Update in unified terroir zoning methodologies

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Abstract. The concept of terroir is based on the assumption that the quality and the typicity of an agricultural product are linked to its origin. The precise definition of an origin requires zoning. Because terroir expression in viticulture is largely driven by interactions between the vine and its natural environment, soil and climate play a key role in terroir zoning. For clarity, soil-based and climate-based zoning are presented separately in this paper. They are, however, ideally carried out simultaneously, because of the existence of multiple interactions between these terroir factors. Prior to the implementation of zoning, the objectives need to be carefully defined. The appropriate scale at which the zoning is implemented depends on the objective and the available budget. The use of geomatics enables the production of maps at reduced cost and, possibly, increased accuracy. This paper is update of the unified zoning methodology which was adopted by the OIV in 2012 (OIV-VITI 423-2012).

1 Introduction

Wine style and quality are influenced by environmental factors, particularly soil and climate. Therefore, quality and pricing of wine are related to its origin. This feature is generally referred to as the "terroir" effect [1]. Because terroir has a spatial dimension, zoning is required to precisely delineate production areas. Many approaches for terroir zoning have been developed over the past decades, varying according to the objectives and scientific disciplines used. Comparing characteristics of terroirs worldwide then becomes difficult when zoning is carried out with such different approaches. In 2012 a unified methodology was developed by the International Organisation of Vine and Wine (OIV) with its *OIV Guidelines for vitivinicluture zoning methodologies on a soil and climate level* (Resolution OIV- VITI 423-2012 http://www.oiv.int/public/medias/400/viti-2012-1-en.pdf). Application of these methodologies enables the comparison of terroir zoning studies implemented in various winegrowing regions and countries. This paper presents an update of the OIV guidelines adopted in 2012.

Terroir zoning comprises soil and climate related aspects. Because soil and climate interact in terroir expression, their zoning should be ideally undertaken simultaneously. However, for the sake of clarity of presentation, soil and climate zoning are presented below separately. As a prerequisite to each zoning project, objectives and scale need to be clearly identified. Once the zoning is completed, several approaches allow validation of the zoning.

2 Terroir zoning objectives

Terroir zoning studies may have various objectives. It is important to define these objectives prior to the implementation of the zoning, as methodology and scale will vary accordingly. For instance, zoning of climatic risks requires focussing on specific climatic parameters, while landscape protection from urbanisation rather involves soil related zoning aspects. Optimization of technical vineyard management may require larger scale zoning (e.g. 1/5,000th), while landscape protection from urbanisation may be relevant at a smaller scale (e.g. 1/50,000th). Table 1 lists some potential terroir zoning objectives together with the relative importance of the role of soil, climate and soil/climate interactions. For some objectives only soil-based zoning is required, while others require only climate-based zoning. When soil-climate interactions are involved, it is necessary to implement soil- and climate-based zoning together.

Table 1. Objectives of terroir zoning with relative importance of the role of soil, climate and soil/climate interactions (modified from OIV Resolution OIV-VITI 423-2012).

Zoning objectives	Role of the soil	Role of the climat	Role of soil/climate interactions
Delineation of territories in accordance with their potential to produce wine of a certain quality and style	++	++	++
Zoning of potential precocity (phenology and grape ripening dynamics)	+	++	+
Optimisation of terroir expression by adaptation of plant material (variety and root stock) to soil and climate characteristics	++	++	+
Optimisation of technical and environmental management by adaptation of growing practices to soil and climate	++	+	+
Territorial management of crop protection risks	+	++	+
Plot selection	++	+	+
Territorial management of water resources	++	++	++
Zoning of climate risks and strong climatic constraints	0	++	0
Protection of terroirs and landscapes from various threats and in particular urbanisation	++	0	0

3 Soil based zoning

Soil based zoning is proposed to be implemented in three-steps. First, the approach needs to be defined, which is based on one or several scientific disciplines. Second, taking into account the objectives of the zoning and the available budget, a scale is chosen at which the zoning will be implemented. Finally, when available, complementary tools based on geomatic technologies are chosen to increase the accuracy of the zoning or to reduce the cost.

