



COCOON
Interreg Europe



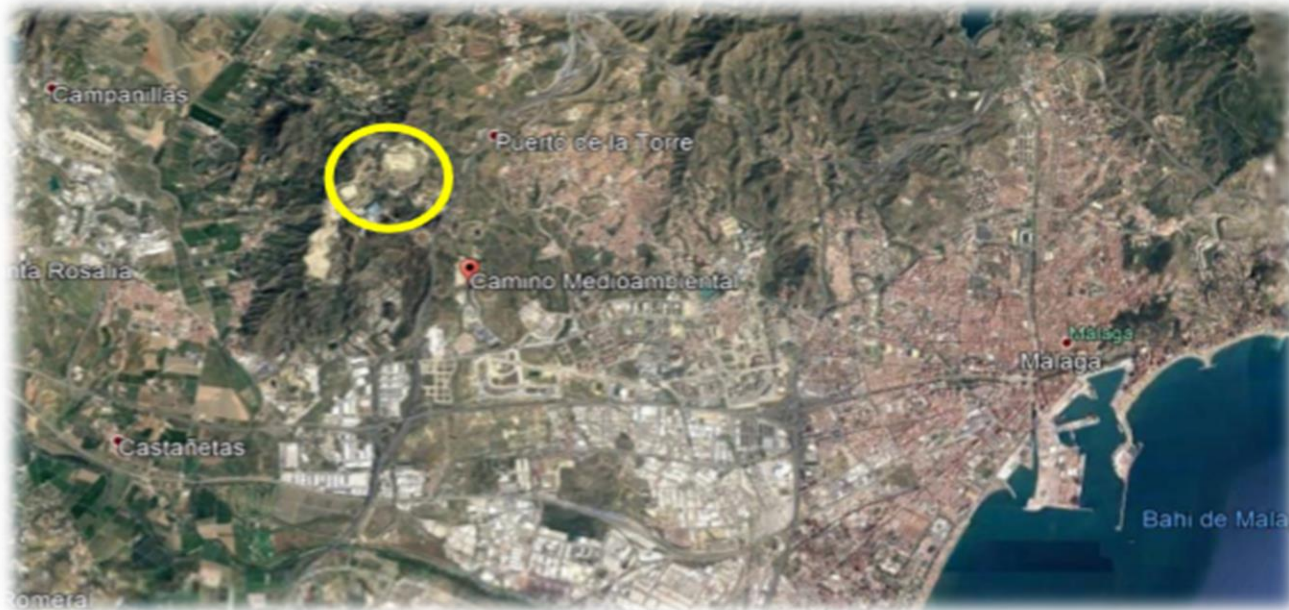
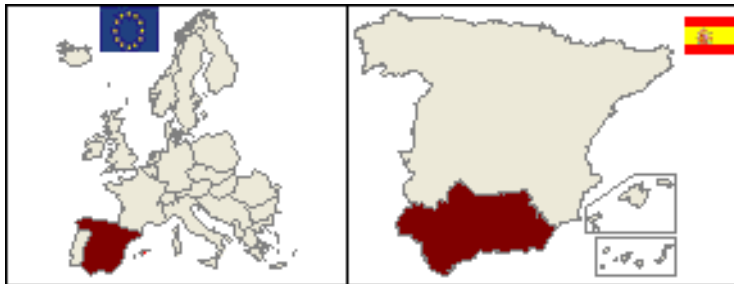
European Union
European Regional
Development Fund

GEOPHYSICAL PROSPECTION (ERT) FOR THE DETECTION OF ACCUMULATION OF LEACHATE IN A MUNICIPAL SOLID WASTE LANDFILL

Postdam 6th February 2019

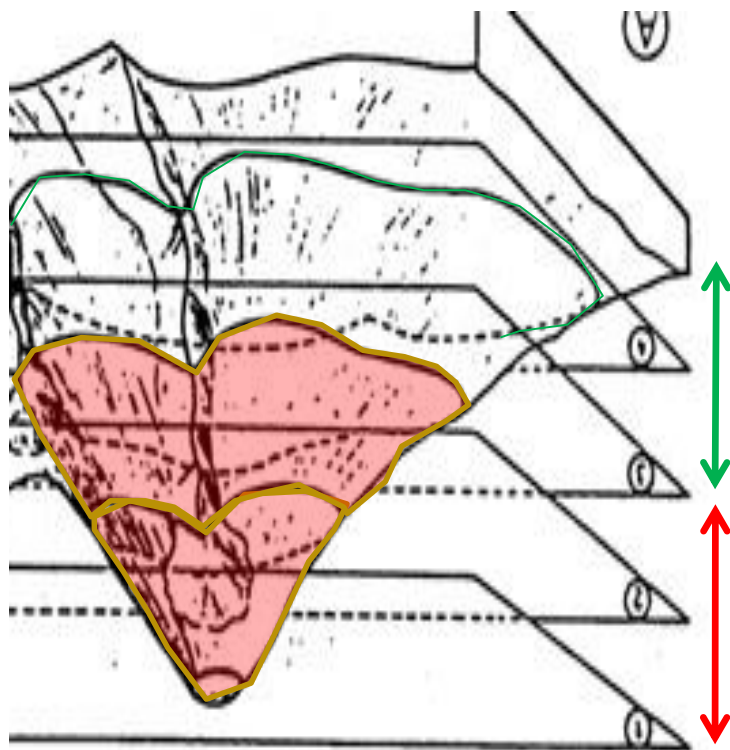
7th Interregional Exchange of experience meeting of COCOON

