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PS 5.3 The Future Changing Environment

Indirect root distribution detection by 2D Electrical Resistivity Tomography. Application to *Pinus pinea* root system, in different soil type with a field approach

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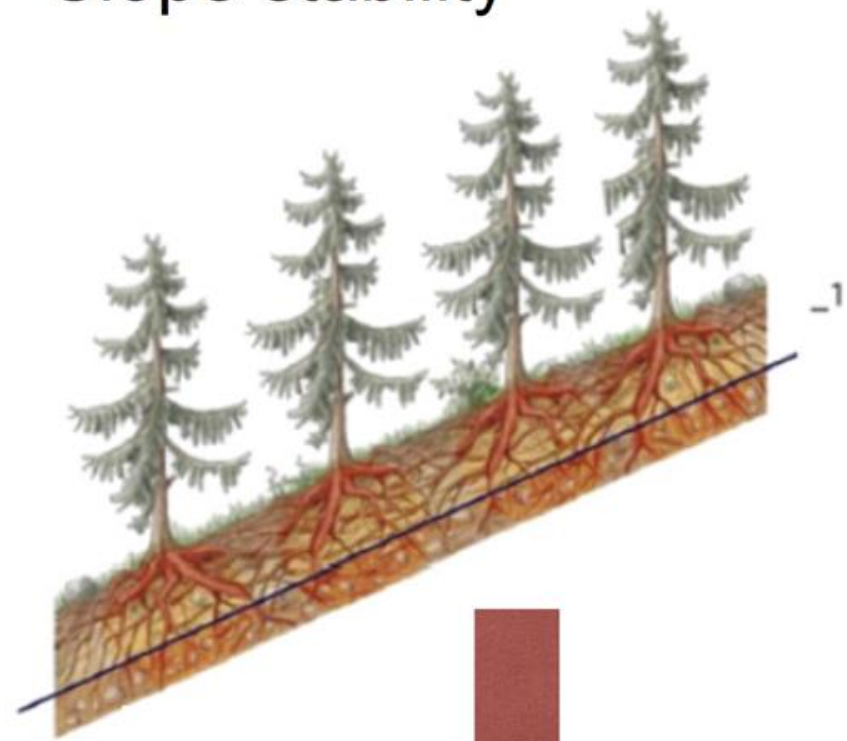
…studying the plant roots for:

Tree overturing

Slope stability



$$\textit{Root Cohesion}\ \mathbf{Cv}:\ \Delta S = k''\ Tr\ (Ar/A)[\text{sen}\ \theta + \cos\theta\ \tan\phi]$$

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DENSITY & DISTRIBUTION

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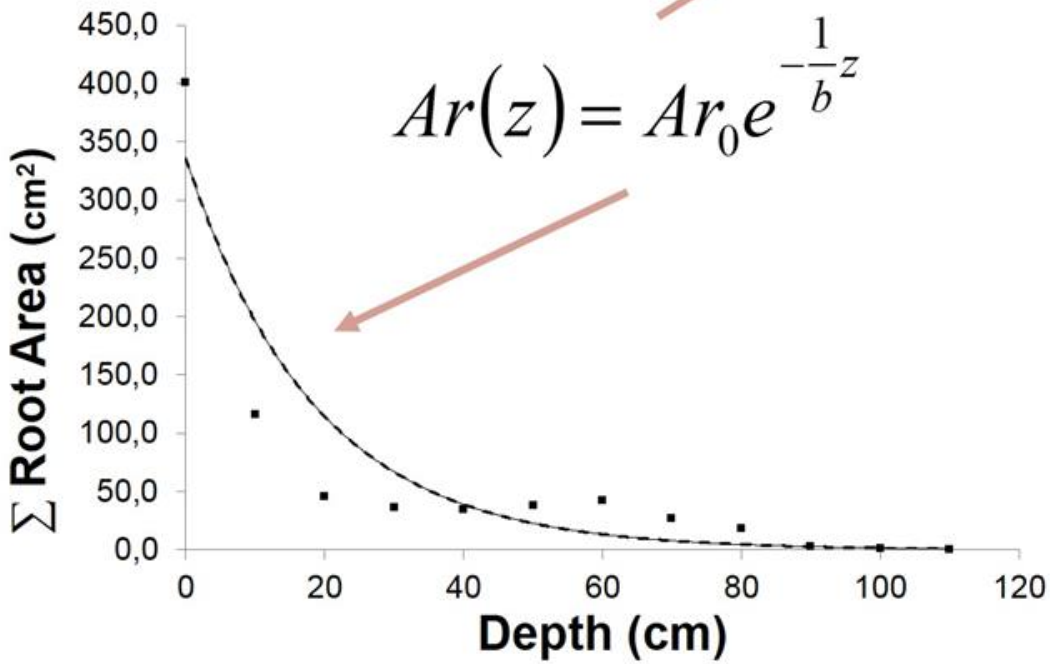
$$RAR\ z = \frac{Ar\ (Root\ area)}{As\ (Explored\ area)}$$

$$Ar(z) = Ar_0 e^{-\frac{1}{b}z}$$



CV

Modelling tree stability

Root reinforcement

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Usually, i dig plant roots, destroying root system and bringing the plants to death