3.1 Selection of appropriate scientific basis

Geology enables a synthetic approach that is adapted to smaller-scale zoning (≤ 1/ 50,000th). Geological maps are quite cheap to produce and they do exist for most regions worldwide. However, the relation between geology and vine responses in terms of development, yield parameters and grape ripening is rather loose. Hence, geology can be used as a first approach in terroir zoning, but it needs to be augmented.

Geomorphology describes the surface landforms (plateau, slope, valley, terrace, etc.) resulting from the nature of rocks (especially the differences in hardiness), tectonic phenomena and erosion. Geomorphology maps can be easily established at reduced cost with the use of digital elevation models (DEMs), which are available at increasingly refined scales. This enables a synthetic approach well adapted to smaller-scale zoning (≤ 1/ 50,000th), as with geology, but explains vine behaviour only indirectly. Geomorphology helps to understand the distribution of soils and climatic parameters (in particular radiation and temperatures) over a given area.

Pedology (soil science) is an approach adapted to medium or larger-scale zoning (≥ 1/25,000th). The creation of soil maps requires auger sampling and soil pits studies. Pedology enables, to a certain extent, an explanation of soil effects on the physiological functioning of the vine. Many soil type classification systems exist worldwide but only a few are internationally validated; in particular the “Soil Taxonomy” (United States Department of Agriculture classification; USDA, [2]), the “World Reference Base for Soil Resources” (Food and Agriculture Organization; FAO ftp://ftp.fao.org/agl/agll/docs/wsrr103e.pdf) or the “Référentiel Pédologique” (Institut National de Recherche Agronomique, INRA; [3]). If a local classification is used, a match with one of the three above-mentioned classifications must be indicated. The advantages and drawbacks of the use of each of these three classifications are discussed in Appendix 1.

If only one discipline is chosen, pedology should be preferred. The combination, however, of geological, geomorphological and pedological approaches allows particularly accurate terroir zoning. Note that geological zoning can be mandatory to produce accurate pedology-based zoning, when subsoil is highly variable in space such as regions with a large number of faults. Certain disciplines, like the use of botanic indicators, can provide useful information to increase the accuracy of the zoning. They cannot, however, be considered an approach by themselves.

3.2 Selection of an appropriate scale

The scale of soil-based zoning must be defined beforehand. The scale depends on the zoning objectives (Table 1) and the scientific discipline chosen (Section 3.1). The larger the scale, the more precise the zoning, but the cost will also be higher. To produce soil maps at a given scale a certain density of observations are needed to provide acceptable resolution (Table 2). This table is based on a general rule of 0.5 to 1 observations per cm^2 of soil map, and the following:

for the scale 1/2,500 = 30 auger samples/soil pit
for the scale 1/10,000 = 20 auger samples/soil pit
for the scale 1/25,000 = 10 auger samples/soil pit
for the scale 1/100,000 = 5 auger samples/soil pit
for the scale 1/250,000 = 5 auger samples/soil pit

Table 2. Density of auger samples and soil pits, both as hectares (ha) per sample and number of samples per hectare needed to produce a soil map at a given scale (modified from OIV Resolution OIV-VITI 423-2012).

Scale	Number of ha per auger sample	Number of auger samples per hectare	Number of ha per soil pit	Total number of observations per ha
1/2,500	0.06 - 0.13	8 - 16	2 - 4	8 - 16
1/10,000	1 - 2	0.5 - 1.0	20 - 50	0.5 - 1
1/25,000	7 - 14	…	70 - 140	0.08 - 0.16
1/100,000	120 - 240	…	600 - 1,200	0.005 - 0.01
1/250,000	750 - 1,500	…	4,000 - 8,000	0.0008 - 0.0016

If soil distribution is locally complex, it may be necessary to increase the density of auger samples and / or soil pits, especially for the scales 1/25,000 and 1/100,000. For the scale 1/250,000 it is recommended to map one or more “reference areas” at a larger scale to establish rules for soil distribution in relation to the geology and geomorphology [4].

3.3 Spatial modelling, digital and remote sensing technologies

Various technologies, more or less recent, can be implemented to increase zoning accuracy and/or to reduce costs. Some of these new technologies have been developed in the framework of precision agriculture and are listed below. Although very useful, they cannot completely replace field work (auger samples, soil pits).

