Elaboration of maps for climatic actions in Italy

Pietro Croce

Convenor of CEN/TC250/HG "Bridges"

Department of Civil and Industrial Engineering

Univ. of Pisa - I

Statistical elaboration of Climatic data

- *Statistical elaboration of climatic data (snow, temperature, wind) generally requires:*

  1. *Selection of meteorological stations granting a sufficiently uniform coverage of the Country or of the Region in terms of area (longitude and latitude) as well as of altitude for the examined climatic variable (basic wind speed, weight or height and density of snow cover, maximum and minimum temperature), provided that the measurements are available for a sufficiently long time interval (30-50 years)*

Statistical elaboration of Climatic data

2. *Definition of the series of annual extreme values for the variable under consideration;*

3. *Adoption of a suitable extreme value distribution, like Gumbel distribution, GEV distribution, Weibull distribution, 3-parameters log-normal distribution, generalized Pareto distribution, checking a posteriori its aptness to represent the given variable*

4. *Elaboration of extremes in order to obtain the characteristic value of the climatic variable (2% upper fractile of annual extreme, corresponding to a return period of about 50 y (49.5 y)*

Statistical elaboration of Climatic data

5. *Definition of climatic maps identifying homogenous climatic areas: each climatic area is characterized by a particular relationship expressing the characteristic value of the climatic variable as function of the altitude of the site;*

6. *When, like in Italy, the climatic variables are correlated to the altitude, climatic maps can be referred at sea level, modifying the values previously determined at the actual altitude, according to the altitude-characteristic value relationship.*

Statistical elaboration of snow load
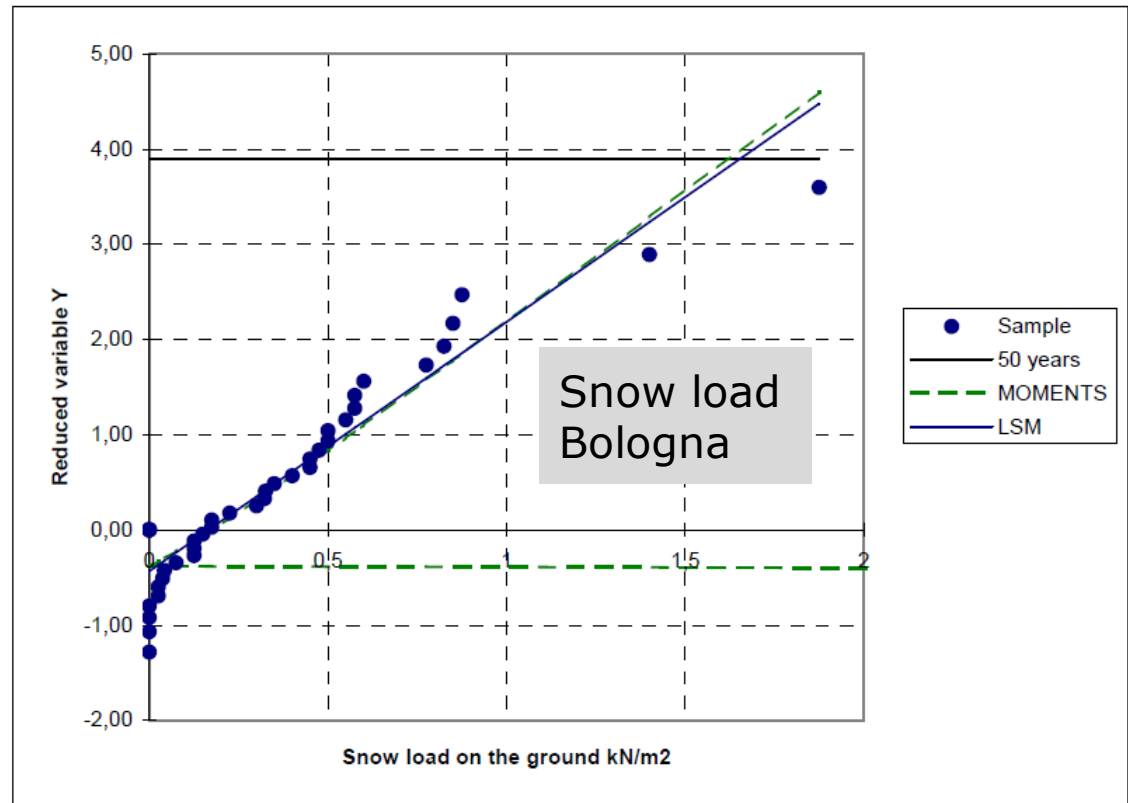
COV=0.3 Alpine Region

COV=1.0 Mediterranean Region

Snow load Bologna

Sample	●
50 years	
MOMENTS	
LSM	

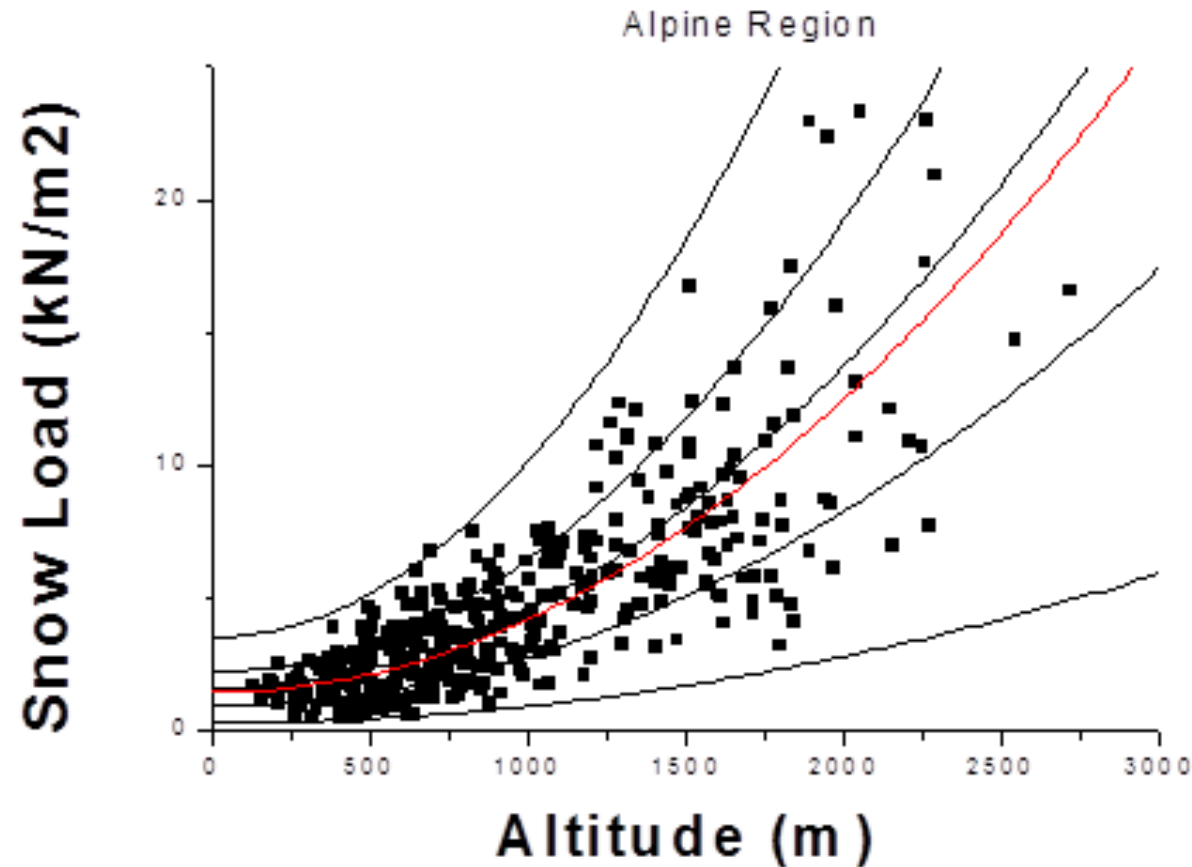|		
50 years charcteistic value LSM (Gumbel)	1,66	kN/m2
50 years charcteistic value Moments	1,62	kN/m2

