The «smoking gun» of climate change in wines

Goût de fumée des vins: ça sent le changement climatique !

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Head of Research & Development

Adapted from

Mirabelli-Montan, Y. A., Marangon, M., Graça, A., Marangon, C. M. M., & Wilkinson, K. L. (2021). A review of the techniques for mitigating the effects of smoke taint in wine production: Sourced from the article "Techniques for Mitigating the Effects of Smoke Taint While Maintaining Quality in Wine Production: A Review"(Molecules, 2021). Original language of the article: English. IVES Technical Reviews, vine and wine.

Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia (…)
AR6 WGI – B.5
Observed increases in areas burned by wildfires have been attributed to human-induced climate change (…)
– AR6 WGII – B1.1

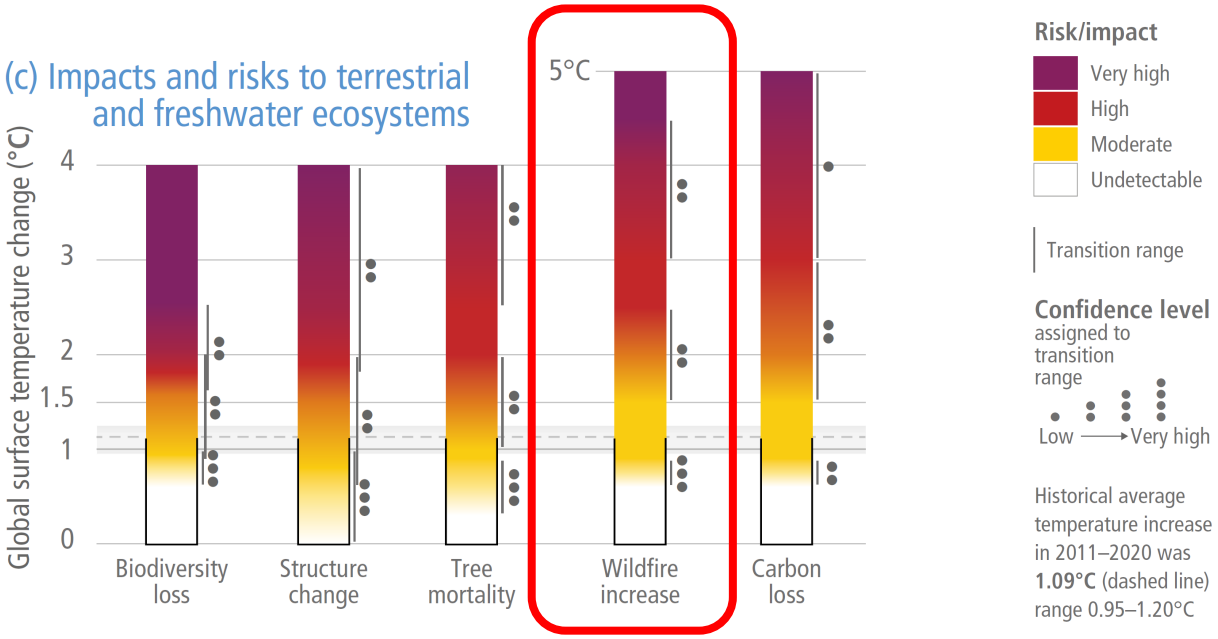
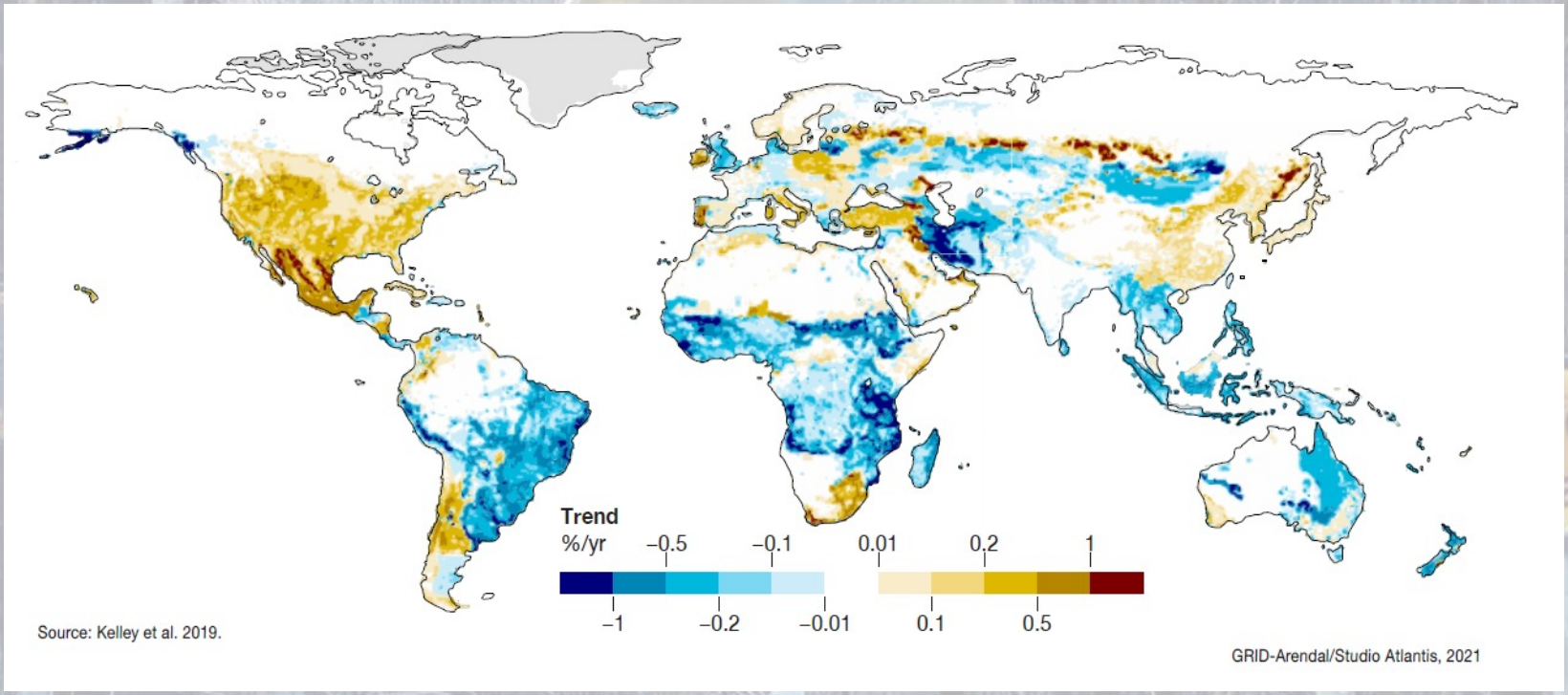


Figure SPM.3 | Synthetic diagrams of global and sectoral assessments and examples of regional key risks. Diagrams show the change in the levels of impacts and risks assessed for global warming of 0–5°C global surface temperature change relative to pre-industrial period (1850–1900) over the range.