- Geographic Information Systems (GIS) are computer based technologies designed to manage spatial information. They are particularly useful to design maps and combine several layers of spatial information.
- Digital Elevation Models (DEM) can provide highly accurate geomorphological maps at reduced cost, through GIS modelling.
- Prior to soil mapping, the implementation of geophysical surveys such as electrical resistivity tomography (ERT) or electromagnetic induction (EMI) enables the production of very precise soil maps while limiting the number of auger sampling points. This approach is particularly adapted to large scale zoning studies (≥ 1/5,000th). In established vineyards, ERT provides best results, as the presence of metal wires interferes with EMI technology [5].

- Airborne remote sensing can help tanalyzing soil surface differences when no vegetation is present.
- Point-based information can be transformed into spatial information by means of geostatistics.

4 Climate-based zoning

Climate-based terroir zoning is generally implemented in three steps. First, appropriate climatic indicators are selected for the purpose. Second, high quality climatic data is sourced. Finally, homogeneous climatic zones are identified.

4.1 Selection of appropriate climatic indices

Climate-based terroir zoning uses different agro-climatic indices, depending on the objective of the zoning and the available data (Table 3).

Table 3. Accurate agro-climatic indices in relation to the objectives of climate-based terroir zoning (modified from resolution OIV-VITI 423-2012).

Zoning objectives	Appropriate agroclimatic indices and climate data	Timescale required
Precocity of phenological stages and grape ripening potential	HeatSum (GFV, HI, WI,…), AvGST	Month, day, hour
Delineation of territories in accordance with their potential to produce wine of a certain quality and style	WB, DI, RR (flowering - harvest), ET0, HeatSum, AvGST, MIN	Month, day, hour
Water management (vine water status and water resource management)	WB, DI, RR (vegetative period), ET0	Month, day, hour
Territorial management of crop protection risks	TM, RH, DH, GFV, ProtecModels	Day, hour
Frost threats	TN, TS, BudBurst, Hard, economic data, surveys	Day, hour
Hail threats	Hail pads, meteorological radar, economic data, surveys	Day, hour
Extreme heat threats	TX	Day, hour
Wind issues	W	Day, hour

Acromyms used:
AvGST: Average growing season temperature; DI: Dryness Index (climatic water balance); ET_0: Reference evapotranspiration; GDD: Growing degree days; GFV: Grapevine Flowering Veraison model; Hard: winter hardiness; HeatSum: indices based on heat summations; HI: Huglin Index; MIN: Indices based on temperature minimums in the ripening period; ProtecModels: crop protection models; RH: Relative humidity; RR: Cumulative rainfall; TM: Average air temperature; TN: Minimum temperature; TS: Surface temperature; TX: Maximum temperature, W: Wind speed; WB: Water Balance models based indices; WD: Wetness Duration; WI: Winkler Index.

For the purpose of comparison with other zoning operations performed at other sites or at other times, it is useful to work wherever feasible with commonly used and relevant indicators. In other words, producing a climate zoning with a non-conventional index has the drawback of preventing comparisons with previous work made in other regions. Most of climate zoning performed so far have been based on temperature, e.g. [6–8]. The average growing season temperature (AvGST) is a very popular and simple way to compare relative earliness in grapevine ripening in space and time. Indices derived from heat summation models are more precise, retaining only temperatures affecting grapevine growth rate and development. Amongst them, commonly used growing degree days accumulation indices are the “base 10°C” Winkler Index (WI) and the Huglin Index (HI), that can be computed either at a monthly or a daily time step. As these indices have been widely used, they allow appropriate time and space comparison of wine producing regions. The GFV model predicts flowering and veraison dates, using a “base 0°C” daily sum of temperatures [9]. As it has been calibrated for a wide range of grapevine cultivars, it is an accurate tool to perform zoning of phenological timing [10].

Several indices based on minimal temperature during the ripening period have been proposed such as the Cool Night Index or daily temperature amplitude. High night temperature has been shown to be detrimental to anthocyanin production, sugar and acidity in grapes [11]. These results were, however, obtained in controlled conditions with high night temperatures (over 25°C). Such conditions are seldom found in wine producing regions, except in some tropical viticulture areas. In contrast, no study, to our knowledge, validates the concept that low night temperatures (below 15°C) or considerable temperature ranges benefit to grape quality. Consequently, the use of such indices should be restricted to the potential need to cool the grape temperature prior to wine making.

