

## ***Interactive comment on “Precision agriculture suitability to improve vineyard terroir management” by J. M. Terrón et al.***

**J. M. Terrón et al.**

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In some aspects this paper presents excellent results. Studying four irrigation treatments in the field with four replicates is unique as this type of field studies is hardly done anymore but is still very necessary. Studying behavior of crops and soils only behind the computer screen becomes all too common! The authors use two techniques: proximal sensing focused on the NDVI and the ECa measurements. Those techniques have so far been widely applied but the authors do so in a good, professional manner and what is particularly interesting and excellent in this study is their use of statistics and geostatistics to test their results. Relations between NDVI and ECa are explored for two years. Unfortunately, this positive analysis has to be followed with more nega-

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tive points, summarized as follows:

Comment 1: The authors seem to implicitly assume that an ECa analysis suffices to characterize soils. This is not the case. The technique offers valuable information but the geoelectric signal being measured is determined by several factors, among them: general resistance of soil materials, water and salt content. Authors reply: Comment accepted. Text implementation Section regarded to the soil classification and properties was added in Material and Methods: - Orography description and soil classification of the study area. - Figure with the spatial distribution of some soil physicochemical parameters.

Comment 2: ECa values run at different times when the soil has different water contents vary considerably. Continuous ECa patterns are shown but what these patterns mean for growing grapes is and remains a complete mystery. Authors reply: Comment partially accepted. Text implementation Authors agree with reviewer, nevertheless several published studies refer that ECa changes in time, in absolute terms, but normally is stable, in relative terms. Considering the previous authors believe that the ECa spatial pattern can help producers interpreting different crop behaviors, namely vegetation. Other authors also revealed that vegetation differences is normally associated with grape quality differences and considering this authors believe that this type of information is relevant in order to detect possible management zones.

Comment 3: The authors mention: terroir management, but how can you do that without looking at the soil (la terre!)? Why submit an article to the SOIL journal without giving any attention to soil? No soil information is provided. Of course, a soil classification, as such, is not very helpful but soil types can be functionally characterized as is shown elsewhere in this special issue. What is the soil texture and structure and the associated water availability when irrigation water enters the soil? Does it enter the soil or is there crusting and surface runoff? Is there compaction? Very important: what are the rooting patterns? The pH is important for grapes and so is the presence of absence of micronutrients and lime. Authors reply: Comment accepted. Text

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implementation Section regarded to the soil classification and properties was added in Material and Methods: - Orography description and soil classification of the study area. - Figure with the spatial distribution of some soil physicochemical parameters.

Comment 4: Nothing is said about soil management. Manuring? Tillage? Weeds? Pests and diseases? Only one conclusion is possible: This paper hardly covers terroir management. Authors reply: Comment accepted. Text implementation Soil and canopy management was included in the text.

Comment 5: The NDVI measurements show that there is quite some variation within the experimental plots, also between the years. This indicates the limitations of only having data for two years, even though this is exceptional for soil and crop research at this point in time. Here, computer simulation of crop growth can provide an answer, as is illustrated elsewhere in this special issue. But these simulations have to be validated and NDVI values are highly suitable for that. Authors reply: Comment partially accepted. In terms of climatic studies on agriculture and in Mediterranean climates, having two extreme years are normally more important than having data for 10 years. Authors agree with reviewer that having 10 years is different to having only two years, nevertheless considering the objectives of the article (spatial and temporal vegetation behaviour) these two years reveal extreme climatic years behavior and in our opinion are relevant for the discussion here presented.

Comment 6: There is some correlation of NDVI and ECa, but an average r-square of around 0.50 indicates that only 50% of variation is explained by the ECa patterns (that, again, have unknown relations with grape growth, as mentioned above) and that is a low value. Not inspiring for management. Authors reply: Comment partially accepted. Authors partially agree with reviewer because in agriculture activities 50% is rather relevant, especially if it's statistically significant. Nevertheless authors want also to point that besides ECa (soil), some other factors, namely soil water availability differences from one year to the other (climatic year quality), influence vegetation patterns presented in this study.

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Comment 7: It remains unclear what the authors have in mind when mentioning precision agriculture. It seems they advocate irrigation scheduling as a function of real-time NDVI measurements. That, of course, is quite different from following the effects of four types of irrigation as done in this study! When is the best moment to observe NDVI patterns in a given growing season? When the leaves show signs of wilting? That is usually too late as has been widely observed in the literature on precision agriculture. Damage in terms of growth retardation has then already occurred. The alternative (published in literature) is to do real-time modeling and irrigate at a time when no damage has yet been done but when the moment of problems is near: a pro-active rather than a reactive approach. And fields are heterogeneous, so which crop reaction where in the field is going to determine an (relatively expensive) NDVI observation run? All such operational issues are not covered so the conclusion must be: this paper hardly addresses precision agriculture. Authors reply: Comment partially accepted. Maybe is not perfectly stressed in the text but the idea was to test different irrigation schemes and their respective impact on vineyard vegetation behaviors (more leaves, more evapotranspiration) in order to interpret possible precision agriculture strategies (water and grape quality management).

