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► To cite this version:

Floriane Sordes, Isabelle Techer, Slimane Sahli, Solène Cothelet, Allyson Moureaux, et al.. Salinity problems in dredged sediments treated by phytoremediation. International symposium of LabEx DRIIHM, Sep 2021, Toulouse, France. , 2021, 10.34972/driihm-9b297b . hal-03346815

HAL Id: hal-03346815

<https://hal.science/hal-03346815v1>

Submitted on 21 Sep 2021

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Salinity problems in dredged sediments treated by phytoremediation

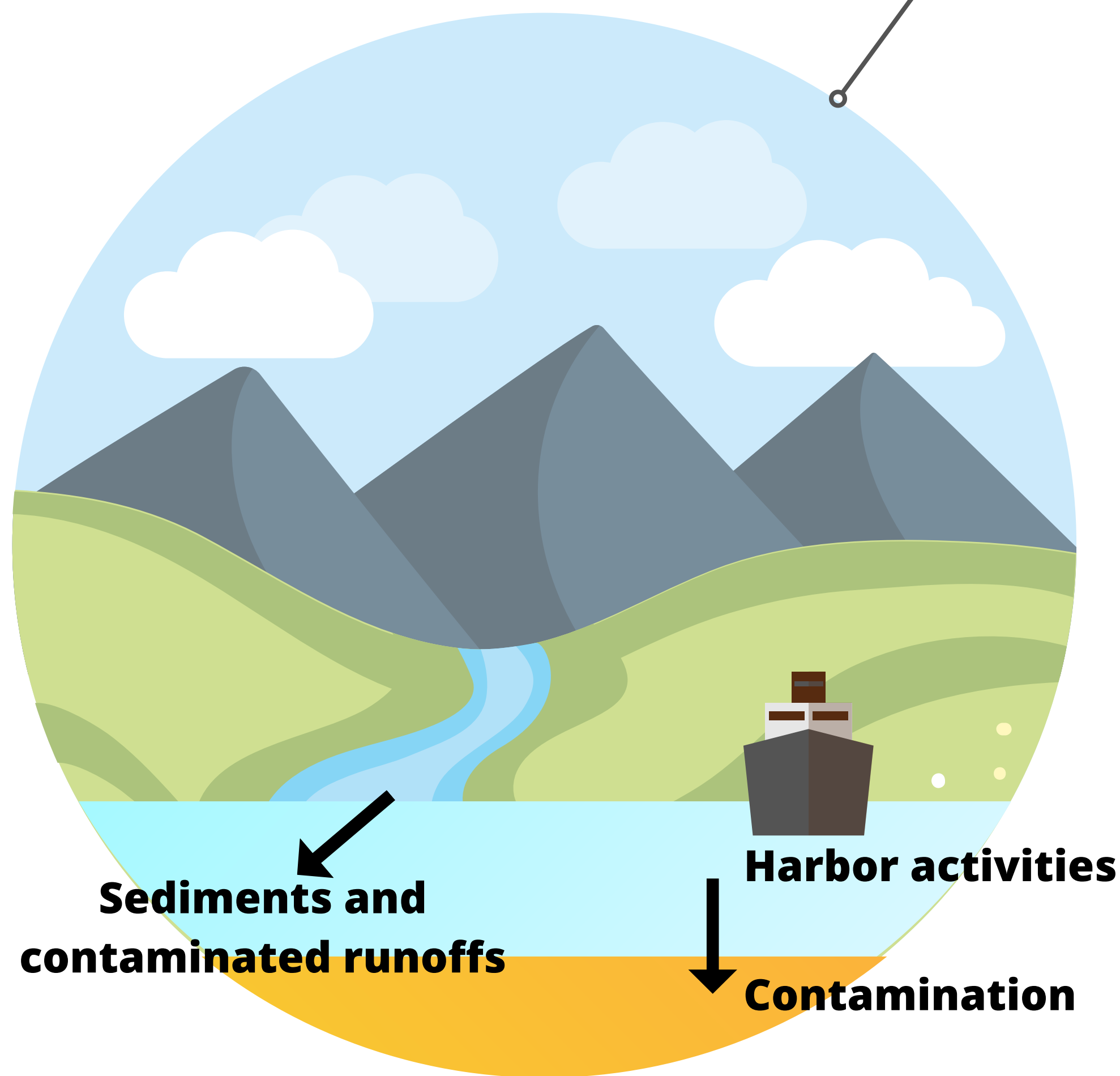
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Context



Sediments and contaminants accumulate in the harbor. They both come from :

- Geological background
- Harbor activities
- Agriculture
- Waste water
- Industry

- Sediments need to be **dredged** to maintain touristic and economic activities.
- Level of heavy metals, PBC, HAP and TBT determine if dredged sediments should be **brought back inland, instead of released offshore**.
- Dredged sediments management face environmental, juridic and economic issues. Nearly one quarter of them are brought to land where they must be treated as waste. Regulation calls for a strict limitation of the offshore dumping.