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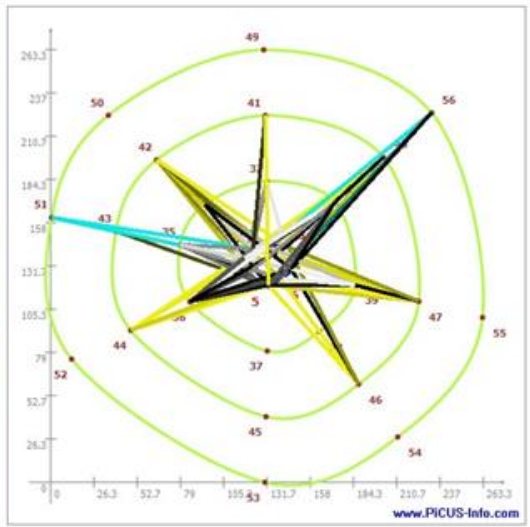
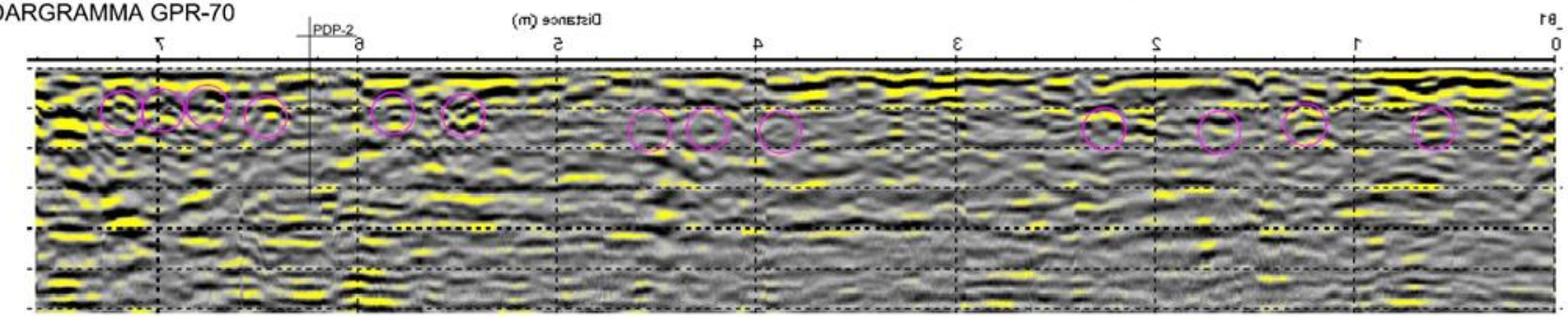
How we can assess plant roots, without digging them?

Arboradix – sonic tomography



GEORADAR

RADARGRAMMA GPR-70



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Plant roots presence affects soil resistivity?

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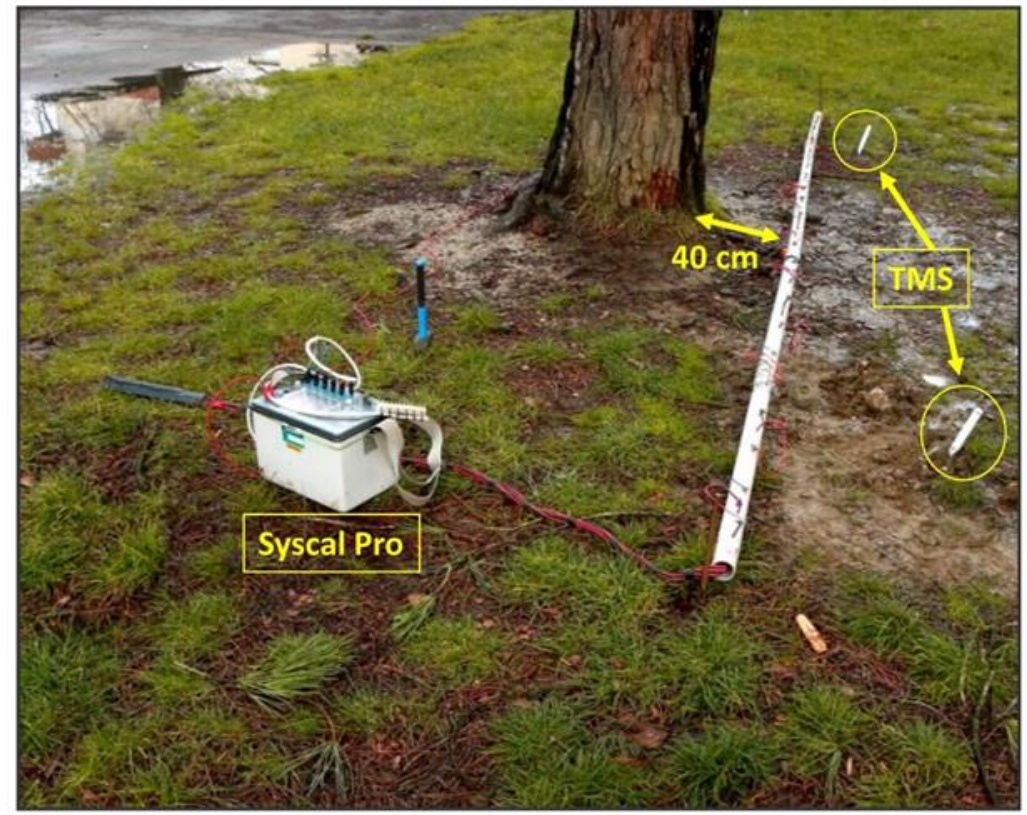
Materials & Methods

2 cases of study
- Sandy soil
- Urban soil

- 8 Stone pine (4+4)
- Adding water during the test
- Granulometric analysis of soil
- Soil moisture measured (TMS probes)

Site	Plant	DBH cm	Height m	Volume dm³	Crown area m²
AREZZO	1	59.55	12	1.748.16	91.61
	2	57.64	13	1.706.00	105.68
	3	59.55	13	1.821.05	75.43
	4	56.69	13	1.715.91	181.46
SAN ROSSORE	1	81.53	22	3.279.29	109.36
	2	60.51	23	2.575.82	47.78
	3	81.21	23	3.418.93	84.95
	4	71.66	22	3.448.97	95.03



