LAB AND MODELLING TESTS TO DEVELOP A GEOELECTRIC MONITORING SYSTEM FOR MUNICIPAL SOLID WASTE LANDFILLS

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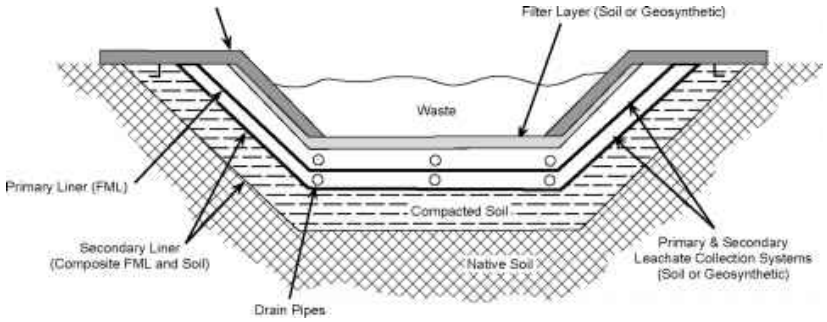
MUNICIPAL SOLID WASTE LANDFILLS (MSWLFs)

The substrate of the base and sides of the landfill consists of a natural geological formation that meets the requirements of permeability and thickness.

- **Hydraulic conductivity**
- **Layer Thickness**
- **Single or double liner**

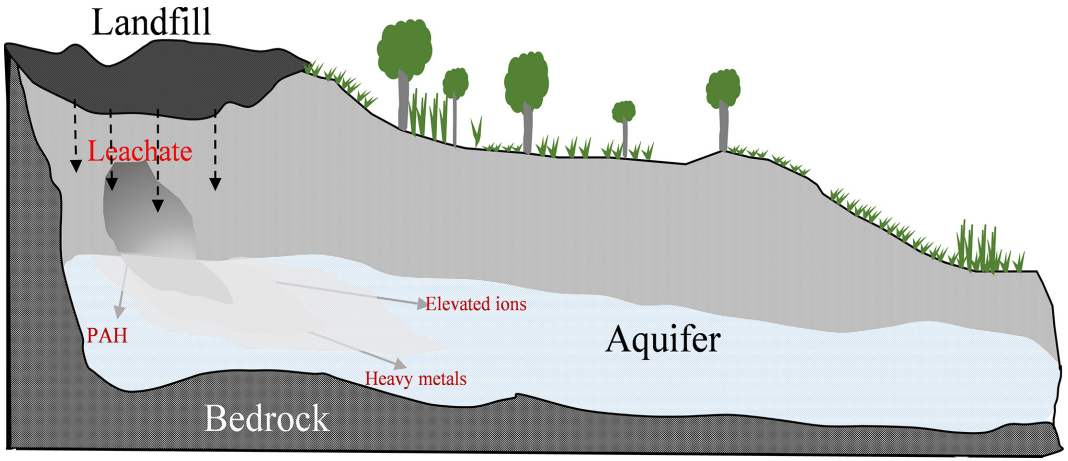


W.C. Blackman, 1992.

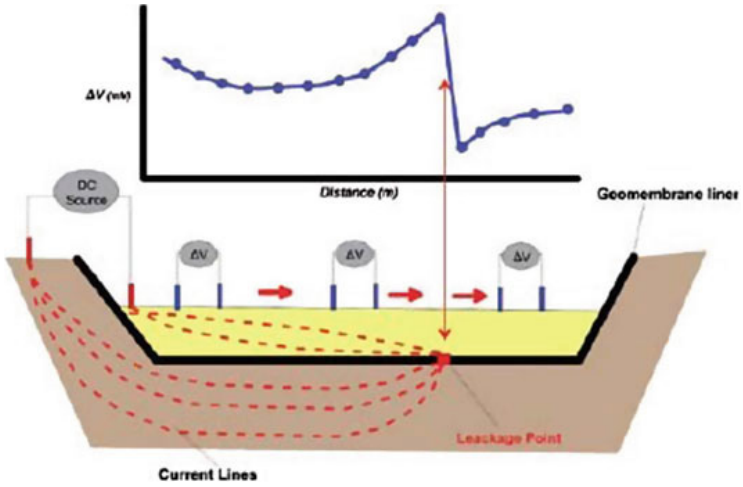
Installation of the HDPE liner by using a long arm excavator [https://www.agru.at//]

ISSUE

- **Damage to the HDPE** membrane would lead to the diffusion of highly polluting **leachate** into the **aquifer**.
- **Alterations in the liner** covered by the waste are difficult to detect.



