

IPBeja, 27th October 2021, Portugal

Use of *Vetiveria Zizanioides* floating beds to improve river water
quality in the Mediterranean climate
- Real scale preliminary results-

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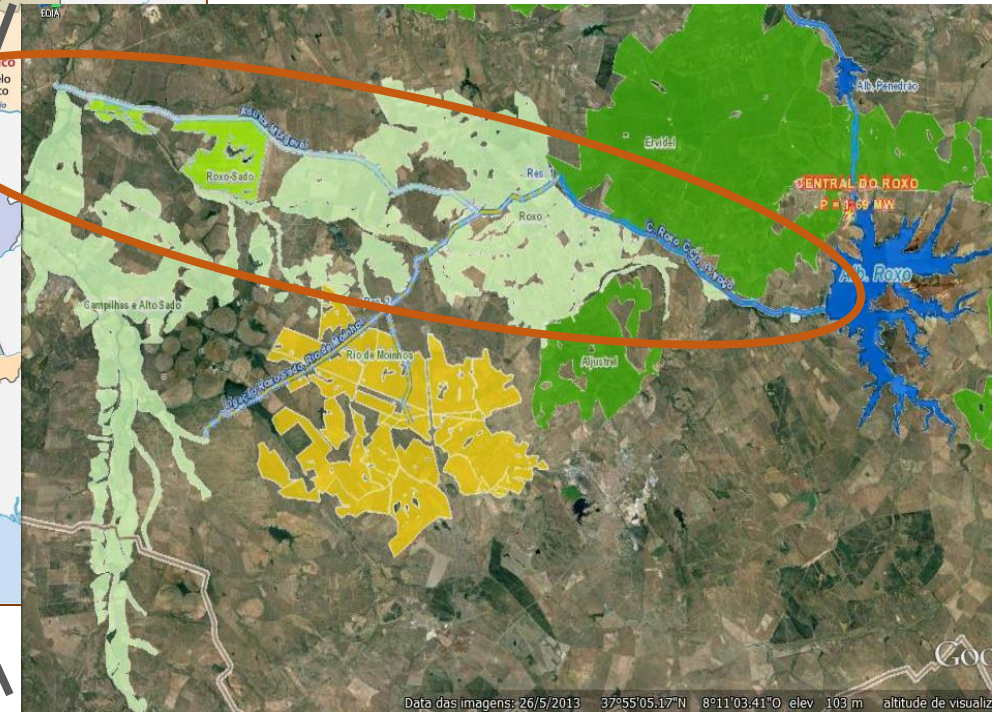
1. Framework

- ✓ The Roxo Stream is located in the Southern of Portugal,
- ✓ Mediterranean Climate

Climate Changes

Most common droughts

Rains with torrential regimes



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1. Framework

The results of the project **QARSC** (Borrvalho& Durão, 2016)

revealed the poor quality of the water of Roxo stream due the contribution of its main tributaries/ bordering activities.



Agricultural activities



Mining activity on stream basin



Livestock Farms

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1. 1. Eco-Rehabilitation Measures

River rehabilitation projects (alternatively called Eco-rehabilitation) aim to remedy modified and degraded bodies of water (United Nations, 2015).

River rehabilitation and restoration cover a wide range of measures (Durão, 2013)

