Electroosmotic dewatering of lake sediments for lakes restoration

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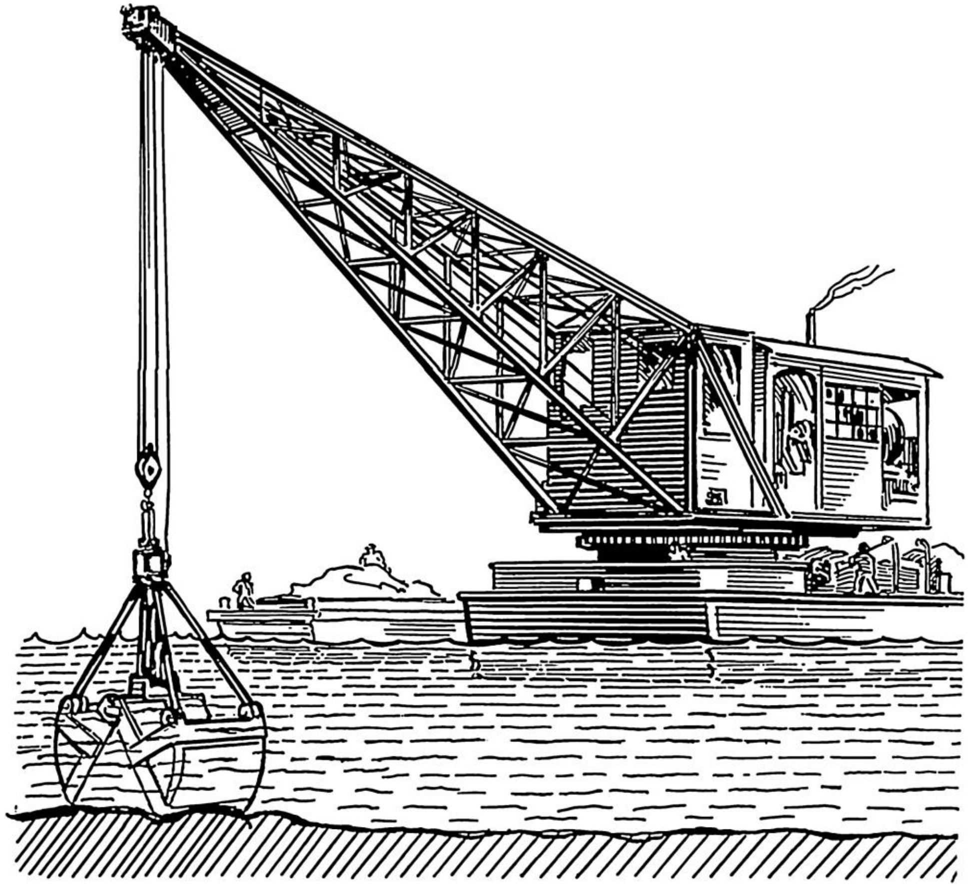
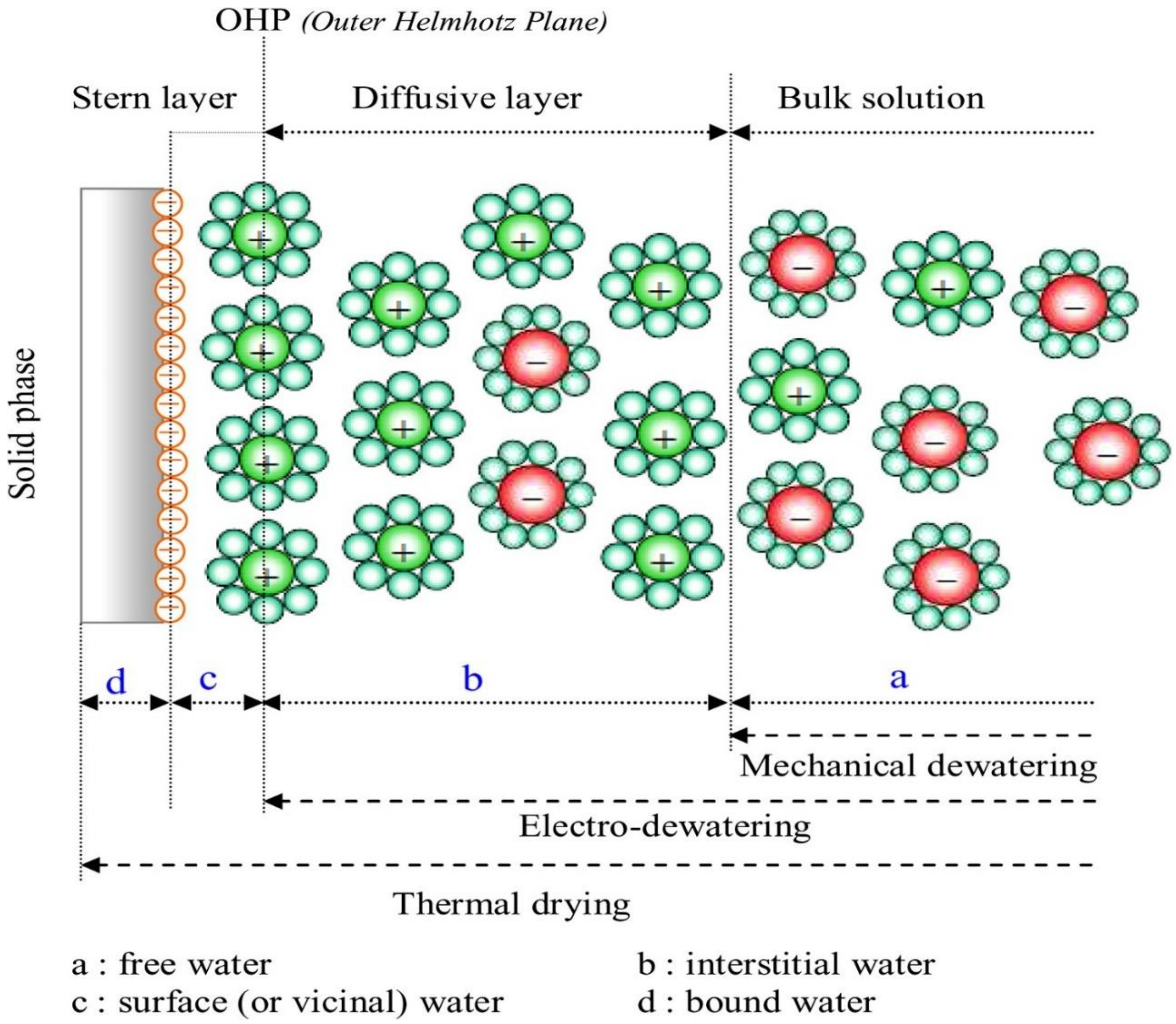
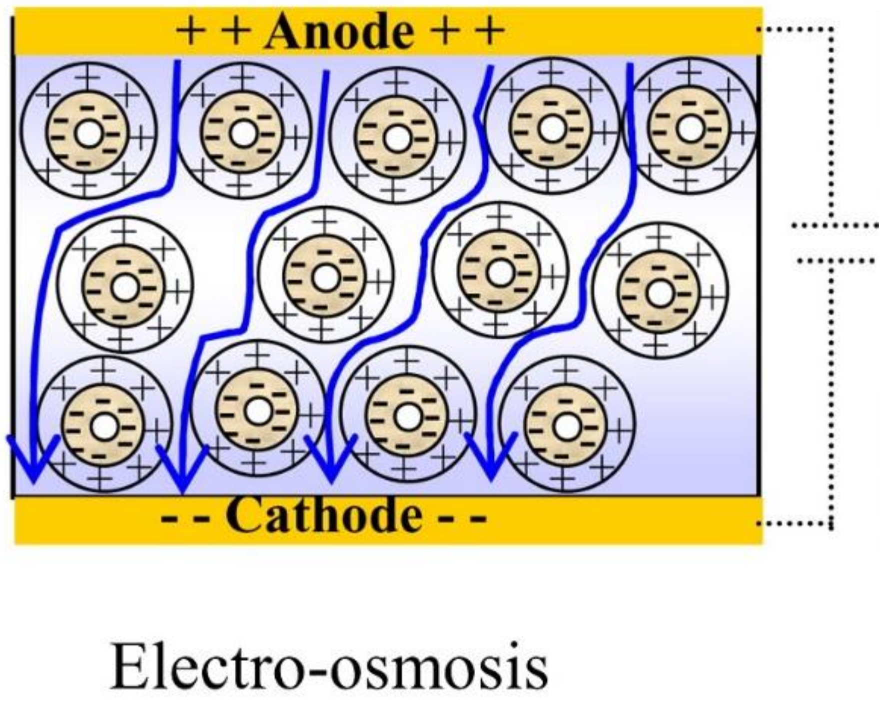
Background