Wildfires are progressing faster than prevention measures

IMPACT OF HUMAN-INDUCED LANDSCAPE CHANGE ON GLOBAL FIRES



2001-2014 yearly change in burnt area due to combined effects of human ignitions, active suppression, and land fragmentation from agriculture - © 2022 United Nations Environment Programme

Wildfires are progressing faster than prevention measures

THE MEDITERRANEAN HOTSPOT

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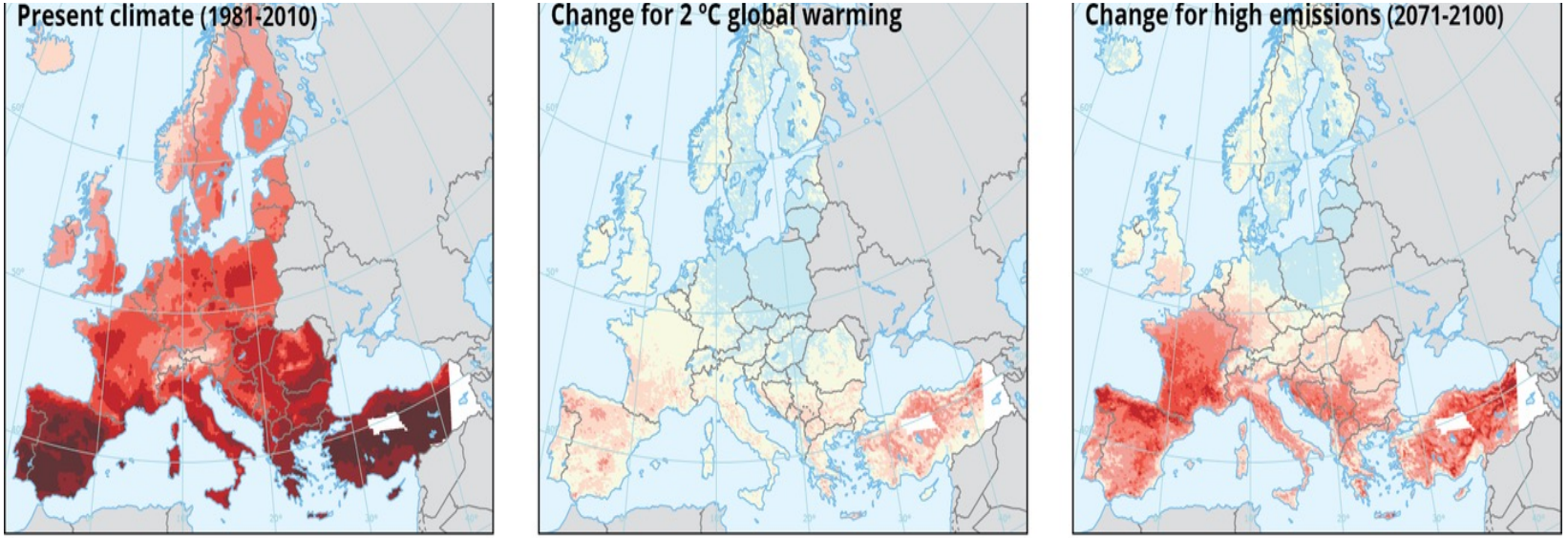

Wildfires are progressing faster than prevention measures

DÃO, CENTRAL PORTUGAL, AUGUST 2017

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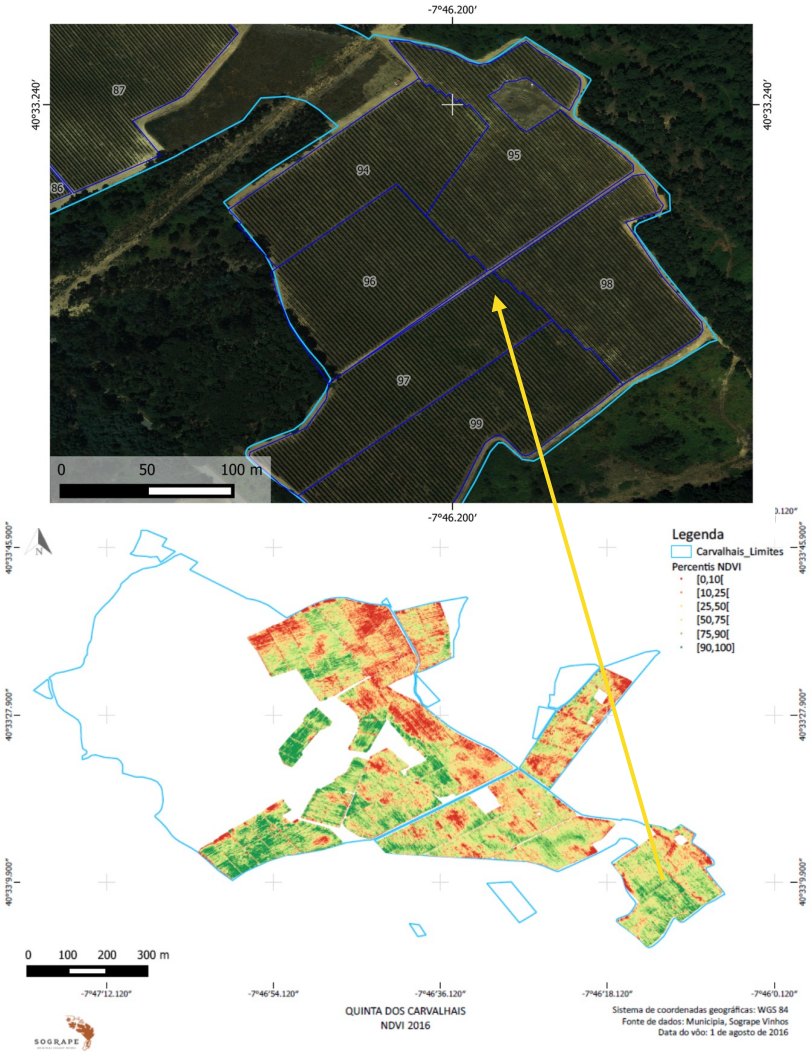