LOCATION: ENVIRONMENTAL CENTER "LOS RUICES" MÁLAGA



5 km from Malaga city

LOCATION: MSW LANDFILL AT "LOS RUCES" MÁLAGA



**In theory, there are two different landfills:
Sanitary landfill (2^o) is built above the sealing
of previous non sanitary landfill (1^o)**

2^o) From 2003 to 2010 sanitary landfill
in line with EU directive (no complete
sealing system)

1^o) From 1994 to 2002 non sanitary landfill
(before Directive) with sealing
system in line with EU directive

Landfill is located at a **natural depression** (talweg).

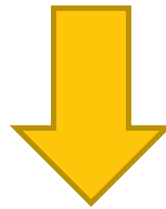
LOCATION: ENVIRONMENTAL CENTER “LOS RUICES” MÁLAGA

800 t/day
Av. density : 0,6 t/m³
Av. depth: 50 m



Why to apply Electrical Resistivity Tomography?

Since landfill was built upon another landfill, “*unpredictable behaviour was expected*”, **specially risk of instability**



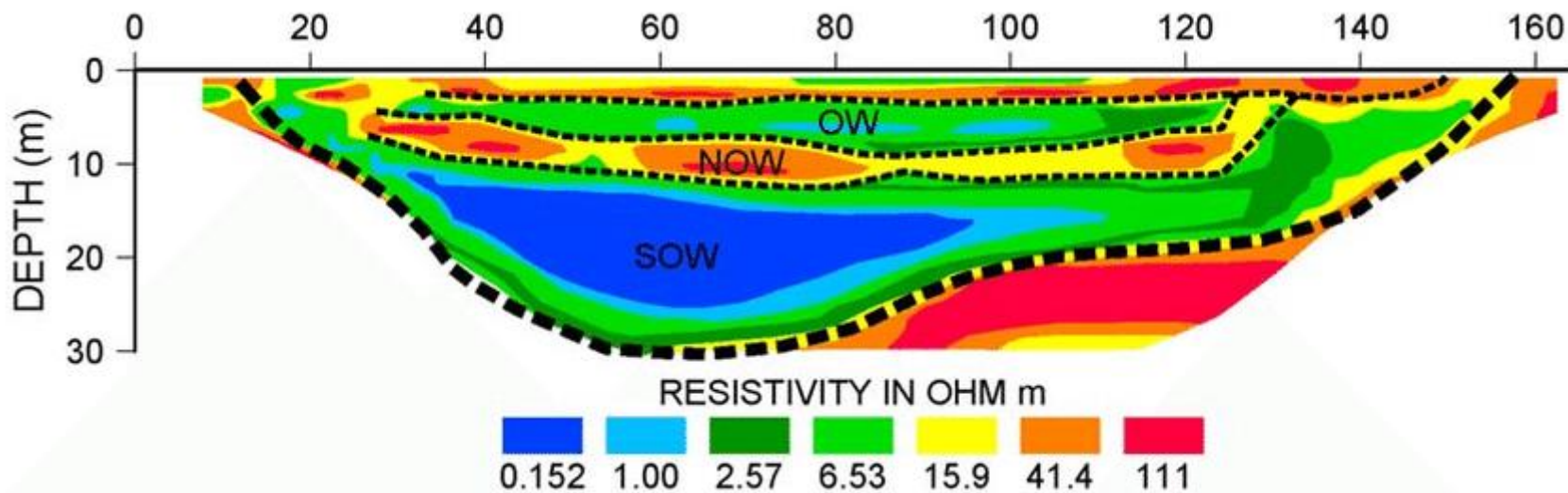
Need for acquiring data about landfill but
minimising the affection on waste mass to
avoid collateral effects



Non-invasive geophysical technique: ERT

Objective of ERT in MSW landfill?

Detection of landfill areas with high content of leachate



Improving landfill
management and aftercare



Avoiding unexpected settlements in
order to guarantee landfill stability



What is ERT?

Electrical resistivity tomography (ERT) is a geophysical technique for imaging sub-surface structures from electrical resistivity measurements made at the surface of landfill.