Problem of Eutrophication





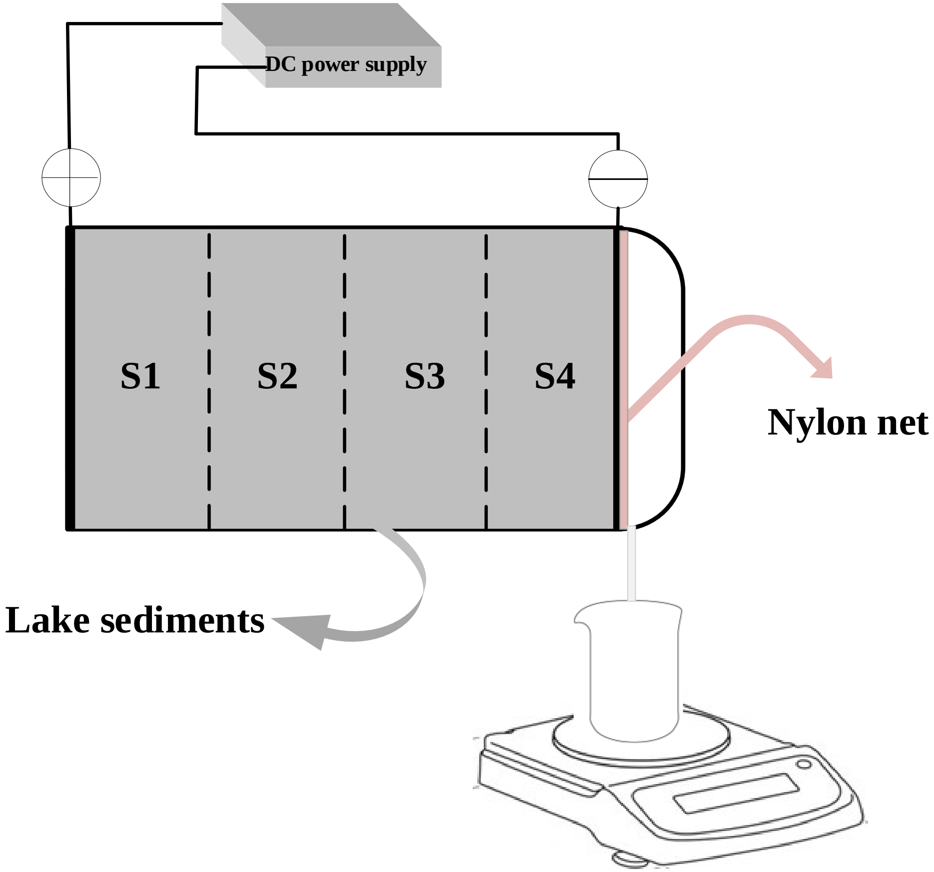
Dewatering methods in relation to water distribution in the materials (Mahmoud et al., 2010)



Demonstration of Electroosmosis(Mahmoud et al., 2010)

Aims and methods

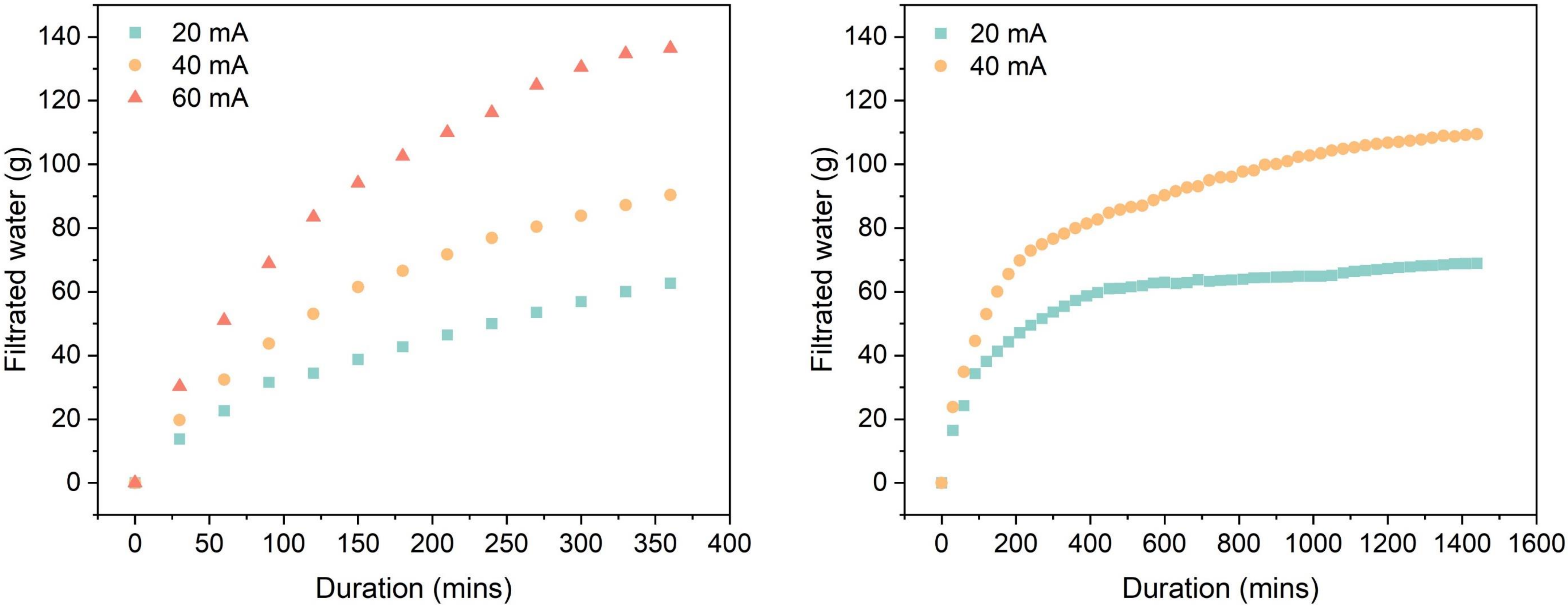
- The understanding of fundamental mechanisms involved in electroosmotic dewatering
- The overall assessment of characteristics changes of treated sediments and energy consumption to propose potential lake restoration strategies



