A novel method of land zonation to improve olive farming and oil quality

Claudio Cantini , Tomaso Ceccarelli

Trees and Timber Institute (IVALSA)

National Research Council of Italy (CNR)

Agriculture – Olive cultivation

Production, Environment, Landscape, Sustainability, best use of naturale resources

ZONATION

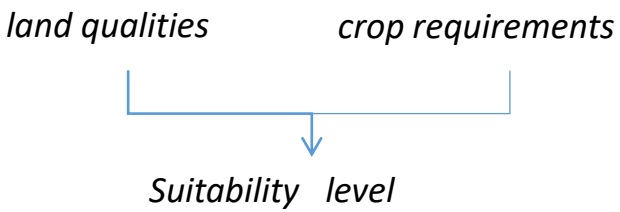
Definition of homogeneous areas for several aims:

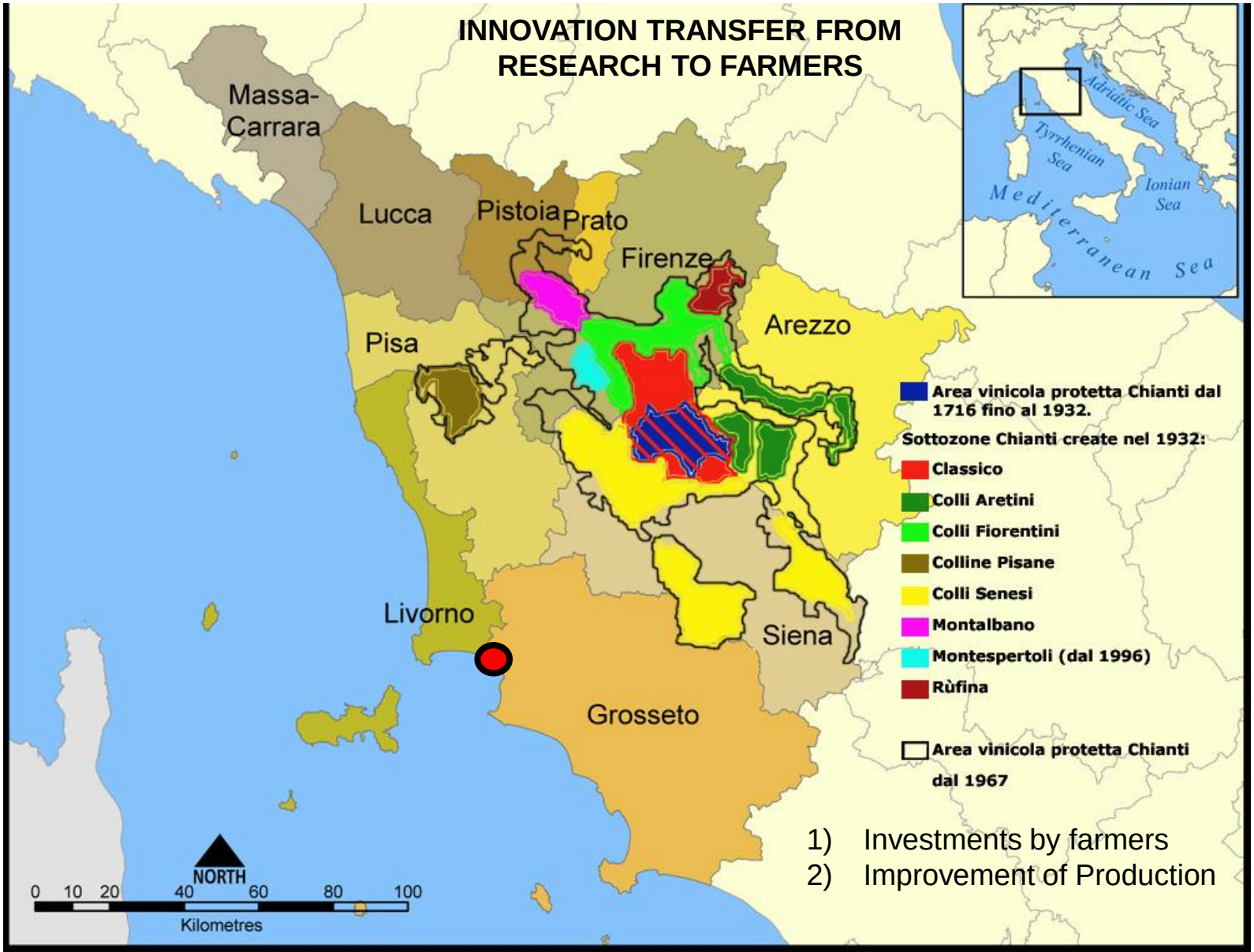
Soil conservation
Potential Yields
Economic value
Landscape value
Eco System value

Land capability: USDA, following years ’20 crisis *(Dust bowl)*

Land suitability : F.A.O. from the ‘70 developed a *land evaluation* procedure to set the suitability
the fitness of a given type of land for a defined use

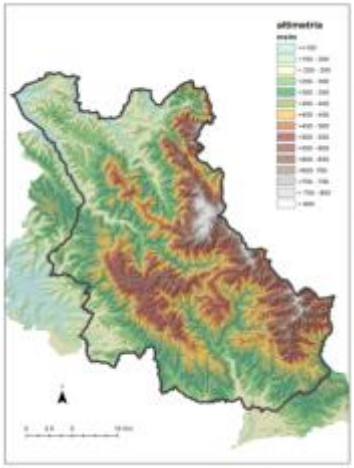
French definition of TERROIR for wine quality

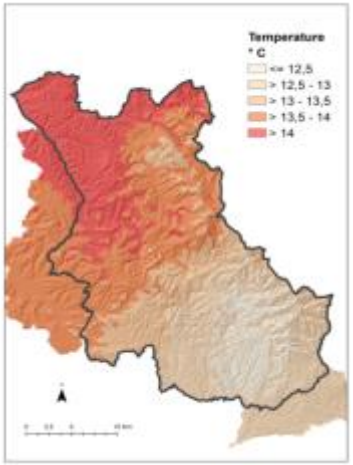


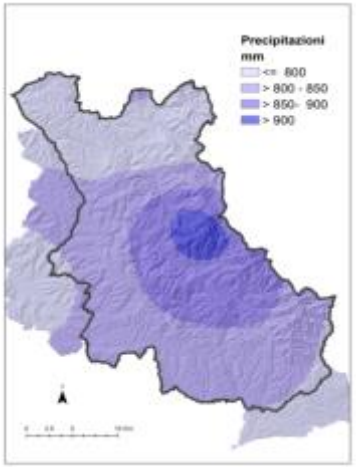

INNOVATION TRANSFER FROM RESEARCH TO FARMERS
Massa-Carrara
Lucca
Pistoia
Prato
Firenze
Pisa
Arezzo
Livorno
Siena
Grosseto
Adriatic Sea
Tyrrhenian Sea
Ionian Sea
Mediterranean Sea
Area vinicola protetta Chianti dal 1716 fino al 1932.
Sottozone Chianti create nel 1932:
Classico
Colli Aretini
Colli Fiorentini
Colline Pisane
Colli Senesi
Montalbano
Montespertoli (dal 1996)
Rùfina
Area vinicola protetta Chianti dal 1967
NORTH
0 10 20 40 60 80 100
Kilometres
1) Investments by farmers
2) Improvement of Production