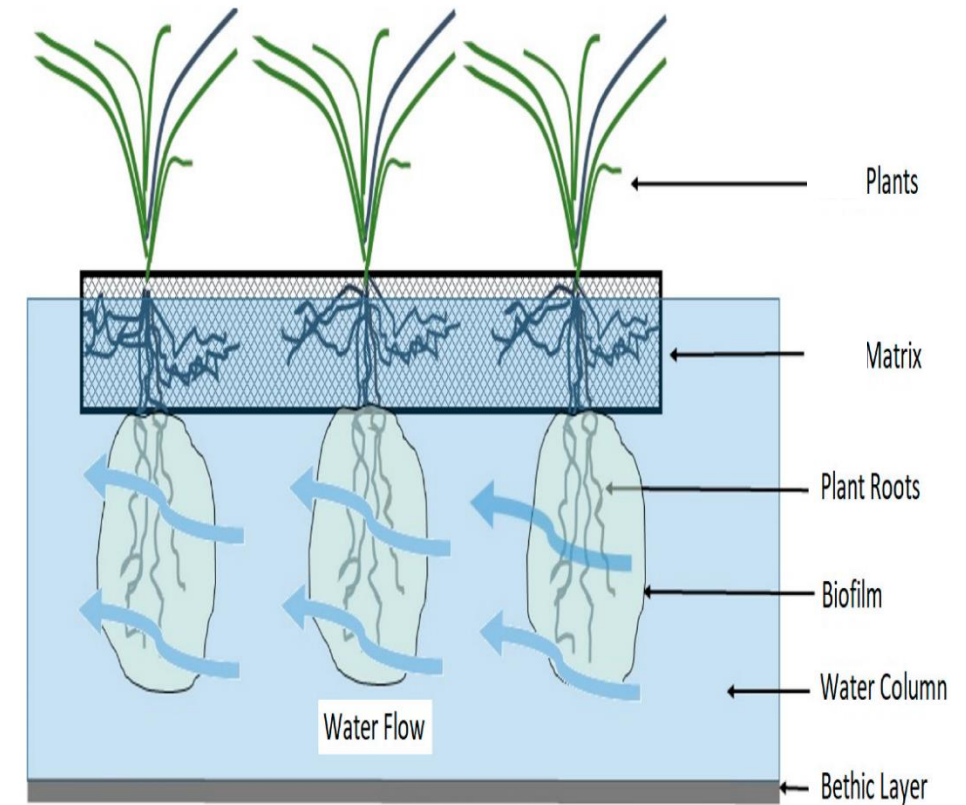


- Riparian galleries;
- Stability of margins;
- Wetlands and
- Floating Beds

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- Floating beds (FBs) consist in a floating artificial medium (i.e., a floating matrix), to which emergent macrophytes with phytoremediation capacity are planted.
- Those are placed directly on the surface of the water and the roots of the plants are fully or partially immersed, and there should be no obstruction of their growth.



Adapted from Walker et al., 2017

Fig.1. Floating bed scheme.

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2. Aim of the Work

The main aim of this work is to test, in real scale, the floating bed technology (FB) using floating matrix with the macrophyte *Vetiveria zizanioides*, with the purpose to improve water quality of Roxo stream, contributing to its ecological improvement and also, to be using in irrigation (Project GreenEcoRoxo).



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3. Methodology

NH_4^+ , Cl^- , Cu, Zn and Mn, exceed the maximum recommended values (VMR)



Non-compliance with the parameter NH_4^+ and P_t



Poor ecological state, when evaluated only for the physicochemical parameters.

Table 1. Water physicochemical quality characterization of Roxo's stream.

Parameters	Units	Roxo's Water Quality	Irrigation Water quality Decree-Law No. 236/98 (Annex XVII)		Ecological State (Water Institute, 2009)
			VMR	VMA	
pH	Escala de Sorensen	6,2± 1,6	6,5-8,4	4,5-9,0	6-9
T _w	°C	17 ± 2	-	-	-
Eh	mV	522 ± 19	-	-	-
B ³⁺	mg/L	0,2 ± 0,1	0,3	3,75	-
EC	µS/cm 20°C	1 813 ± 117	-	-	-
DO	mg/L	7 ± 1	-	-	≥5
DQO	mg/L O ₂	23± 3	-	-	-
CBO ₅	mg/L O ₂	4 ± 0,0	-	-	≤6
PO ₄ ³⁻	mg/L	0,007 ± 0,001	-	-	-
P _{total}	mg/L	0,2± 0,2	-	-	≤0,13
Nkj	mg/L	4 ± 1	-	-	-
NH ₄ ⁺	mg/L	2 ± 1	-	-	≤1
NO ₃ ⁻	mg/L	7 ± 1	50	-	≤25
SO ₄ ²⁻	mg/L	391 ± 31	575	-	-
F ⁻	mg/L	1,0 ± 0,0	1,0	15,0	-
Cl ⁻	mg/L	700 ± 21	70	-	-
TSS	mg/L	19 ± 1	60	-	-
TDS	mg/L	1 238 ± 232	-	-	-
Zn	mg/L	3,0 ± 2,1	2,0	10,0	-
Fe	mg/L	0.5 ± 0,3	5,0	-	-
Cu	mg/L	0,6± 0,3	0,20	5,0	-
Mn	mg/L	2.2 ± 0,7	0,20	10	-
SAR	-	2 ± 1	8	-	-