Metallic and organic contamination

Inland sediment treatment
Dredging

↓
Drainage

↓
Phyto-remediation (Experimental)

Sea water (chloride, sulfate)
Salt contamination

Dredged sediments are naturally rich in different salts (Sea water chloride mean concentration: $[Cl] = 20g/L$).

↓
Decrease of soluble contamination

Sediments drainage are usually observed (various drainage methods). After this treatment step, chloride sediments concentration usually qualify them as **non hazardous and non inert waste french category** ($[Cl] = 0.8-15 g/kg$).

↓
Decrease of chloride

Phytoremediation can be a solution to reduce chloride sediment concentration. Cl^- can be uptaken by some plants and accumulate in shoots:

- Expected to decrease chloride concentration to an **inert waste level** in a reasonable amount of time ($[Cl] < 0.8 mg/kg$).
- Energetic valorisation of the plants by-products.

Occitanie dredging projects

Occitanie plan to dredge **5.8 millions m³** of sediments in the next **10 years**.

26% of french dredged sediments are brought back inland and therefore are considered as waste.

64% of these sediments are **silt or clay**.

-> **Chloride tend to accumulate** in fine granulometry (Hu et al. 2013)



Occitanie Region (CC BY-SA 4.0)

Material and method

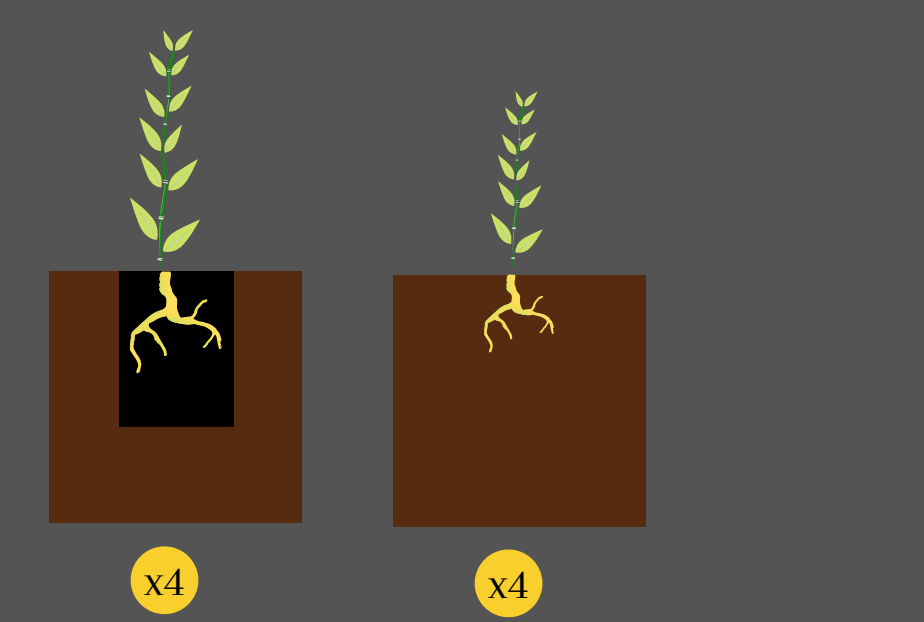
- 3 sites were studied : Pérols (65% < 63µm, 5 months drainage), Port Camargue (58% < 63µm, 2 month drainage) and le Grau du Roi (70% < 63µm, totally drained).
- *Arundo Donax* plants were selected