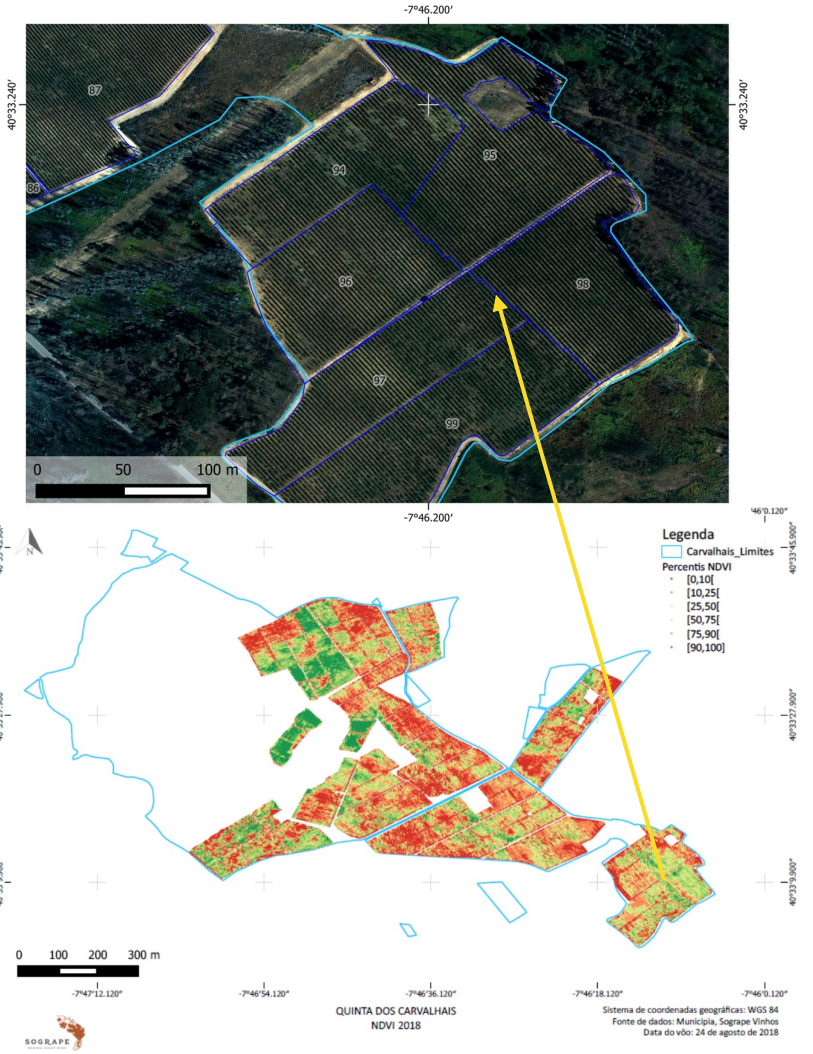

Veraison 2016

Veraison 2018

Wildfires are progressing faster than prevention measures

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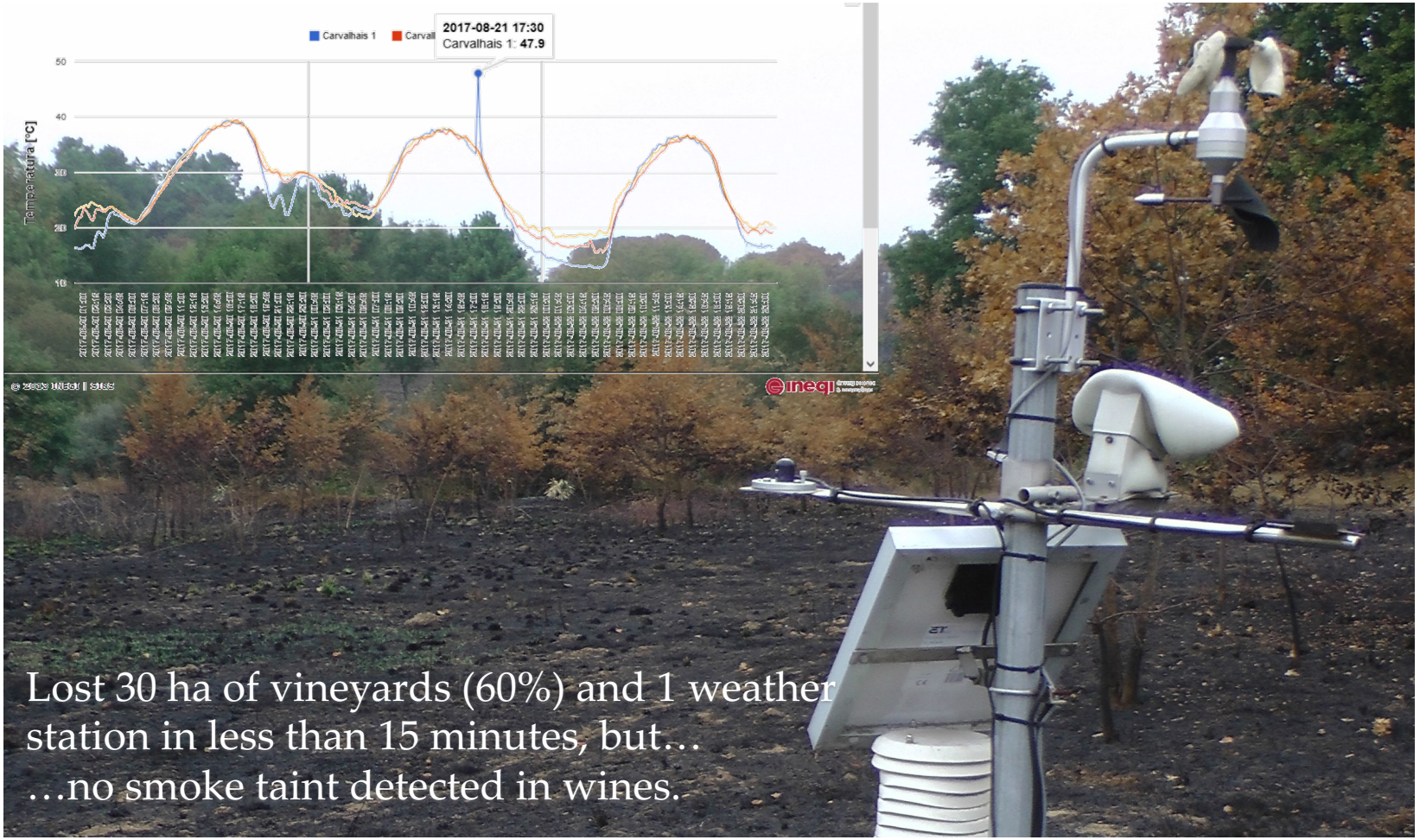
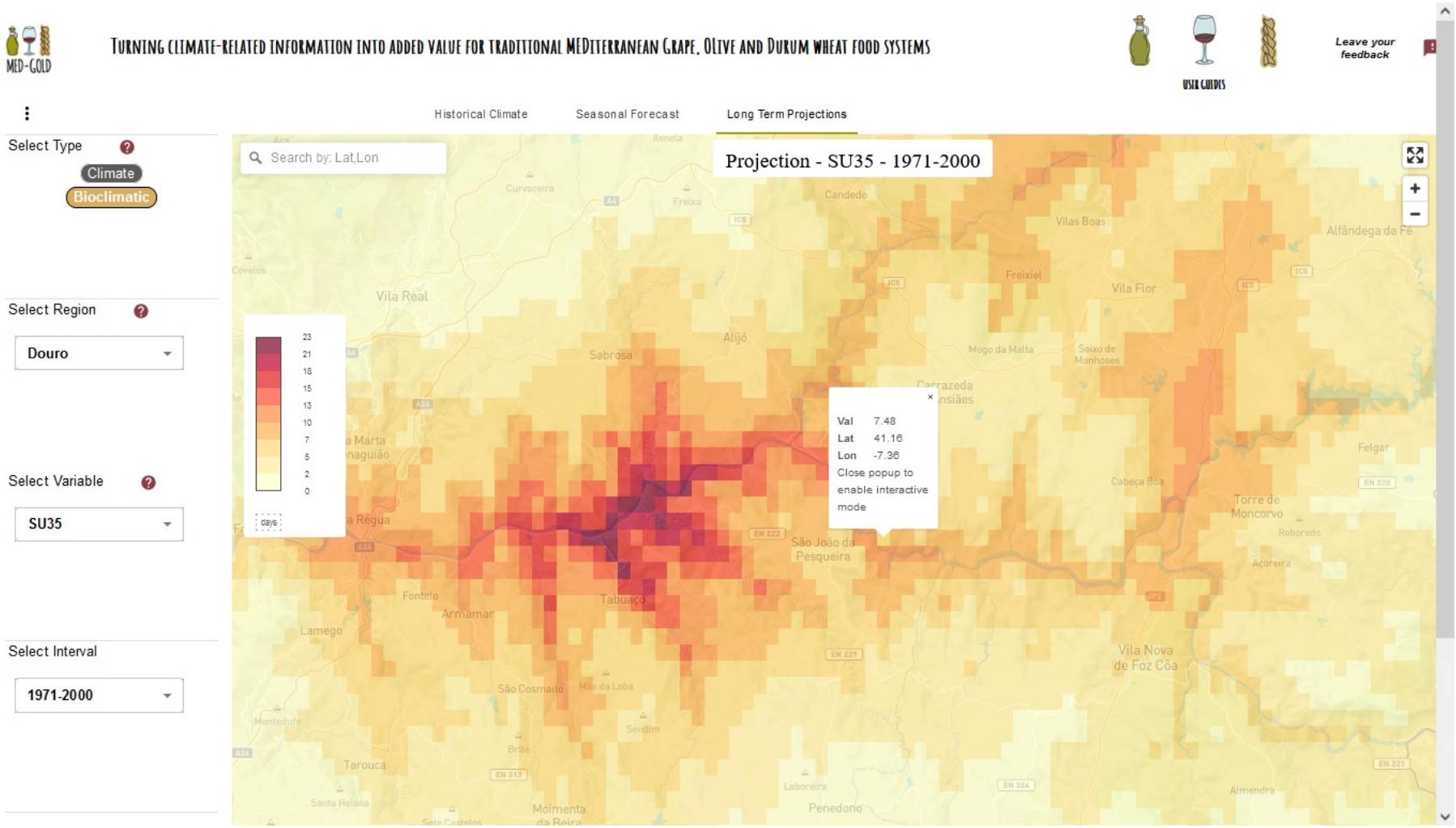


Lost 30 ha of vineyards (60%) and 1 weather station in less than 15 minutes, but…
…no smoke taint detected in wines.