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3. Methodology

3.1. Field Instalation

- The FB are constituted by a floating system and a support system for plants(Network in PEAD and organic blanket) (Fig.2) on which were planted the macrophyte *Vetiveria Zizanioides* (Density 40.5 plants/m²) and tied to the borders of the water course.

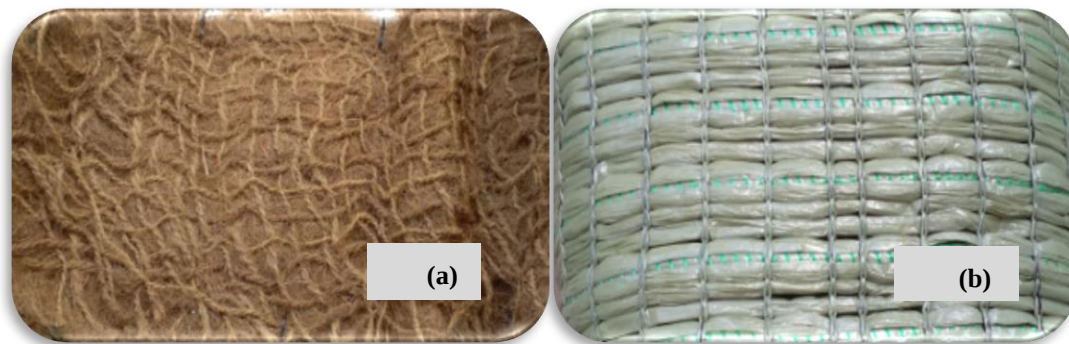


Fig. 2- (a) Support System for plants (organic blanket) (b) floating system (PEAD Network).



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3.1. Field Instalation

-Three floating beds with the dimensions of 3.3 m²/unit were placed on Roxo stream (location: coordinates GPS: 37.944685-8.153876), on May 2020. (Fig.3). They were placed in a water section, that presented the depth of $0,9 \pm 0,3$ m, the wide of $10,0 \pm 1,3$ m and a flow rate of $0,12 \pm 0,10$ m³/s.

- The sampling collection was made in two points, namely after floating beds location and around 100 m before them at Roxo stream.



Fig. 3..Field Installation of floating beds.