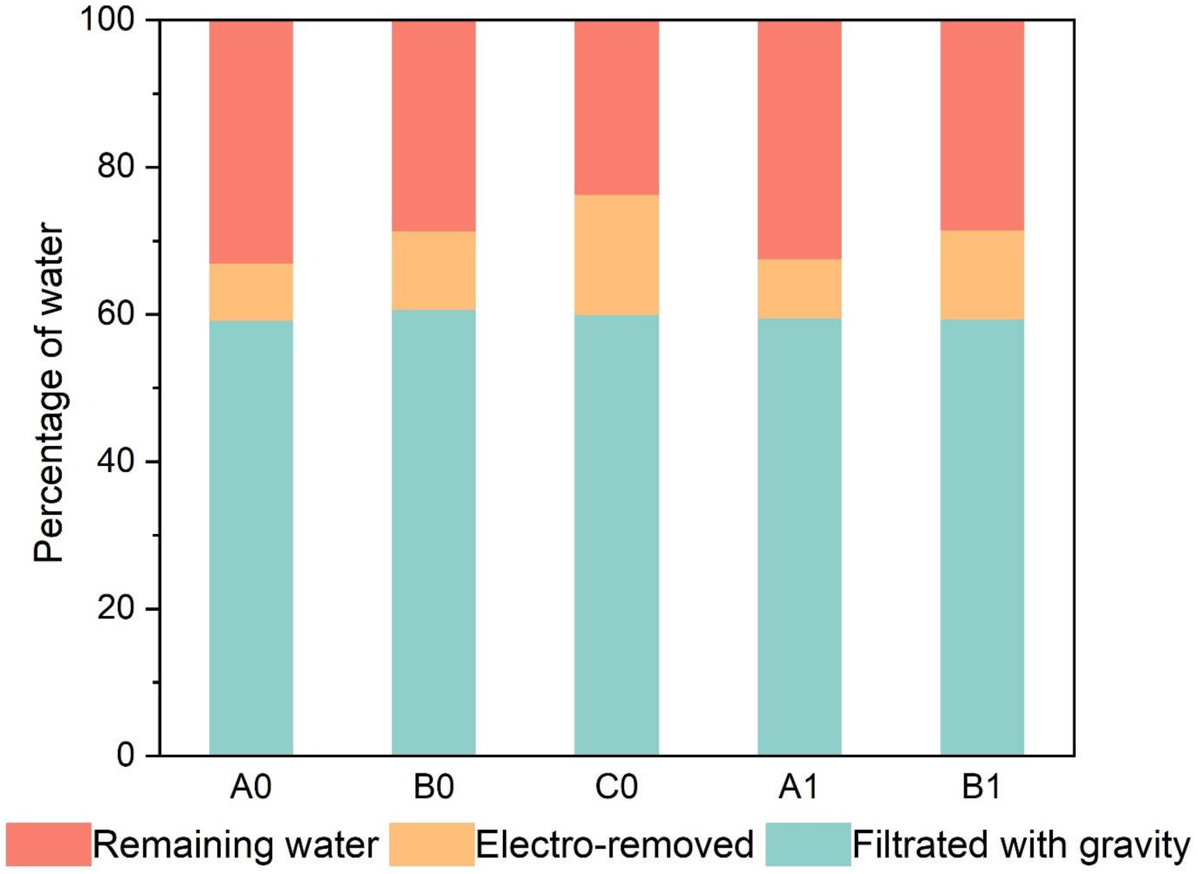
Experiment	A0	B0	C0	A1	D1
Sediments	1 L raw sediments sieved with gravity				
Current (mA)	20	40	60	20	40
Duration (hours)	6	6	6	24	24

Main results and discussions

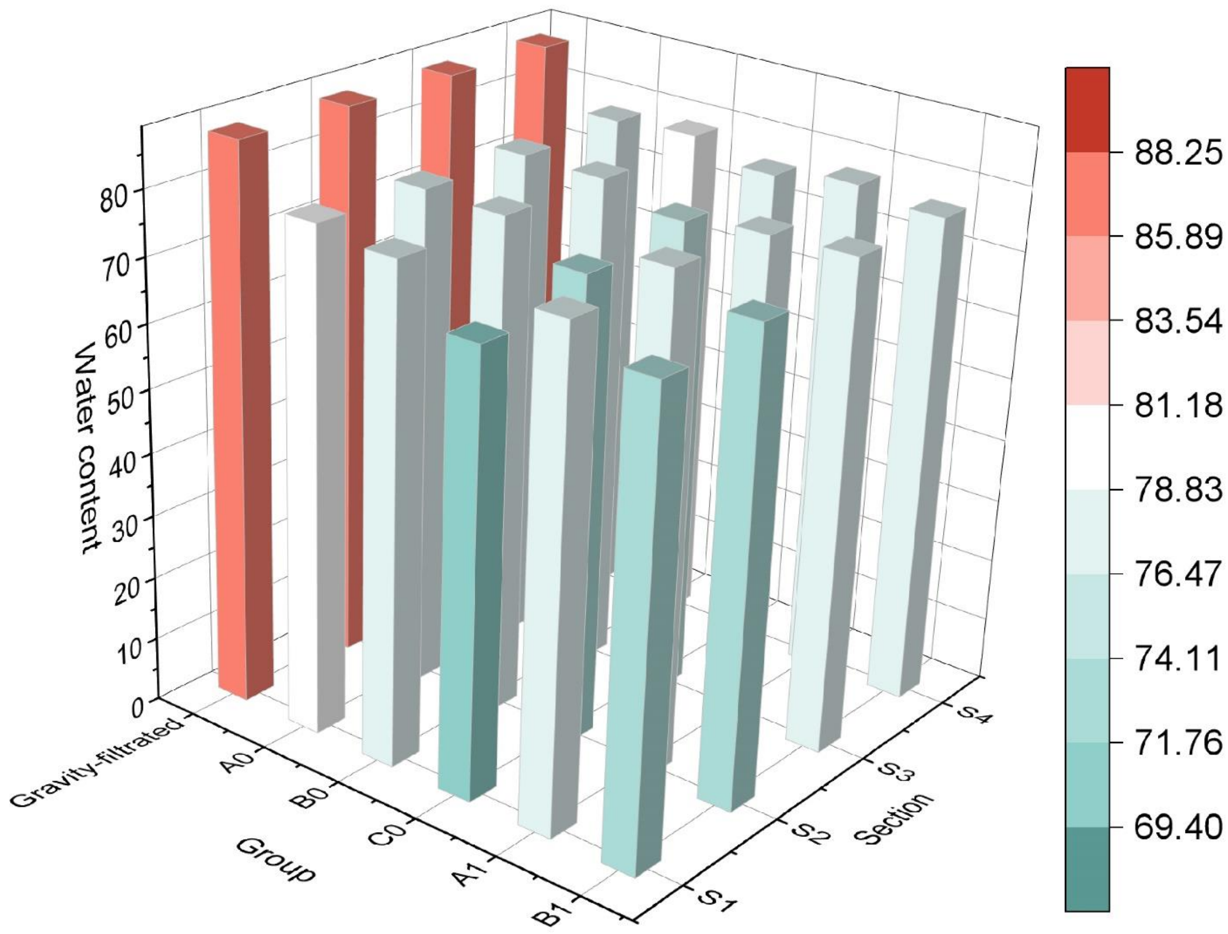
➢*Sediments electroosmotic dewaterability*