Climate indicators point towards increased risk in the future

MED-GOLD SHOWS INEXORABLE TREND IN IBERIA



Climate indicators point towards increased risk in the future

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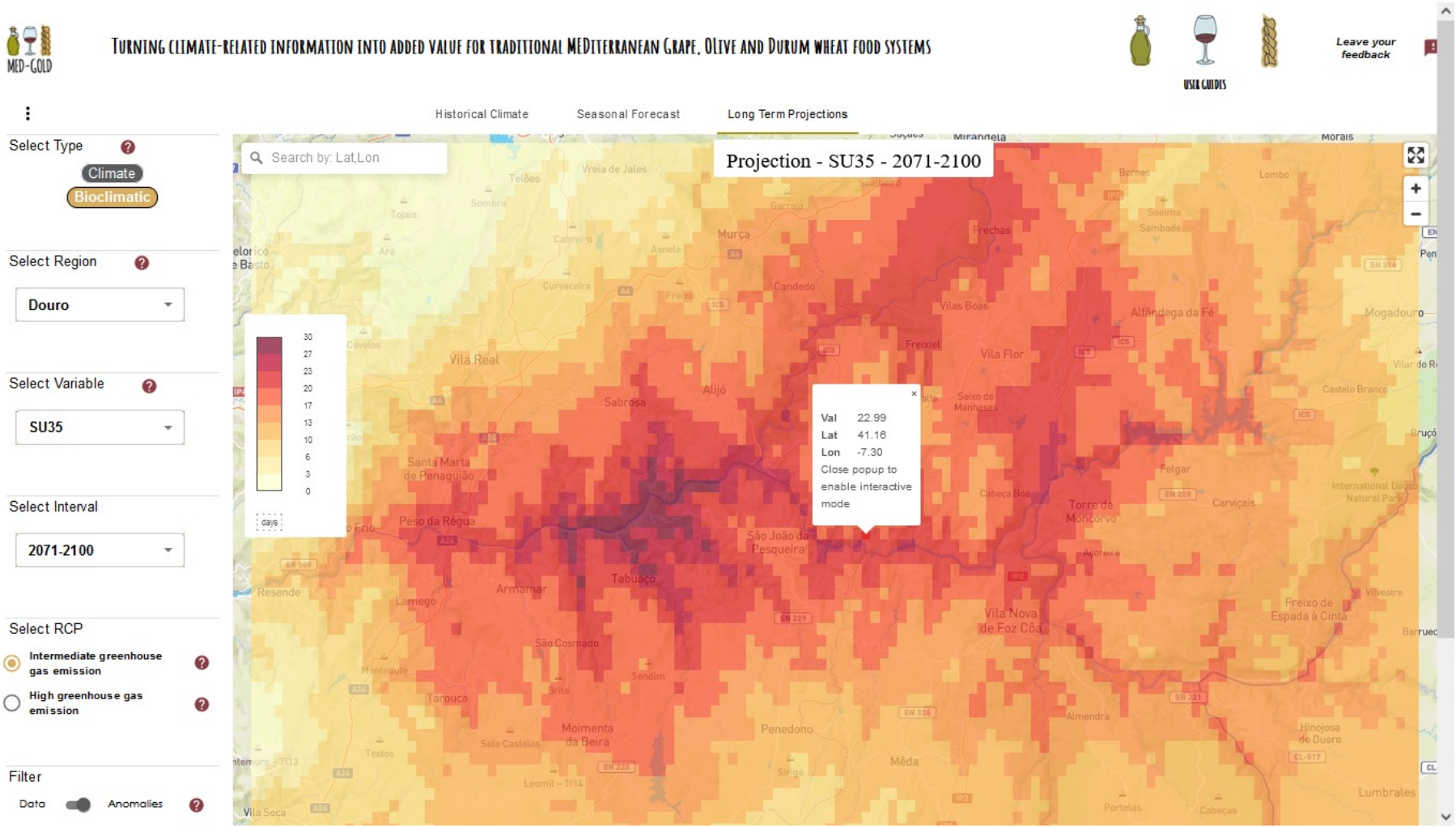

Climate indicators point towards increased risk in the future

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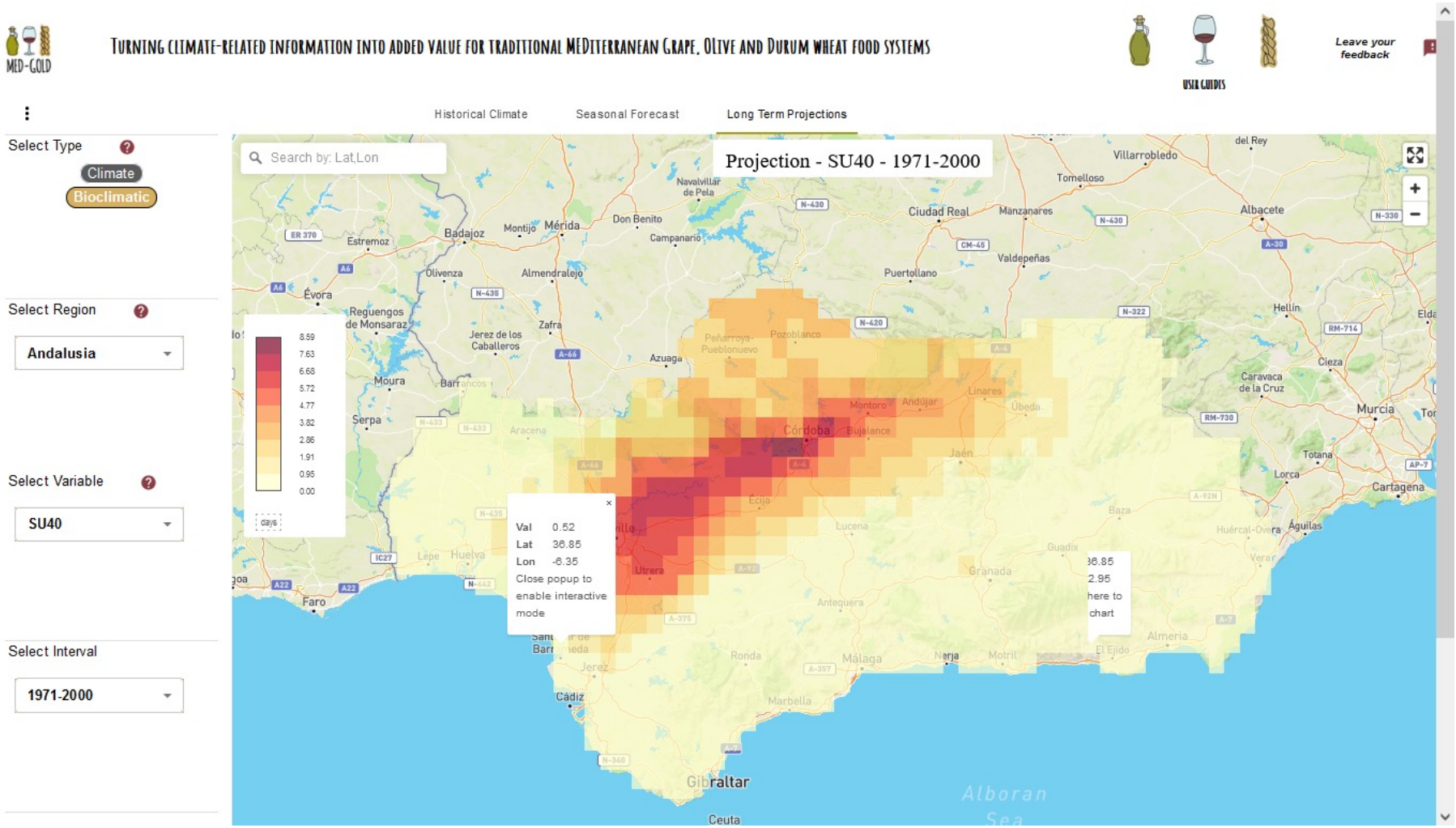