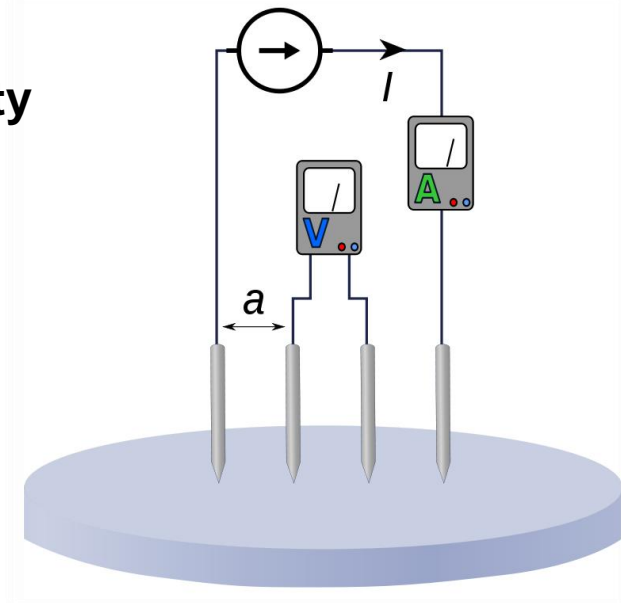
The resistance of a material, as well as its nature, depends on factors like porosity, the geometric arrangement of the pores, the proportion of pores filled with water or leachate in comparison to dry holes and resistance of the liquid filling.



“How does ERT work”?

Introduction of a continuous current of a known **intensity** into the ground by two electrodes. The **difference in power** is measured by two other electrodes

Both measurements allow to obtain the apparent resistance in several points of the substratum.



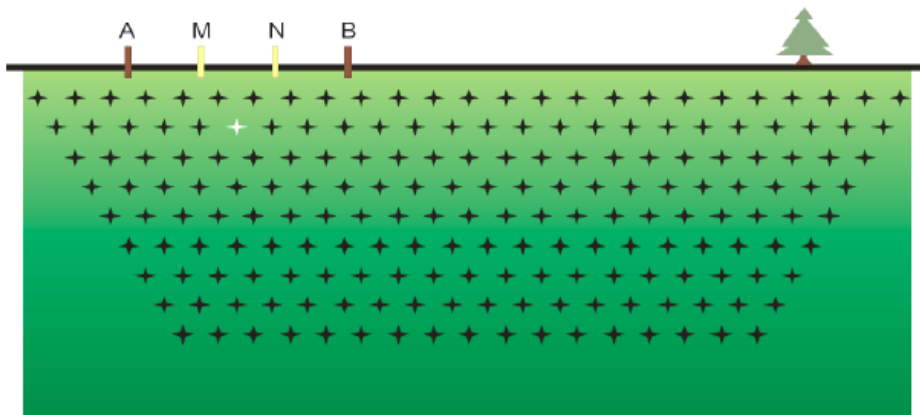
ARRAY NAME	ELECTRODE CONFIGURATION
GRADIENT	
DIPOLE-DIPOLE	
POLE-DIPOLE	
SCHLUMBERGER	
WENNER	

According to electrode configurations, different results are obtained. In the case of Los Ruices landfill two methods were applied to increase data reliability.

“How does ERT work” in landfill?

Several electrodes and measuring equipment are placed on the surface of the landfill, working with a specific sequential programme.

The distance between electrodes in the profiles will be conditioned by the required resolution level and the depth needed.



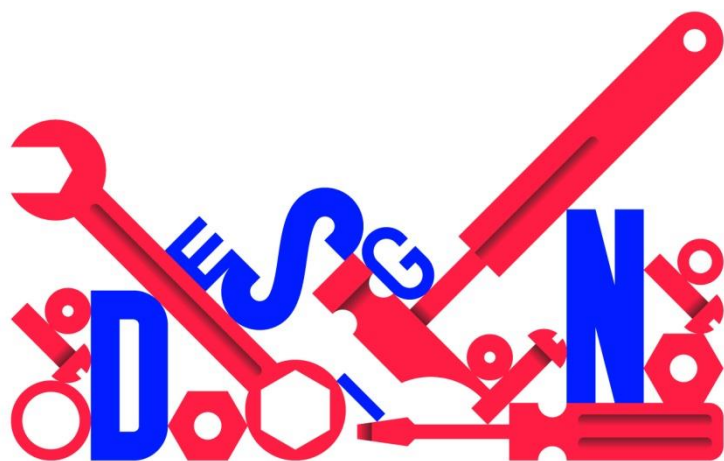
“Los Ruices” landfill distance between electrodes was 5 meters

Fig: Results provided via Wenner-Schlumberger electrical configuration

How to design application of ERT technique in landfill?

Before starting the field campaign, it is necessary to review:

- ✓ LfM exploitation plans
- ✓ Reports and annual controls



...in order to determine the areas with a greater possibility of having accumulations of leachate and **design** a campaign of profiles.

