

Interactive comment on “An overview of the recent approaches for terroir functional modelling, footprinting and zoning” by E. Vaudour et al.

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Firstly, we would like to thank Anonymous Referee#1 for helpful comments. We have extensively revised the paper based on his/her suggestions. The list of specific points and how we address them in the review article is given below.

Anonymous referee #1: “The authors have made a huge effort in order to try to include many aspects of soil, vine, wine, climate relationships, environmental risks, and many new tools and methods to capture and analyse data. Due to this wide range of aims, not all the objectives have been achieved in the present version. [. . .] the topic is of importance and is addressed with a valuable interdisciplinarity.” “In my opinion, the paper tries to consider too many objectives and it is impossible to include and discuss all of

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them as would be desirable. It might be preferable to reduce the number of objectives and expose more clearly the relationship between the soil (terroir) and the production and / or product quality. I think that in this article, the relationship remains unclear. I recommend the authors to reduce the number of objectives. In fact the title only mentions “An overview of the recent approaches for terroir functional modelling, footprinting and zoning”. Therefore, the core of the article is the section 3. Terroir zoning at different scales using geospatial technologies They could avoid (or only mention in the introduction) the sections regarding: 2 Quantifying the influences of terroir components on plant growth, fruit composition and wine quality 2.1 Climate-soil relationships 2.3 The perspective of climate change 4 Terroir sustainability assessment and new preservation practices I don't mean that they are not important, just I think that this paper needs to focus on less themes to fulfill other important objectives: 1. New tools for assessing terroir footprints: metabolomics, metagenomic approach and microbial/chemical fingerprinting, 2. terroir zoning at different scales: mapping terroirs and using remote and proxy sensing technologies to monitor soil quality and manage the crop system for a better food quality”

Our reply to that comment: Both anonymous referees share the critic that the paper is rather long and not well-organized because too many objectives are treated and that the reader would have expected to know more about relationships between soil and vine features. Possibly the critics come from the fact that relationship between soil and wine, which is at the basis of the terroir concept, is not yet fully acknowledged by the scientific consortium and must be further documented. For this reason and in order to clarify the reading of this paper, we followed the objectives suggested by Anonymous Referee#1.

How this is implemented in the revised manuscript: The manuscript was reduced to the following sections corresponding to the most original objectives suggested by Anonymous Referee#1: 1/ New tools for assessing terroir footprints: metabolomics, metagenomic approach and microbial/chemical fingerprinting, 2/ terroir zoning at dif-

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ferent scales: mapping terroirs and using remote and proxy sensing technologies to monitor soil quality and manage the crop system for a better food quality. The last section about terroir sustainability was reduced but maintained because we considered it as a perspective deriving from the new tools developed. Section 1 was improved and restructured and updated with last recent references. We added a new figure 1 to illustrate this first part (please see the attached supplement file).

Figure 1. Differences in grape surface microbial communities present between wine regions of California. From: <https://cosmosmagazine.com/earth-sciences/winemaking-art-or-science>

Anonymous referee #1: "I like the section 3. I think that the authors put together the last methods to study soil (or terroirs) providing updated and organised information. I think that a general table with methods, pros, cons, examples and references would be useful."

Our reply to that comment and how this is implemented in the revised manuscript: We provided such a table (new table 2, please see the attached supplement file, page 5) and added some comments in the text. " Table 2 puts together the main last combination of methods, pros, cons, and references examples to study grape characteristics, canopy/yield/biomass/trunk circumference and/or enological parameters, vineyard identification, vine rows and vineyard characteristics, vineyard soil properties (or management zones or terroir units), soil surface condition, erosion and evapotranspiration.[. . .] Most approaches combine several data sources, methods (geostatistical/statistical/image processing/computer vision/mechanistical models)and remote or proxy sensors (Table 2). All approaches use geopositioning devices (not detailed in Table 2) the error positioning requirements of which need to be compatible with the study objectives (i.e. accurate positioning of individual sampled vines) and the spatial resolution of the acquired imagery."

In addition to Table 2 and its comments, section 2 (former 3) was improved with some

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additional references and sentences.

Anonymous referee #1: "I think that conclusions could be improved if the paper focus only in the questions mentioned in the title. The influence of terroir in grapes/wines and the sustainable land management are not included in the title."

Our reply to that comment: The revised paper mainly focuses in the questions mentioned in the title, but we consider the sustainable management as perspectives enabled by the new zoning approaches and already emerging through them.