Climatic region for snow loads
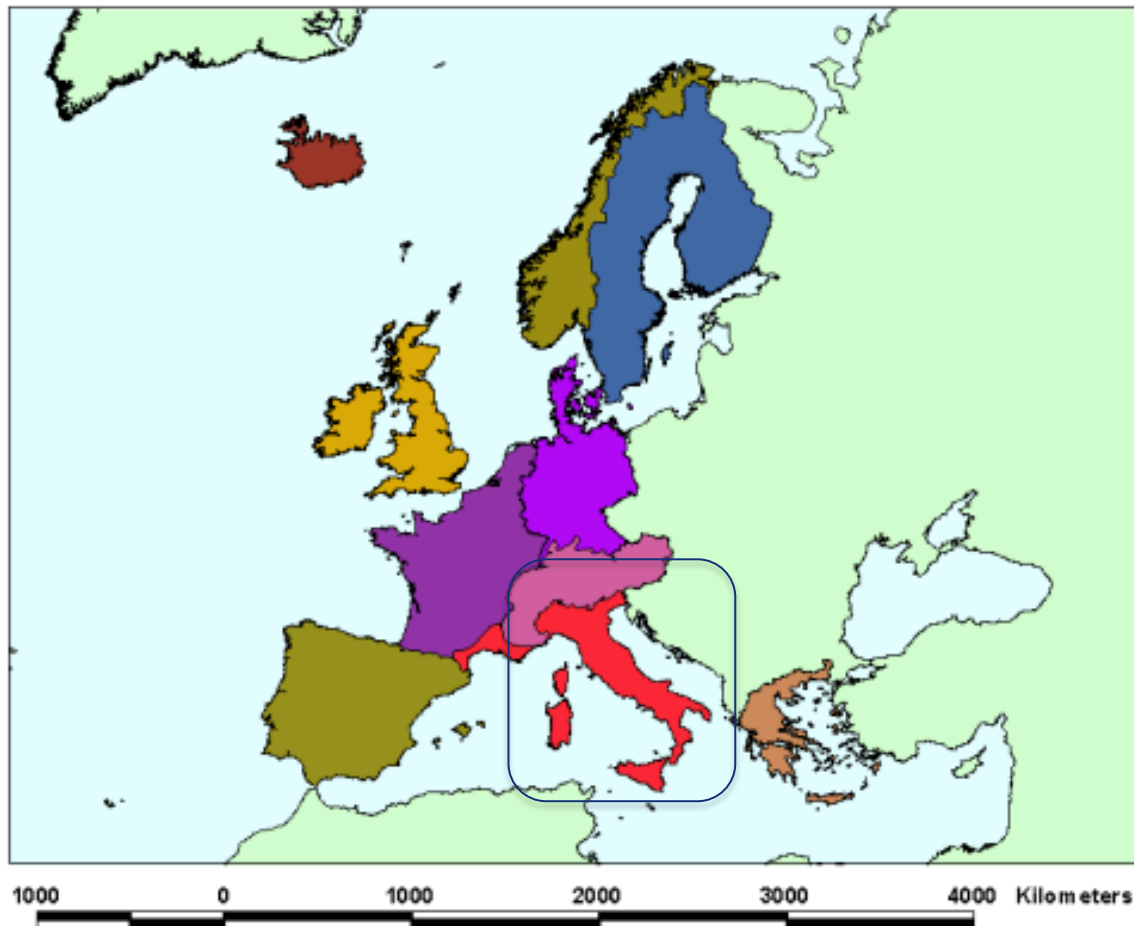
Snow load at Sea Level (Mediterranean Region)
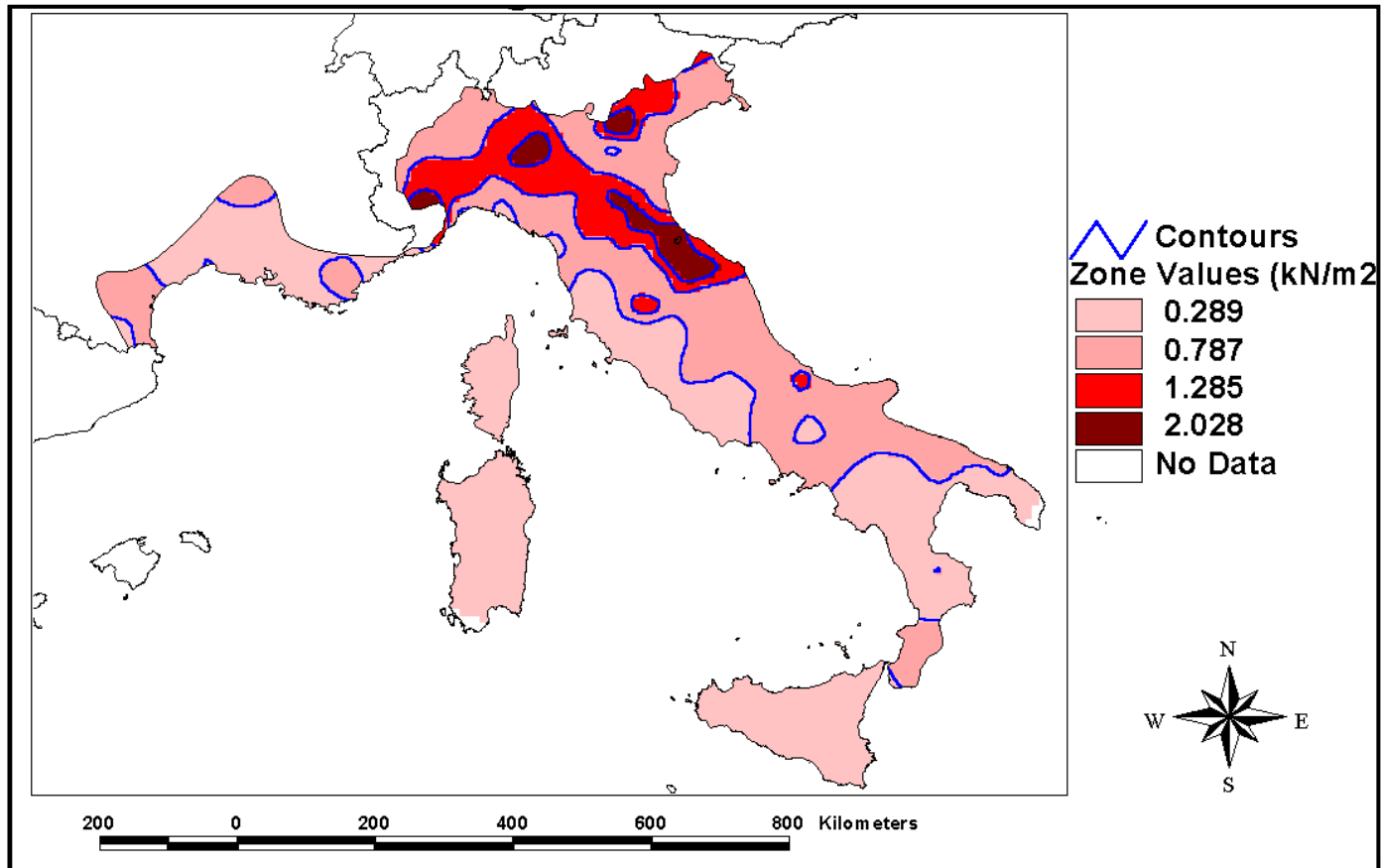
Altitude-snow load relationship

Alpine Region

$$s = a\left[1 + \left(\frac{h}{b}\right)^2\right]$$

a=snow load at ground
h=altitude
b=parameter

Snow load map on the ground Italy

Zone 1

$q_{sk} = 1.50$ kN/m² $a_s \leq 200$ m

$q_{sk} = 1.35 \left[1 + \left(\dfrac{a_s}{602} \right)^2 \right]$ kN/m² $a_s > 200$ m

Zone 2

$q_{sk} = 1.00$ kN/m² $a_s \leq 200$ m

$q_{sk} = 0.85 \left[1 + \left(\dfrac{a_s}{481} \right)^2 \right]$ kN/m² $a_s > 200$ m