Evolution of filtrate volume with different current and duration

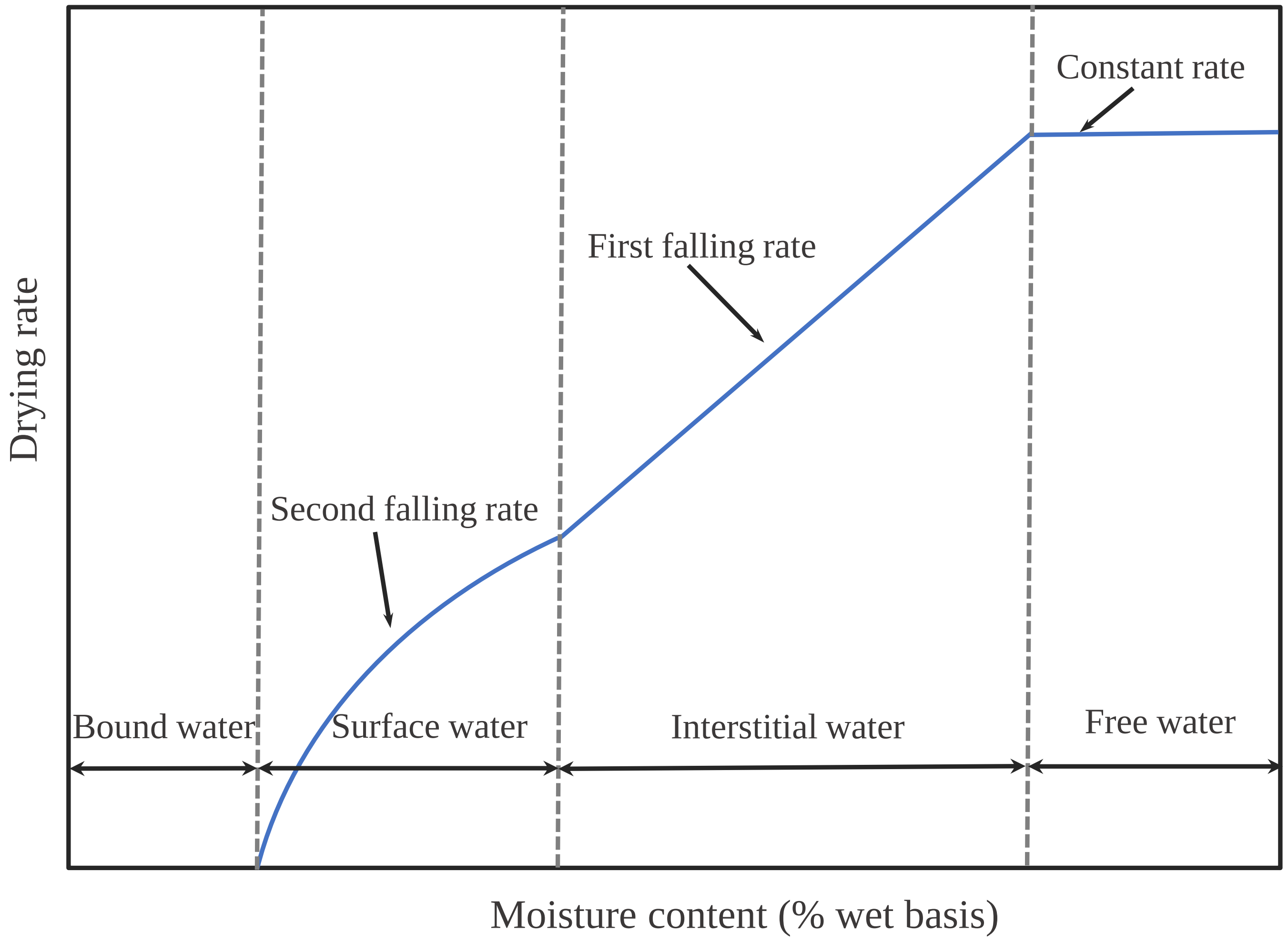


Percentage of removed water and the remaining water



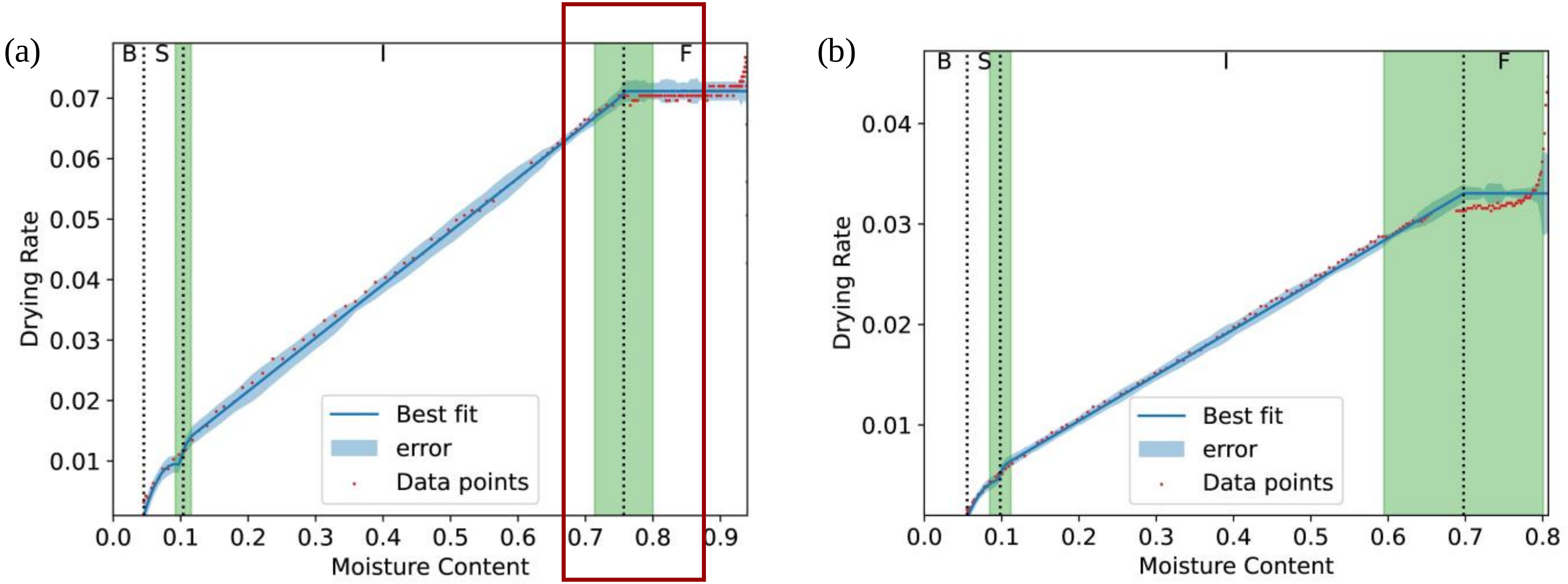
Changes in water content

➢*Changes in moisture distributions*



Typical drying curve of sludge (Vaxelaire et al., 2004; Deng et al., 2010)