OBJECTIVES

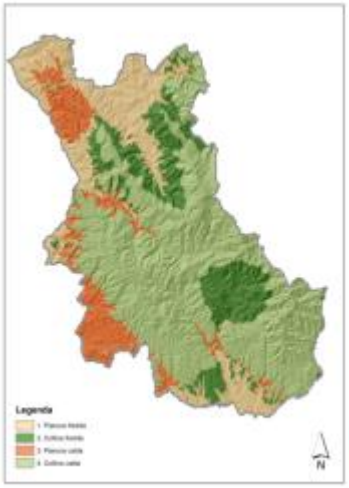
CHARACTERIZATION







ZONATION

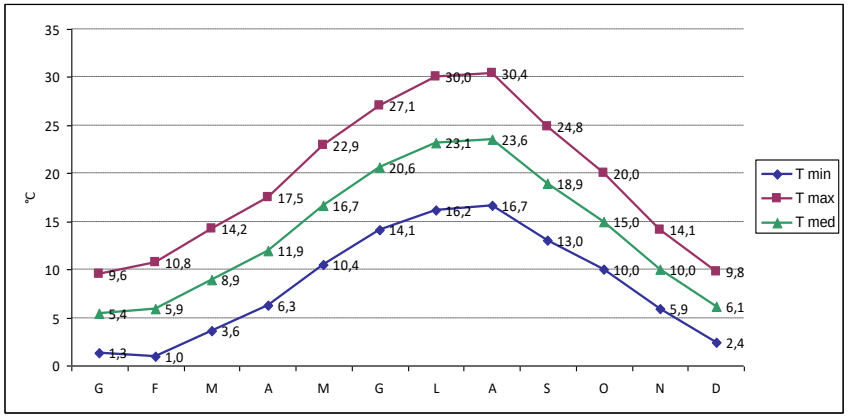


Comune Catasto	Ha	% Ha	TREES	% TREES		Comune Catasto	Ha	% Ha
Barberino Val d'Elsa	121	4	11222	3	72	Barberino Val d'Elsa	168	3%
Castellina in Chianti	302	11	32816	10	58	Castellina in Chianti	522	10%
Castelnuovo Berardenga	472	17	41836	13	54	Castelnuovo Berardenga	877	16%
Gaiole in Chianti	202	7	33066	10	34	Gaiole in Chianti	591	11%
Greve in Chianti	664	24	63287	19	53	Greve in Chianti	1244	23%
Poggibonsi	113	4	20546	6	158(*)	Poggibonsi	71	1%
Radda in Chianti	80	3	10160	3	34	Radda in Chianti	235	4%
San Casciano V.P.	570	20	88070	27	36	San Casciano V.P.	1569	29%
Tavarnelle Val di Pesa	273	10	30812	9	141(*)	Tavarnelle Val di Pesa	193	4%
Totale	**2796**		**331015**	**100**			**5470**	**100%**

CLIMATE DATASET 20 YEARS

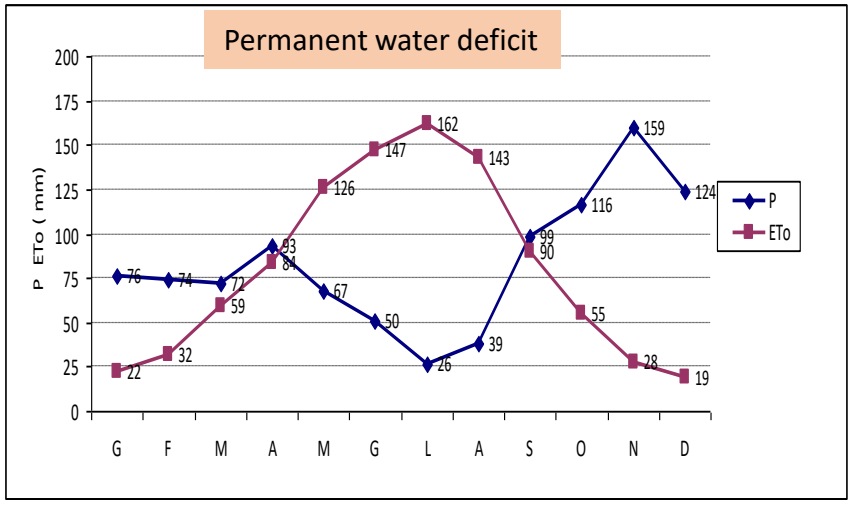
18 locations inside the area and 14 on the premises