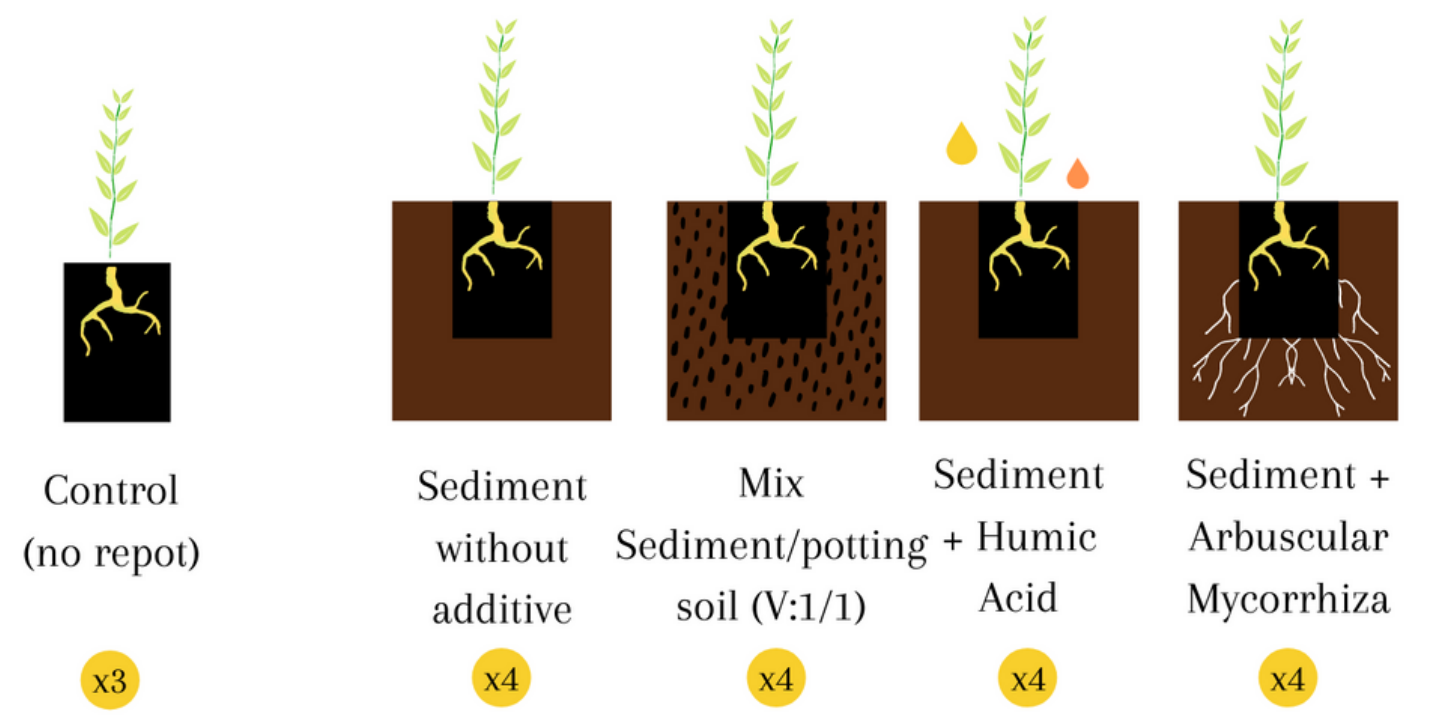
Drainage in geotubes - Pérols (Sordes 2020)

Preliminar Survival test for *Arundo donax* in similar sediments regarding the granulometry. Sediments comes from Le Grau du Roi ($[Cl] = 2.4 g/kg$) :

Repoting vs planting from cutting.

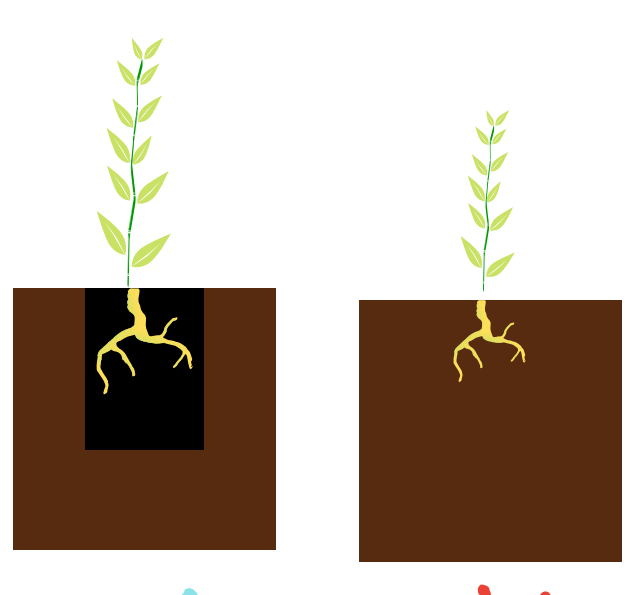


Experimental cultures were realised in Le Grau du Roi sediments (**potting soil, Humic Acid, Arbuscular Mycorrhiza**)