ERT – Electrical resistivity tomography

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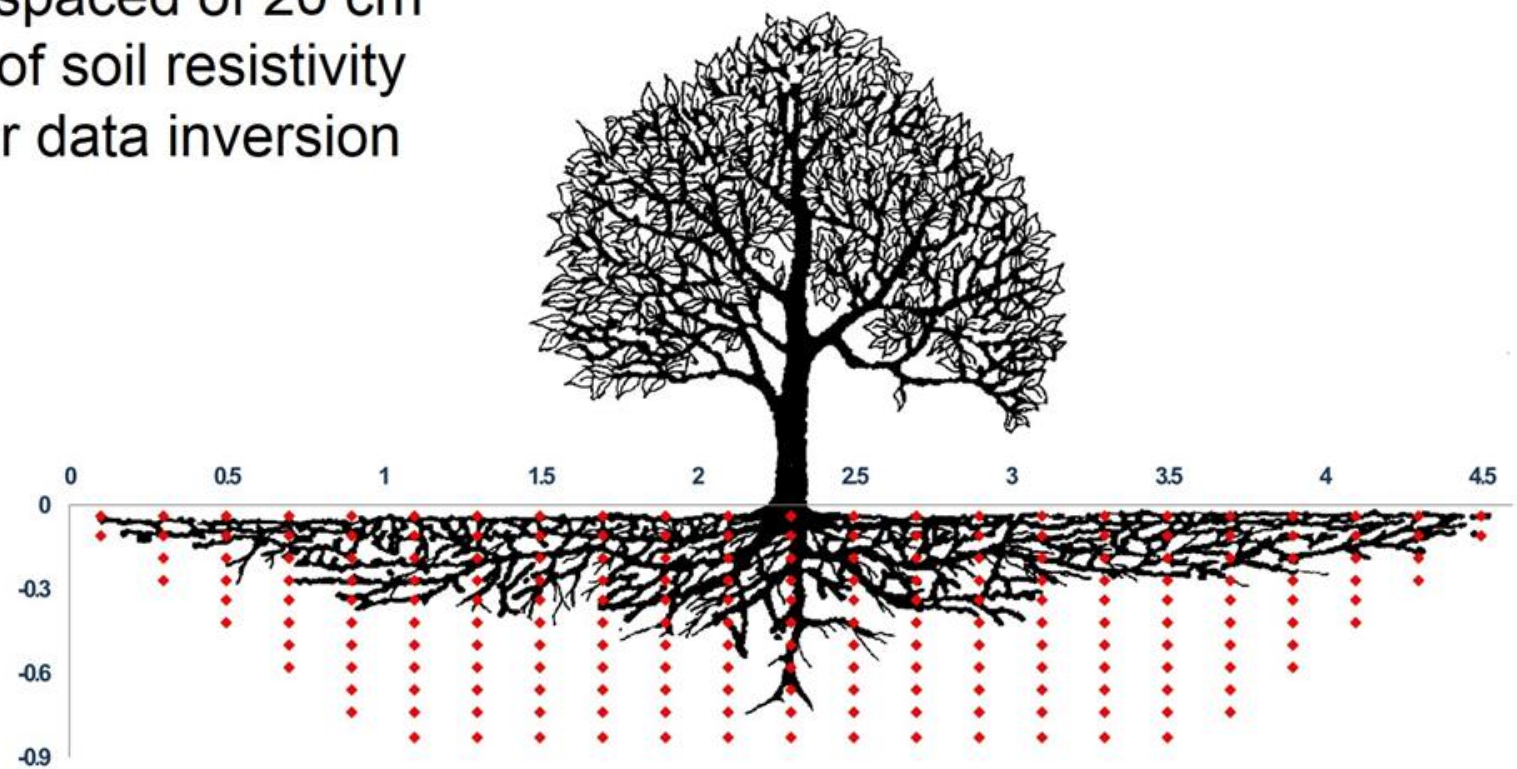
Resistivity measurement

- 2 measures with different soil moisture (adding water)
  - Pole-dipole configuration
- 24 electrodes regularly spaced of 20 cm
- 200 points of measure of soil resistivity
- RES2DINV software for data inversion



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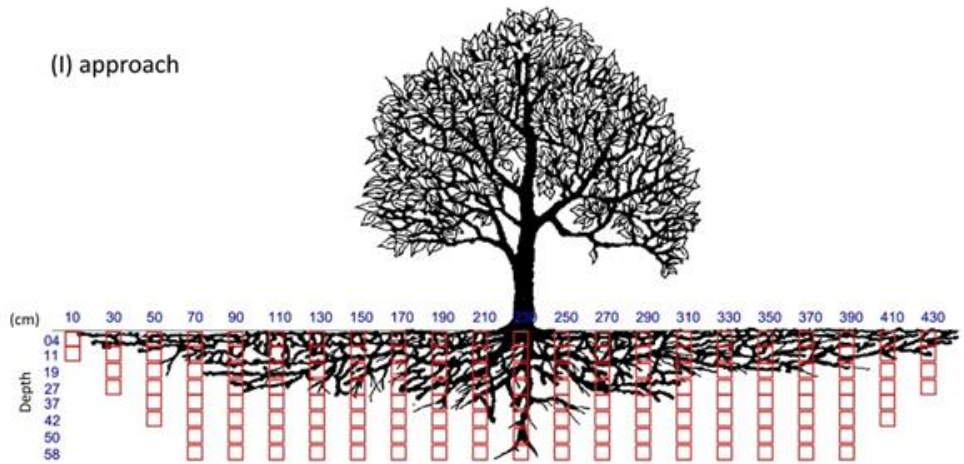
RAR measurement