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3. Methodology

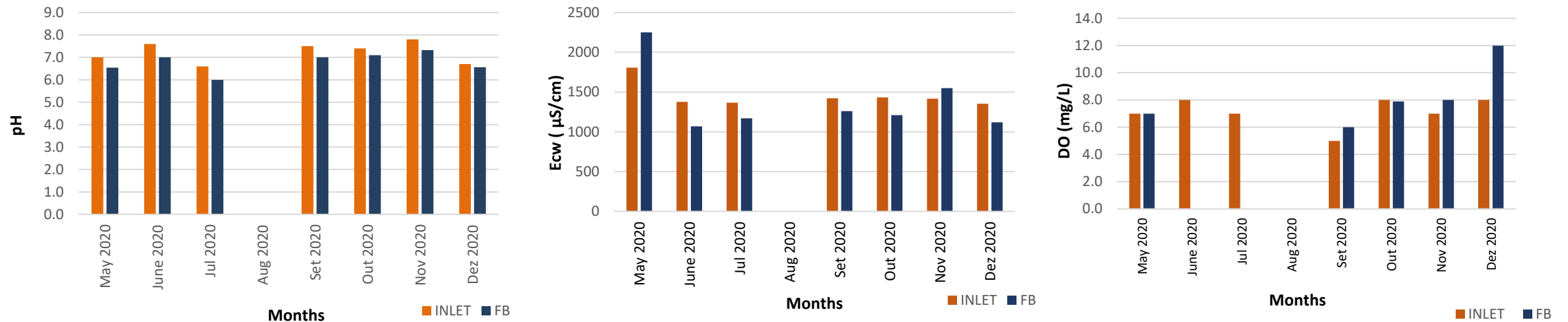
3.2. Experimental Procedure

- The sampling collection were carried out during May 2020 to December 2020 according to Standard Methods of Analysis for the Examination of Water and Wastewater.
- Physical-chemical monitoring was performed bimonthly, *in situ*, for the parameters: pH, Temperature ($^{\circ}\text{C}$), Potential redox (Eh); Electrical conductivity (ECw) and Total Dissolved Solids (TDS), using multiparametric portable probe (HI9829 HANNA).
- The remaining parameters were monitored monthly *in lab*, and were determined according to Standard Methods for the Examination of Water and Wastewater: Sodium (Na^+); Potassium (K^+); Magnesium (Mg^{2+}); Calcium (Ca^{2+}); Total Suspended Solids (TSS); Chlorides (Cl^-); Ammoniacal Nitrogen (NH_4^+); Kjeldhal Nitrogen (Nkj); Nitrates (NO_3^-); Nitrites (NO_2^-); Phosphorus (P); Phosphate ($\text{P}_2\text{O}_5^{2-}$); Boron (B^{3+}); Chemical Oxygen Demand (COD); and Sulphates (SO_4^{2-}).