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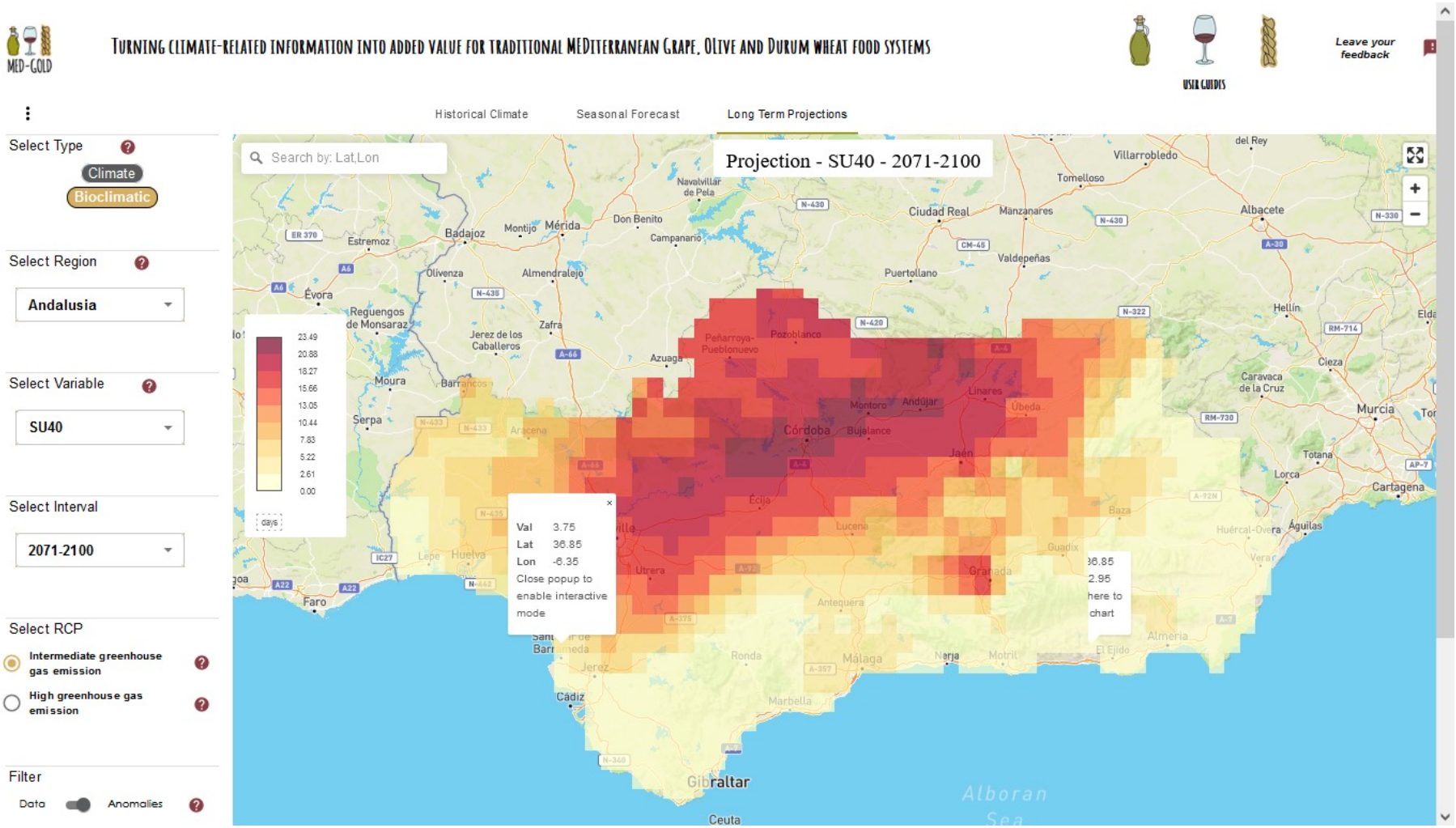
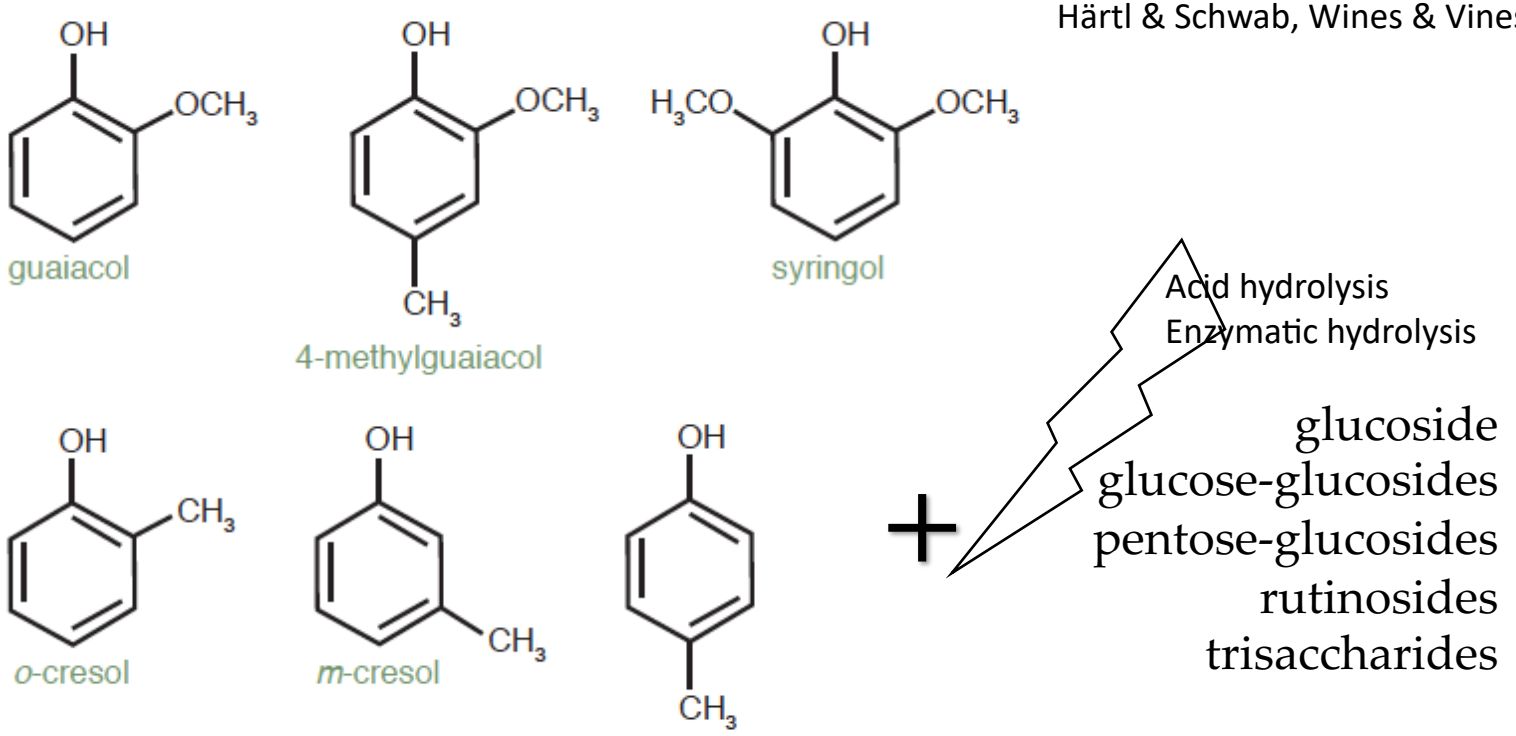


How do wines get «smoked»?

KEY DISCOVERIES IN SMOKE TAINT RESEARCH

Härtl & Schwab, Wines & Vines 2018



Chemical structures of characteristic smoky aroma volatiles found in smoke from wood fire (guaiacol, 4-methylguaiacol, syringol, *o*-cresol, *m*-cresol, and *p*-cresol)

Kennison et al., 2007, 2008, 2009
Hayasaka et al., 2010
Caffrey et al.., 2019

How do wines get «smoked»?