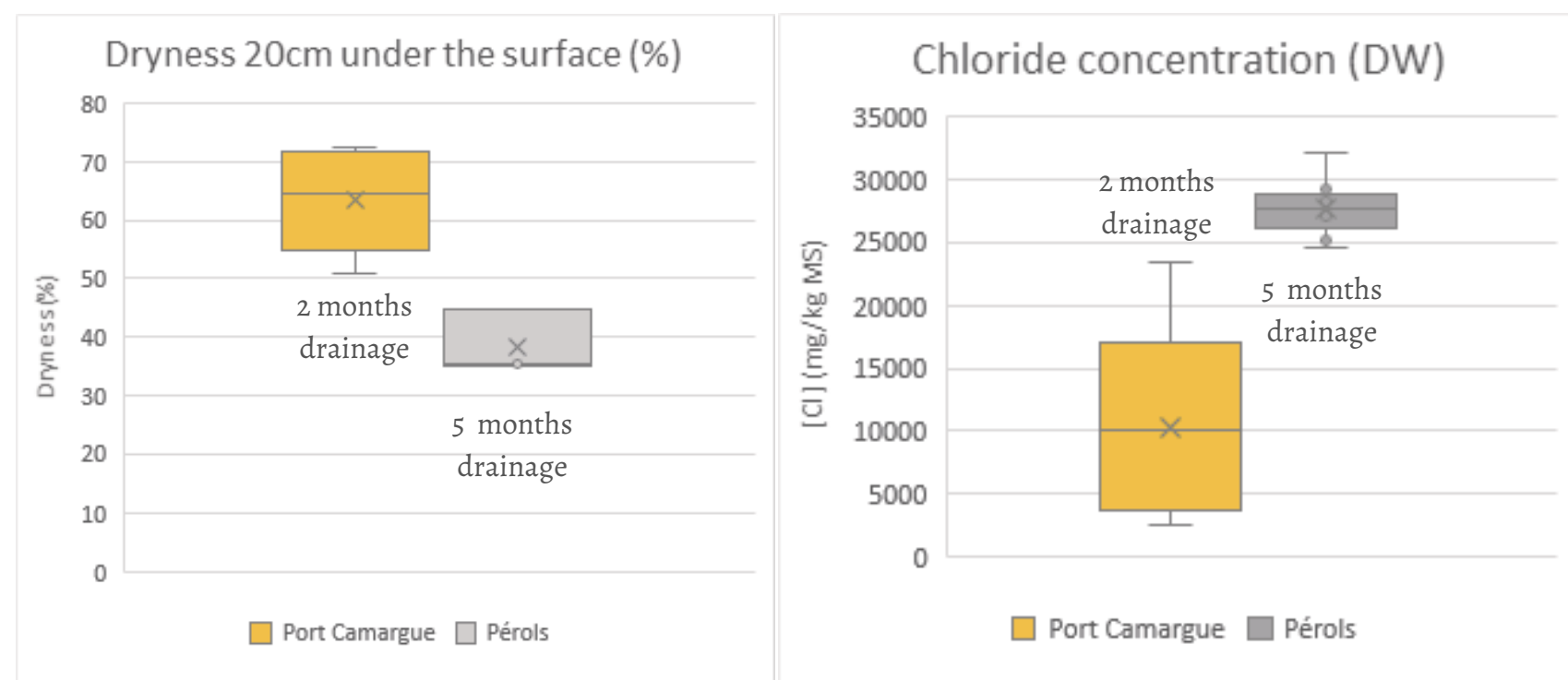


- 2.5L repot into 7L of sediments
- Grow box (10 hour of light per day, 20°C, 0.5L water/pot/week)
- Harvest after 2 weeks and 4 months