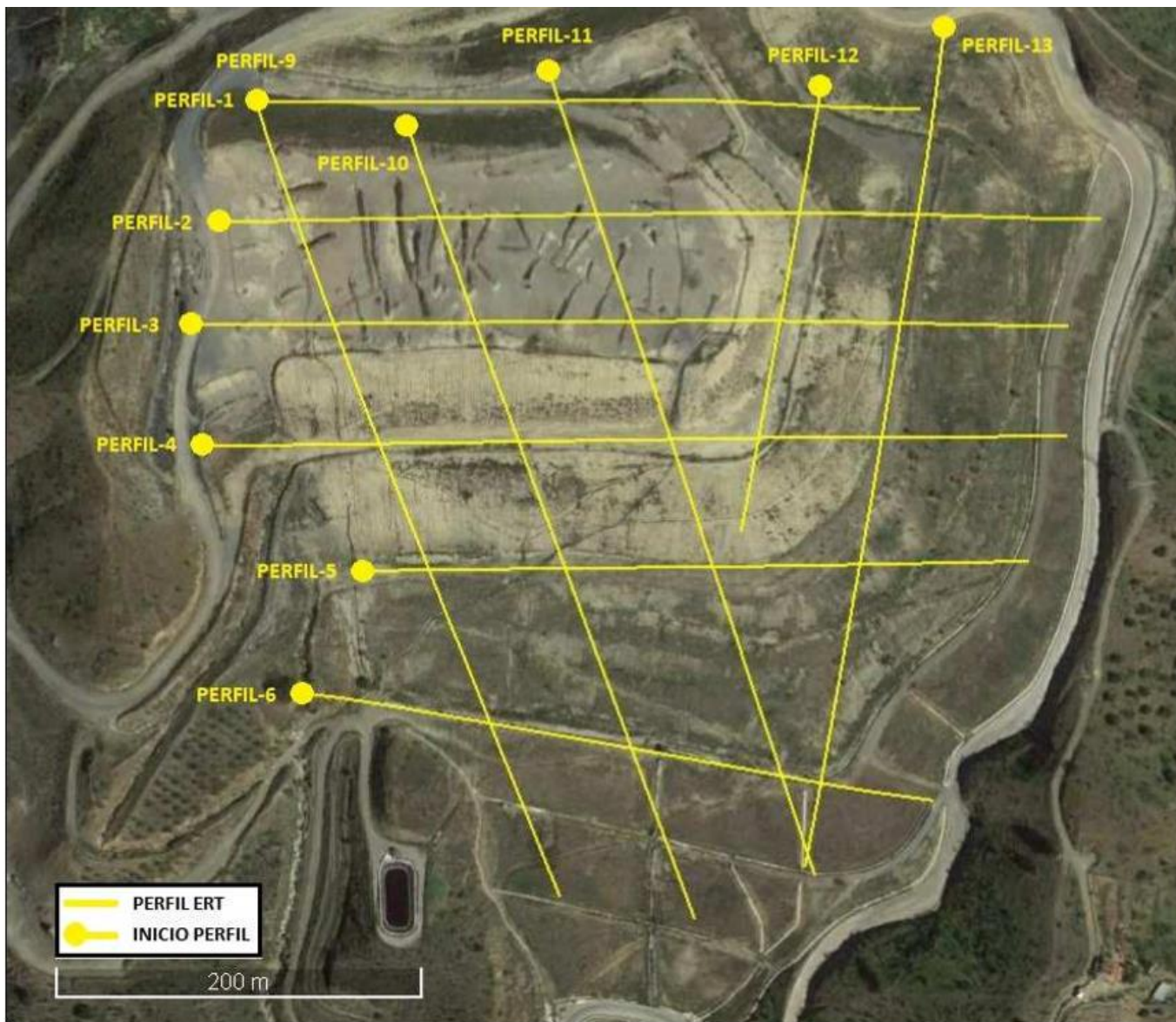
How to design application of ERT technique in landfill?

- The centre of the profiles (deepest info) must be above the expected thickest areas.



- The profiles follow three main directions, trying to achieve the straightest line and following the existing limits.

How to design application of ERT technique in landfill?