Zone 3

$q_{sk} = 0.60$ kN/m² $a_s \leq 200$ m

$q_{sk} = 0.51 \left[1 + \left(\dfrac{a_s}{481} \right)^2 \right]$ kN/m² $a_s > 200$ m
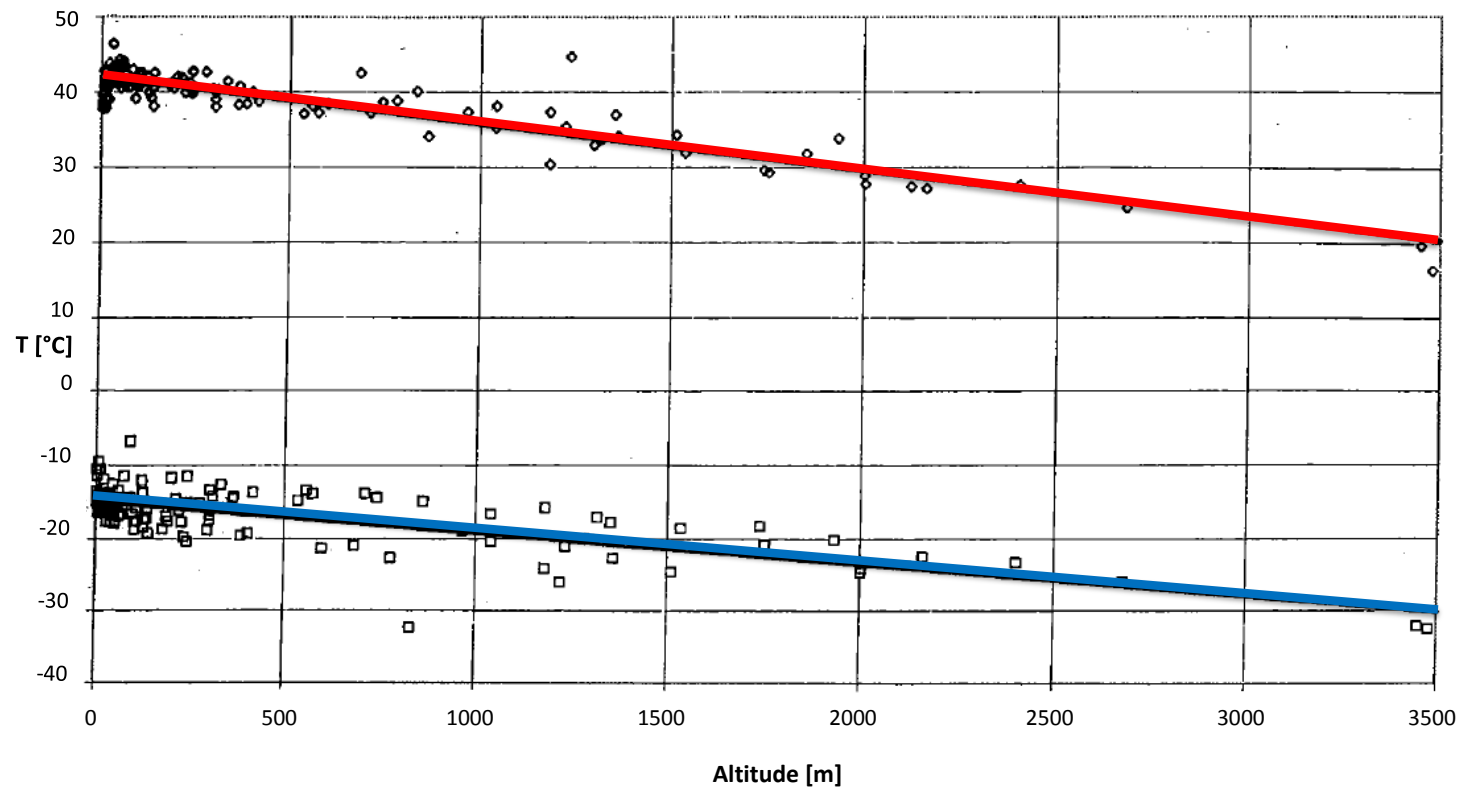