Results



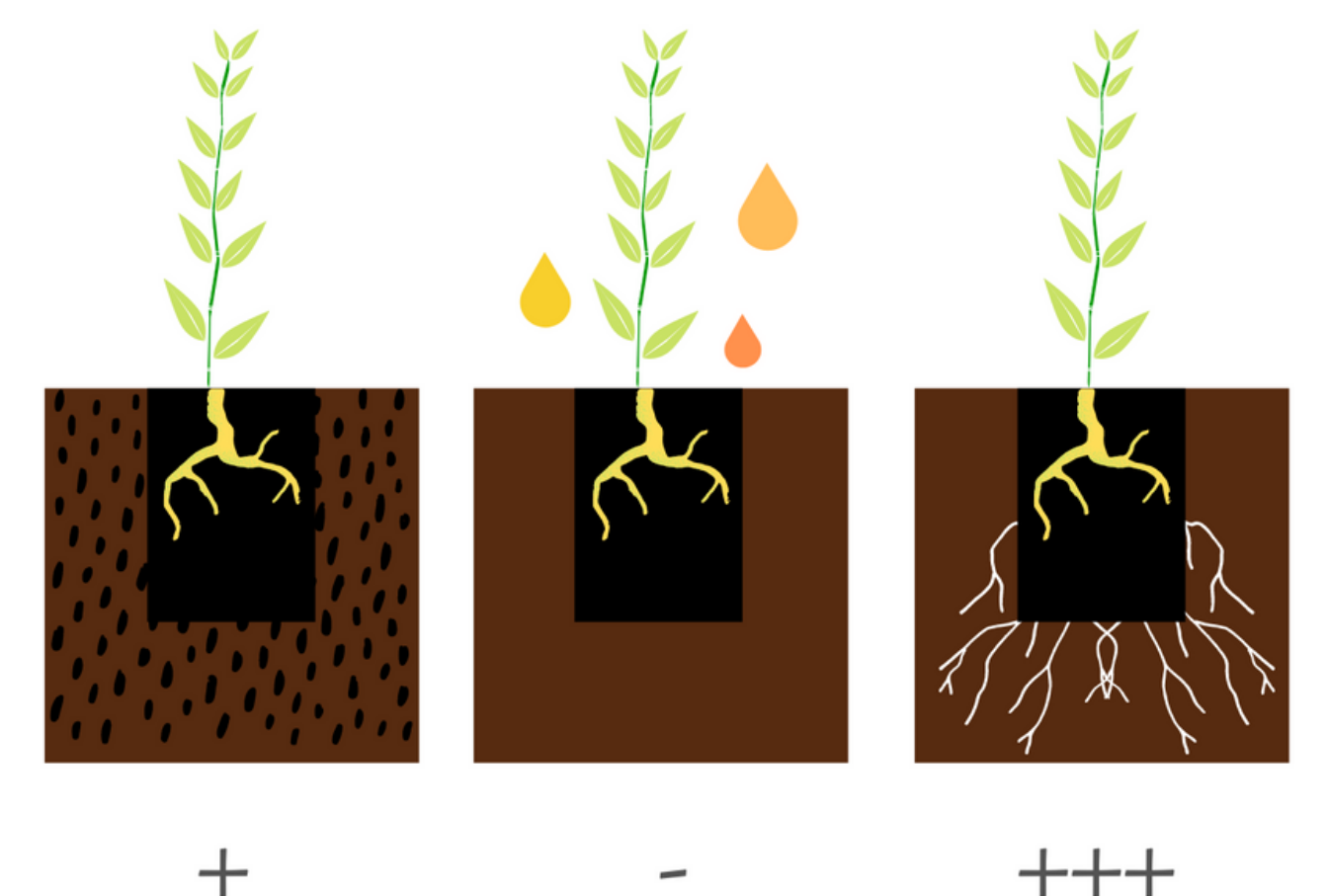
100% survival 0% survival



Sediments are in hazardous waste category ($[Cl] > 15 g/kg$) which make it difficult to eliminate.

Conclusion

- Longer drainage should improve chloride elimination. Phytoremediation seems a good complementary technique.
- Tests realised with *Arundo donax* commonly used for energetic valorisation show good results in terms of uptake of chloride. Even with smaller bioaccumulation than other species, this specie have more interesting biomass production and economic valorization.
- Repot and Arbuscular Mycorrhiza show the best result in term of Cl^- extraction and bioaccumulation.



In the long run, when facing high chloride level, Arbuscular Mycorrhiza modality shows the best results in bioconcentration and translocation in *Arundo donax*.

Results in accord with Pollastri et al. 2018 findings on salt stress reduction by Mycorrhiza.