Length: 265-470 m

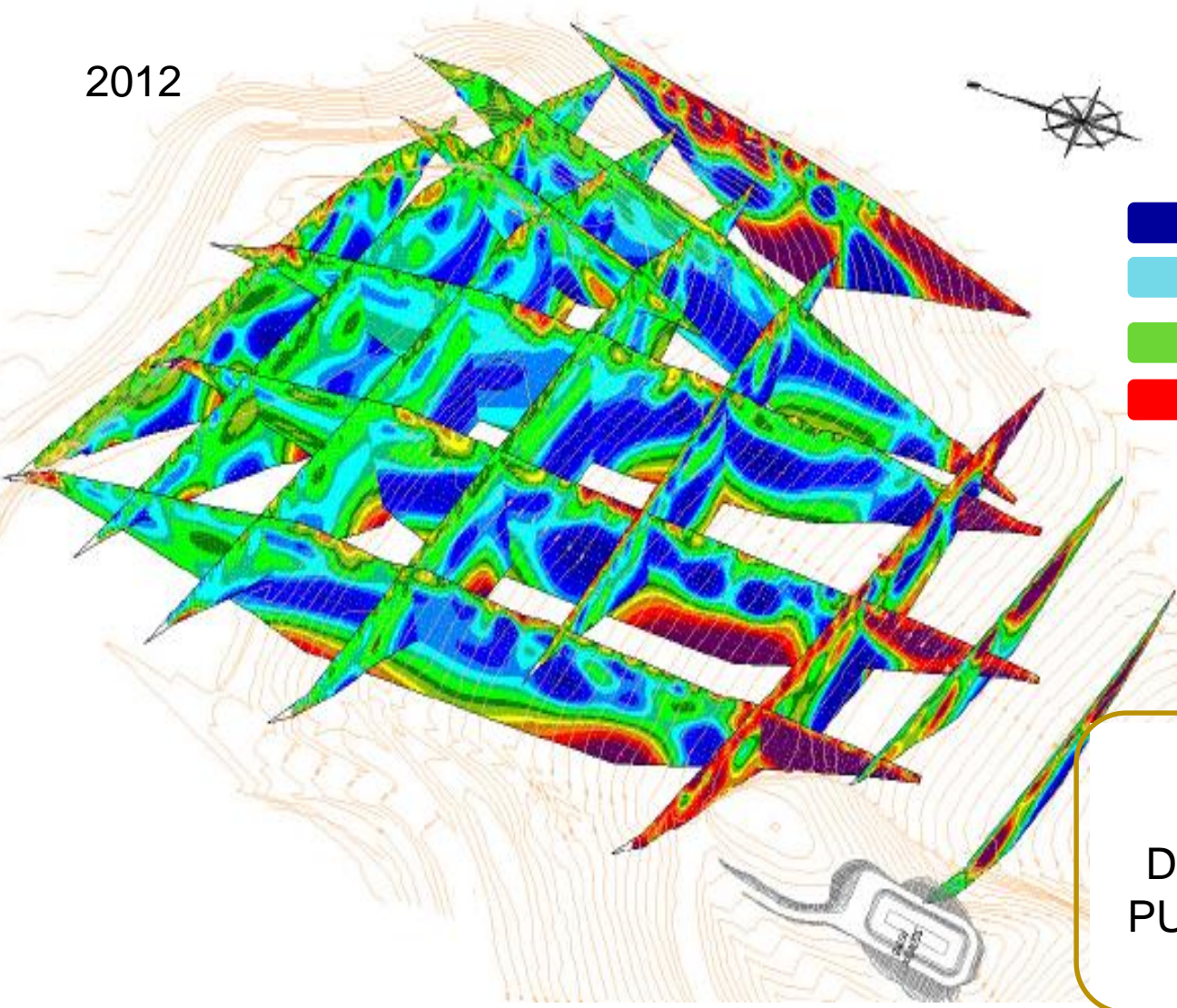
Max Depth: 50-70 m

Number of electrodes: 54-95

Number of resistivity measures:
2500-9000

Results of application of ERT technique in landfill

2012



- 0-5 ohm x m resistivity
- 5-15 ohm x m resistivity
- 15-50 ohm x m resistivity
- >50 ohm x m resistivity

RESULT IN 2012
DRILLING OUT AND PUMPING LEACHATE IN 6 LOCATIONS

D
R
A
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ERT Costs for Los Ruices Landfill

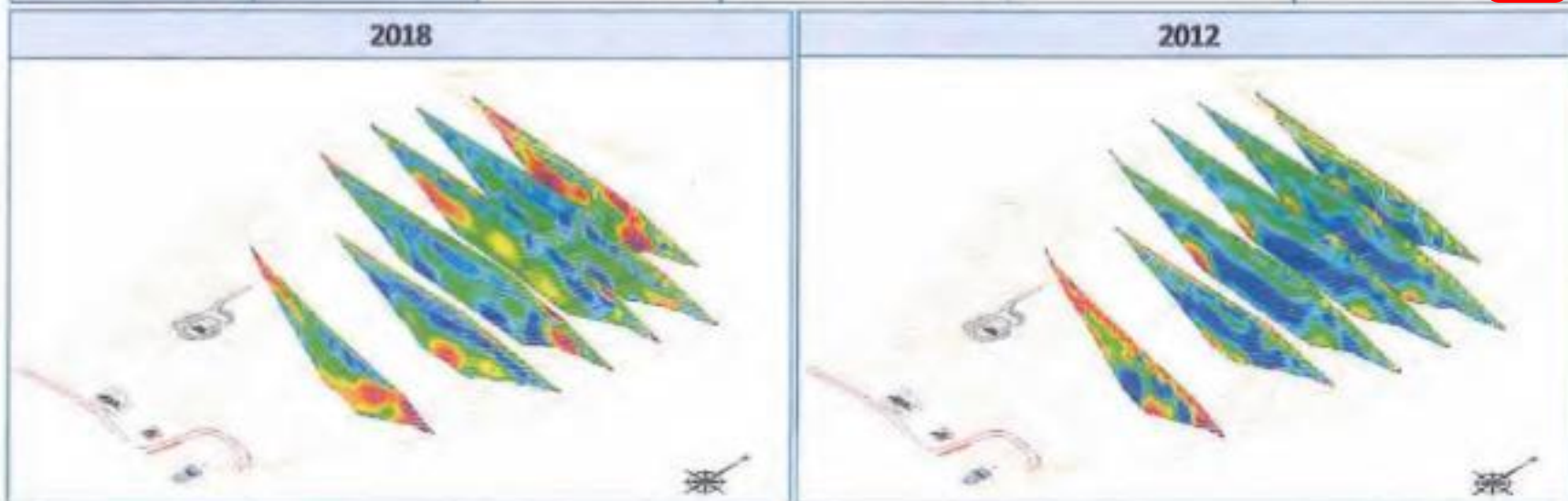
Concept	Unit price	Units	
Field work and equipment	750	1	750,00 €
Linear meter of ERT profile	1,78 €/m	4590 m	8170,20 €
Data process and Reporting	750	1	750,00 €
TOTAL			9670,20 €