(I) approach



One RAR value for each red square

To compare one-to-one Resistivity and RAR

(II) approach

One RAR value for each green transect

To compare Resistivity and RAR Distribution in depth

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Results

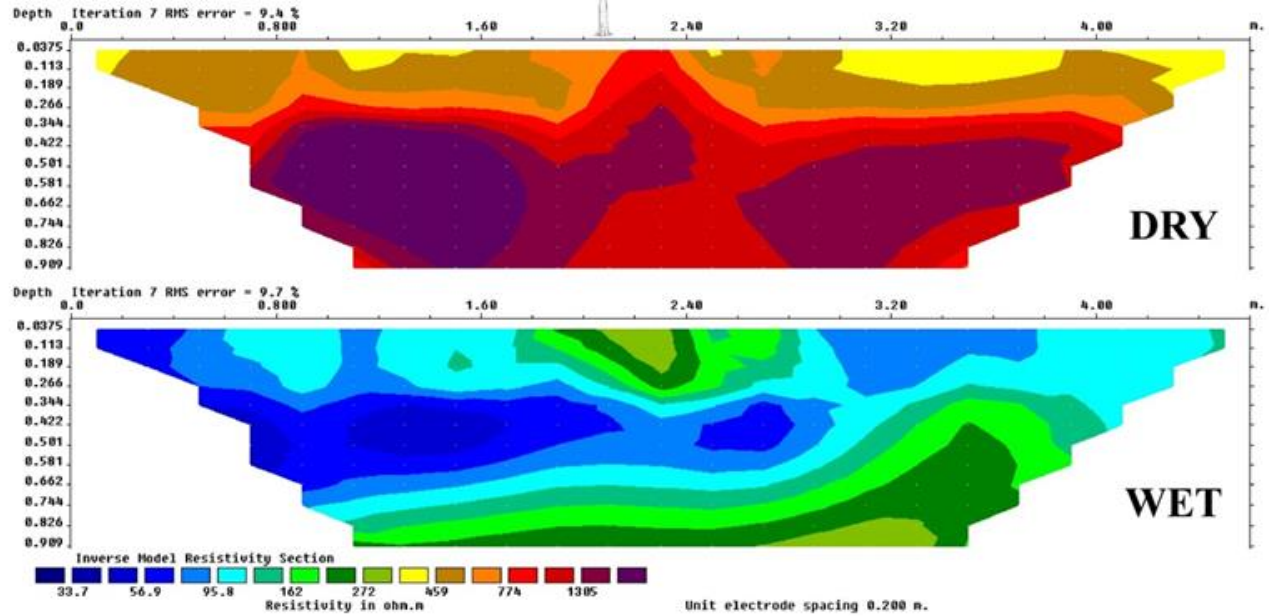
Resistivity: Different behavior

AREZZO		MAX	MIN	MEAN	SD
Pine 1	Dry	147.14	6.34	39.88	29.95
	Wet	119.35	6.04	30.13	17.36
Pine 2	Dry	342.55	7.94	57.05	58.56
	Wet	228.76	8.18	42.28	38.23
Pine 3	Dry	174.33	6.57	33.79	31.16
	Wet	87.88	8.12	27.26	15.21
Pine 4	Dry	101.13	4.83	24.26	18.13
	Wet	123.70	4.40	31.46	23.47

SAN ROSSORE		MAX	MIN	MEAN	SD
Pine 1	Dry	2.461.00	420.54	1.121.96	511.06
	Wet	1.567.50	41.85	265.98	245.69
Pine 2	Dry	2.798.00	278.63	1.154.05	586.31
	Wet	832.30	66.38	152.41	84.25
Pine 3	Dry	1.905.10	262.54	929.79	383.12
	Wet	1.152.30	42.08	221.76	172.60
Pine 4	Dry	2.904.60	375.41	1.101.46	566.02
	Wet	339.19	46.21	132.40	67.47