Comment 8: A basic principle of land evaluation is to balance what the user needs versus what the soil has to offer. The user here is the grape (and, ultimately, the owner of the orchard). There is no mention of the needs of the grape, however briefly. This is needed because (as the Americans say) if you don't know where you want to go, any road will lead you there! I would think that the ultimate objective is not necessarily a high yield of grapes but grapes of high quality that can produce a very good wine. Authors reply: Comment no accepted. The relationship between the amount of vegetation (LAI) and quality of the fruit is fully studied and there must be a balance between these two parameters. So, as NDVI is related to LAI, it can be shown through the estimation of NDVI as an indicator for the quality/yield of the grapes.

Comment 9: When describing the NDVI measurements the impression is established

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that the aim is to have maximum evapotranspiration all the time. I am not an expert on viticulture but seem to know that the better wines are produced from grapes that suffer some stress at certain growth phases. Also, there are many quality parameters for wine and an intriguing aspect of terroir studies is to find out which soil properties—among them the water supply capacity—affect grape and wine quality in the end. This, of course, in addition to weather aspects. In my view, use of the term terroir in the title of this paper is therefore hardly justified because the grapes remain out of sight. Authors reply: Comment accepted. Text implementation Title was changed to another more appropriated: “The effects of four irrigation regimes on vineyard vigor using proximal multi-spectral active sensors.”

Comment 10: I have full sympathy for authors that have to write in a language which is not their own. But the language quality of this paper needs to be improved because too many sentences are unclear, possibly because of linguistic formulations. Also, the authors should not make the common mistake to repeat in the text of the articles all numbers that are shown in tables and figures. Pages 6-9 do so. And too much data are reported in the tables. Report the main items and let interested individuals know in a footnote, if so desired, that the complete sets can be obtained from the authors when requested. Authors reply: Comment accepted. Text implementation Text was revised.

Comment 10: As stated above, the authors have presented some valuable data and even though the paper, as presented, is not acceptable to be published in SOIL for reasons explained above, publication of some of their results would be quite valuable. Why not select another title, for example: “Using proximal sensing to characterize the effects of four irrigation regimes on the development of grapes”. Authors reply: Comment accepted. Text implementation Title was changed to another more appropriated: “The effects of four irrigation regimes on vineyard vigor using proximal multi-spectral active sensors.”

Comment 10: The ECa data can be included but not as a main feature of the publication. In the discussion section the authors can point out that the ECa data (that are

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here weakly correlated with NDVI) could be the basis for more in-depth soil research (which is covered in other papers in this special issue). Using NDVI to calibrate and validate models is certainly a valid item as well. Enough critical mass for an interesting article. Authors reply: Comment accepted. Text implementation Text was modified to adapt the issue. ECa was considered such as support to identify the study variability of vegetative vigour (NDVI) intra- and between years. Text was unified in order to not include the ECa as a main feature of the publication.

Finally, a general comment. Doing justice to the terroir concept requires a lot of activities that go way beyond what can reasonably be expressed in a single paper (for example: surveying the soil, functional characterization of the soils, spatial variability, soil characteristics, soil analyses, (real time) dynamic modeling soil water regimes, possibly including irrigation and all details that go with that, soil management, dealing with pests and diseases, fertilization, including organic manure, precision agriculture and the type of management that goes with that, climate and weather data, distance between rows, exposition on the slope and incoming radiation, grape harvest and handling, desired wine characteristics etc. etc.). It would be good if the overall editor of this special issue of SOIL would paste together the various contributions to paint an overall image of what a modern approach to the terroir could mean. That overall image should cover all aspects mentioned here, and maybe more.

What is thus the storyline for the future? What are the strong points already? What are the weak points? Where are the missing links? That would be a real contribution that goes way beyond what can be covered in a single paper.

This paper by Terron et al. would provide an excellent contribution illustrating on site experimentation with irrigation practices, NDVI measurements (and ECa as a starting point for soil analyses) and statistical treatment of data obtained. I would hope that in this way this study receives the credit it deserves.

Please also note the supplement to this comment:

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<http://www.soil-discuss.net/1/C691/2015/soild-1-C691-2015-supplement.pdf>

Interactive comment on SOIL Discuss., 1, 947, 2014.

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