Remote sensing of apparent soil electrical conductivity (EC_{ap}) and NDVI to delineate different zones in a vineyard for precision fertilization†

Catarina Esteves, David Fangueiro, Henrique Ribeiro, Ricardo Braga

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About the authors

Catarina Esteves
PhD student in Agronomic Engeneering

David Fangueiro

Ricardo Braga

Henrique Ribeiro

Professors at Superior Institute of Agronomics
Lisbon, Portugal

Nutri2Cycle
Transition towards a more carbon and nutrient efficient agriculture in Europe

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Contextualization

Problem

Need for higher productity in food production systems

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Reduce nutrient losses and increase nutrients use efficiency

Proposed solution

Precision fertilization (PF) within Precision Agriculture framework

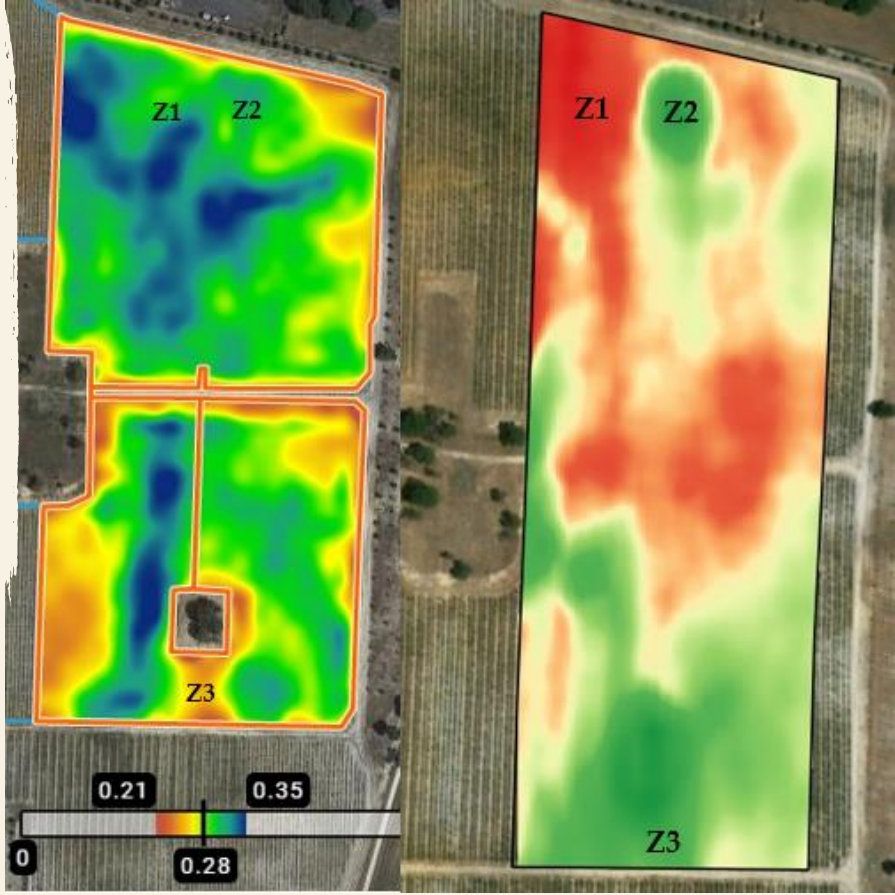
Problem

Difficulty in the definition of different zones within a field with homogeneous characteristics

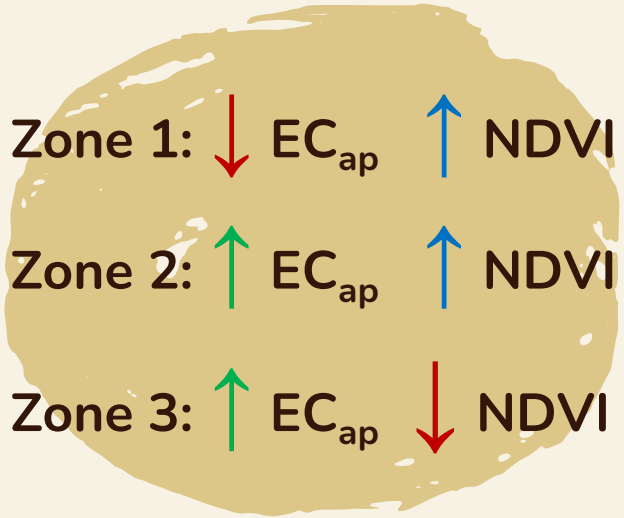
Tractor applying organic fertilizer to alternated inter-row in the studied vineyard

Our case study

Selection of three distinct zones within a parcel of 6,7 ha in a vineyard, using remote sensing of apparent soil electrical conductivity (**Ec_{ap}**) and normative difference vegetation index (**NDVI**)



NDVI on the left and EC_{ap} on the right (where green and red correspond to high and low values respectively).