Though water resource management is a crucial issue for many grape producing regions, few zoning attempts and indices regarding climate-related water issues have been proposed. Cumulative precipitation during the vegetative period or during the fruit development (RR) is a simple and useful way to depict the potential excess or deficit of water. Yet, it should not be considered alone for precise water requirement assessments. Vineyard potential water loss has to be addressed using potential evapotranspiration, ideally, through water balance modelling. Several water balance models are available, and they provide a large amount of inputs which can be synthetized through various indices. In many cases, grapevine water deficit during the growing season or during grape development is estimated by the actual/maximum daily transpiration ratio [12, 13], using rather complex water balance modelling. The dryness index (DI), a more easy-to-use alternative to estimate climate-related water resources for viticulture; it requires monthly climate data [14].

Vineyard pest and diseases management is a challenging issue for viticulture from economic, environmental and human health points if view. Yet, so far, terroir zoning do not account for pest related aspects. They are, however, to be considered for plant protection strategies. The zoning of phytosanitary risk can be achieved using climate-based models simulating a potential risk for diseases or pest population outbreaks, combined with plant modelling to account for the sensitivity period of the grapevine [15].

Climate hazard zoning is challenging, because extreme events do not occur frequently. Thus, robustness of such type of zoning requires long series of climate data. For zoning of cold-related risks, comparisons based upon simple temperature threshold might be relevant at small scale only. At large scale (i.e. small territories), the risk for cold-related damage do not depend only on the occurrence of one or several cold events. Sensitivity of the grapevine to low temperatures also needs to be accounted for. The limit below which temperature damages grapevine tissues depends on various factors. For winter cold, grapevine sensitivity to low temperature differs according to the cultivar and changes dramatically during the season. This "winter hardiness" is estimated using specific models [16]. Concerning spring frost, budburst date has to be assessed, because, obviously, no frost damage will occur prior to this date. As budburst timing modelling is still subject to substantial error, zoning results can differ according to the choice of the budburst model [17].

Because long time climate data series and sufficiently accurate models might not be available, climate related hazard could be assessed through additional information, such as insurance pay-outs or surveys. This is specifically relevant for hail risk zoning [18], because hail measurement devices are usually not installed on weather stations.

4.2 Selection of high-quality climatic data

Three possible sources of climate data can be identified: (i) weather stations, (ii) remote sensing, and (iii) dynamic circulation models. Most of the relevant indicators needed for climate-based terroir zoning can be obtained from weather stations. For data sourced from weather stations, quality control is critical as invalid data from poorly located weather stations, or due to either sensor malfunctioning or database construction errors has to be identified and rejected. Optionally, such data can be replaced by estimates obtained from surrounding weather stations. Weather stations provide point-located data. Spatialization of point-data can be achieved by interpolation. Numerous methods are available to perform climate data spatial interpolation (see [19] for a review). An estimation of the uncertainty of the interpolation has to be carried out with an independent data set (e.g. "leave-one-out" cross validation). Spatial variability of a mapped climatic parameter needs to be greater than the uncertainty of the interpolation. Recently, small weather stations containing a temperature sensor, a shelter and a data logger have been increasingly used for terroir zoning studies [8]. Because of their low cost, they allow high density temperature assessment. This information, combined with the use of a DEM, allows temperature mapping at very high resolution through the implementation of spatial models [20]. When the weather stations are located inside the canopy, however, absolute temperatures recorded differ from those measured by standard weather stations. Hence, absolute values of climate indices obtained with small scale weather stations cannot be compared to those obtained with standard weather stations.

Remote sensing provides climate data over large areas and over continuous timescales. These data have to be pre-processed to eliminate artefacts (e.g. cloud cover; corrections for differences in land use, etc.). It is also important to check the quality of the data, especially with regard to the spatial and temporal uniformity of the signal.

Dynamic circulation models produce very large quantities of climate data, covering extensively large areas and manipulation of this type of data requires specific software packages, programming skills and considerable computational power. The spatial resolution of this type of data has considerably increased over the past few years and it is now currently available in grids of 8 km^2, and sometimes even 1 km^2 or lower. Quality assessment of data derived from dynamic circulation models, however, is challenging, because they provide climate data corresponding to an area, usually covering several km^2. Hence, comparing this data to climate observations from one weather station (point data) is not relevant. Spatial interpolation of climate station data should therefore be performed before.