Abiriga et al, (2020)



Liner hole detection in landfills (from Tsourlos et al. 2014)

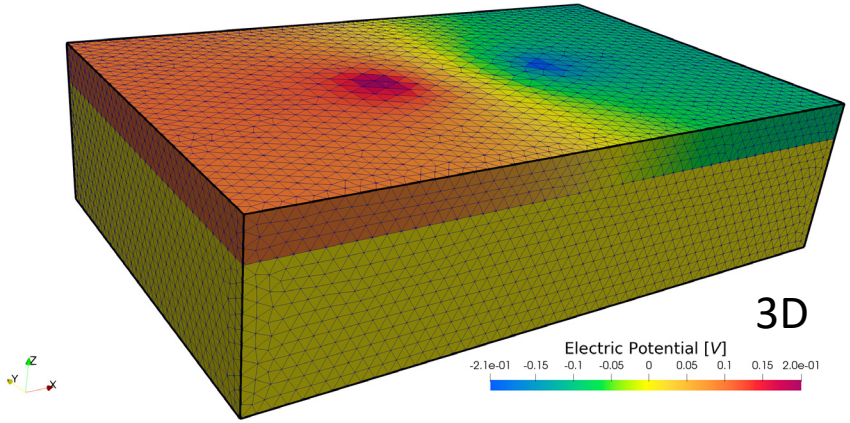
APPROACH - METHODS

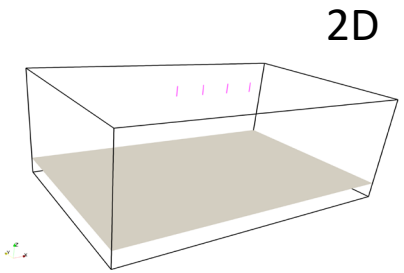
- **GEOPHYSICAL DC METHODS**

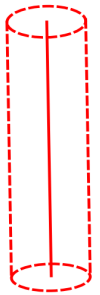
→ Resistivity **ρ** [Ωm]

→ Induced polarization (**IP**)
Chargeability **M** [$\frac{mV}{V}$]

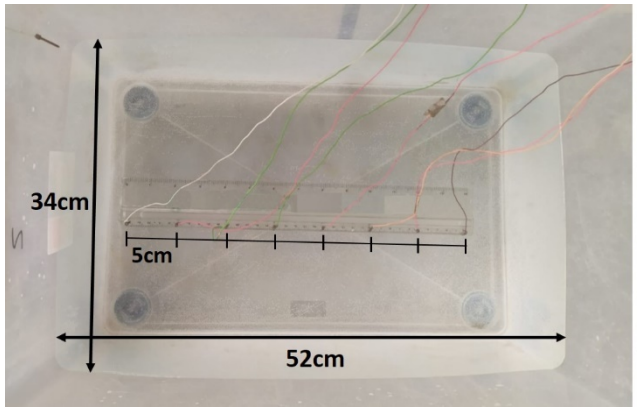
- **NUMERICAL MODEL** → **FE** Mixed dimensional modelling scheme programmed in Python

