Removal efficiency of constructed wetlands with two different wetland halophytes for Cd, Ni and Zn polluted water treatment

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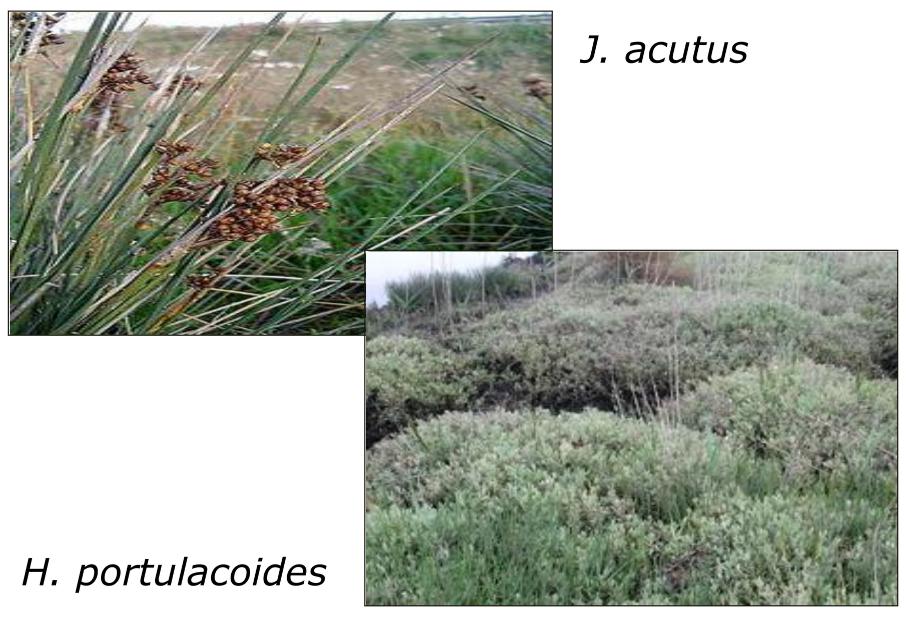
INTRODUCTION

Constructed wetlands (CWs): The use of constructed wetlands (CWs) is an alternative wastewater or contaminated water remediation method. The selection of plants to be used in a CW for heavy metal removal requires special attention.

Halophytic plants are under investigation based on findings that they are able to tolerate a wide variety of stresses except salt, such as heat, cold, drought and heavy metals. In this study two halophytic plants are under investigation: *Juncus acutus* L. and *Halimione portulacoides* L.



J. acutus

H. portulacoides

AIMS

- To investigate the potential of halophyte-based CWs for the removal of Cd, Ni and Zn from contaminated water
- To evaluate the heavy metal rhizofiltration ability and tolerance of two halophytes

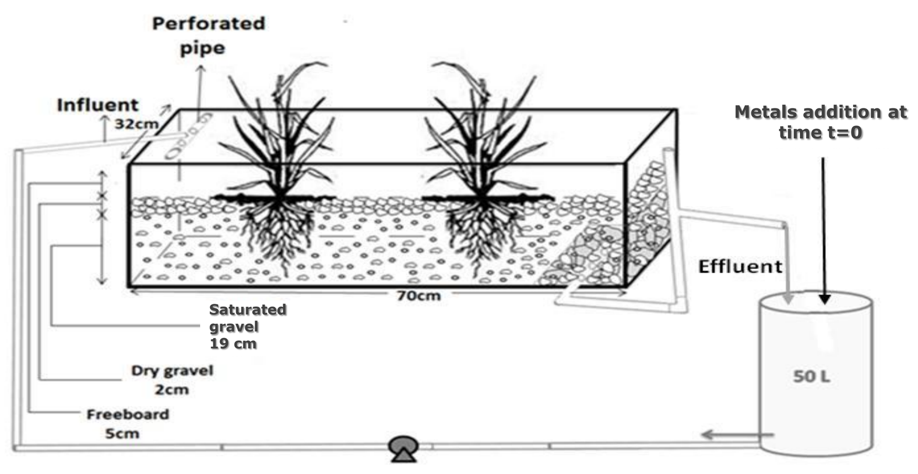
MATERIALS AND METHODS

Experimental setup

- *J. acutus* and *H. portulacoides* were collected from mature plants growing in Souda Bay in Chania (Crete, Greece).
- Two horizontal, continuous flow and with complete water recirculation CWs were constructed and planted with each plant species.
- The plants' roots were fully covered with gravel.
- An external barrel containing the contaminated water was placed near the tank.
- The end of each experimental cycle was reached when the influent metals concentrations of the CW (i.e., the exit of the external barrel) were well below the EU limits for wastewater reuse.