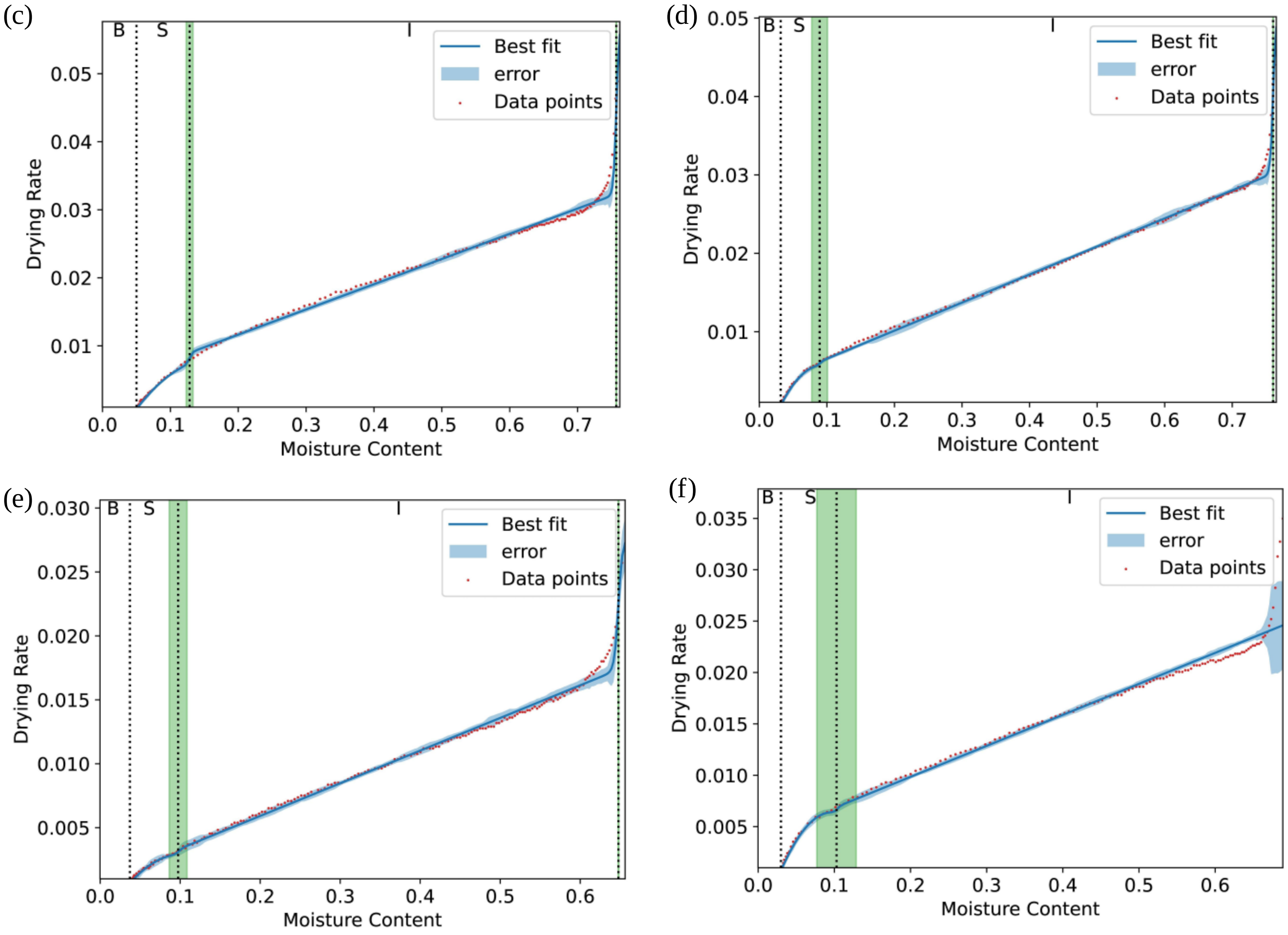
➢Changes in moisture distributions



Drying curves after non-linear least-squares minimization and curve fitting of raw sediments (a) sediments after filtration with gravity (b). B – Bond water, S – Surface water, I – Interstitial water, F – Free water.