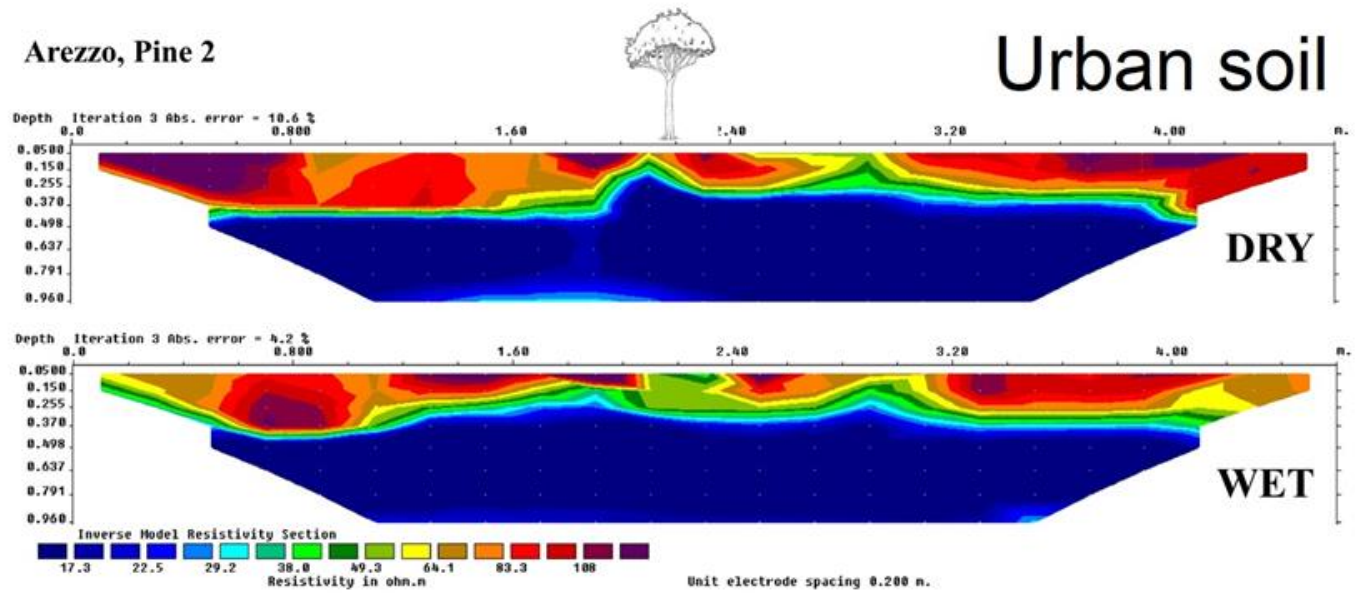
San Rossore, Pine 4

Sandy soil



Arezzo, Pine 2

Urban soil



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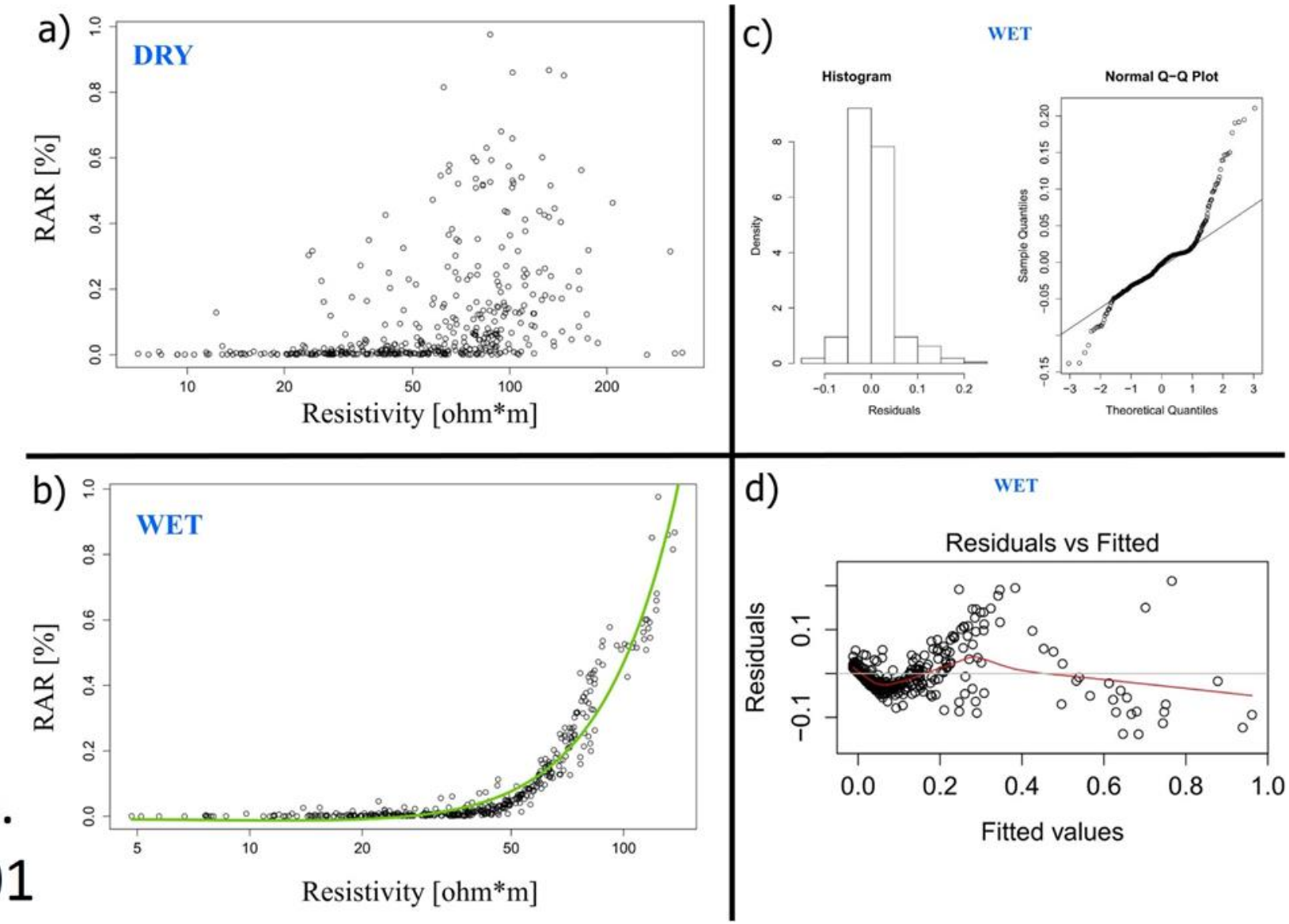
Urban soil



R^2 = 0,9313.