Temperature and annual rainfall



Average monthly temperature 1993-2012

Potential Radiation:
Made on soil digital model



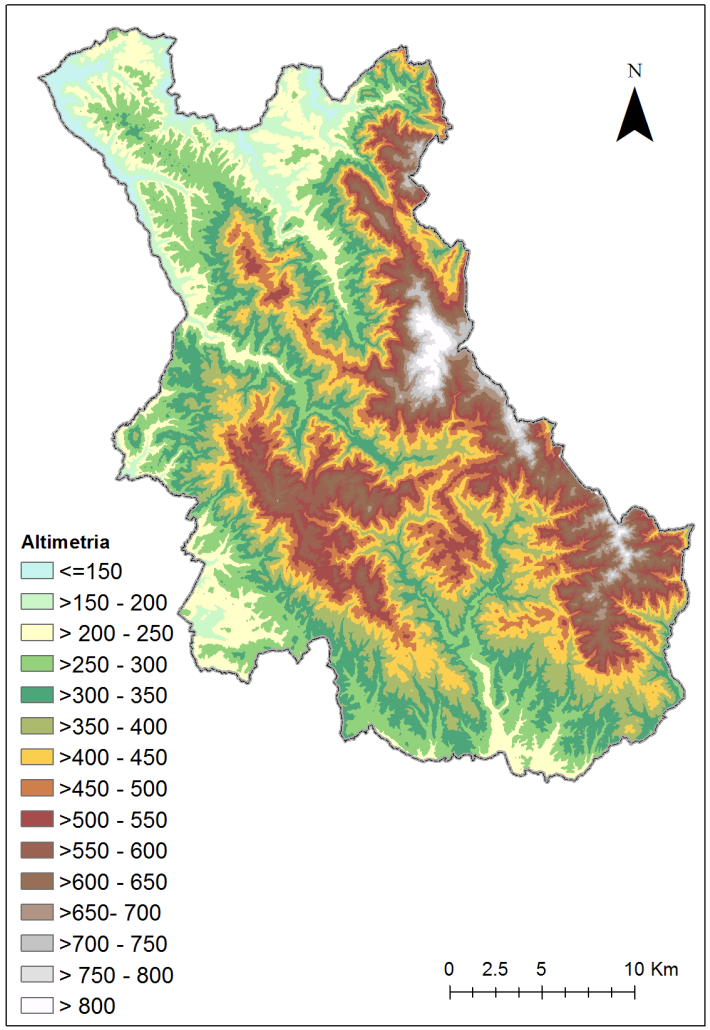
Water balance 1993-2012

Index of freezing risk (late, early in season)

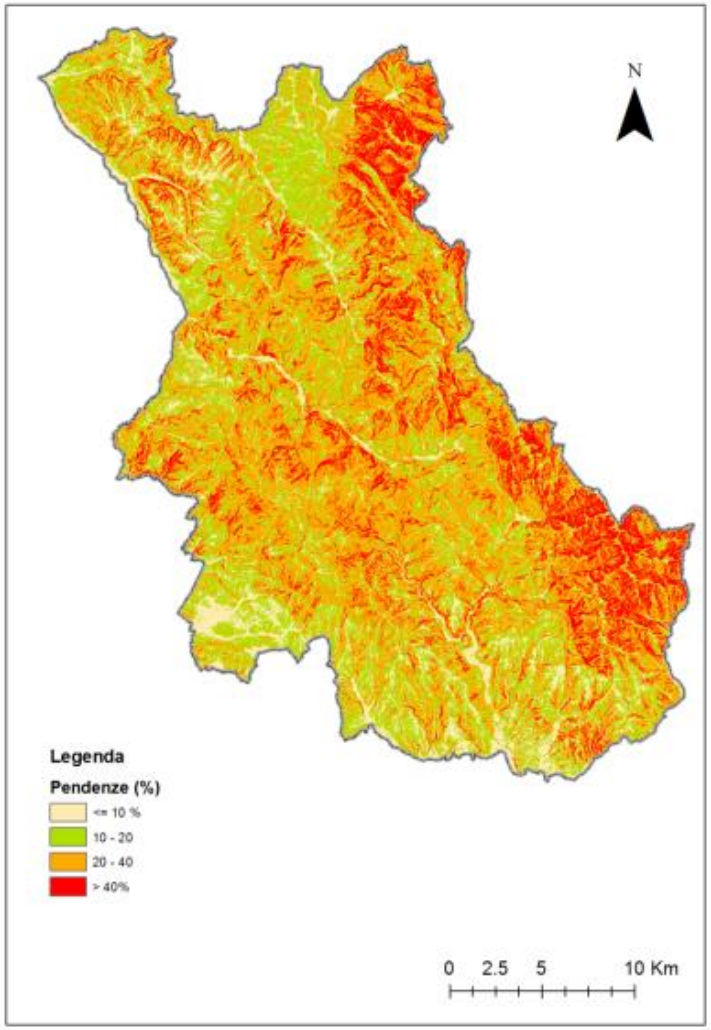
Geomorphology

Digital Elevation Model o DEM

altimetry



slope

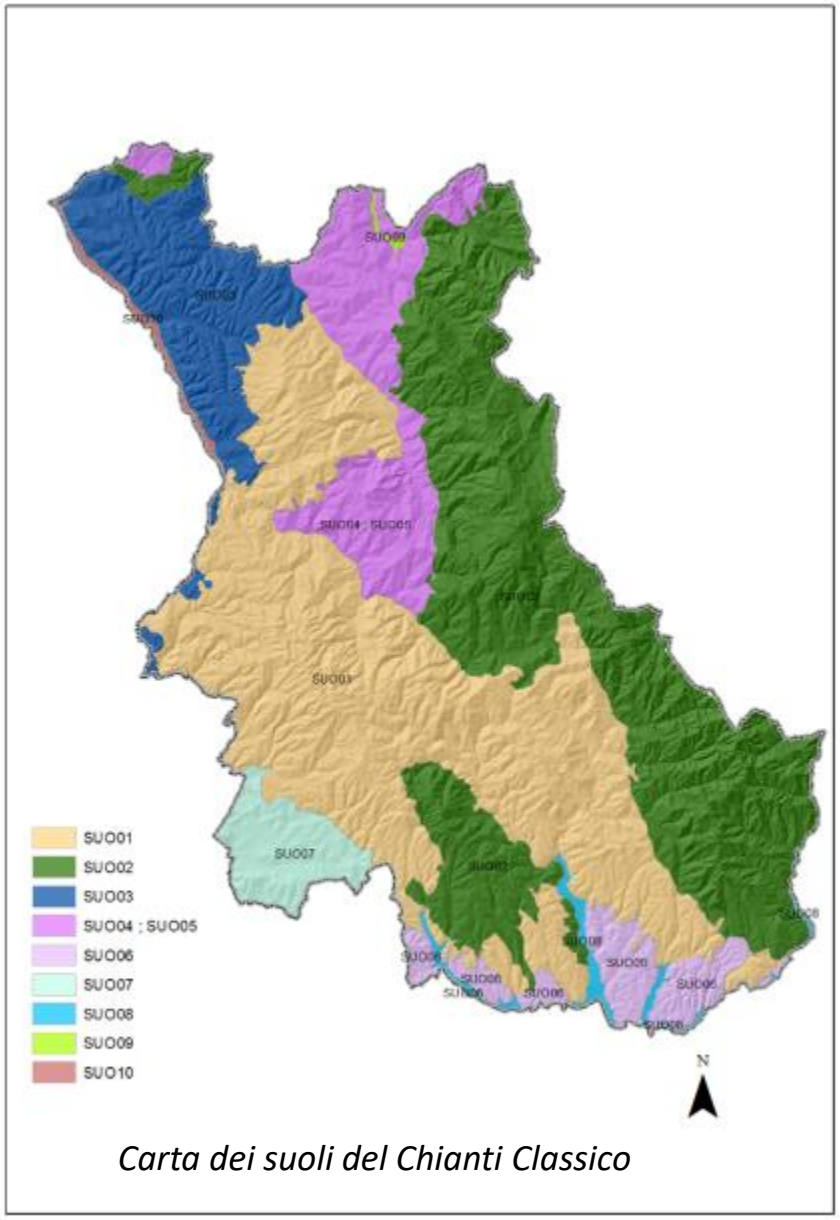


SOIL DATASET

Pedologic characterization made on the Regione Toscana soil chart 1:250.000

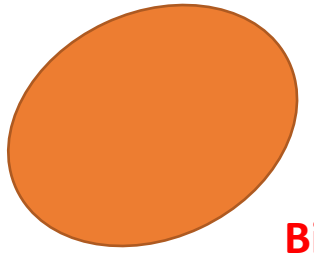
We integrated also information:about

- Soil erosion (Zanchi et al. 2006)
- Hydrogeologic trends (Zanchi et al. 2010)



