Monitoring and Measuring the biomass of the floating macrophytes by numerical image processing: Case duckweeds (*Lemna minor*) in Waste Stabilisation Ponds

Tangou T.T.[1,2,3], Musibono E.D.[2] et Vasel J.L.[1]

[1] *Sanitation and Environment Laboratory, University of Liege, Faculty of Science, Department of Science and Environmental Management, 185 Avenue de Longwy 6700 Arlon, Belgium*
[2] *Ecotoxicology and Aquatics Ecosystems Laboratory, University of Kinshasa, Faculty of Science, Departments of Environment and Chemistry, P.O. Box 190 Kin XI, D.R.Congo*
[3] *Hydrology Laboratory, Congo Atomic Energy Commission, Departments Soils Physic and Hydrology, P.O. Box 868 Kin XI, D.R.Congo*

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INTRODUCTION

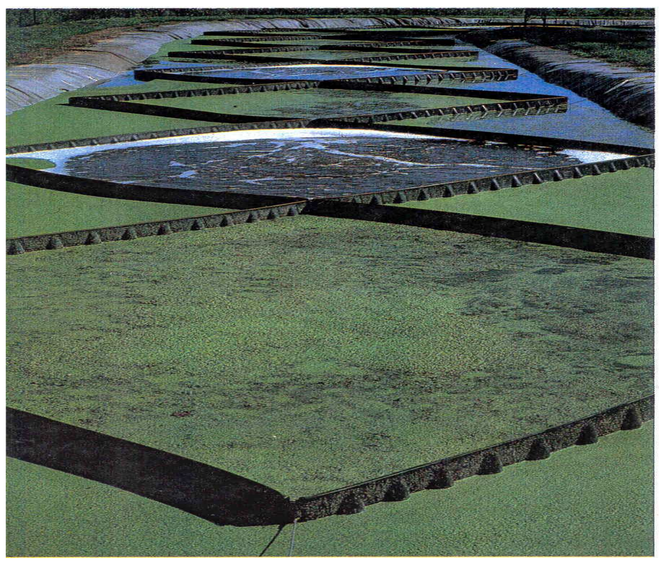


Fig.1: Duckweeds in WSP (From Airone, septembre 1991)

In hot countries temperature conditions allow the use of various WSP technologies, including floating macrophytes systems. Duckweeds have been used for industrial or domestic waste water treatment. However, to maintain a good efficiency and to avoid the induction of a new pollution, a good management of the duckweeds is required. In addition, inapropriate harvesting of the lenses can involve the reduction in the treatment capacity and also support the development of algae. We tried to monitor the biomass and the environmental parameters of the system (light intensity, temperature, pH, nitrogen, phosphorus, alkalinity, COD…) as well. Indeed, duckweed biomass measurements were carried out by many researchers (Edwards et al., 1992; Köner and Vermaat, 1998; Rhamani and Sternberg, 1999; Caicédo et al., 2000….) according mainly to two methods (**the measurement of fresh or weights)** which present disadvantages especially for rather long experiments. If the last one is more reliable but destructive, the first on the other hand is less destructive but less accurate and not very reproducible. In the present work, we considered an alternative method using **numerical image processing by adapted softwares,** namely: ACDsee® and Image Pro-Plus®. The purpose of this study is thus to establish the surface-biomass relationship for a possible comparison of the resulting biomasses by image and weighing.

METHODOLOGY

The duckweeds samples tests were performed in a special designed pilot located in a phytotron. Photoperiod of 16/8 was adopted. We performed three tests during three weeks at a rate of a test per week. Light intensity was controlled by sodium lamps (310 µmol/m^2/s). The initial biomass (± 1g/144 cm^2) *Lemna minor* was placed in six opened Plexiglas transparent parallelipedic tanks of 12x12 cm of side containing 500 ml of water. The water losses due to evapotranspiration were compensated daily by addition of tap water. The follow-up and the measurement of the cultivated duckweeds biomass were made successively by three methods, particularly: the measurement of the fresh weight (FW); the measurement of the dry weight (DW); and processing digital images by ACD-See® and Image Pro-Plus®.