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4.Results and discussion



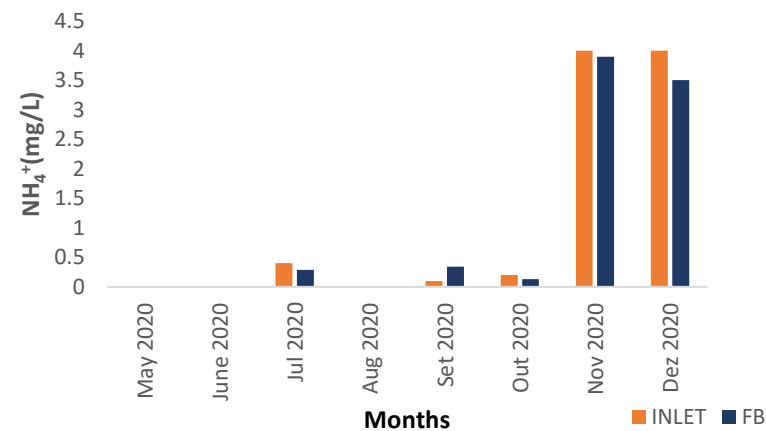
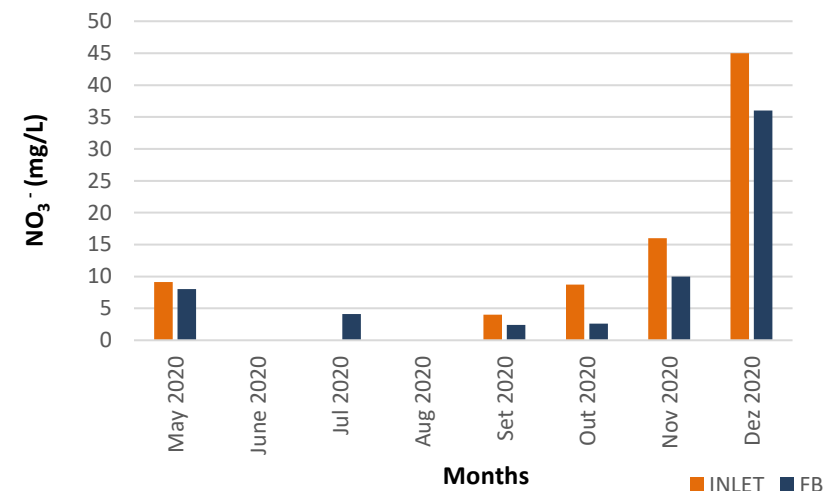
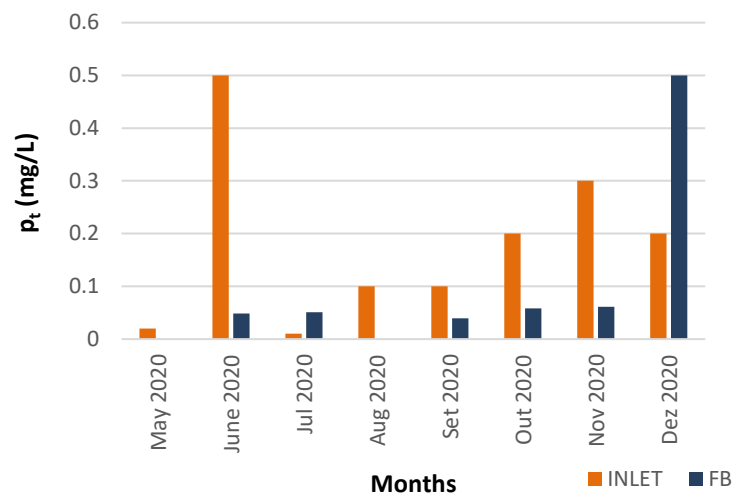
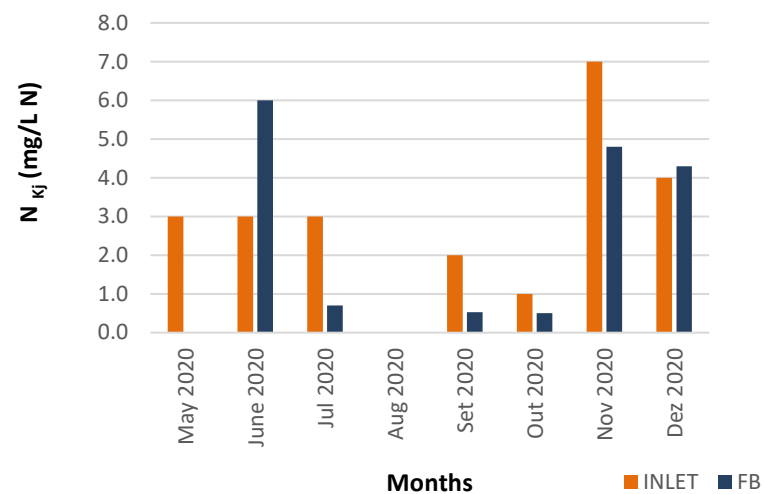
-The pH remained neutral.

- RR (Ecw)=5,4%

-The DO level increased slightly.