Goals

Soil sampling in specific locations, respective chemical and physical analysis, combined with statistical evaluation to determine if:

1) EC_{ap} and NDVI were effective in the delineation of different zones within a field and

2) if there is a potential for the implementation of precision fertilization within the vineyard.

01

Results

Zones	pH	pH	$EC_{1:2,5}$	SOC	N_{tot}	Extractable	
						P	K
	(H_2O)	($CaCl_2$)	(μS cm^{-1})	(%)	(mg kg^{-1})		
Signif.	**	***	***	*ns*	***	*ns*	***
Z1	6,25 b	5,36 b	64,60 b	0,42	255,30 b	19,85	56,90 b
Z2	6,48 a	5,35 b	81,11 b	0,42	315,98 a	18,55	91,50 a
Z3	6,51 a	5,70 a	161,27 a	0,42	179,85 c	8,83	90,33 a

Signif. – significance level by the F test, ns – non-significant at $p<0.05$ level, significant at $p<0.05$(*), at $p<0.01$(**) and at $p<0.001$(***) by the F test. In each column, values followed by the same letter do not significantly differ by the LSD test at $\alpha=0.05$.

$EC_{1:2,5}$ - soil electrical conductivity extracted in a 1:2,5 soil:water proportion; SOC – soil organic carbon; Ntot – total N (Kjeldahl method); Extractable P and K (Égner-Rhiem method).

01

Discussion

→ Most of selected soil properties vary in relation to the zone. Except for P and SOC.

→ Since most of these properties vary at the highest significance level, indicating that the zones significantly differed from each other.

→ Zones with high NDVI values (Z1 and Z2) presented the highest soil total N concentration.

→ Zones with high EC_{ap} (Z2 and Z3) presented the highest pH and $EC_{1:2,5}$.

02

Results

Zones	Exchangeable cations				EA	CEC	SB	BSP
	K^+	Ca^{2+}	Mg^{2+}	Na^+				
	($cmol^+ kg^{-1}$)							%
Signif.	***	***	***	***	***	***	***	***
Z1	0,15 b	1,66 b	0,45 c	0,04 b	0,11 c	2,40 c	2,30 c	94,46 a
Z2	0,23 a	2,01 b	1,07 b	0,09 b	0,33 a	3,74 b	3,41 b	90,04 b
Z3	0,23 a	3,03 a	2,96 a	0,43 a	0,22 b	6,87 a	6,65 a	96,35 a

Signif. – significance level by the F test, ns – non-significant at $p<0.05$ level, significant at $p<0.05$(*), at $p<0.01$(**) and at $p<0.001$(***) by the F test. In each column, values followed by the same letter do not significantly differ by the LSD test at $\alpha=0.05$.

EA – exchangeable acidity; CEC – cation exchange capacity; SB – sum of bases; BSP – base saturation percentage.

02

Discussion

→ Z2 and Z3 (↑ EC_{ap}), mostly the latter, shown the highest concentration of exchangeable cations, EA, and consequently, higher value of CEC and SB.

→ Z1 (↓ EC_{ap}) presented the least concentration of the mentioned above parameters, in relation to the other zones.

03

Results

Zones	Sand	Silt	Clay
	%		
Signif	***	***	**
Z1	85,06 a	5,71 b	9,23 b
Z2	73,43 b	8,58 a	18,00 a
Z3	71,16 b	6,67 b	22,17 a

Signif. – significance level by the F test, ns – non-significant at $p<0.05$ level, significant at $p<0.05$(*), at $p<0.01$(**) and at $p<0.001$(***) by the F test. In each column, values followed by the same letter do not significantly differ by the LSD test at $\alpha=0.05$.

03

Discussion

→ Z2 and Z3 (↑ EC_{ap}) had the highest percentage of clay. On the contrary, Z1(↓ EC_{ap}) presented the least percentage of clay, and highest of sand.

→ The results in this table agree with previous results, since zones with higher clay content, will have higher concentration of exchangeable cations and higher soil electrical conductivity (due to the exchange surfaces of clay minerals).

Conclusions and prospects

→ The use of EC_{ap} and NDVI as indicators was efficient in the delineation of three distinct zones within the vineyard, regarding the selected soil chemical and physical properties.

→ Therefore, there is potential for the implementation of PF based on these zones, except for P and SOC supplementation.

→ However, more studies are still needed to confirm the potential of PF implementation.

*PF - Precision Fertilization, SOC – soil organic carbon.

Thank you!

Does anyone have any questions?

catarinaesteves@isa.ulisboa.pt

About the project:
https://www.nutri2cycle.eu/

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