How this is implemented in the revised manuscript: Conclusion was reshaped and developed as follows : "Recent studies based either on metabolomics or on the Sr isotopic ratio lead to a strengthening of the assumption that geographical origin does leave a footprint in wines and that both soil and substrate, in interaction with climate and cultural choices, influence the shaping of grapevine phenology and grape and wine quality. Furthermore, the use of the current "omics" technologies seems to confirm the existence of a 'microbial terroir' as a key factor in regional variation among wine grapes. Despite the role of soil microbial communities on terroir is still unclear, in the next future the combination of the omics techniques and traditional approaches could give further insights on activity and composition of vine-associated microbes, especially those living on the grape or leaf surface (phyllosphere) and root surfaces (rhizosphere) but also within the plant tissues (endophytes), and their interactions with plant and soil. Differentiation and mapping of viticultural terroirs meant as homogeneous regions of grape/wine quality need comprehensive spatial modelling of soil, agronomical and climatic properties, including their changes through time. As such the development of a myriad of either remote or proxy sensing techniques and the corollary challenge of processing large quantities of data acquired at a very fine spatial resolution and/or at several spatial resolutions, scales, and organisational levels. These techniques in data collection and processing are needed to produce easy-to-update decision maps with associated uncertainties that allow users to make appropriate and timely management decisions. This is a revolution in the spatial management of terroir units, as the

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managed zones will be updatable and the effects of viticultural and/or soil management practices might be easier to control. The perspective of facilitated terroir spatial monitoring makes it possible to address another great challenge in the years to come: the issue of terroir sustainability and the construction of efficient strategies for assessing and applying them across numerous scales. These include the design of efficient soil restoration practices along with crop and/or intercrop management plans, and/or agroforestry viticultural systems, that take into account the possible effects of climate change. Therefore, terroirs are more and more likely to be addressed through the concept of ecosystem services, as viticultural agro-ecosystems, the services of which need to be constantly evaluated and rationalized.”

We also modified the second part of the abstract as follows:” This review will focus on two main areas of recent terroir research: 1) using new tools to unravel the biogeochemical cycles of both macro- and micronutrients, the biological and chemical signatures of terroirs (i.e. the metagenomic approach and the regional fingerprinting); 2) terroir zoning at different scales: mapping terroirs and using remote and proxy sensing technologies to monitor soil quality and manage the crop system for a better food quality. Both implementations of terroir chemical/biological footprinting and geospatial technologies are promising for the management of terroir units, particularly the remote and proxy data in conjunction with spatial statistics. As a matter of fact, the managed zones will be updatable and the effects of viticultural and/or soil management practices might be easier to control. The perspective of facilitated terroir spatial monitoring makes it possible to address another great challenge in the years to come: the issue of terroir sustainability and the construction of efficient strategies for assessing and applying them across numerous scales.”

Anonymous referee #1: “Sometimes the writing is a bit disjointed. There is no clear thread in presenting different aspects: availability of water, nutrients, salinity Most of the work refers to oenological and biochemical aspects that occur in plants, but no clear relationship between soil and plant is stated, in spite of the fact that this is one of

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the objectives of the paper. One single reference or example per issue is not enough to underpin a relationship between soil and vine features.”

Our reply to that comment: That comment is related to the comment about the number of objectives, which was reduced.

How this is implemented in the revised manuscript: This “disjointed” section was removed.

Anonymous referee #1: “Figures 1 and 2 could be combined, the information that they provide is redundant. Figure 3 is not sufficiently explained in the text. If the information is not really relevant, it would be better to delete it. Figure 5 is not needed.”

Our reply to that comment: In adequation with the new objectives, we agree that Figure 1 had to be removed. We followed Anonymous Referee#1’s suggestions for figures.

How this is implemented in the revised manuscript: Figure 1 was removed and Figure 2 maintained, adding a comment to it “ There is therefore a gap to fill considering farm (≤ 0.1 to 1 km^2), district (\leq some tens km^2) to regional scales (\geq tens to thousands km^2). The number of map units tends to increase with the log of study area, however its variation is higher for larger study extents than for within-field studies, jointly with the fact that regional studies focus on larger span of target properties. ..” Figure 5 was removed. ”

Please also note the supplement to this comment:

<http://www.soil-discuss.net/1/C702/2015/soild-1-C702-2015-supplement.pdf>

Interactive comment on SOIL Discuss., 1, 827, 2014.

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