Climatic zoning can be based on a selection of several relevant indices. For instance, the Multicriteria Climate Classification of Tonietto and Carbonneau [14] combines the use of the Huglin Index, a water balance model (DI) and a cool night index.

4.3 Identify climatically homogeneous zones

Unlike soil-based terroir-zoning, which is mainly based on qualitative data (soil types), climate zoning is based on quantitative data. Homogeneous zones therefore need to be delineated according to quantified climatic parameters. Spatial variability in the climatically homogeneous zones must be greater than or equal to the mapping error. It is also desirable that the areas should be delineated according to criteria that are relevant for viticulture.

Furthermore, since climate can vary considerably over time, climate-based terroir zoning must be based on descriptive statistics calculated over a sufficient number of years. The number of years required depends on the purpose of the zoning, the variable considered and the factors responsible for its variations in space (Appendix 2).

5 Validation of terroir zoning

The relevance of the terroir zoning can be validated by various methods. For example, ecophysiological studies charcaterize the response of the vines to environmental factors, including soil and climate. Major vine responses include phenology, vigor, yield parameters and grape composition. The interactions between the vine and the environment are frequently mediated by vine water and nitrogen status. This approach of validation can be carried out with point measurements across a network of reference blocks, or spatialized using maps of parameters such as vigor, timing of phenological stages, grape composition at ripeness, yield components, vine water status, and/or vine nitrogen status [21]. Terroir zoning can also be validated in other ways:

- Surveys among growers can make use of their empirical knowledge to validate terroir zoning [22].
- Risk levels of climatic threats or pest can be compared against maps of actual damage recorded on the vines.
- Sensory analyses implemented on wines obtained either by real scale or small-scale vinification can be used to validate the accuracy of terroir zoning
- Geographic information systems (GIS) are useful tools to overlay zoning maps with spatialized validation data.

5 Conclusions

Clear objectives have to be defined prior to choosing a terroir zoning methodology and the appropriate scale at which the study will be implemented. A scale of 1/5,000th is appropriate for zoning at the estate level, while 1/10,000th or 1/25,000th is appropriate for zoning at an appellation level. Highly relevant zoning at the soil level can be obtained by combining geology, geomorphology and pedology (soil science). When only one of these disciplines is chosen for the implementation of the study, however, pedology should be preferred. In climate zoning, relevant agro-climatic indicators must be selected and averaged over an appropriate number of years. Quality of source data is a critical issue. Differences among identified homogeneous zones must be greater than intra-zone uncertainty.

References

1. C. van Leeuwen, G. Seguin, J. Wine Res., **17** 1-10 (2006).
2. United States Department of Agriculture, Natural Ressources Conservation Services (USDA), Keys to Soil Taxonomy (2010).
3. D. Baize and M. Girard, INRA Eds. (1995).
4. C. Cam, P. Vital, J.-L. Fort, P. Lagacherie, R. Morlat, Etude et Gestion du Sol, **10** 35-42 (2003).
5. F. André, C. van Leeuwen, S. Saussez, R. van Durmen, P. Bogaert, D. Moghadas, L. de Rességuier, B. Delvaux, H. Vereecken, S. Lamblot, J. Appl. Geophys., **78** 113-122 (2012).
6. G. V. Jones, A. A. Duff, A. Hall, J. W. Myers, Am. J. Enol. Vitic., **61** 313–326 (2010).
7. M. A. Amerine, A. J. Winkler, Hilgardia. **15**, 493–673 (1944).
8. H. Quénol, *Changement climatique et terroirs viticoles* (Lavoisier, Paris, 2014), *Tec & Doc*.
9. A. K. Parker, I. García de Cortázar-Atauri, C. van Leeuwen, I. Chuine, Aust. J. Grape Wine Res., **17** 206–216 (2011).
10. A.K. Parker *et al.,* Agric. Forest Meteorol., **180** 249-264 (2013).
11. K. Mori *et al..*, Vitis, **44** 161-165 (2005).
12. C. van Leeuwen *et al.*, J. Int. Sci. Vigne Vin., **43** 121–134 (2009)
13. H. Fraga, I. Garcia de Cortázar Atauri, A. C. Malheiro, J. A. Santos, Glob. Change Biol. **22** 3774–3788 (2016).
14. J. Tonietto, A. Carbonneau, Agric. Forest Meterol., **124** 81-97 (2004).
15. D. Molitor *et al.*, Eur. J. Plant Pathol. **144**, 785–798 (2016).
16. J. C. Ferguson, M. M. Moyer, L. J. Mills, G. Hoogenboom, M. Keller, Am. J. Enol. Vitic., **65** 59–71 (2014).
17. G. Sgubin *et al.*, Agric. For. Meteorol., **250–251** 226–242 (2018).
18. F. Vinet, Atmospheric Res., **56** 309–323 (2001).
19. J. Li, A. D. Heap, Ecol. Inform., **6** 228–241 (2011).
20. R. Le Roux *et al.*, Agric. For. Meteorol., **247** 159–169 (2017).
21. C. van Leeuwen, in *Managing Wine Quality*, A. G. Reynolds, Ed. (Woodhead Publishing, 2010), *Woodhead Publishing Series in Food Science, Technology and Nutrition*, pp. 273–315.
22. R. Morlat, *Collection Avenir Œnologie, Œnoplurimedia, Chaintré* (2001).