p-value< 0,01

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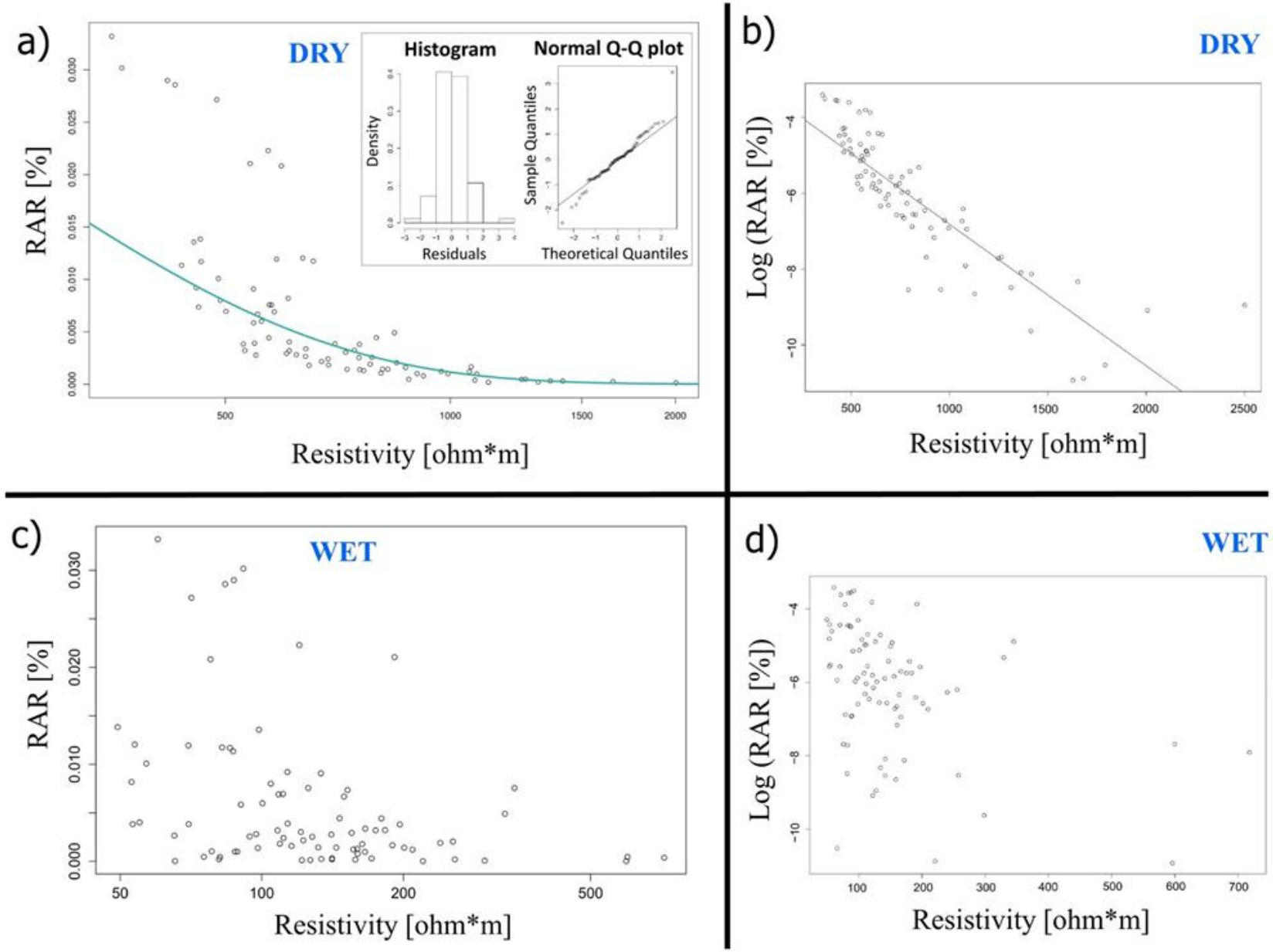
R^2 = 0,740,
p-value < 0,01

Sandy soil



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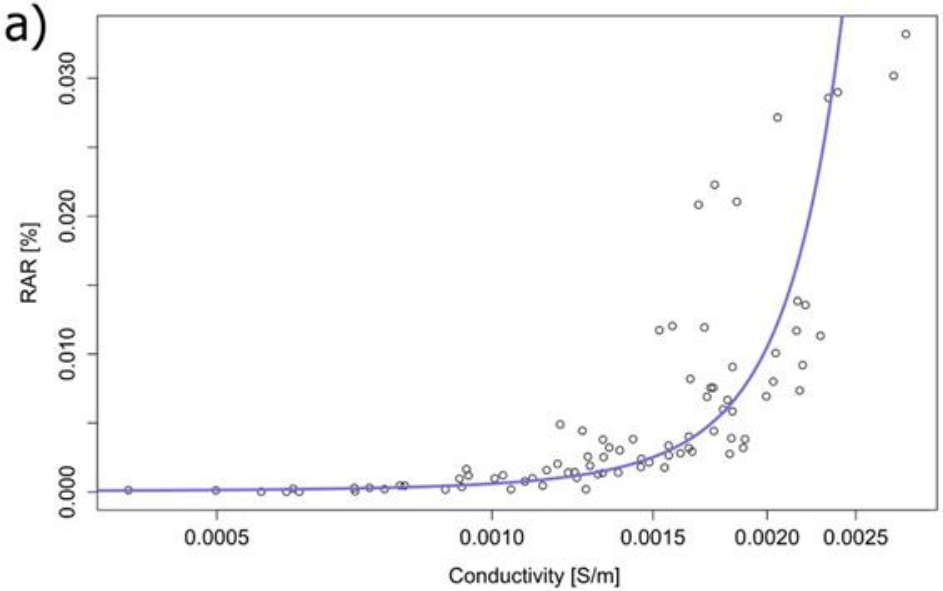
R^2 = 0,7858,
p-value < 0,01

Sandy soil

a)



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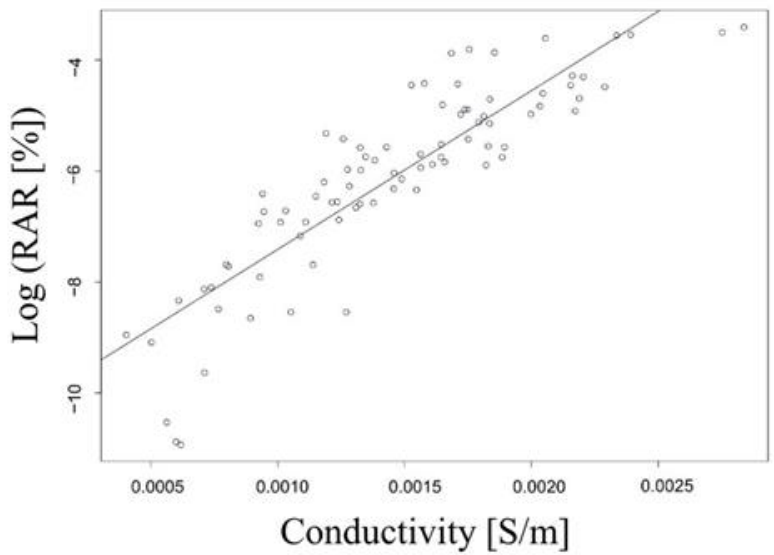