KEY DISCOVERIES IN SMOKE TAINT RESEARCH

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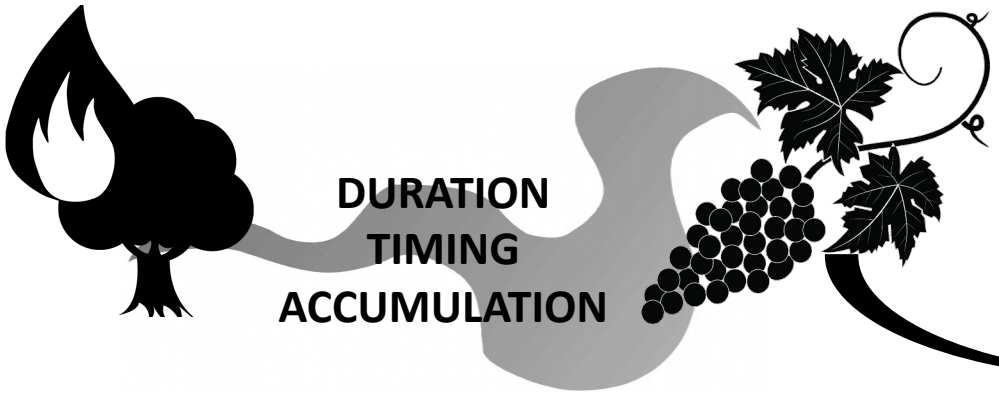
NO TRANSLOCATION
GLYCOSYLATION

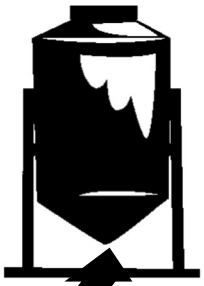


DURATION
TIMING
ACCUMULATION

Kennison et al., 2007, 2008, 2009

HYDROLYSIS
- **ACID ++**
- **ENZYMATIC +**

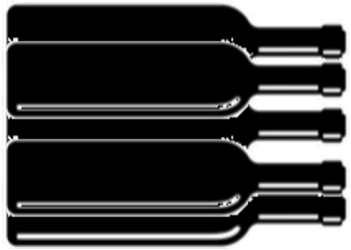
Hayasaka et al., 2010



EXTRACTION
FROM SKINS

Kennison et al., 2008

ACID HYDROLYSIS OR
MATRIX CHANGES?



Singh et al., 2011
Ristic et al., 2017

ENZYMATIC HYDROLYSIS WITH SALIVA
COMPLEX COMPOUND INTERACTIONS

Mayr et al., 2014
Caffrey et al.., 2019

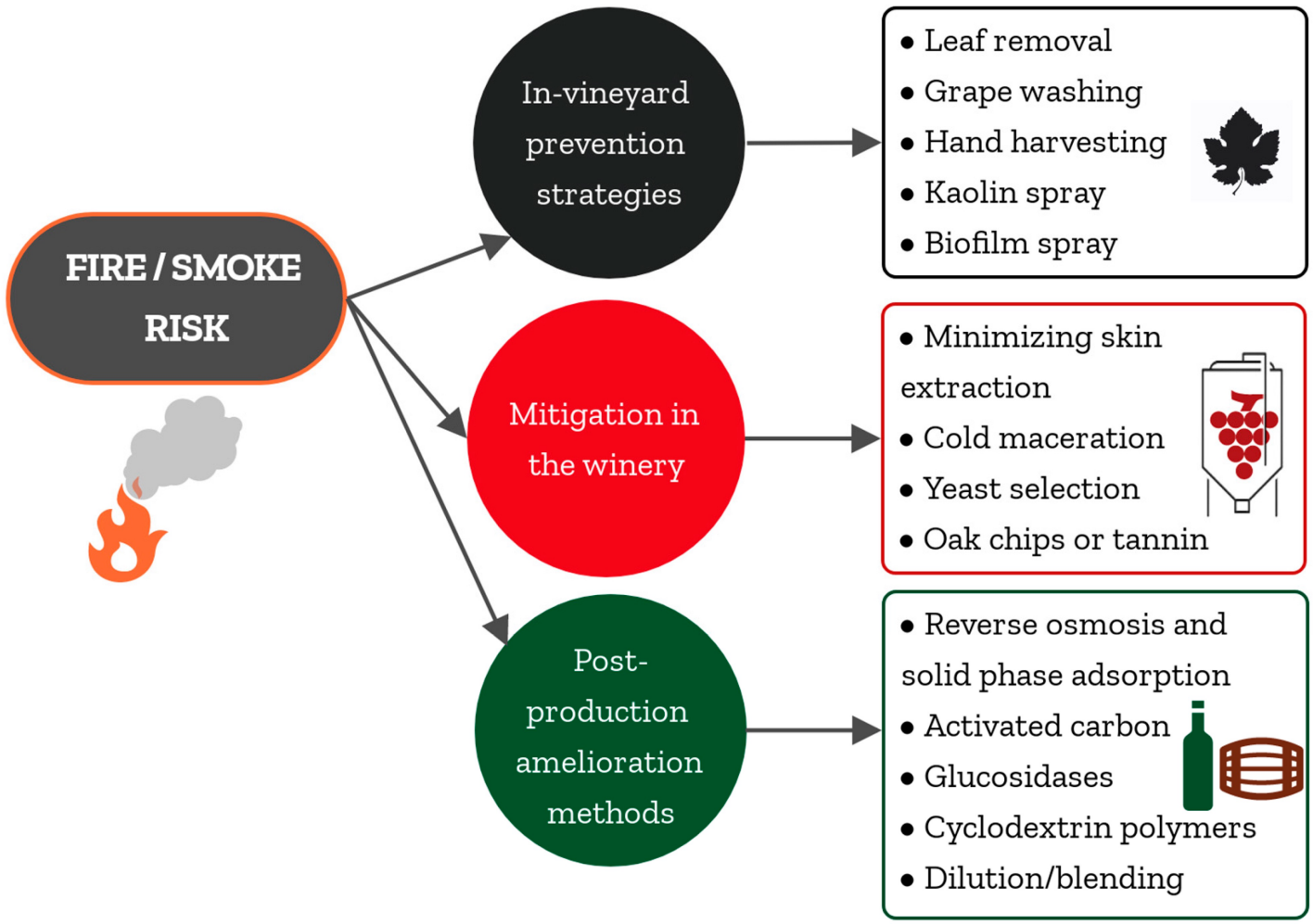


Figure 1. Summary of the different strategies used to reduce the effects of smoke on wine composition and sensory quality.

Table 1. Summary of the methods evaluated for prevention of smoke taint in the vineyard.

Method	Key Findings	Variety and Location	Effectiveness
Washing grapes during/after smoke exposure	Washing vines or grapes with water, aqueous ethanol, or milk after smoke exposure did not affect the guaiacol content of grapes or juice. Misting grapes during smoke exposure partially mitigated the uptake of volatile phenols by grapes but did not influence the perception of smoke taint in wine [29,40,55].	Cabernet Sauvignon, Cabernet Franc, Chardonnay (Australia)	None–Low
Leaf removal prior to or after smoke exposure	Where grapevines were partially defoliated before smoke exposure, wines exhibited more intense smoke characteristics. Where grapevines were partially defoliated after smoke exposure, wines exhibited more intense fruit characteristics which helped mask smoke attributes. However, this did not eliminate the taint, and should be paired with other methods [56].	Chardonnay (Australia)	None
Hand-harvesting fruit	Preventing leaves, which can adsorb smoke-derived volatile compounds from entering the must avoids extraction of additional taint compounds. However, this will not prevent extraction of taint compounds already present in grapes and should therefore be paired with other methods [57–59].	Pinot Noir, Merlot (Canada, Australia)	Low
Application of kaolin to vines	There was no conclusive evidence that applying kaolin to grapevine fruit and foliage prior to smoke exposure provided protection; results varied depending on grape variety and spray coverage [30,60].	Sauvignon Blanc, Chardonnay, Merlot, Pinot Noir (Australia)	More information needed
Application of biofilm to vines	Preliminary results were promising and suggested that applying biofilm to grapevine fruit and foliage prior to smoke exposure provides protection, but more information is needed regarding the efficacy of the spray and the feasibility of application before a fire incident [57].	Pinot Noir (Canada)	More information needed

Table 2. Summary of the methods evaluated for mitigation of smoke taint in the winery.