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$RR(N_{Kj}) = 14,6\%$

$RR(p_t) = 29,6\%$

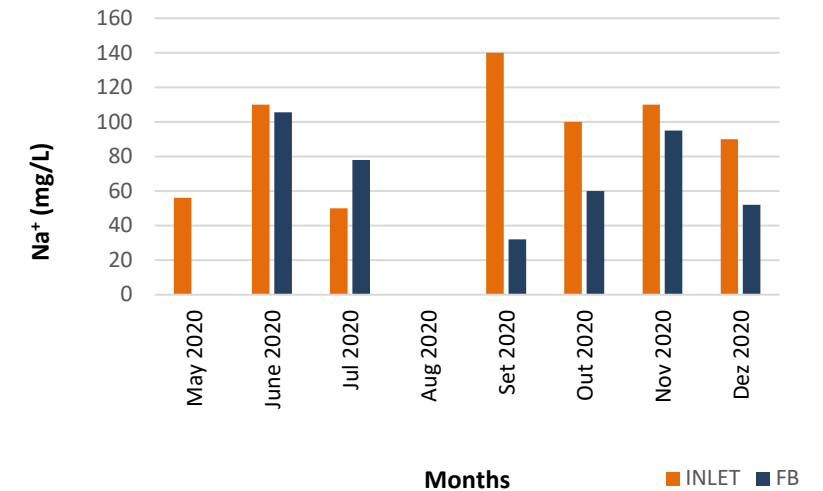
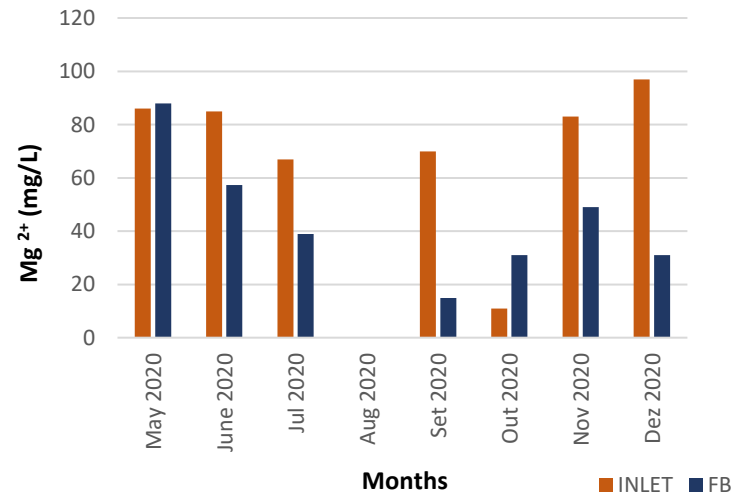
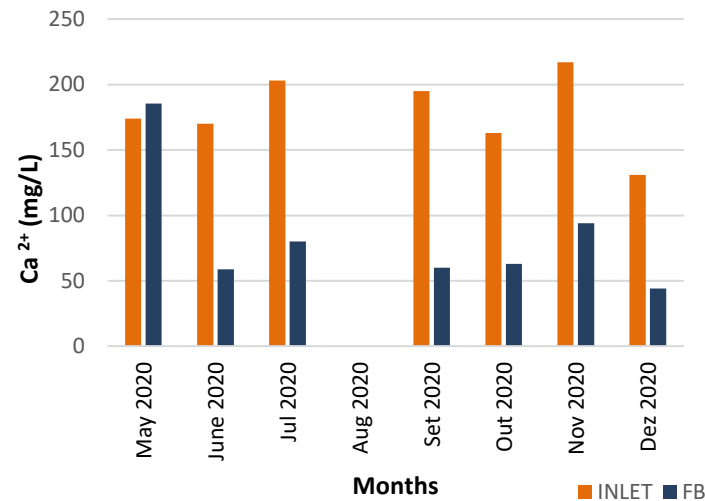
$RR(NO_3^-) = 36,6\%$

$RR(NH_4^+) = 6,3\%$

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$$\text{RR}(\text{Ca}^{2+}) = 53,3\%$$

$$\text{RR}(\text{Mg}^{2+}) = 37,8\%$$

$$\text{RR}(\text{Na}^{+}) = 30,6\%$$

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5. Conclusions

- The characterization of water quality of Roxo stream has shown among others: i) neutral pH, ii) high electrical conductivity (ECw), iii) high Chemical Oxygen Demand (COD), iv) low dissolved oxygen (DO) levels, v) high heavy metal levels (Zn, Cu, Mn) and vi) low concentrations of nitrogen and phosphorous nutrients.
- The main removal rates obtained were i) $\text{NO}_3^- = 36,6\%$, ii) $\text{Na}^+ = 30,6\%$ iii) $\text{ECw} = 5,4\%$; iv) $\text{Nkj} = 14,6\%$, v) $\text{Ca}^{2+} = 53,3\%$ vi) $\text{Mg}^{2+} = 37,8\%$ vii) $\text{P}_t = 29,6\%$ % and $\text{NH}_4^+ = 6,3\%$.
- The DO level increased slightly and the pH remained neutral.
- No evidences of improvement in sulphates, ammoniacal nitrogen, COD and phosphates had been registered (results not shown).
- Although the study carried out was short-lived, the results suggest that the use of FB may constitute a long-term, ecological and economical system for the treatment of the Roxo stream water. Further work is needed to consolidate the results and to determining hydraulic parameters relevant to the possible dissemination of this technology.

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Thank you for your attention!!!!

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