➢*Changes in moisture distributions*

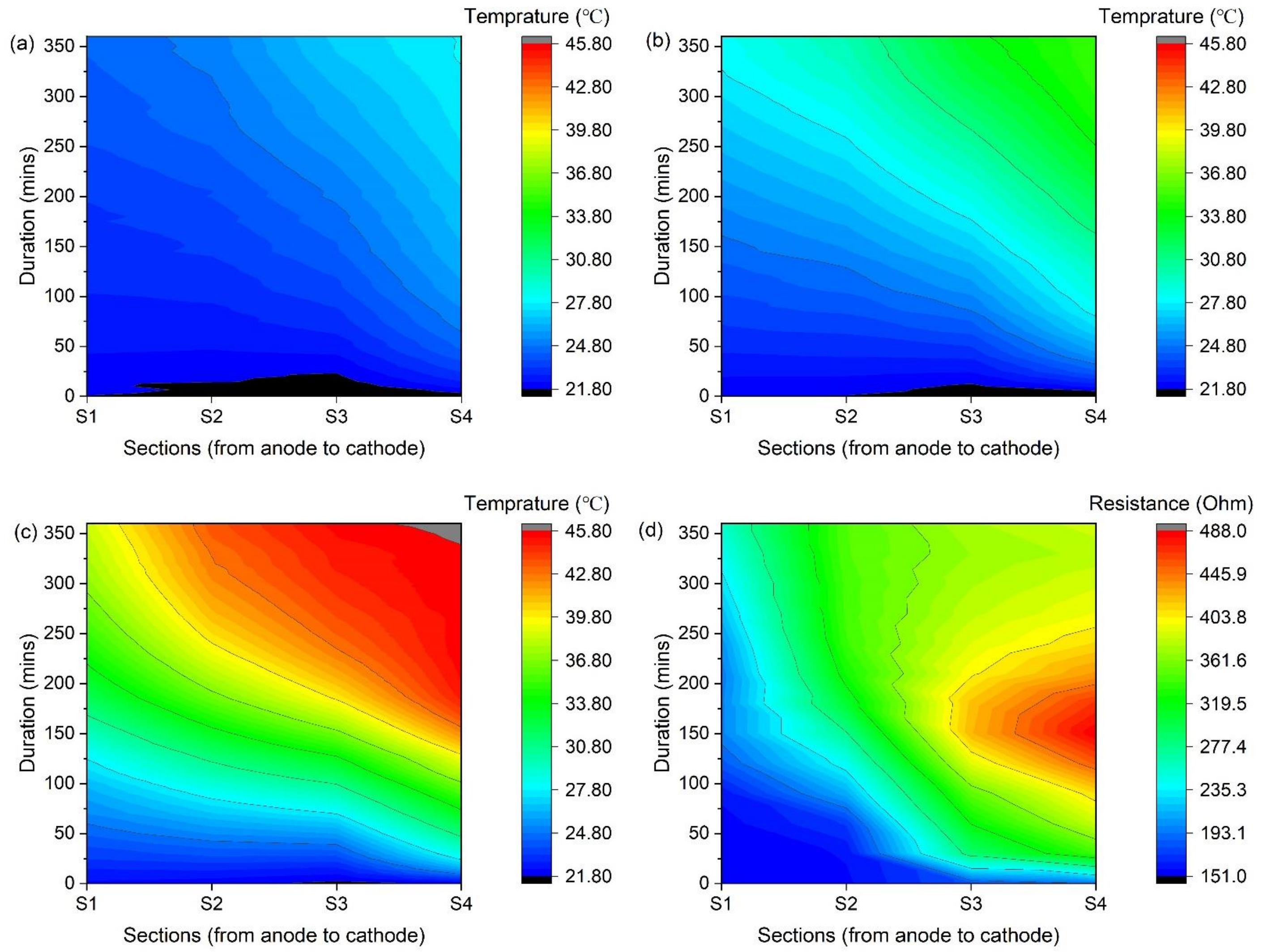
Drying curves after non-linear least-squares minimization and curve fitting of A0-S1 (c) A0-S4 (d) C0-S1 (e), and C0-S4 (f) . B – Bond water, S – Surface water, I – Interstitial water, F – Free water.



➢*Influence of electrochemical reaction on dewaterability*

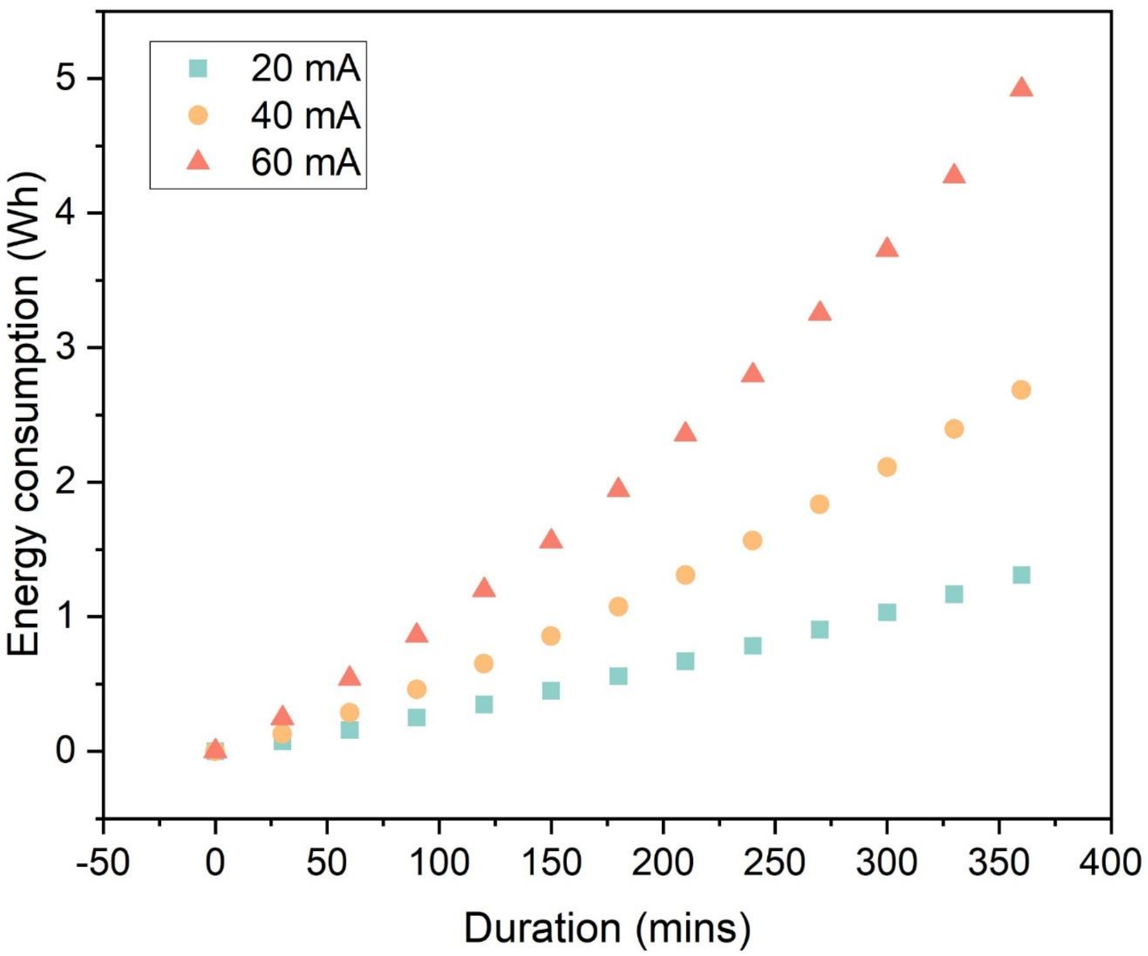
According to Joule's law, the ohmic heating is expressed as Eq. (1):