Carta dei suoli del Chianti Classico

ENVIRONMENTAL DATA SET



Bio-climatic indexes

Multi dimensional
related to physiology requirements

A total of more than 100 variables were generated

- **organized into a geographic data base (*Geographical Information System*, GIS),**
- **Visible by Web-GIS**

THINKING ABOUT : OLIVE GROWTH, FRUIT YIELD, EVOO QUALITY

Which could be the more useful to perform an olive zonation?

Variables selected using personal information and scientific publication:

VARIABLE	ACTION ON GROWTH YIELD
Soil	Growth , yield, mineral elements
Average annual temperature	Plant growth performance
Minimum Temperature April-June	Vegetative growth
Sum of temperature during the summer	oil accumulation, fatty acids, olive fly
Total annual rain	Total growth , Yield
Sum of Rainfal April –June	Vegetative growth
Rainfal July-September	Oil accumulation, satured/unsatured, Pulp/stone; Ripening
Average annual Radiation	General growth / Plant physiology
Radiation July-September	Vegetative growth
Radiation April-June	Oil accumulation, fatty acids
Annual water deficit	Dry matter accumulation , general growth
Summer water deficit	Fruit development and ripening
Height above the sea level	General growth , fatty acids

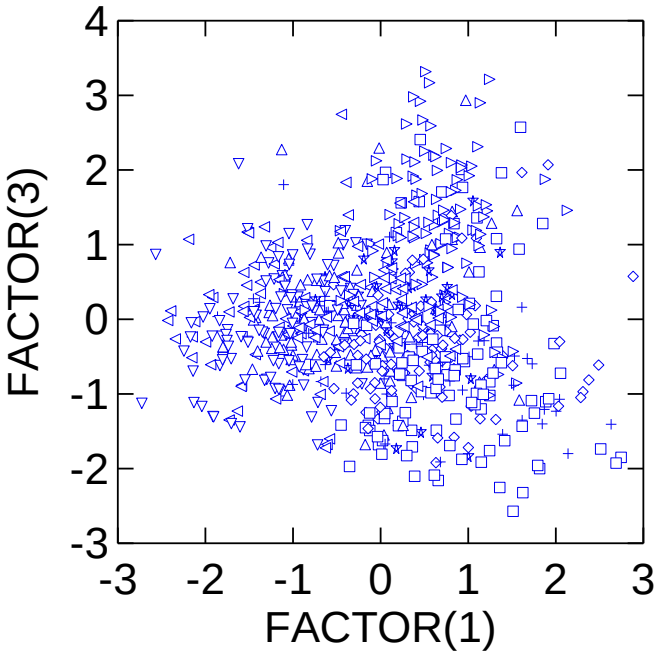
[1] Calculated as (Tmin+Tmax/2)-7,5 °C.

OIL QUALITY

765 Extra Virgin Olive Oil samples 2003-2010 produced in the area

Variable	unit	Min	Max	Mean	StDev	C.V.
Acidity	%	0,080	0,380	0,169	0,048	0,281
VK232		1,410	2,10	1,721	0,138	0,080
K270		0,070	0,20	0,126	0,022	0,173
Deltak		-0,010	0,010	-0,001	0,003	3,020
Peroxides		1,9	12	5,651	1,929	0,341
Poliphenols	mg/L	172	764	383	96	0,252
Tocopherols	mgL	140	383	230	48,	0,209
Miristic	%	0,000	0,030	0,010	0,003	0,287
Palmitic	%	9,850	16,430	12,704	1,122	0,088
Palmitoleico	%	0,080	1,470	0,830	0,137	0,165
Eptadecanoic	%	0,020	0,080	0,040	0,006	0,153
Eptadecenoic	%	0,060	0,160	0,082	0,010	0,121
Stearic	%	1,390	3,220	1,920	0,220	0,114
Oleic	%	71,510	81,990	76,519	1,737	0,023
Linoleic	%	4,360	9,500	6,578	0,958	0,146
Arachidic	%	0,040	0,410	0,305	0,043	0,142
Linolenic	%	0,460	0,820	0,626	0,050	0,080
Eicosenoic	%	0,010	0,430	0,257	0,039	0,152
Behenic	%	0,040	0,140	0,091	0,019	0,214
Lignoceric	%	0,010	0,200	0,032	0,014	0,450