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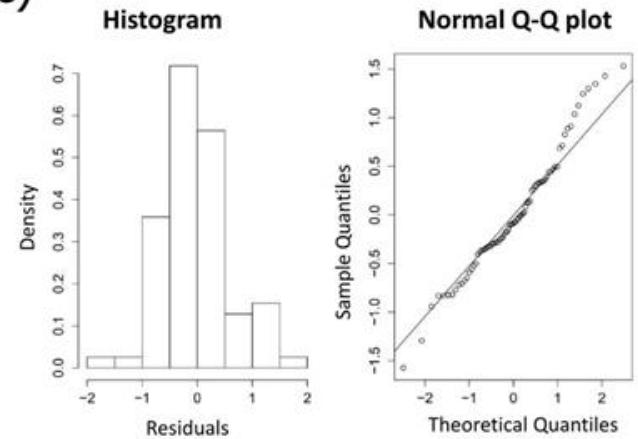

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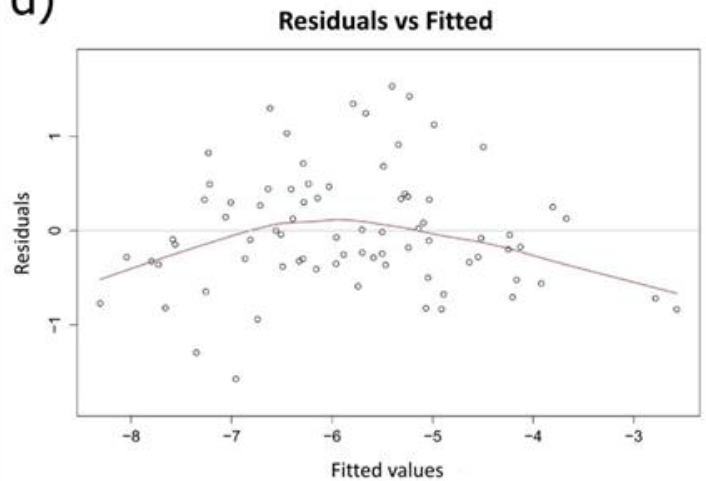

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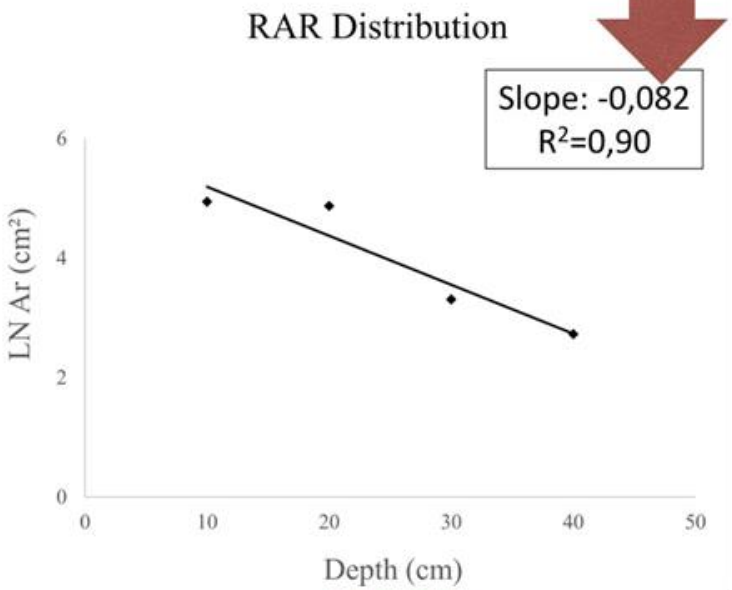
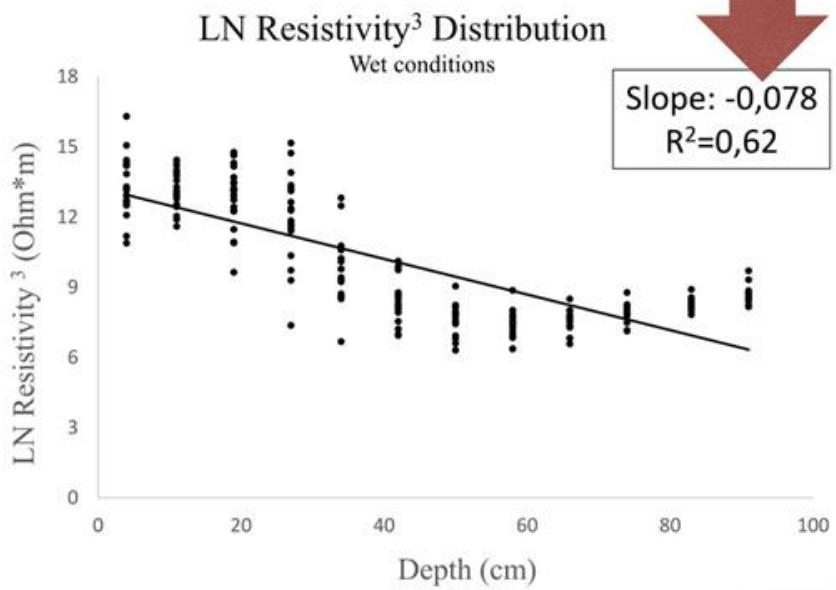
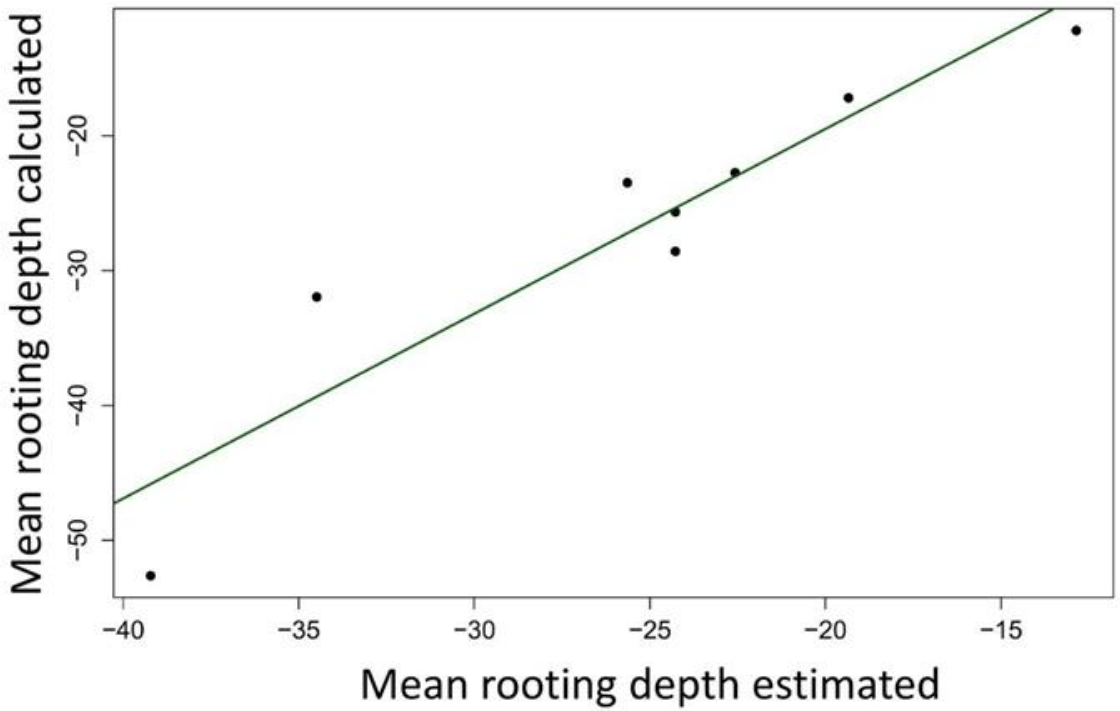