BioConcentration Factor (BCF) and Translocation factor (TF)

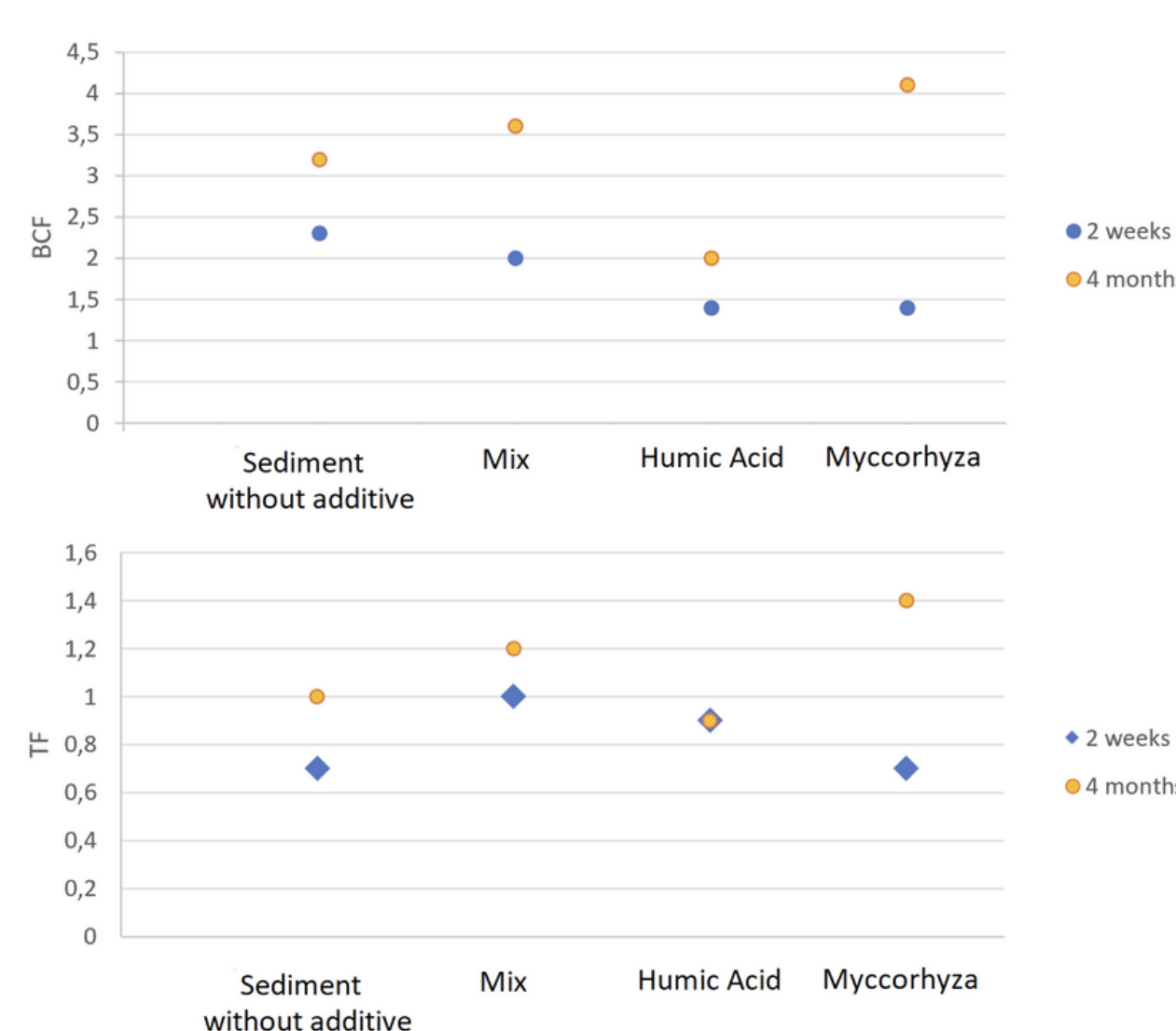


Table 1: Comparison of above ground Cl accumulation in litterature

Species	Cl accumulation	Authors
Suaeda Maritima	70 g/kg DW	Hasanuzzaman et al. 2014
Aeluropus littoralis	20 g/kg DW	Hasanuzzaman et al. 2014
Phragmites australis	24 g/kg DW	McSorley et al. 2016
Juncus maritimus	20 g/kg DW	Al Hassan et al. 2016
Typha latifolia	24 to 63 g/kg DW	Morteau et al. 2009; Rozema et al. 2014
<i>Arundo donax</i>	10 g/kg DW	This study

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