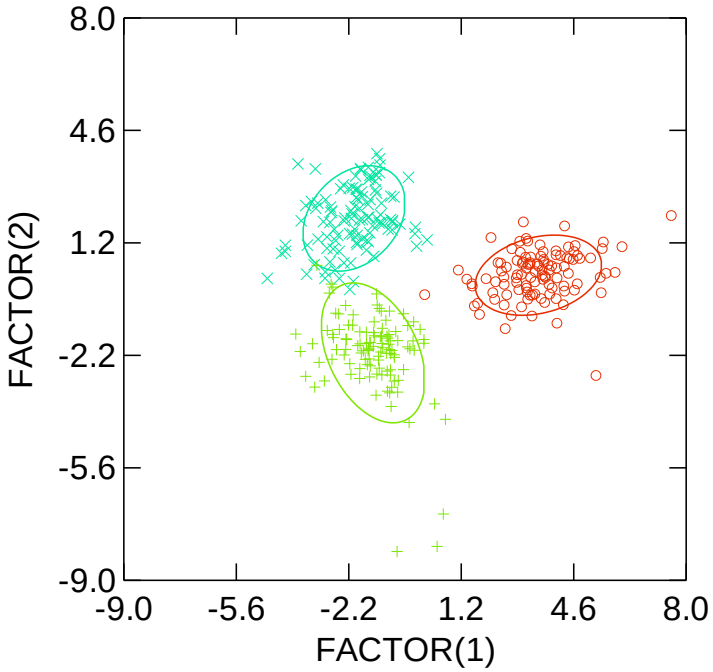
OIL QUALITY



YEAR

ANNO

+ 3
◇ 9
□ 8
▽ 5
▷ 7
△ 4
☆ 10
◁ 6



YEAR

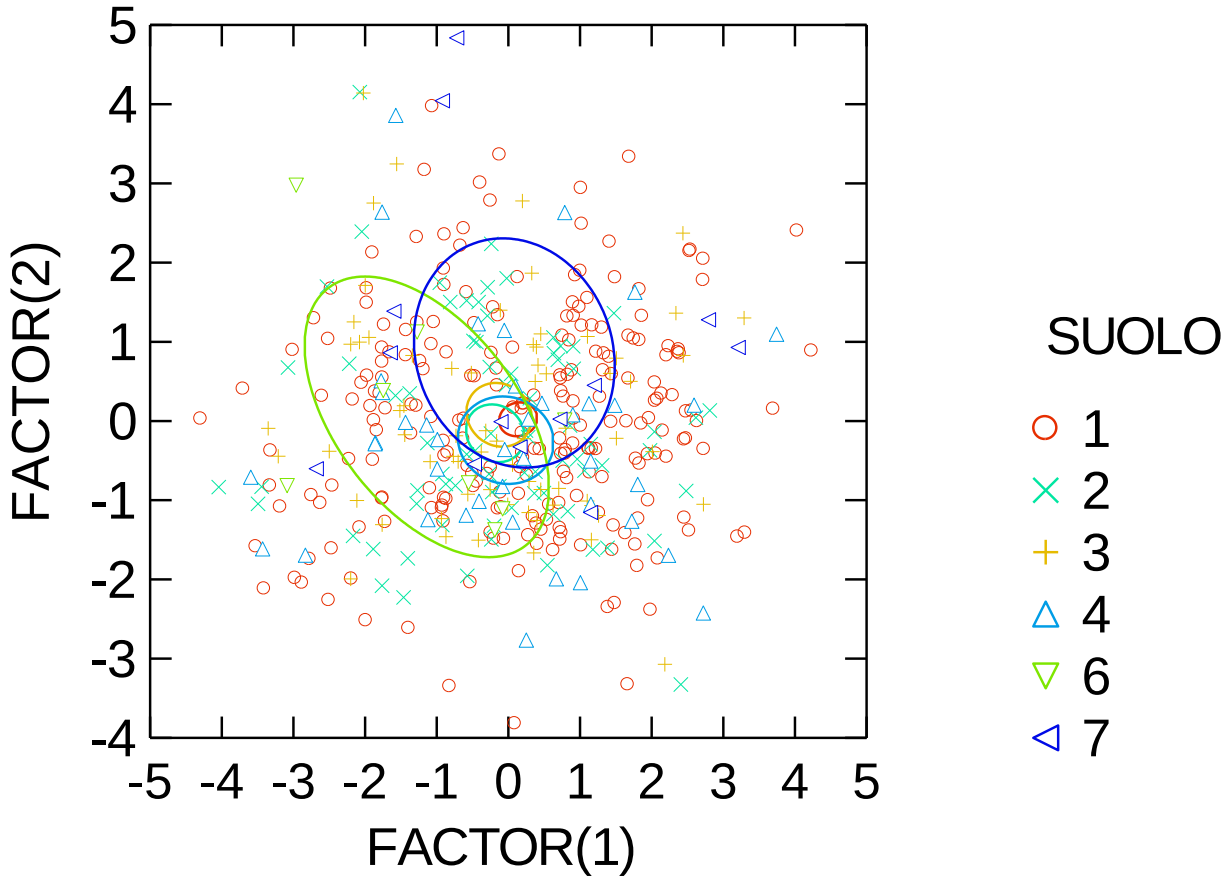
ANNO

○ 2005
× 2007
+ 2008

Year	2005	2007	2008
Number samples	108	108	110
Acidity	0,18	0,22	0,15
Peroxides	5,0	7,2	5,0
Tocoferols	198	209	251
Palmitic	12,9	11,9	11,6
Palmitoleic	0,74	0,81	0,77
Linoleic	5,47	6,81	6,87
Behenic	0,08	0,11	0,10
Lignoceric	0,029	0,015	0,043