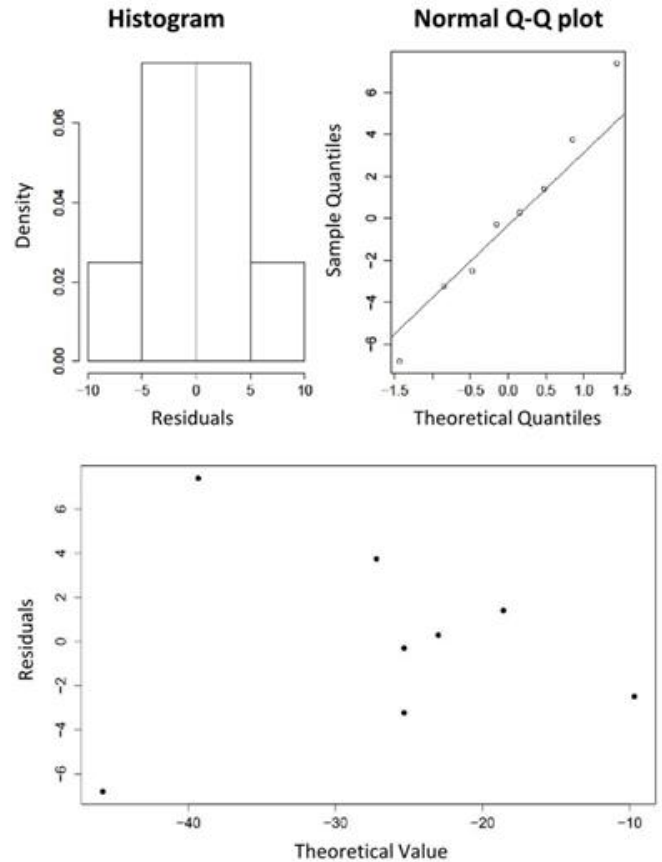


II approach: to compare distribution in depth

Arezzo		DRY		WET		Mean Rooting Depth	
Plant	B-factor	B RES	B RES^3	B RES	B RES^3	Calculated	Estimated
1	**-0,043**	-0,020	-0,060	-0,013	**-0,039**	-23,48	-25,66
2	**-0,082**	-0,029	-0,086	-0,026	**-0,078**	-12,18	-12,85
3	**-0,031**	-0,011	-0,034	-0,010	**-0,029**	-31,92	-34,51
4	**-0,058**	-0,011	-0,034	-0,017	**-0,052**	-17,19	-19,34

San Rossore		DRY			WET			Mean Rooting Depth	
Plant	B-factor	B RES	B COND	B COND^3	B RES	B COND	B COND^3	Calculated	Estimated
1	**-0,019**	36,282	-0,006	**-0,019**	44,026	-0,014	-0,043	-52,63	-53,48
2	**-0,035**	40,742	-0,012	**-0,036**	159,221	-0,002	-0,007	-28,57	-27,47
3	**-0,039**	54,176	-0,013	**-0,040**	43,481	-0,025	-0,074	-25,64	-25,06
4	**-0,044**	45,327	-0,013	**-0,040**	54,956	-0,009	-0,027	-22,73	-25,32





R^2 = 0,8489,

p-value <0,01

Conclusions

- Roots presence affects the soil resistivity, not only due to the plant physiology;
- Resistivity variation can predict the root distribution in depth. Different models have to be used in relation to the soil type. Water content (and its salinity or conductivity) can affect the modeling, highlighting or not the roots;
- Resistivity variation in depth can be equated to the roots distribution trend.

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Thanks for your attention