Measurements

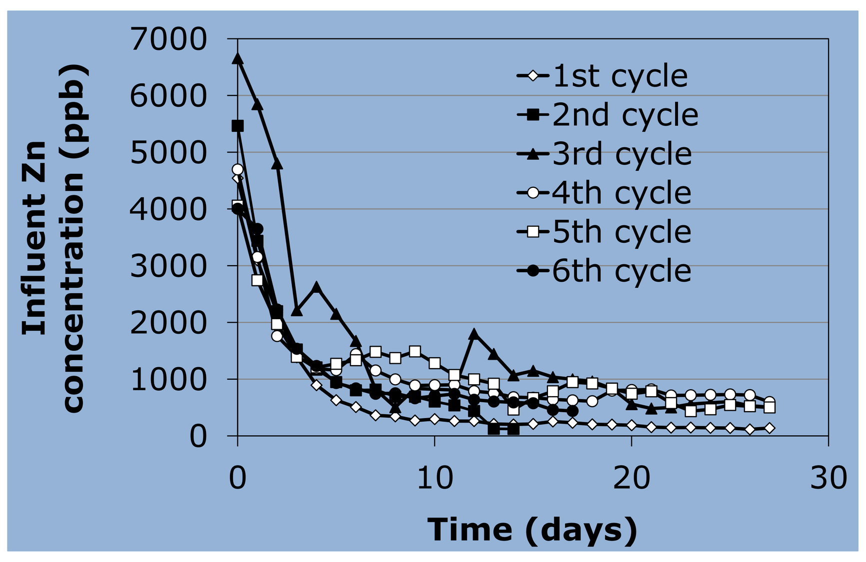
- Cd, Ni and Zn total concentration in the CWs influent and effluent aqueous samples was measured by ICP-MS according to the EPA method 6020A.
- pH, ORP

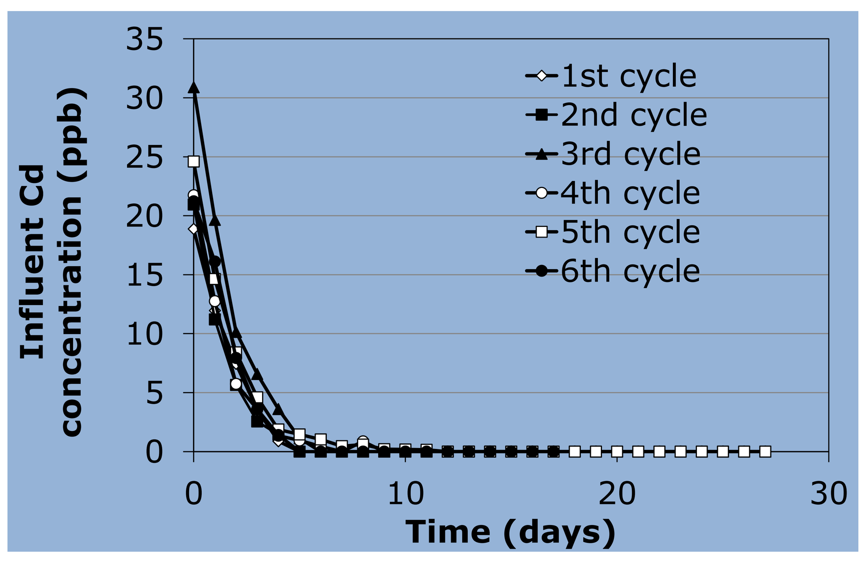


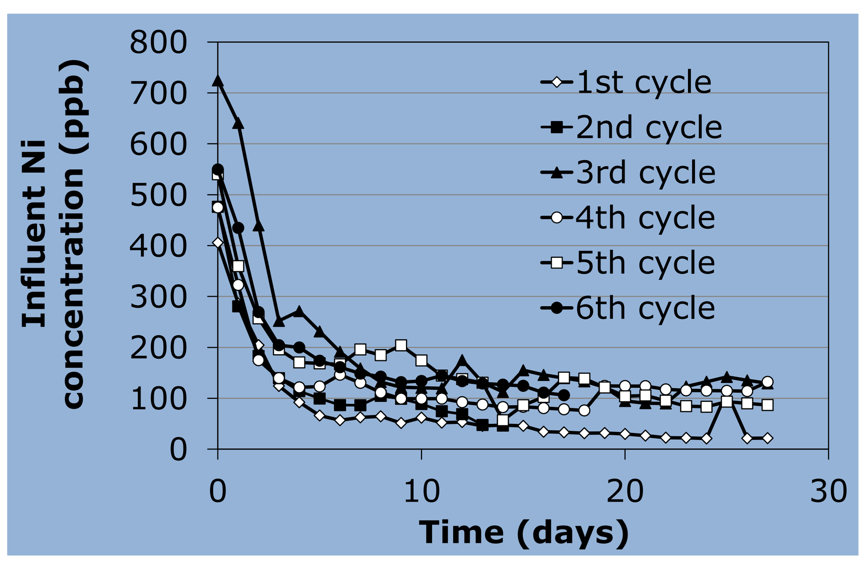
Experimental Design	
Dimensions of the CWs	70cm×26cm×32cm
Volume of external barrels	50L
Total volume of the CW system	65L
Pump rate	≈ 1L/h
Cd initial concentration	≈ 20 μg/L
Ni initial concentration	≈ 400 μg/L
Zn initial concentration	≈ 4000 μg/L