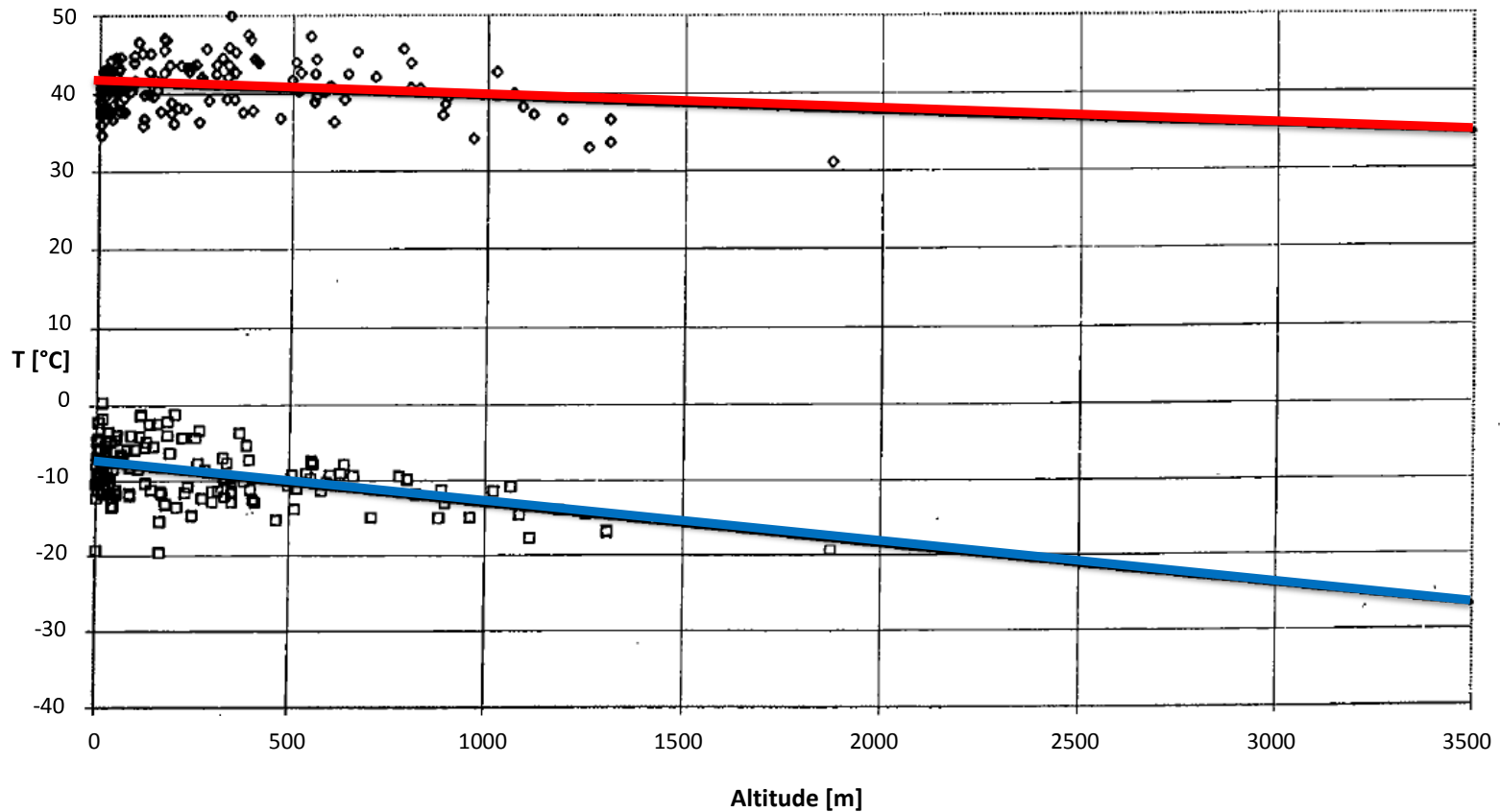1 1,50
2 1,00
3 0,60
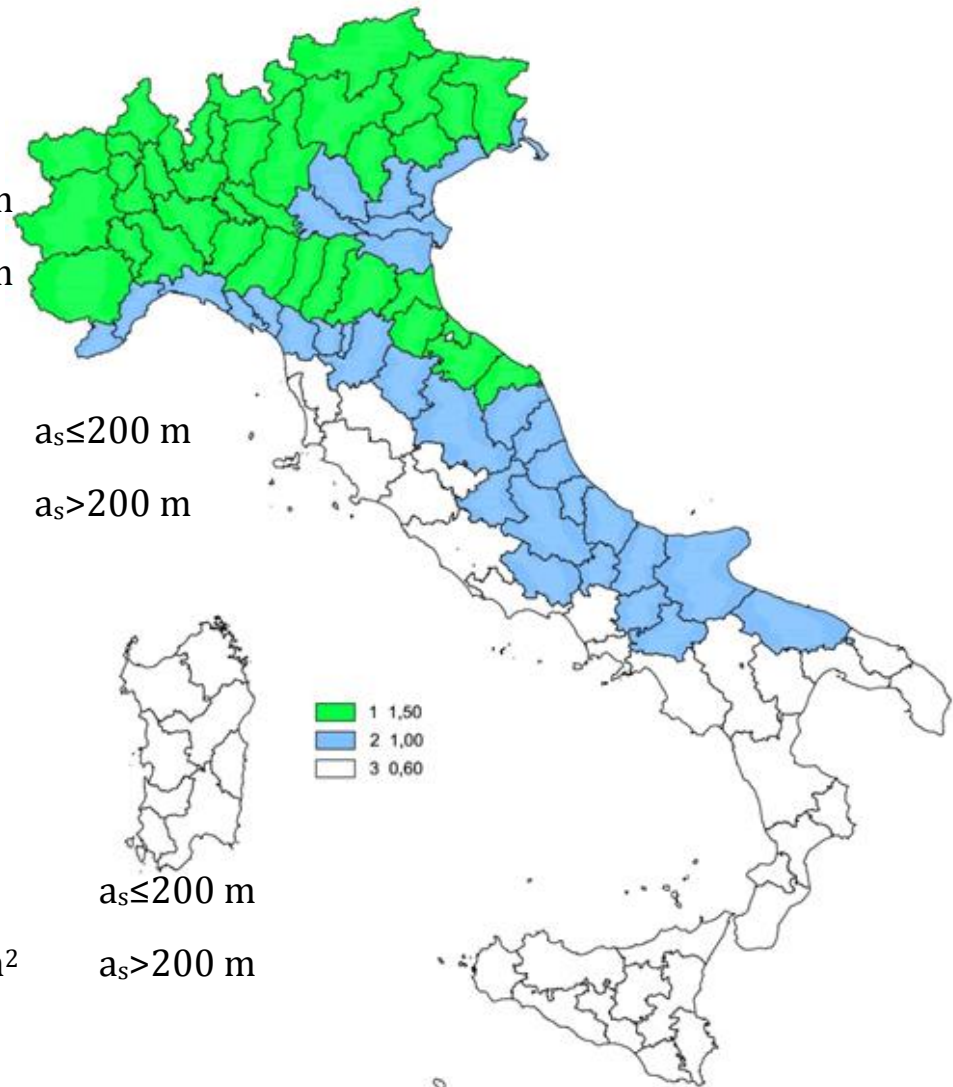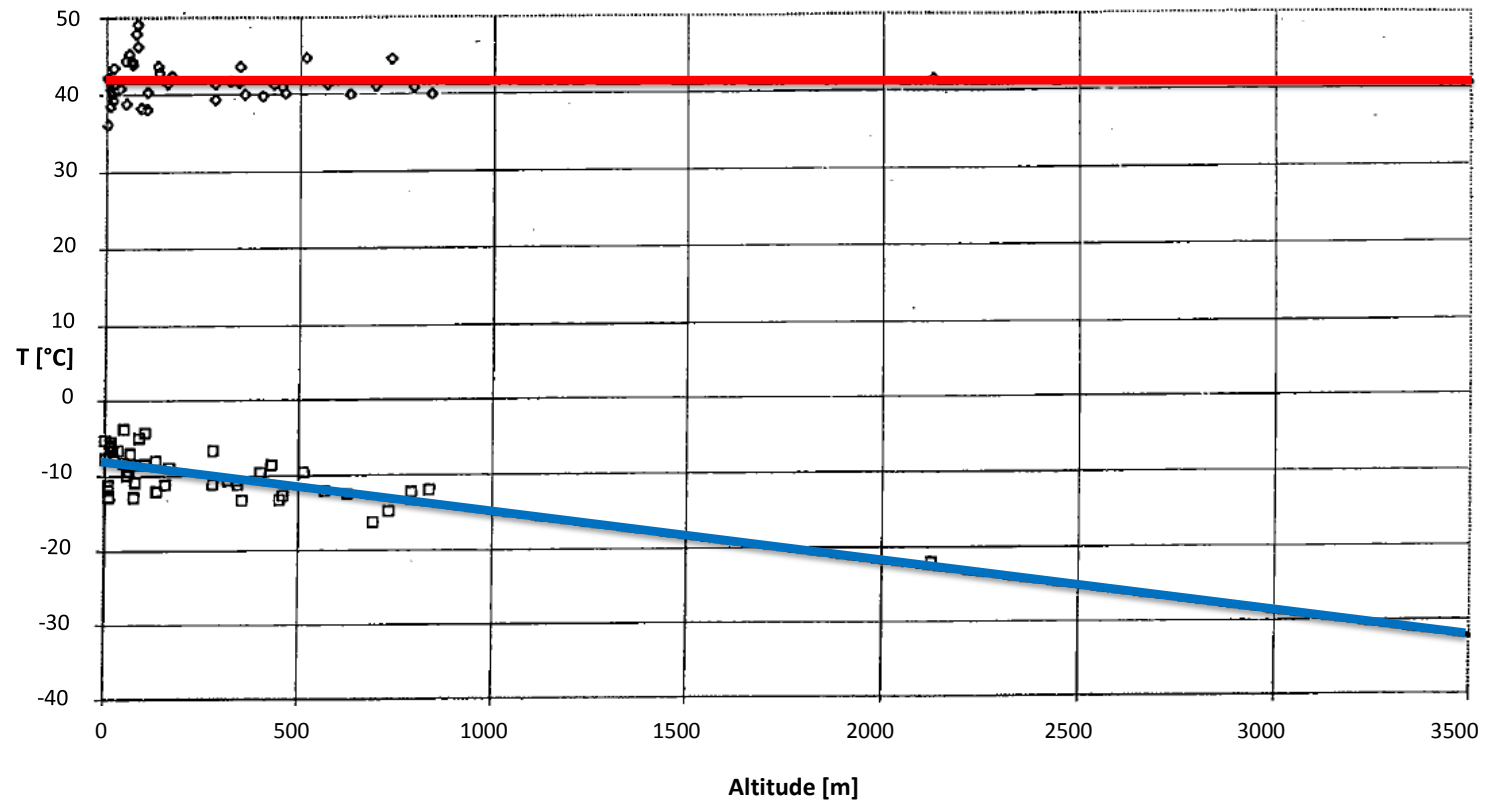
Thermal actions