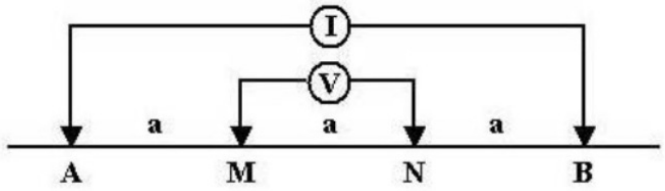






- **DOWNSCALED TESTS**



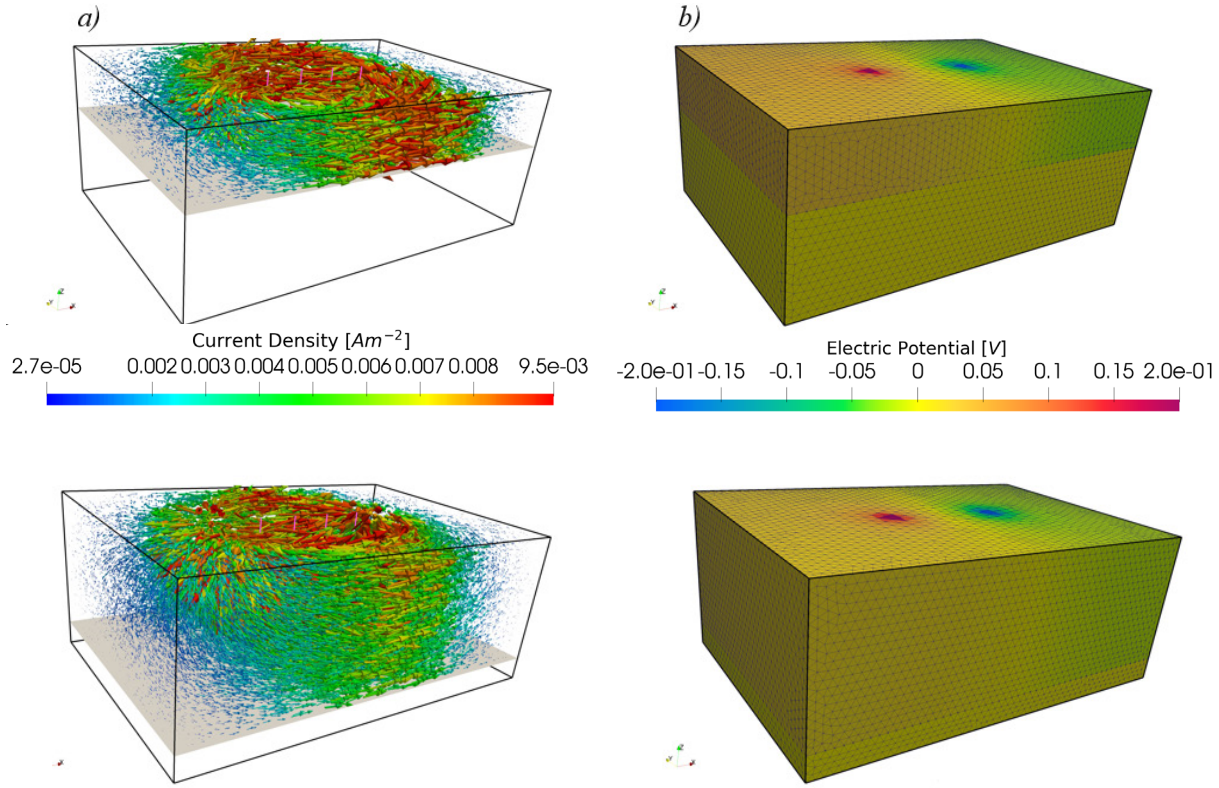


$$\rho_A = 2\pi\ a\frac{V}{I}$$

- **Homogeneous** material
- **Wenner-Alpha** array
- **Controlled parameters**
- **ρ [*Ωm*] measured** with a multimeter (Crison MM40+)
- Values measured with Georesistivimeter **IRIS Syscal Pro**
- Avoid **3D effects**

VALIDATION OF THE NUMERICAL MODEL

- **RESULTS**



Visualization with Paraview software of cases with depth equal to 3 and 17 cm

- Measured values match the modelled ones
- Current propagation **hampered by the liner**.
- Horizontal spread in the case with membrane at 3 [*cm*] of depth.
- **Marked «jump»** in the Electric Potential corresponding to the liner.
- Values close to zero under the membrane.

CONCLUSIONS

- Geoelectrical methods could be employed to monitor MSWLFs.
- **Estimated apparent resistivities do change because** current flow and non-null voltages are **vertically confined by the interface** and their distribution in the horizontal plane is also influenced.
- **Measured data are very similar to modelled ones**, obtained **with a hybrid-dimensional modelling scheme**, but both datasets have apparent resistivities that are overestimated with respect to the theoretical ones, probably because of the **high ratio of the electrode length to the electrode spacing** and to the influence of the **highly resistive membrane**.

ONGOING RESEARCH

- laboratory experiments on a **larger scale**
- Introducing **holes in the liner** to analyze their effect on current flow and voltage differences measured at the surface.
- Solution for the **inverse** ill-conditioned **problem**

THANK YOU FOR THE ATTENTION!