RESULTS AND DISCUSSION

CW- *J. acutus*







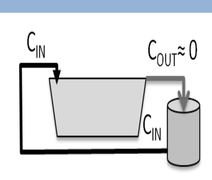


Figure 1. Zn, Cd and Ni concentrations in the influent of the CW in which *J. acutus* plants are grown (pH=7.3-8.1 & ORP=154 – 243mV).

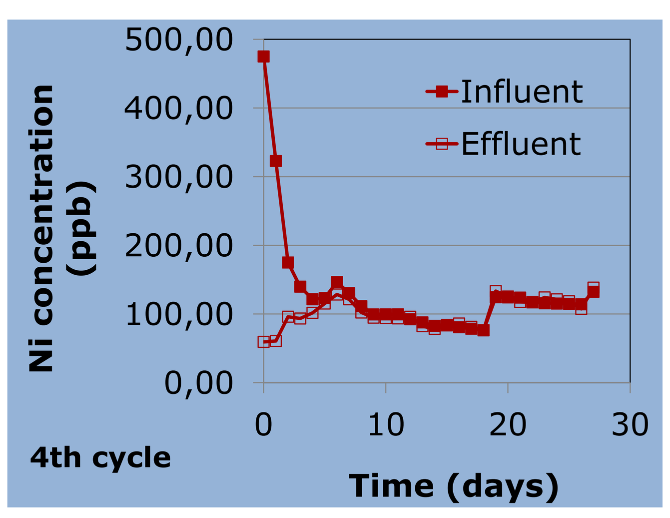
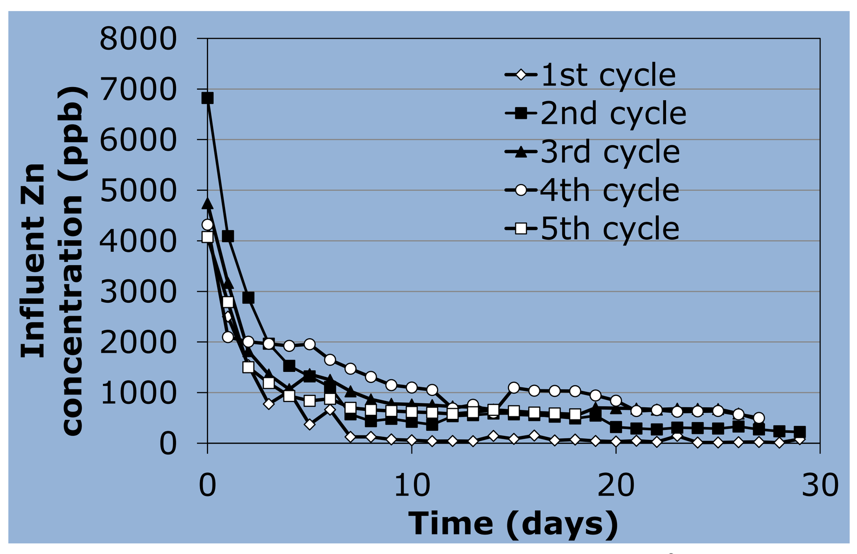
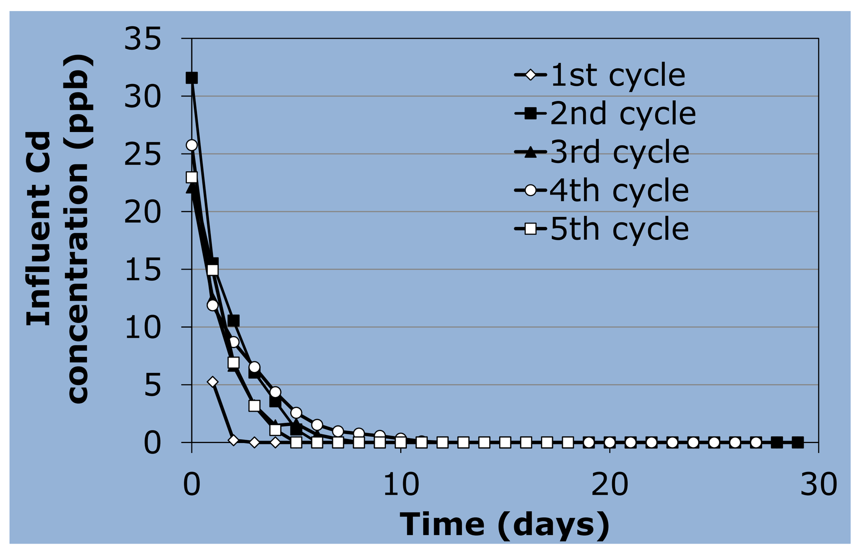