Meteorological stations

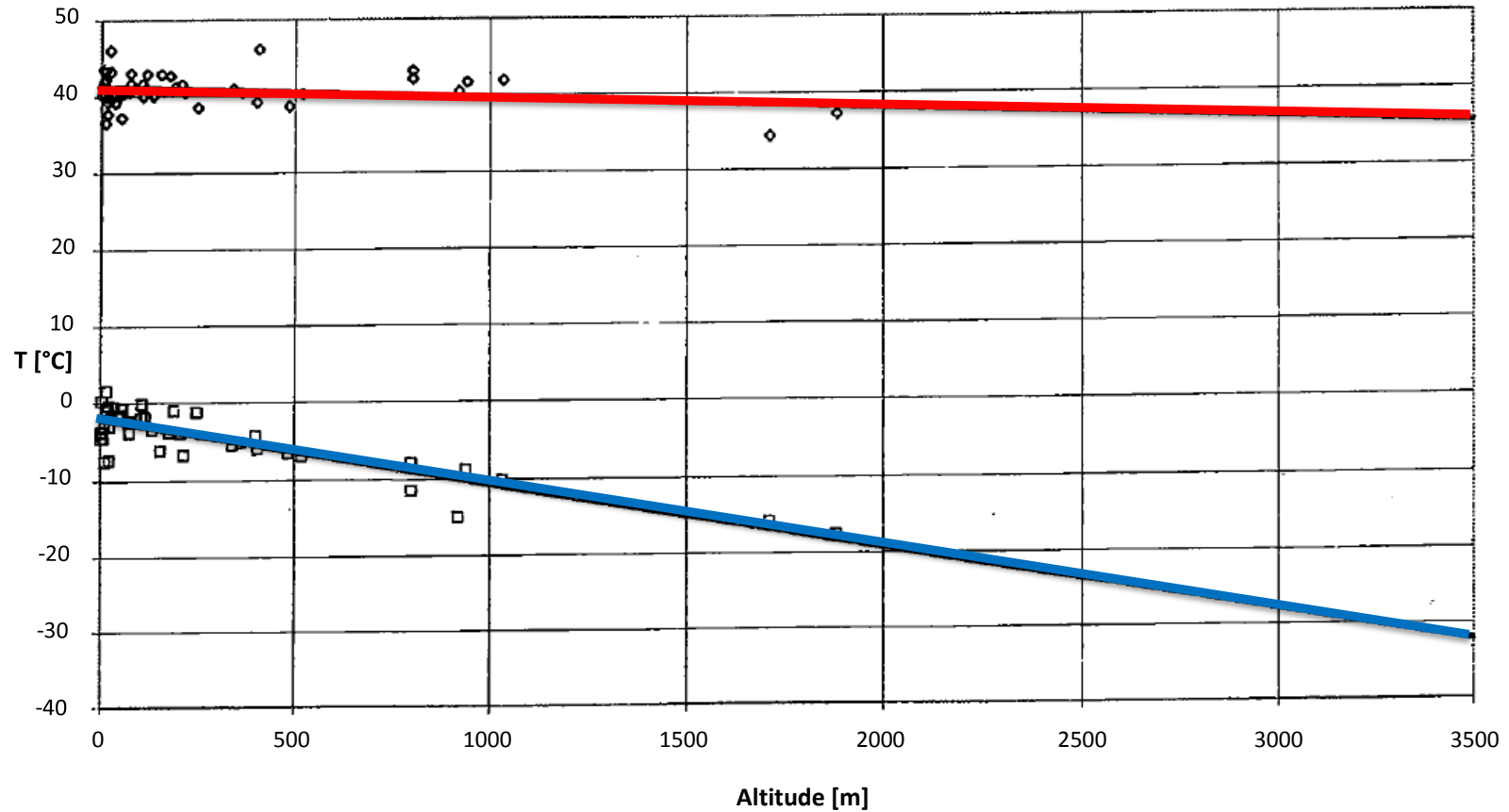# Altitude-T_{max}-T_{min} Zone I (North)

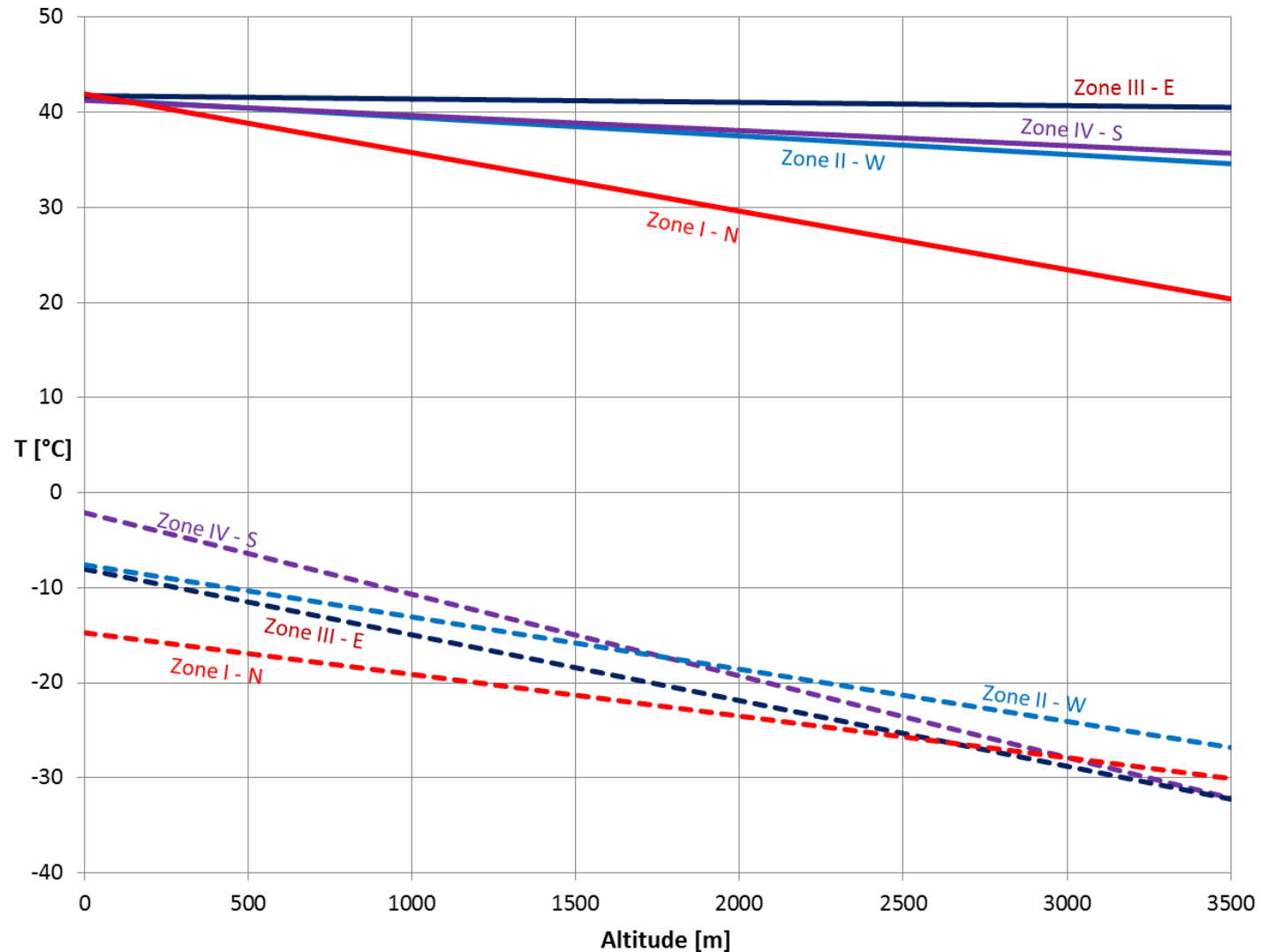# Altitude-T_{max}-T_{min} Zone II (West)

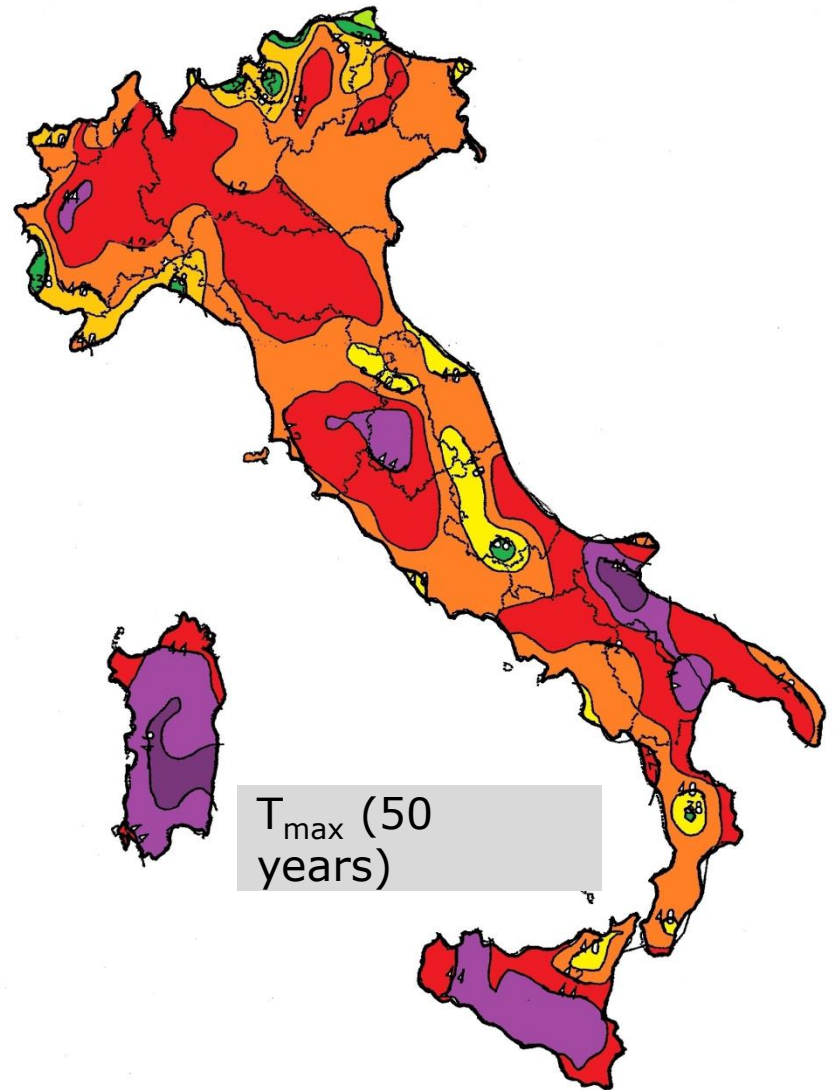# Altitude-T_{max}-T_{min} Zone III (East)