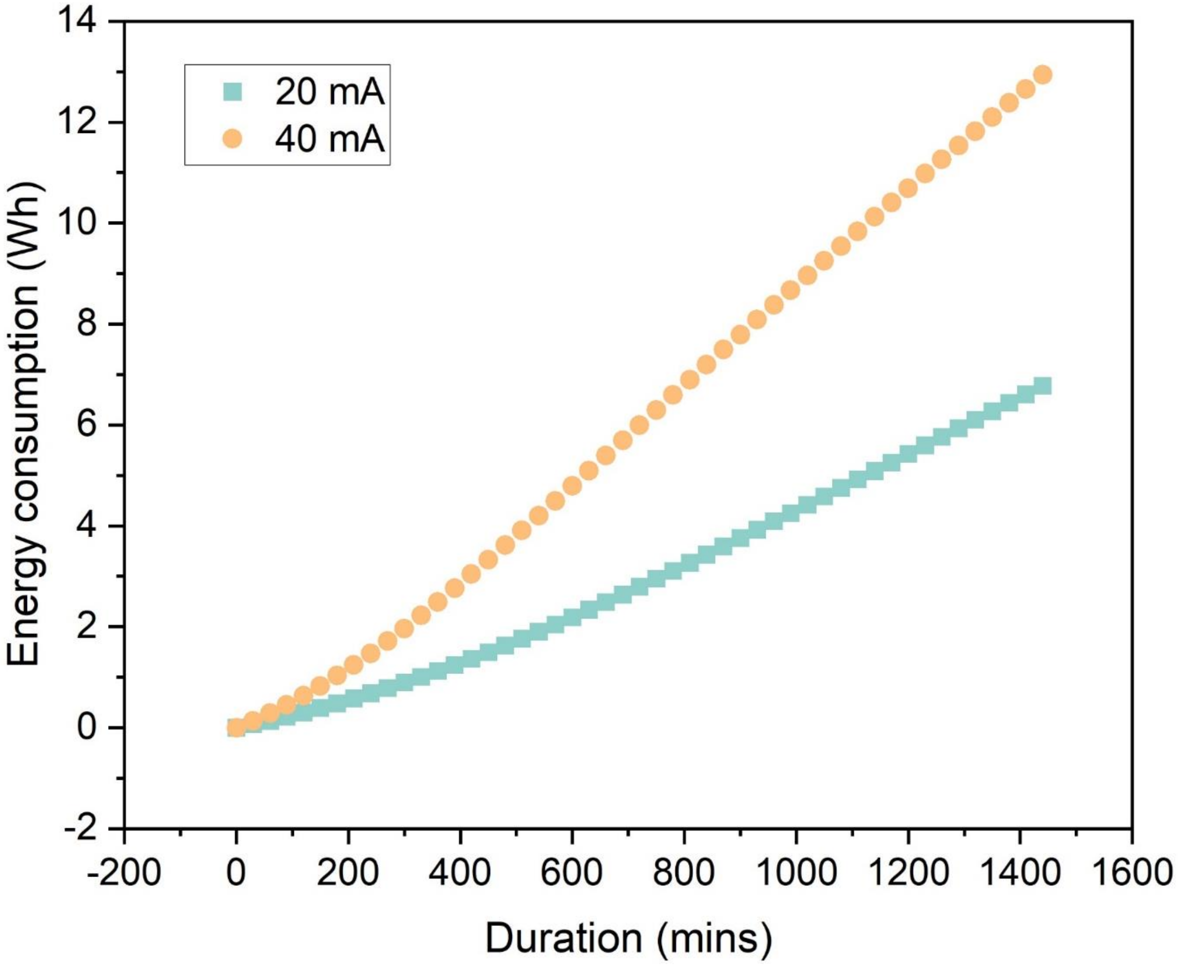
$$Q = I^2 R_{cell}$$



Development of temperature in group A0 (a), B0 (b), and C0 (c), resistance changes of group C0 (d)

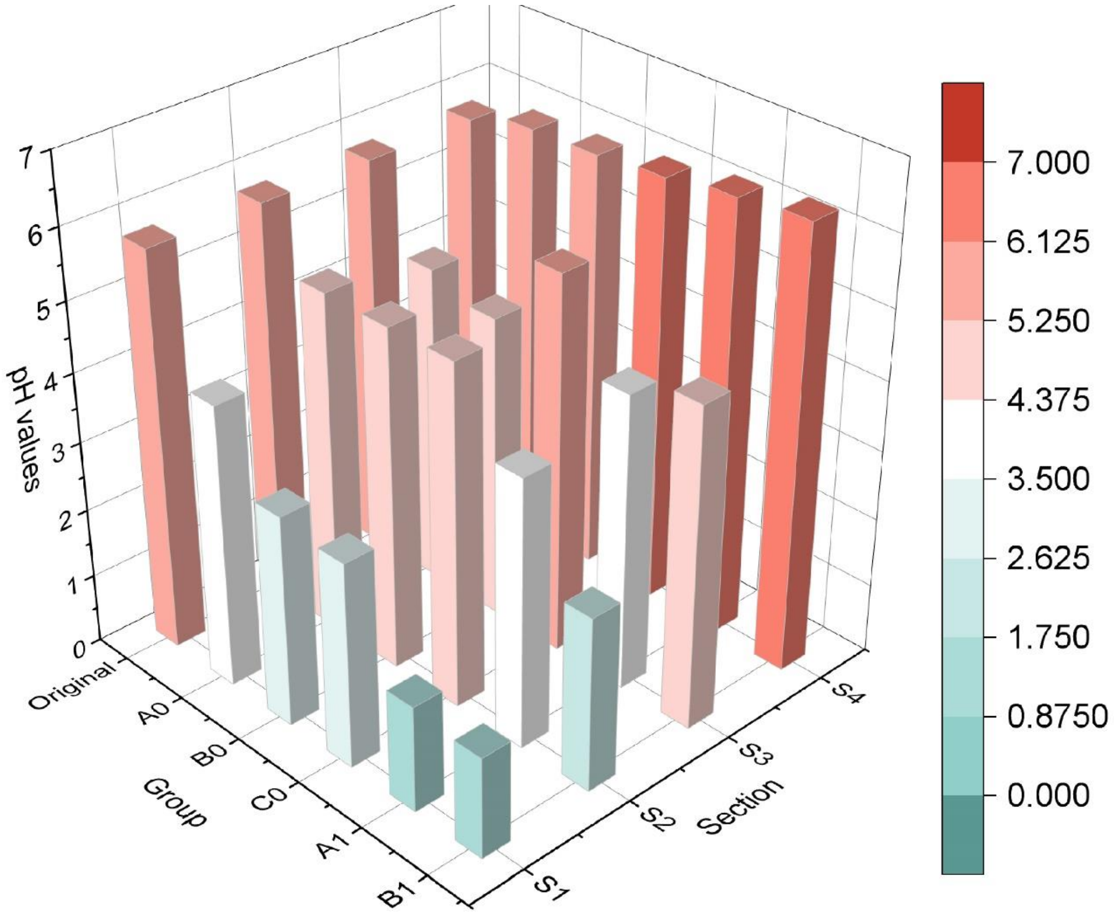
➢*Cost estimates and overall assessment of the practical application*