Figure 2. Ni concentration in the CW water medium during an exp. cycle

- Cd influent concentration was below the detection limit after less than ten days of re-circulating flow while its concentration in the effluent was measured at all times below the detection limits.
- CW achieved more than 85% reduction of Zn and Ni influent concentrations in every cycle, while their effluent concentrations were measured at all times below the EU limits for wastewater reuse.

CW - *H. portulacoides*





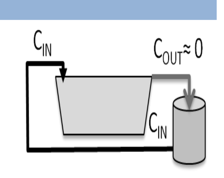
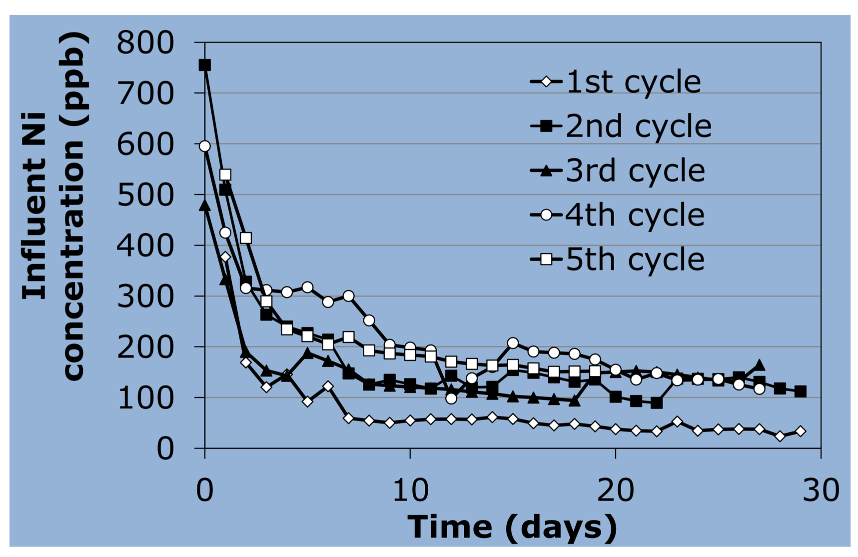


Figure 3. Zn, Cd and Ni concentrations in the influent of the CW in which *H. portulacoides* plants are grown (pH=7.2-8.2 & ORP=152 – 219mV).



- The CW in which *H. portulacoides* plants were grown had a similar performance with the CW – *J. acutus* achieving more than 85% reduction of Ni and Zn influent concentrations and total reduction for Cd influent concentration in every cycle.
- In Figures 2 & 4, an example of one metal concentration monitoring during one experimental cycle.

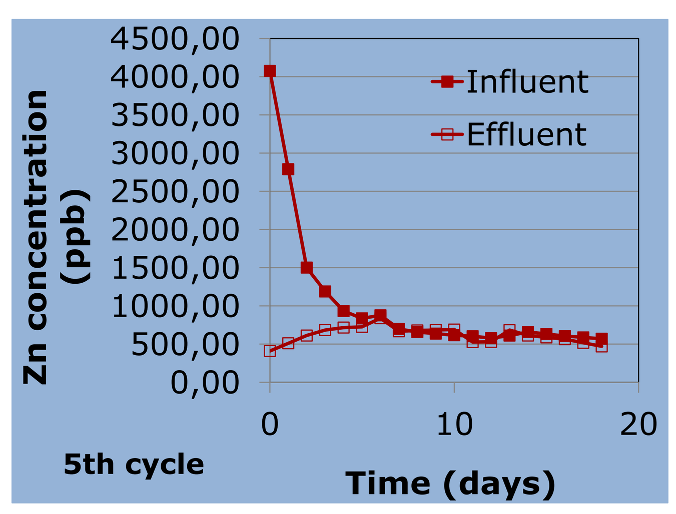


Figure 4. Zn concentration in the CW water medium during an exp. cycle.

CONCLUSIONS

- Both CWs are able to treat heavy metal polluted water.
- *J. acutus*-CW and *H. portulacoides*-CW were found able to achieve more than 85% reduction of the influent Ni and Zn concentrations in every cycle reaching concentrations well below the EU limits for wastewater reuse, while for Cd both wetlands achieved total reduction within a few days.

ACKNOWLEDGEMENTS

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