Method	Key Findings	Variety & Location	Effectiveness
Minimizingextraction from skins	Shorter maceration times, whole bunch pressing, and separating press fractions can help to reduce the extraction of smoke taint compounds from grape skins but limits the wine styles that can be made [46,59].	Grenache (Australia)	Low–moderate
Cold maceration	Cold maceration can help to reduce the extraction of smoke taint compounds but limits the wine styles that can be made. Does not eliminate the taint, just reduces the perceived intensity in wine [46,59].	Grenache (Australia)	Low
Yeast selection	Different winemaking yeast can enhance desirable organoleptic characteristics, thereby masking smoke attributes. Does not eliminate the taint but can reduce the perceived intensity in wine [46].	Grenache (Australia)	Low
Addition of oak chips or tannins	Addition of oak chips or tannin can help to mask smoke taint but does not remove smoke taint compounds and are only effective for mildly smoke-affected grapes, otherwise must be paired with other methods that can remove smoke taint compounds [46,59].	Shiraz (Australia)	Low

Table 3. Summary of the methods evaluated for post-production amelioration of smoke taint in wine.

Method	Key Findings	Variety & Location	Effectiveness
Reverse osmosis and solid phase adsorption	This method reduced the concentration of smoke-derived volatile phenols in wine, but volatile phenol glycoconjugates were not removed and might still impart perceivable taint characters. This approach may not salvage severely smoke-tainted wine [62].	Pinot Noir (Australia)	Moderate
Addition of activated carbon	Activated carbon can remove smoke-derived volatile phenols from wine, with some preliminary evidence suggesting that certain activated carbons might also remove volatile phenol glycoconjugates. This appears effective for treating mildly smoke-tainted wines, but cannot remedy severely tainted wines, and without removal of glycoconjugates, taint might still be perceived. Some activated carbons also strip wine color and/or desirable volatile compounds (aroma and flavors) from wine [58,63,64].	Pinot Noir, Cabernet Sauvignon, Merlot, Chardonnay (Australia)	Moderate
Addition of glucosidases	Preliminary studies involving addition of glucosidase enzymes to hydrolyze volatile phenol glycoconjugates, enabling the resulting volatile phenols to be more easily removed via other methods of amelioration (e.g., reverse osmosis or activated carbon treatments), offered little evidence of success. More research is needed to evaluate the efficacy of other glucosidases to achieve this purpose [58,65].	Pinot Noir, Cabernet Sauvignon, Merlot, Shiraz, Chardonnay (Australia)	None
Addition of cyclodextrin polymers	Two cyclodextrin polymers were evaluated and found to be capable of adsorbing from 45 to 77% of four volatile phenols studied. Additionally, CD polymers can be regenerated. The efficacy of the method for removal of volatile phenol glycosides still needs to be assessed [66].	Cabernet Sauvignon (Australia)	Moderate
Dilution /Blending	Blending or dilution of smoke-tainted wine with a base (unaffected) wine can diminish the intensity of smoke taint to levels that are comparable to the base wine alone. However, the level of dilution required depends on the initial concentration of smoke taint compounds present in the wine [47,67].	Verdelho, Pinot Noir (Australia)	Moderate

In wine, there may be smoke without fire…

OTHER SOURCES OF SMOKE TAINT MARKERS

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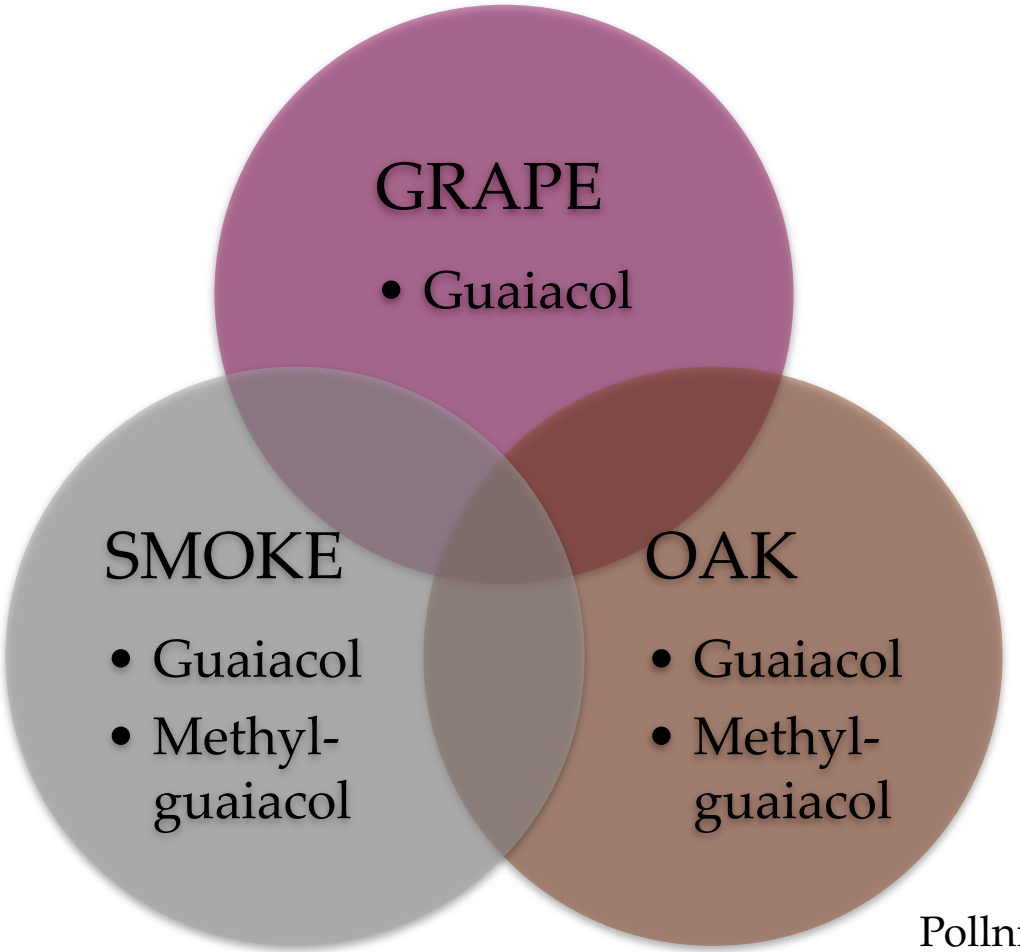
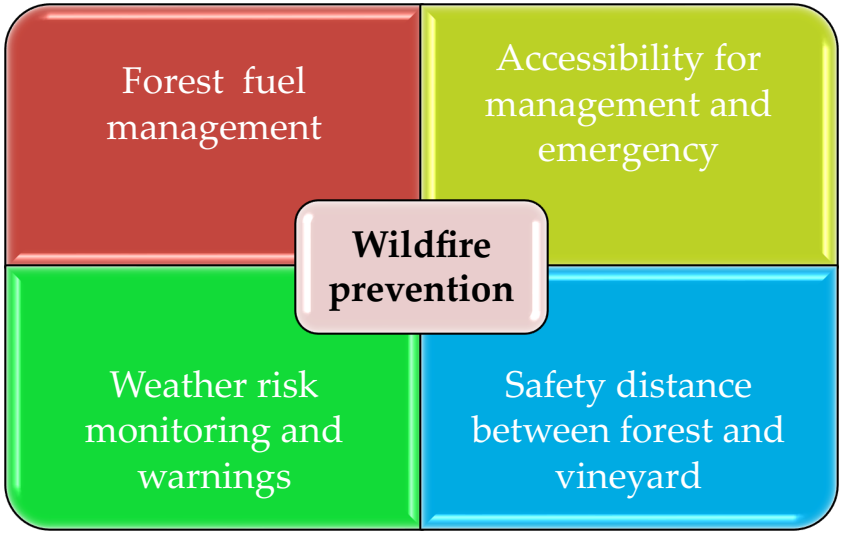