Time	
Field work	3-5 days
Processing info	1 week

Comparison of ERT in 2012 and 2018

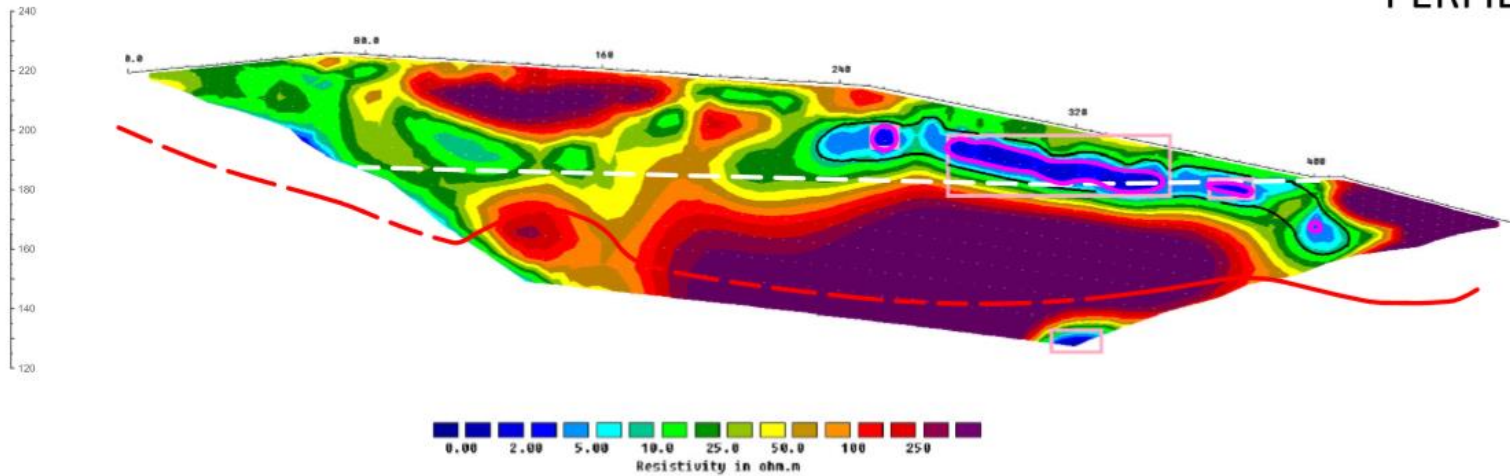
PERFIL	AÑO ESTUDIO	ETAPA	SUP _{SECCIÓN} (m ²)	SUP _{SAT} (m ²)	SUP _{SAT} (%)	
TOTAL PERFILES TRANSVERSALES	2018	ETAPA 2	50.794	4.436	9%	
		ETAPA 1	42.450	3.264	8%	
		TOTAL	93.244	7.699	8%	
	2012	ETAPA 2	48.643	2.405	5%	
		ETAPA 1	41.104	18.218	44%	
		TOTAL	89.747	20.624	23%	
	VARIACIÓN 2018-2012					
		ETAPA 2	4%	84%	4%	
		ETAPA 1	3%	-82%	-37%	
		TOTAL	4%	-63%	-15%	