Energy consumption during the dewatering process

➢*Cost estimates and overall assessment of the practical application*

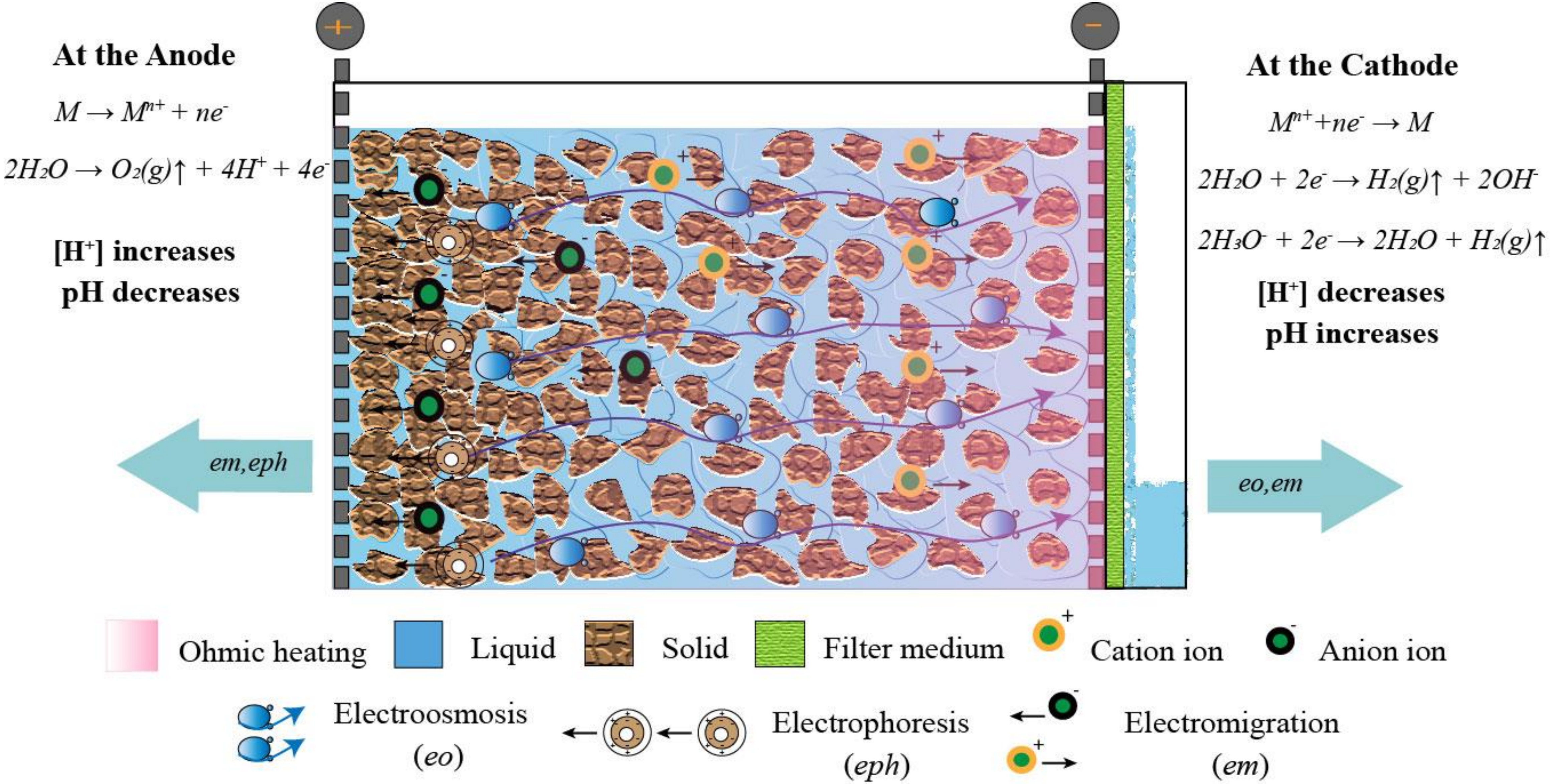


Development of sediments' pH

- Only Na and K were extracted around 4% - 15% and 25% - 45%, respectively.
- Concentrations of Ca, Mg, and Fe were also found to be lower at the anode and higher at the cathode after electroosmotic dewatering.
- A higher concentration of P was found at the anode.

How should we disposal of the treated sediments?

Conclusions and perspectives



Schematic representation of the electroosmotic dewatering with different mechanisms of liquid and solids occurring when lake sediments is placed in an electrical field

➢*Conclusions*

➢All four types of free, interstitial, surface, and bond water existed in raw sediments. Electroosmotic dewatering could effectively reduce the mass of sediments by removing free and part of interstitial water, but the optimal duration and current should be considered to balance water removal and energy consumption.

➢A higher current can enhance the dewatering with lower energy consumption, where ohmic heating may help to decrease viscosity and release the water from the capillary. However, it may result in excess ohmic heating, more precipitates, and gas generation (especially near the cathode), thus decreasing energy efficiency and compromising the system's stability.

➢The current conditions did not significantly extract heavy metals or P from the sediments, which may facilitate the disposal of the removed water. The considerable changes in metals and P distribution suggest that this could lead to reusing treated sediments from different sections in different fields like construction, P extraction, etc.

➢*Perspectives*

➢Future work should aim to improve the contact between the cake and the electrodes, the sediments particles, and the efficient release of gas to maintain the systems stability.

➢It should also consider pretreatment to weaken the bond between the remaining moisture and the sediment particles and alleviate the excess ohmic heating to improve the electric energy efficiency for commercial viability.

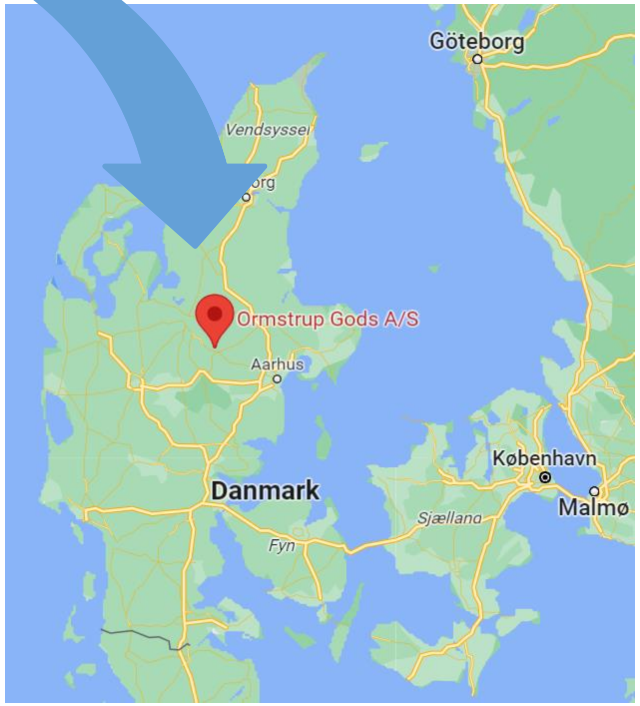
The rePair Project

- Circular lake restoration: transforming lake sediments into valuable products. Lake Ormstrup is used as demonstration lake.

Size: 12 acers

Average depth: 2.3 m.

Maximum depth: 5 m.



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Thank you for your attention!!!
Comments and suggestions?

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Funded by

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