Fig. 2: Sodium lamps

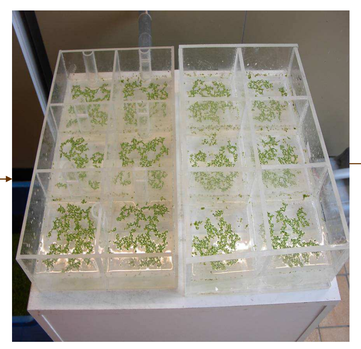


Fig. 3: Biomass in culture

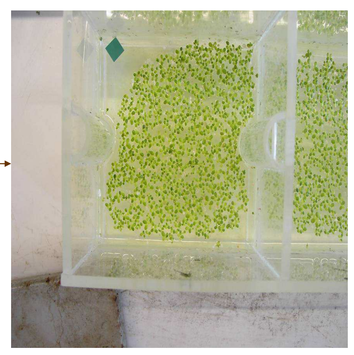


Fig. 4: Untreated Image

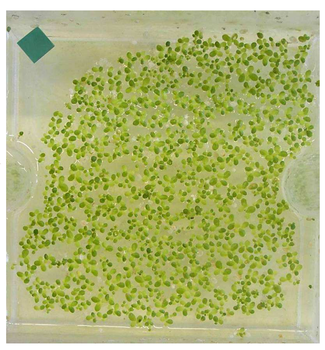


Fig. 5: Image processing by ACD-See®

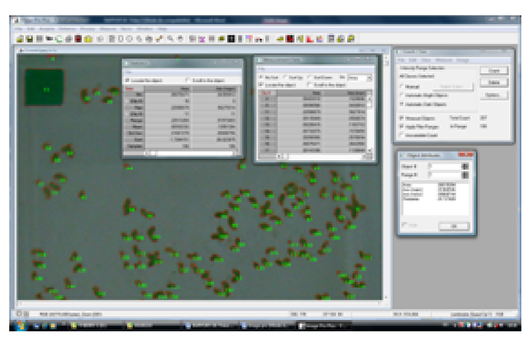
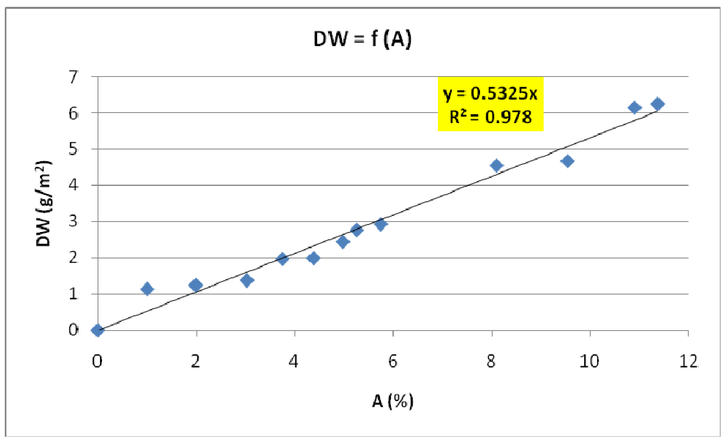


Fig. 6: Image processing by Image Pro-Plus®

RESULTS



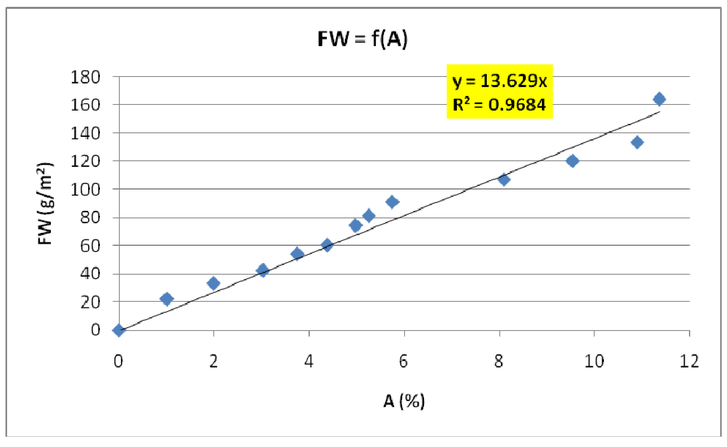


Fig. 7 and 8: Biomass-surface relationship (calibration line)

Good (R^2>0.96) linear relationships are obtained between covered surfaces and weight:

DW (g/m²) = 0.5325*A (%) with R^2 = 0.978 (1)

FW (g/m²) = 13.629*A (%) with R^2 = 0.968 (2)

With DW and FW respectively dry and fresh weights, and A surface (area).

This result shows that for a covered area of about 10%, it has a density of at least 5 g DW/m² and 13g FW/m².

This methodology is rather efficient to study the growth kinetics of duckweeds species and others floating macrophytes in laboratory and field conditions.