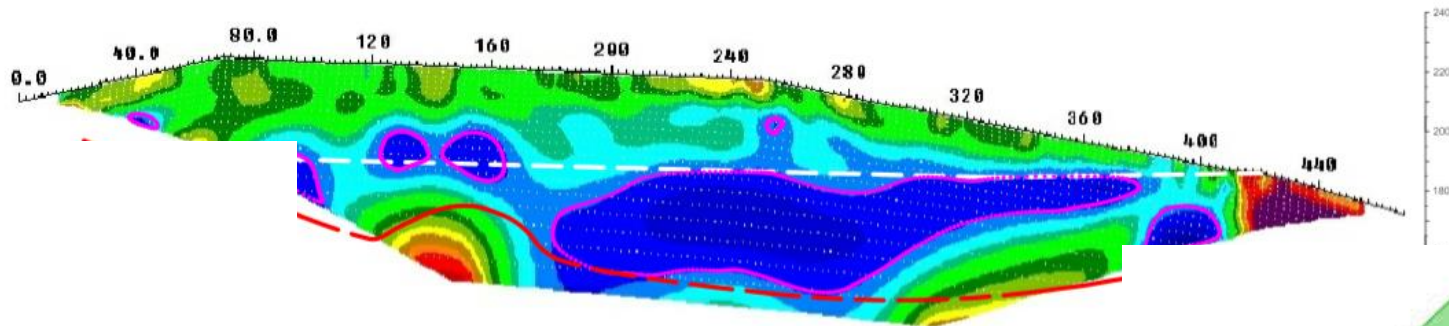
Comparison of ERT in 2012 and 2018

PERFIL 13

2018



2012

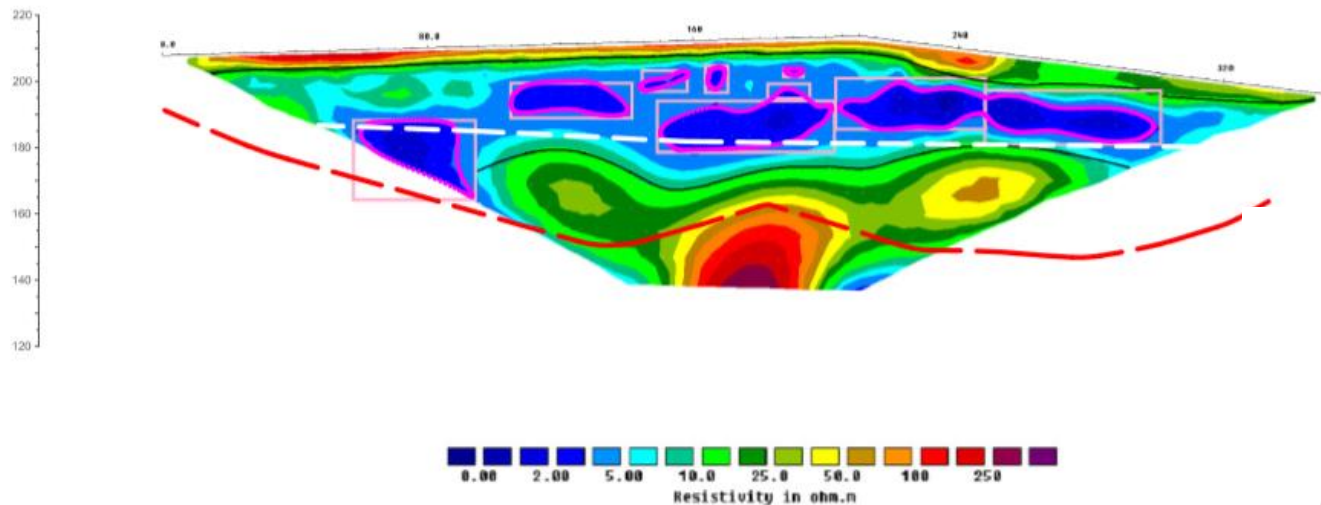


PERFIL	AÑO ESTUDIO	ETAPA	SUP _{sección} (m ²)	SUP _{sat} (m ²)	SUP _{sat} (%)
P13	2018	ETAPA 2	9.543	527	6%
		ETAPA 1	9.945	49	0%
		TOTAL	19.497	577	3%
	2012	ETAPA 2	9.445	443	5%
		ETAPA 1	9.961	4.740	40%
		TOTAL	19.417	5.182	27%
	VARIACIÓN 2018-2012				
		ETAPA 2	1%	19%	1%
		ETAPA 1	0%	-99%	-47%
		TOTAL	0%	-89%	-24%



