The DO follows a negative gradient along with the depth of the pond.

Thus, we have confirmed that our design of a small-scale phytodepuration system with no control on the flow accomplishes DO's expected values and variability.

Conclusion

In future work we will:

- evaluate the denitrification process in each pond. We will include low-cost water quality sensors measuring the turbidity and the organic matter.
- study the crop performance in each pond to evaluate if the different amounts of nutrients in the ponds affect crop performance.

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THANK YOU FOR YOUR ATTENTION

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