Altitude-T_{max}-T_{min} Zone IV (South)

Altitude-T_{max}-T_{min} Comparison

Thermal actions

T_{min} (50 years)

T_{max} (50 years)

Temperature map - Italy

Zone I

$$T_{min} = -15 - 4 \cdot a_s / 1000$$

$$T_{max} = 42 - 6 \cdot a_s / 1000$$

Zone II

$$T_{min} = -8 - 7 \cdot a_s / 1000$$

$$T_{max} = 42 - 0.3 \cdot a_s / 1000$$

Zone III

$$T_{min} = -8 - 6 \cdot a_s / 1000$$

$$T_{max} = 42 - 2 \cdot a_s / 1000$$

Zone IV

$$T_{min} = -2 - 9 \cdot a_s / 1000$$

$$T_{max} = 42 - 2 \cdot a_s / 1000$$
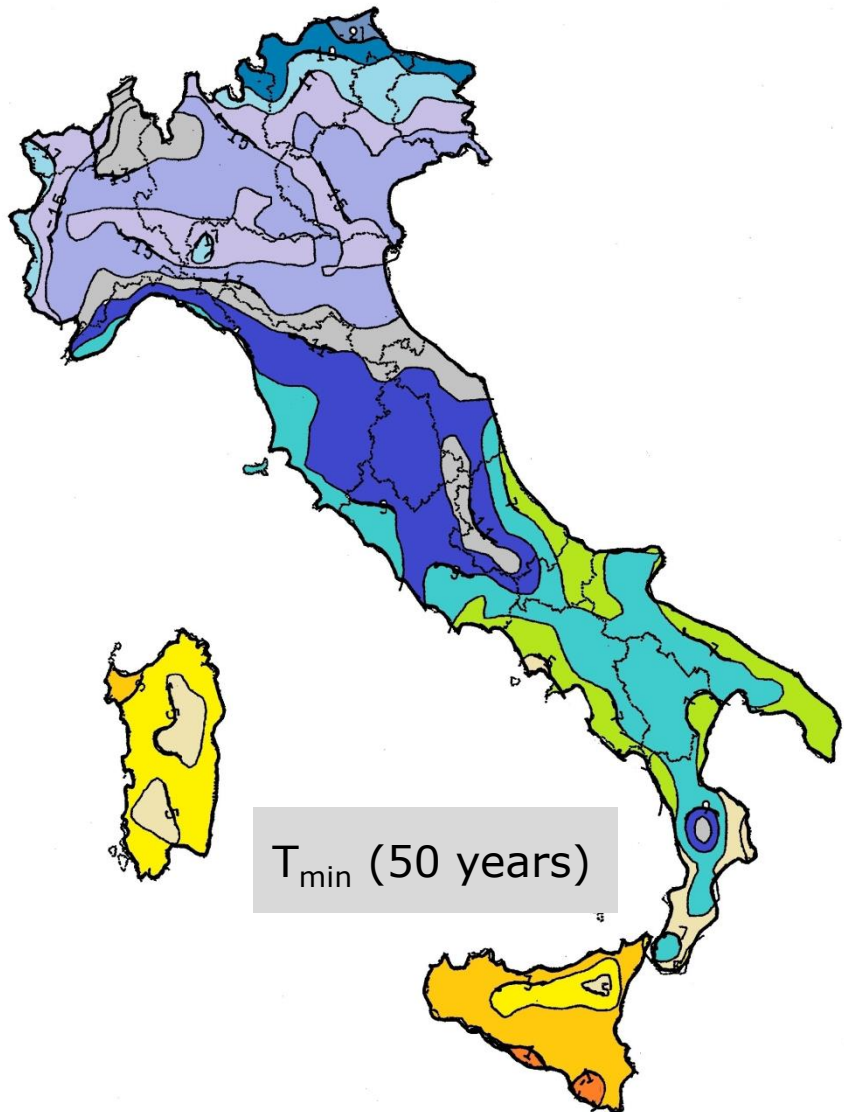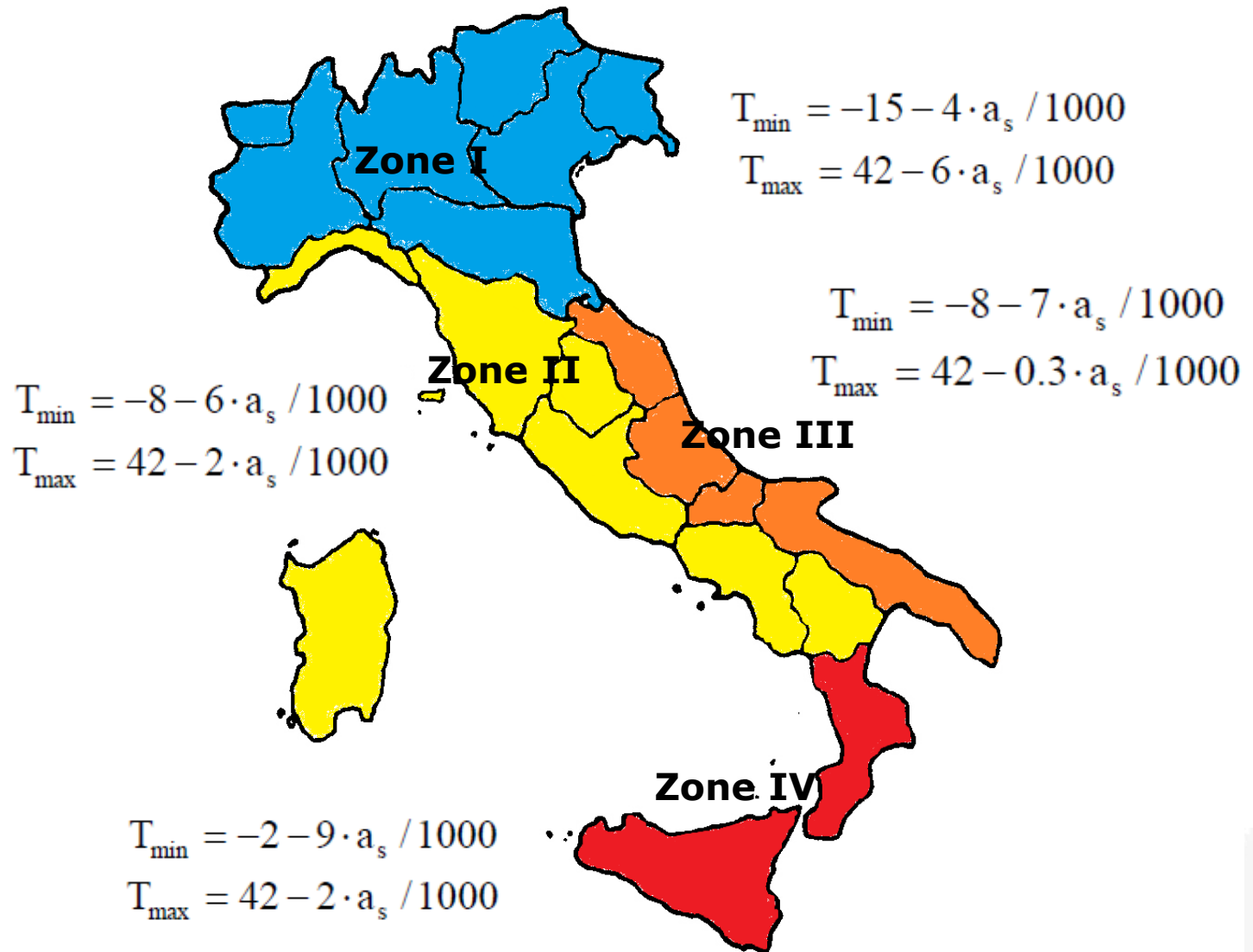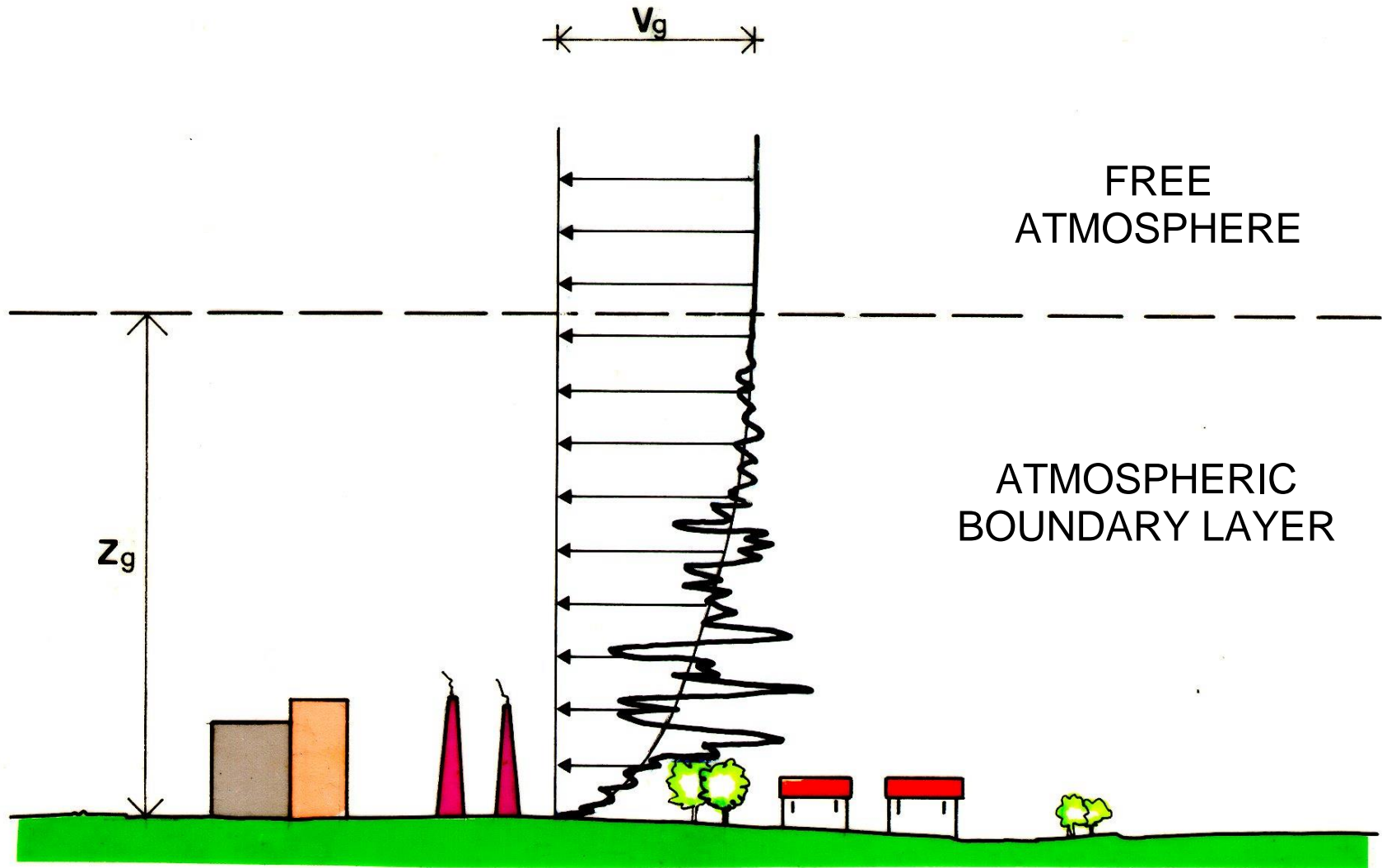
Wind actions