2005 one of the hottest year ever registred

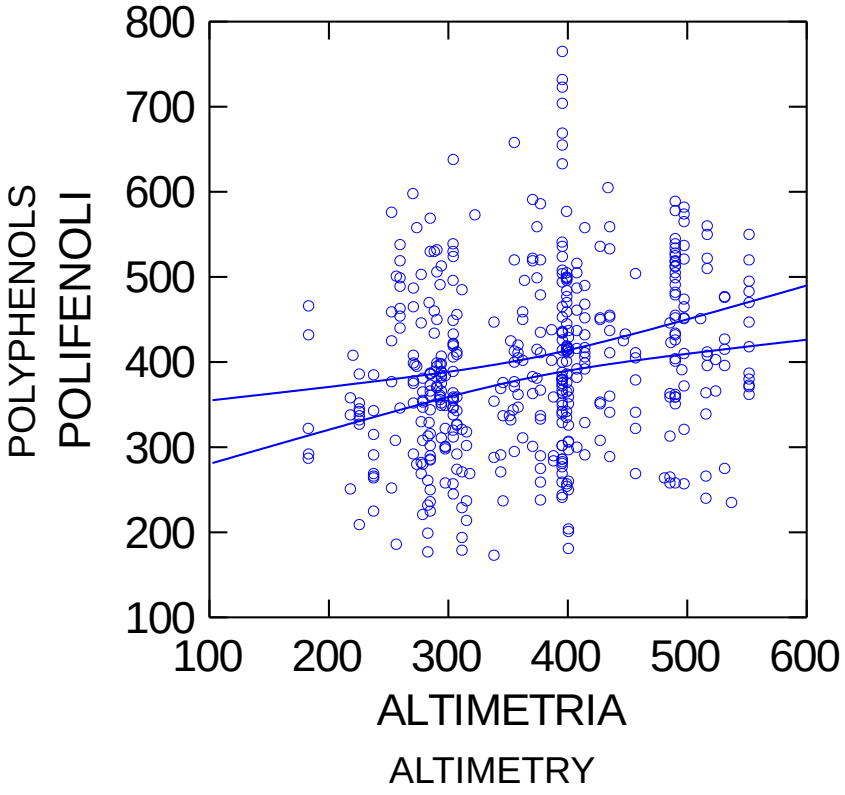
SOIL/OIL QUALITY



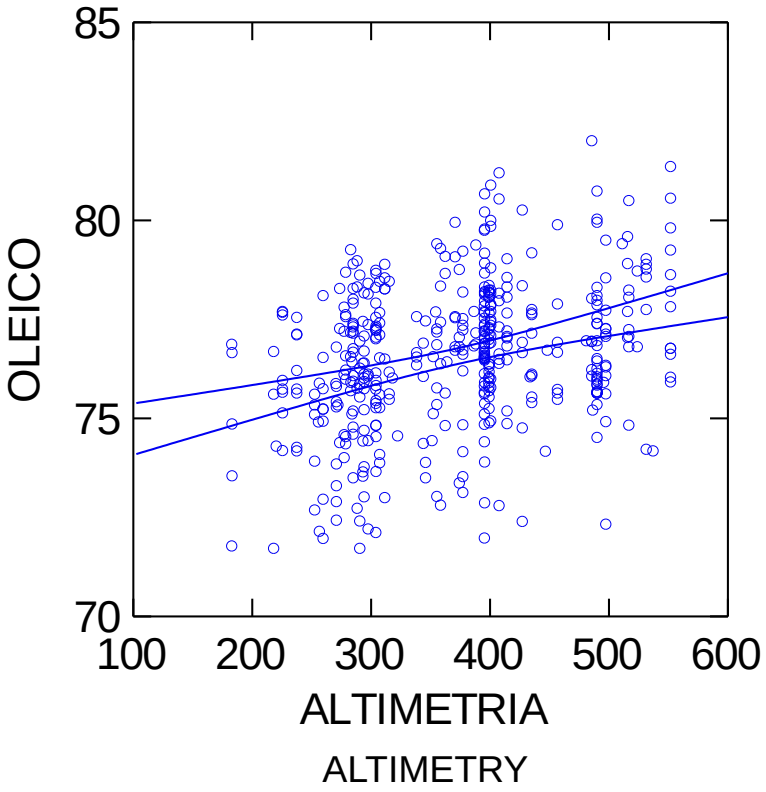
OIL QUALITY

Environmental actions

(Y=74,05 + 0,007x R^2=0.329 *p*=0,000)



Y=289 + 0,281x R^2=0.244 *p*=0,000



Agriculture, Ecosystems & Environment

Volume 233, 3 October 2016, Pages 147–157

Rainfall regimes control C-exchange of Mediterranean olive orchard

L. Brilli[a, d], B. Gioli[a], P. Toscano[a], M. Moriondo[a], A. Zaldei[a], C. Cantini[c], R. Ferrise[b], M. Bindi[b, e]

Eddy covariance measurements covered three contrasting and extreme years, spanning over 90% of the long-term rainfall variability. Across those years, the olive orchard resulted overall a net carbon sink (3.6 Mg ha^{-1}year $^{-1}$) Annual and seasonal NEE was found to be mostly driven by rainfall regimes and their seasonal variability.

We used and propose variables with action on **growth potential** and **oil qualitative traits**

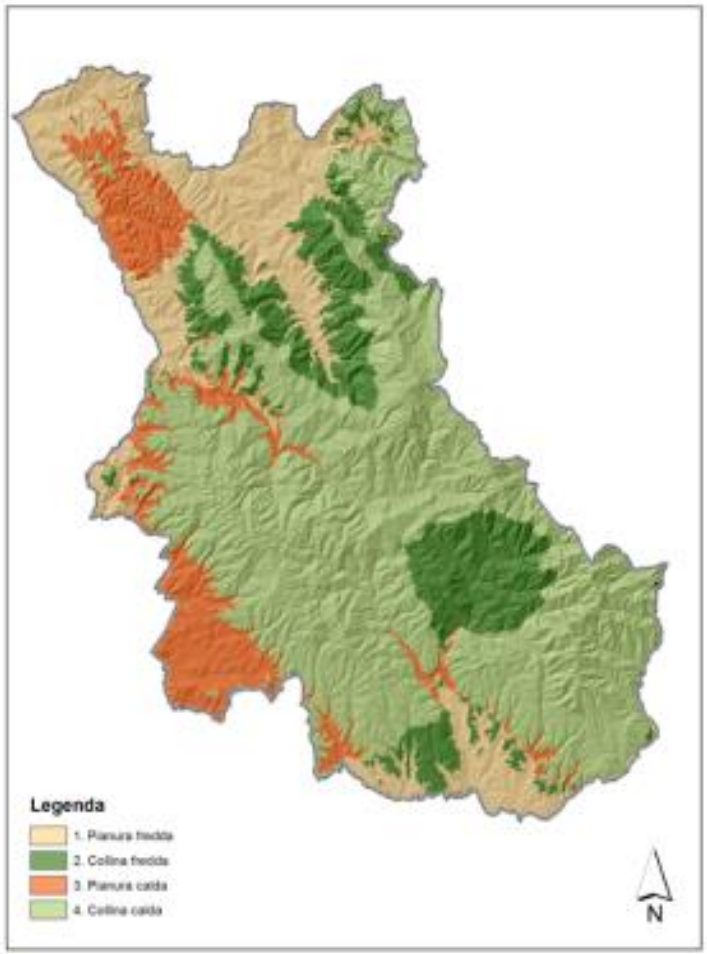
- **Active Temperature Sum** (ATS): daily temperature above 7,5 °C March-October.
- **Active Temperature Sum** (ATS_{GR}): daily temperature above 7,5 °C April-June
- **Active temperature sum** (SAT_{IM}): dayily temperature above 7.5 August-October**.**
- **Rainfall April-October**
- **Rainfall August-October**
- **HYdroclimatic balance** (P-Eto): difference among rainfall and potential evapotraspiration. June-August