Comparison of ERT in 2012 and 2018

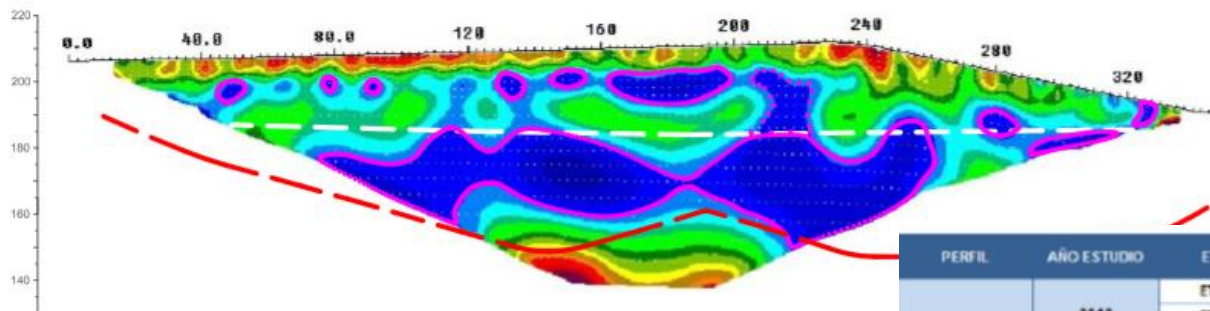
2018



PERFIL 5



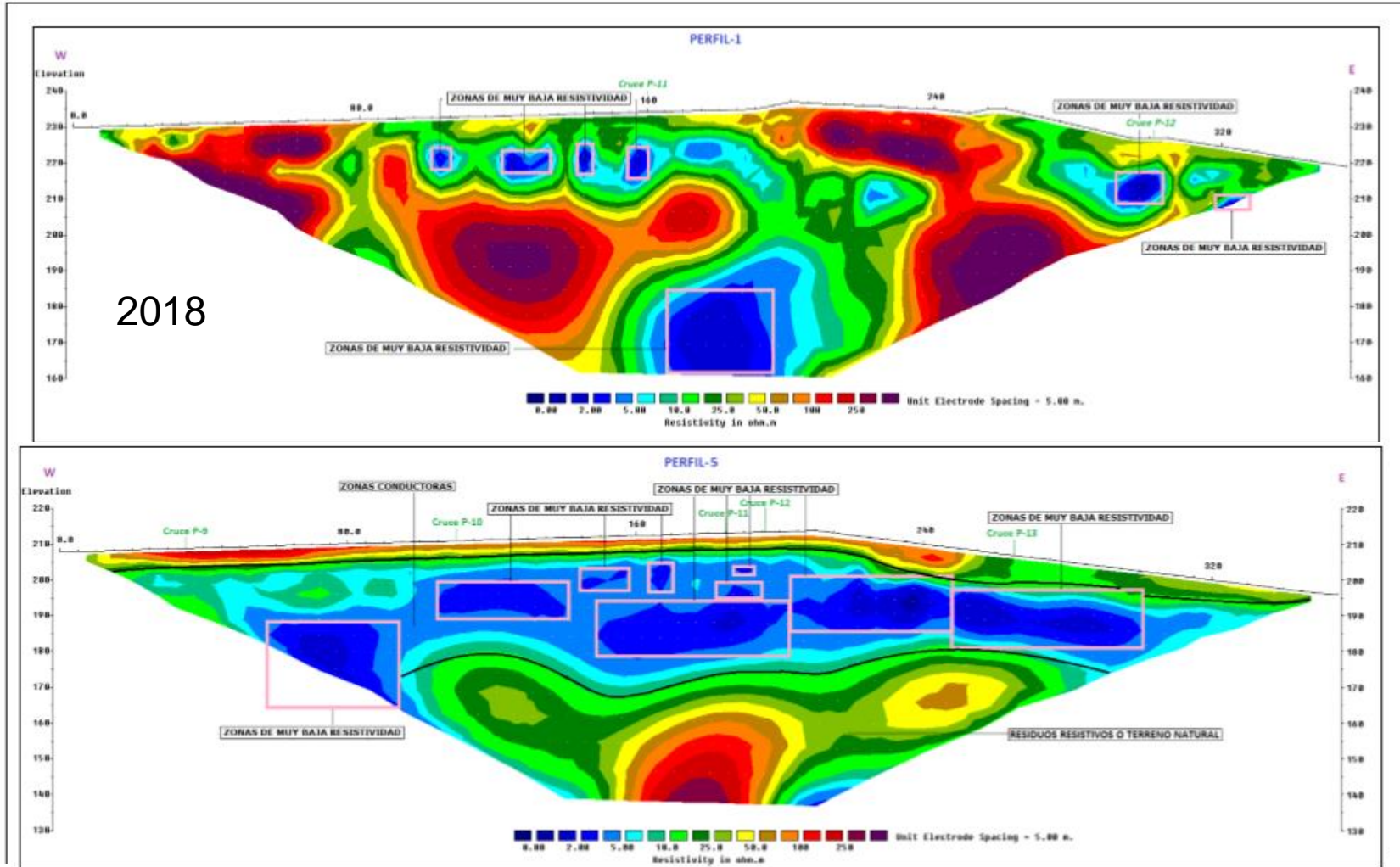
2012



PERFIL	AÑO ESTUDIO	ETAPA	SUP _{RECCION} (m ²)	SUP _{tot} (m ²)	SUP _{tot} /SUP _{RECCION}
P5	2018	ETAPA 2	7.784	1.775	23%
		ETAPA 1	5.350	411	8%
		TOTAL	13.133	2.186	17%
	2012	ETAPA 2	6.546	767	12%
		ETAPA 1	5.965	3.315	56%
		TOTAL	12.511	4.082	33%
	VARIACIÓN 2018-2012				
		ETAPA 2	19%	131%	11%
		ETAPA 1	-10%	-86%	-40%
		TOTAL	5%	-46%	-16%

Results of application of ERT technique in landfill

DRAW CONCLUSIONS



RESULTS IN 2018 PLANNING TO SLOPE OF PRE-SEALING TO INCREASE RAINFALL RATE AND INCREASING PRE-SEALING CLAY LAYER IN ORDER TO REDUCE INFILTRATION

ERT is a cost-effective decision making tool in LfM (landfill management) for:

- Identifying and partially characterizing materials inside the waste mass
 - Locating leachate acumulations
 - Controlling and monitoring landfill evolution and stability





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Thank you!

Questions welcome



Project smedia