Wind actions
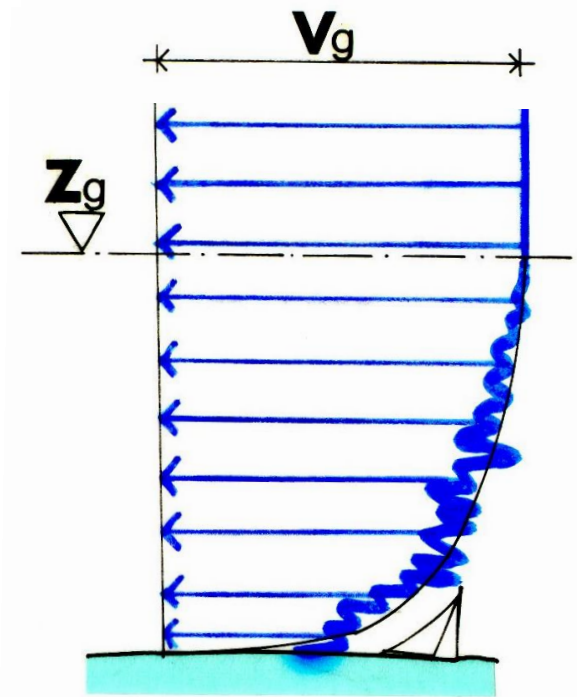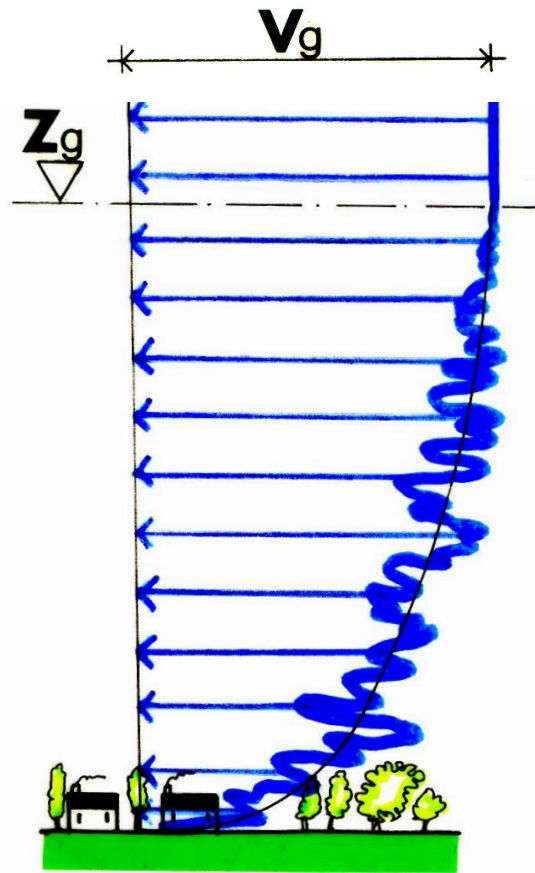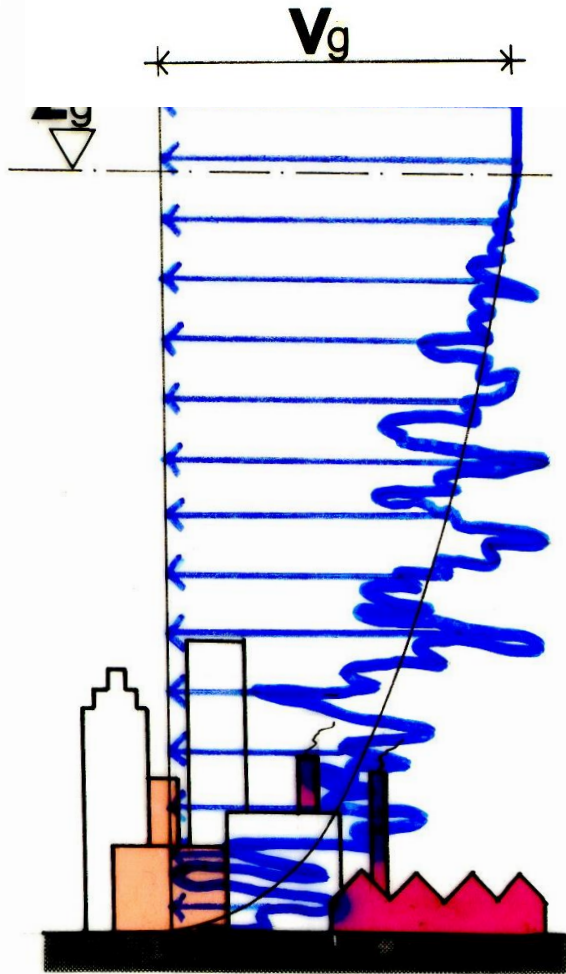
Wind speed
Common extreme value distribution