Climate and physiology knowledge as a base for a proposed method of zonation

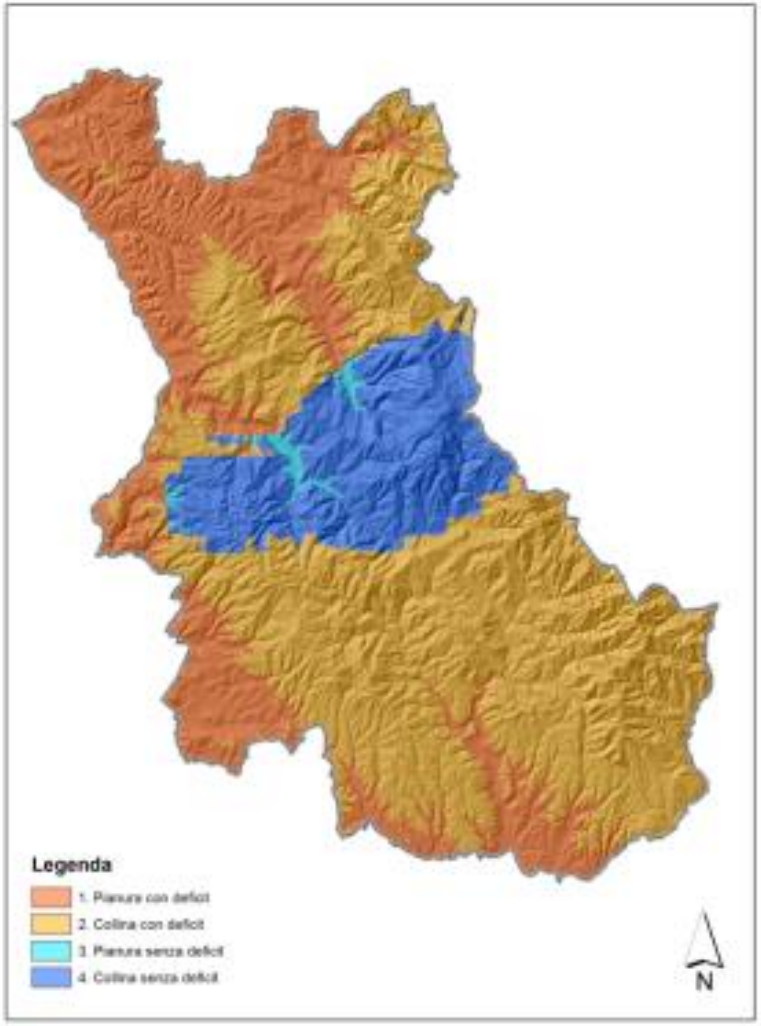
SCHEME 1: ZONATION SUMMER TEMPERATURE AND ALTIMETRY	
Variable	**classes and limits**
1. Sum of Summer Active Temperature	1. <= 1100 2. > 1100
2.Altimetry	1. > 300 m 2. <= 300 m
classes	*1. plain, "cold"* *2. hill "cold"* *3. plain "warm"* *4. hill "worm"*
SCHEME 2: ZONATION SUMMER TEMPERATURE AND WATER DEFICIT	
Variable	**classes and limits**
1. Sum of Summer Active Temperature	AS IN SCHEME 1
2. Water Deficit	**1.** <= 0 with deficit **2.** >0 without deficit
classes	*1. "cold" with deficit* *2. "warm" with deficit* *3. "cold" no deficit* *4. "warm" no deficit*
SCHEME 3: ZONATION ALTIMETRY AND SUMMER WATER DEFICIT	
Variable	**Classes and limits**
AS IN SCHEMES 1 AND 3	
classes :	***1.** plain with deficit* ***2.** hill with deficit* ***3.** plain no deficit* ***4.** hill no deficit*
Scheme 4: ZONATION TEMPERATURE AND RAINFALL APRIL - JUNE	
Variabile	**classi e soglie**
1. SPRING MEAN TEMPERATURE	1. < = 16 ° C 2 > 16 ° C
2. SPRING RAINFALL	1. < = 180 mm 2 > 180 mm
classes:	*1. "cold" rainy* *2. "warm" rainy* *3. "cold" dry*

1. Summer active temperature and altimetry: **acids and phenol**

2. Summer active temperature and water deficit: **fruit growth, ripening, fatty acids**



3. Altimetry and summer water deficit:
combination of the first two



4. Spring Mean Temperature and Total Rainfall:
vegetative growth, canopy expansion, yield

Ex post Zonation Validation

Classes Altimetry/Sum T	Linolenic Ac	Palmitic Ac	Oleic Ac
1 plain cold	0,65 ±0,006	13,4 ±0,16	75,5 ±0,24
2 hill cold	0,63 ±0,005	12,6 ±0,09	76,6 ±0,18
3 plain warm	0,63 ±0,004	12,8 ±0,11	76,5 ±0,16
4 plain warm	0,60 ±0,004	12,3 ±0,08	76,9 ±0,13

Classes Summ Term/Deficit	Poliphenols
1 cold with deficit	403 ±15
2 warm with deficit	354 ±9
3 cold no deficit	481 ±26
4 warm no deficit	403 ±6

Classes Altimetry/Deficit	Poliphenols	Palmitic Ac	Oleic Ac
1 plain with deficit	372 ±9	13,2 ±0,11	75,8 ±0,16
2 hill with deficit	392 ±6	12,5 ±0,06	76,9 ±0,10
3 plain no deficit			
4 hill no deficit	466 ±17	12,5 ±0,15	77,0 ±0,26

Comunità Europea
Fondo Europeo agricolo
per lo sviluppo rurale (FEASR)
L'Europa investe nelle zone rurali

REGIONE TOSCANA

Coltiviamo il Futuro
PSR 2007-2013 PROGRAMMA DI SVILUPPO RURALE 2007-2013

CHIANTI CLASSICO DOCG

. . . Where possible a picture by Google Street View ©

MANAGEMENT

Use of Web GIS

Landscape and Environmentale Zonation

Selection and catalog of olive orchards typologies (soil, characteristics, slope, soil coverage) .

Photo:

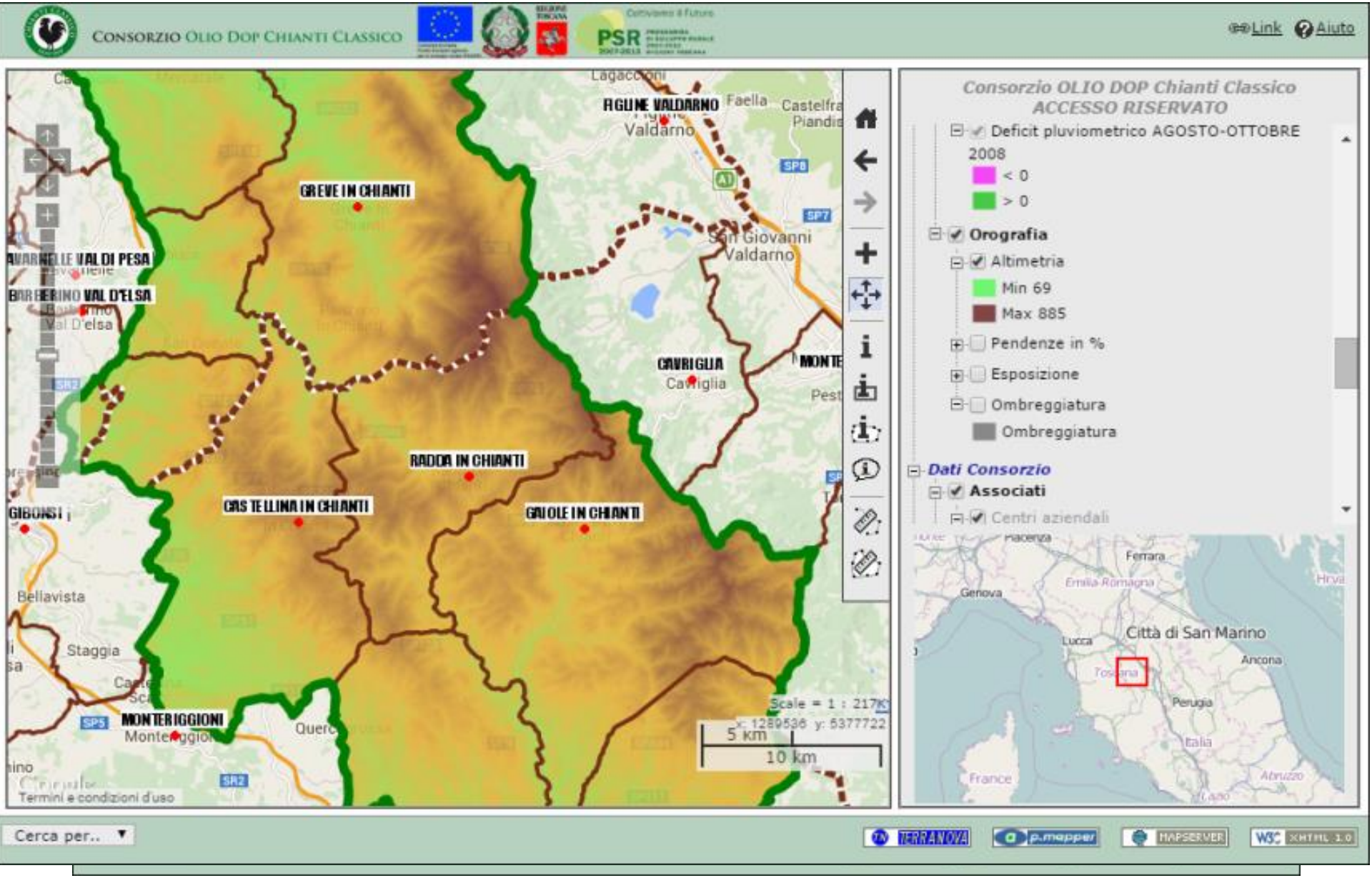
Terraces of 10 m plants at 13x13 m

Specialized various slope 6 or 7 m distances

MANAGEMENT

Canopy soil coverage

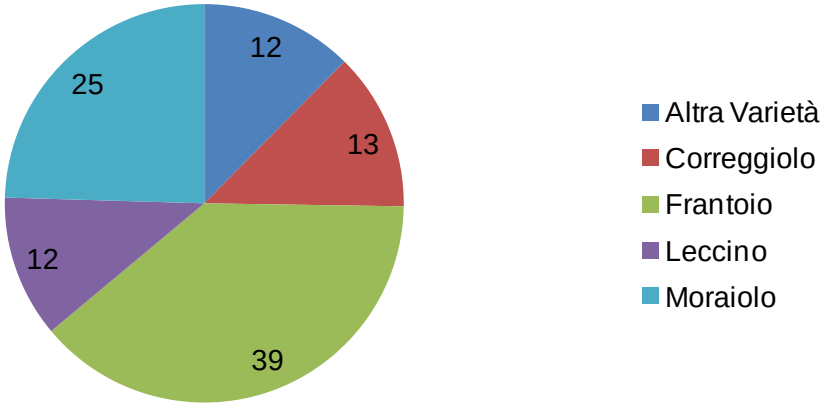
- **Classes of coverages: good, sufficient, insufficient, none**
- **Why? Humidity, management mistakes**
- **DECISION: new planting, other cultivar, other specie.**
- **DECISION: *modify the soil plant management, pruning***


Consorzio Olio DOP Chianti Classico
PSR
Link
Aiuto
FIGLINE VALDARNO
Valdarno
Faella
GREVE IN CHIANTI
San Giovanni Valdarno
BARBERINO VAL D'ELSA
Barberino Val D'elsa
CAVRIGLIA
Cavriglia
RADDA IN CHIANTI
CASTELLINA IN CHIANTI
GAIOLE IN CHIANTI
GIBBONS
Bellavista
Staggia
MONTERIGGIONI
Monteriggioni
Scale = 1 : 217K
x: 1289536 y: 5377722
5 km
10 km
Termini e condizioni d'uso
Consorzio OLIO DOP Chianti Classico
ACCESSO RISERVATO
Deficit pluviometrico AGOSTO-OTTOBRE
2008
< 0
> 0
Orografia
Altimetria
Min 69
Max 885
Pendenze in %
Esposizione
Ombreggiatura
Ombreggiatura
Dati Consorzio
Associati
Centri aziendali
Ferrara
Genova
Emilia-Romagna
Città di San Marino
Lucca
Ancona
Toscana
Perugia
Italia
France
Abruzzo
Cerca per..
TERRANOVA
p.mapper
MAPSERVER
XHTML 1.0

MANAGEMENT

Consortium

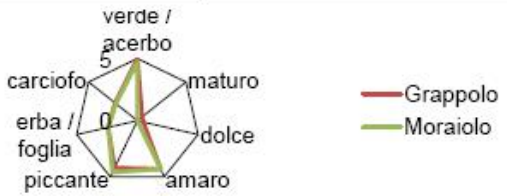
Cultivar Selection



It is possible to select the cultivar which "best fit" the area in base of rainfall, ripening time, susceptibility

Freezing resistance
Leaf desease
Olive fly
Irrigation

Grappolo	
Poco conosciuta, poco diffusa, frutto piuttosto piccolo, maturazione tardiva, pianta resistente al cicloconio, pianta ad accrescimento limitato	



Utilizzabile nei nuovi impianti in ragione del 5-10 % fino al 20 percento soltanto in impianti a sesti ridotti. Geneticamente molto simile alla madre mignola dalla quale però differisce per la maturazione che ha invece di questa tardiva. Assolutamente non paragonabile alle varietà spagnole è una di quelle a minore accrescimento vegetativo del germoplasma toscano. Si presta bene ad una leggera intensificazione del sesto di impianto senza però scendere mai al di sotto dei 4 metri tra le piante nelle zone più fredde Classe 1 e 3 della zonazione con schema 4 basato su temperature e pluviometria. Può probabilmente resistere per circa 20-25 anni alla distanza di 3 metri se allevata ad asse unico. Utilizzare a distanza di 5 metri negli impianti tradizionali a vaso. Maturazione tardiva, può presentare qualche prolema di accestimento nelle zone più aride e siccitose.

A novel method of land zonation to improve olive farming and oil quality

THANK YOU

Claudio Cantini , Tomaso Ceccarelli

Trees and Timber Institute (IVALSA)

National Research Council of Italy (CNR)

WAGENINGEN
UNIVERSITY & RESEARCH

Home ▾ | Earth informatics - dr. T (Tomaso) Ceccarelli MSc

dr. T (Tomaso) Ceccarelli MSc

DLO Onderzoeker