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Appendix 1: Soil classifications for soil-based terroir zoning

There are many soil classifications. For standardisation, the OIV recommends that its members use one of the following three classifications for soil-based terroir zoning works: the "Soil Taxonomy" (American classification [2]), the "World Reference Base for Soil Resources" (FAO Classification ftp://ftp.fao.org/agl/agll/docs/wsrr103e.pdf) or the "Référentiel Pédologique" (French classification [3]). Each of these classifications has interests and limits of use.

The "Soil Taxonomy" [2] is the classification that allows the most accurate definition of the soil types encountered. It is used in many countries. Its complexity, however, makes it a tool for soil science experts rather than for soil-based terroir zoning objectives.

The "World Reference Base for Soil Resources" (FAO classification ftp://ftp.fao.org/agl/agll/docs/wsrr103e.pdf), also called the "FAO classification", is an internationally recognised classification that is easy to use, however, it is limited to only 32 proposed references. Furthermore, this classification does not recognise the predominant role of the rock type in pedogenesis (soil formation). Consequently, there is no group of carbonated soils, which clearly limits its interest for vitiviniculture zoning.

The Référentiel Pédologique, established by the French Institut National de Recherche Agronomique [3] is a relatively comprehensive and easy reference to use. It is based on both morphological criteria (diagnosis horizon) and pedogenetic criteria (type of parent rock in particular). Even though this classification is used in several countries, its national origin (French) is a limit.

Appendix 2: Temporal sampling requirements for agro-climatic indices used in climate-based terroir zoning

The climate differs from the soil in particular due to its temporal variability. Also its characterization, for vitiviniculture requires a study over several years. The size of this temporal sample, hereafter referred to as the "study duration", is highly dependent on the objectives defined. There are 2 cases, among others:

- The zoning objective is limited only to the identification of areas considered as climatically homogeneous (in terms of one or more agroclimatic indices) within the study area.
- The zoning objectives are (1) to distinguish areas considered climatically homogeneous within the study area, (2) to compare the climatic characteristics of areas identified in the study area with other wine producing regions (intra- and extra-regional comparison).

In the first case, the study duration can be variable, depending on the spatial scale and the atmospheric and environmental factors that govern the spatial variability of the climate. Thus, for large-scale zoning (study area of a size less than 100 km), certain variables such as air temperature may be affected, primarily, by lasting geographical features or those that are only slightly variable over time, such as the relief or land use. Thus, a study period of several years (5 years minimum) may be sufficient to demonstrate redundant spatial structures over the years. However, for variables where the spatial distribution depends largely on weather conditions, such as rainfall, substantial study duration is required. It is recommended that the times given for the calculation of climate normals, as defined by the World Meteorological Organization (WMO) are used, which is 30 years.
In the second case, it is also recommended that a study period of 30 years is used. It is clear that the comparison of the climatic characteristics of the areas identified in the study area with other wine regions requires identical periods of study, due to climate change over the long term.