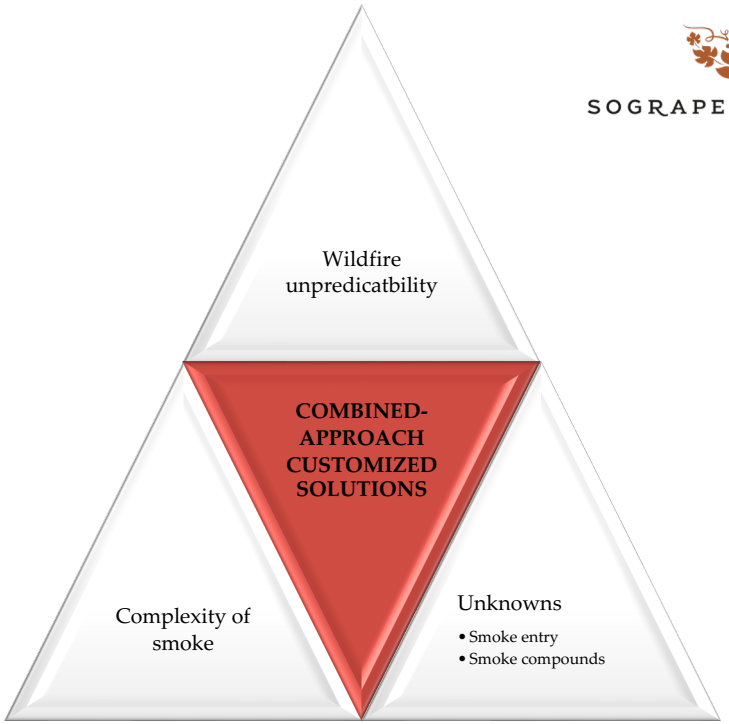
Pollnitz et al., 2004
Wilkinson et al., 2011
Culbert et al., 2020

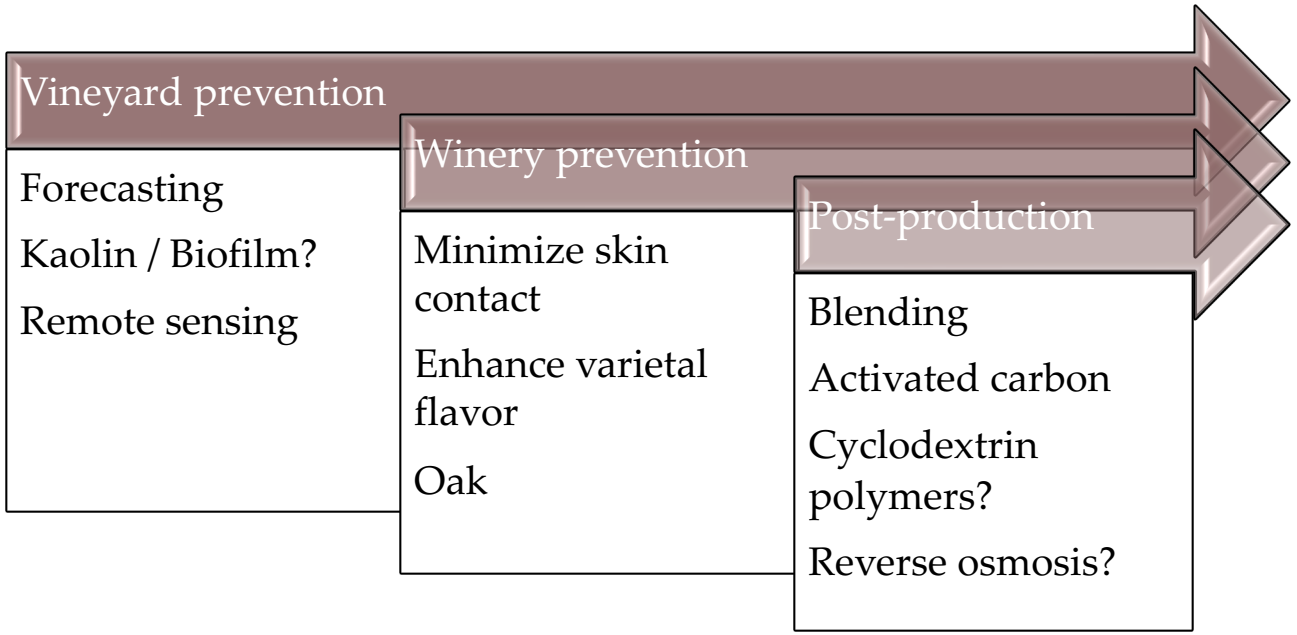
Baseline databases are needed!

Cutting down on smoke

NO SILVER BULLET!







SOGRAPE

AVOID WILDFIRES

Adequate forest managent | Keep safe distance

DECREASE UPTAKE

Agricultural biofilms | Cold soak / Limited maceration

REDUCE CONCENTRATIONS

Carbon fining / RO | Blend / Yeast / Oak

WHEN ALL ELSE FAILS

Insurance / Distillation

Cultivar	Variable	Concentration (µg/kg)								
		SyGG	MSyGG	PhRG	CrRG	GuRG	MGuRG	MeGu	Gu	*m*
Cabernet Sauvignon (*n* = 44)	Median	1.7	0.4	0.5	1.3	0.5	0.7	0.0	0.0	0.0
	95% CI for median	1.4–2.1	0.4–0.5	0.3–0.7	1.1–1.5	0.5–0.6	0.6–1.1	n.a.	n.a.	n.a.
	IQR	1.4	0.3	0.7	0.8	0.3	0.8	0.0	0.0	0.0
	Maximum	7.9	1.3	2.6	3.6	2.3	4.0	0.0	2.9	1.0
	99th percentile	7.6	1.1	2.5	3.6	2.2	3.9	*1.0*	2.9	*1.0*
Grenache (*n* = 44)	Median	2.4	0.4	0.6	2.2	0.7	0.6	0.2	0.6	0.1
	95% CI for median	2.0–2.9	0.3–0.5	0.5–0.8	1.7–2.6	0.5–0.8	0.4–0.7	0.2–0.2	0.5–0.8	0.1–
	IQR	2.4	0.2	0.6	1.5	0.4	0.4	0.2	0.6	0.0
	Maximum	7.1	0.8	2.7	4.7	1.8	1.0	0.9	2.4	0.2
	99th percentile	7.0	*1.0*	2.4	4.7	1.8	1.0	*1.0*	2.0	*1.0*
Mataro (*n* = 25)	Median	2.8	0.2	0.5	2.5	0.5	1.9	0.4	1.3	0.1
	95% CI for median	2.3–3.5	0.2–0.3	0.4–0.6	1.7–2.8	0.4–0.6	0.4–0.6	0.3–0.5	0.8–1.5	0.1–
	IQR	1.7	0.2	0.3	1.2	0.3	1.5	0.2	0.8	0.1
	Maximum	7.4	0.7	1.1	5.4	1.3	5.0	0.6	2.5	0.3
	99th percentile	7.3	*1.0*	1.1	5.0	1.3	4.7	*1.0*	2.4	*1.0*

Coulter, A., Baldock, G., Parker, M., Hayasaka, Y., Francis, I. L., & Herderich, M. (2022). Concentration of smoke marker compounds in non-smoke-exposed grapes and wine in Australia. *Australian Journal of Grape and Wine Research*.

BREAKING NEWS!

ACTIVATED CARBON IN VINEYARDS

SOGRAPE

Wilkinson, K. L., Ristic, R., Szeto, C., Capone, D. L., Yu, L., & Losic, D. (2022). Novel use of activated carbon fabric to mitigate smoke taint in grapes and wine. Australian Journal of Grape and Wine Research.

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SOGRAPE

THANK YOU!




Ysadora Matteo Christine Kerry