Wind speed

Annual wind speed maxima in Schiphol (1950-2002)
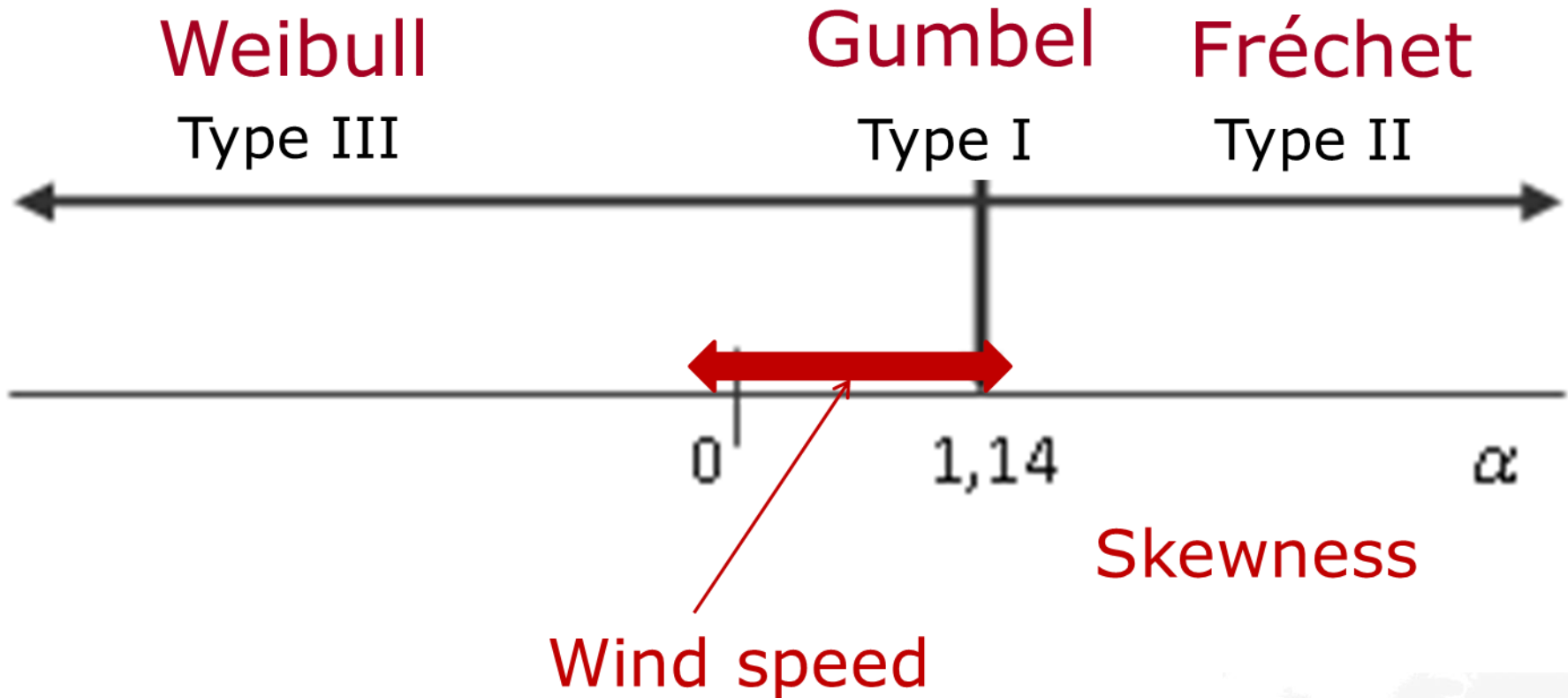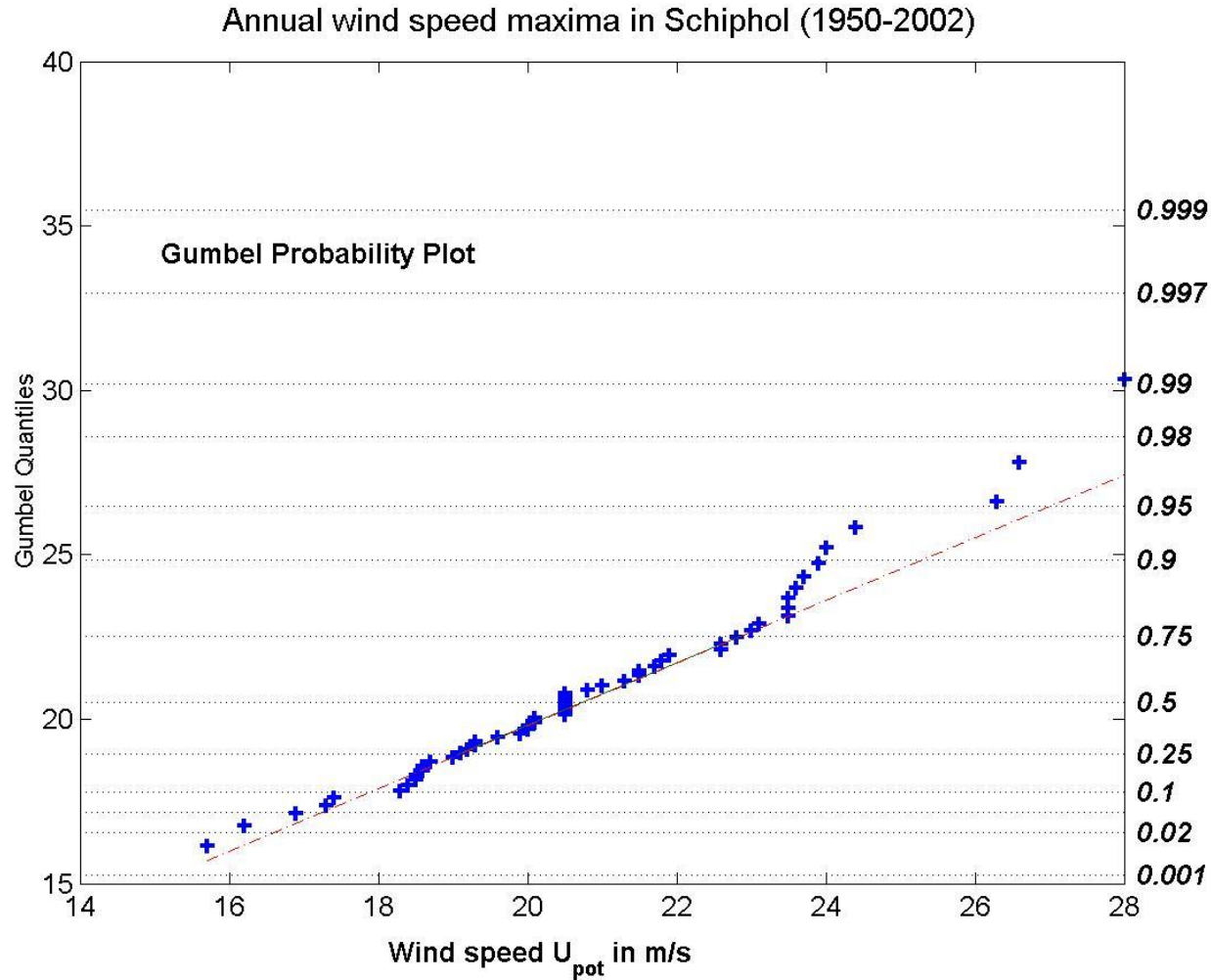
Wind speed

Annual maxima of wind speed at Pisa airport weather station

Wind speed – Pisa airport annual maxima elaboration

vk=28.87 m/s
vk=28.97 m/s
Sk=0.929

Wind actions
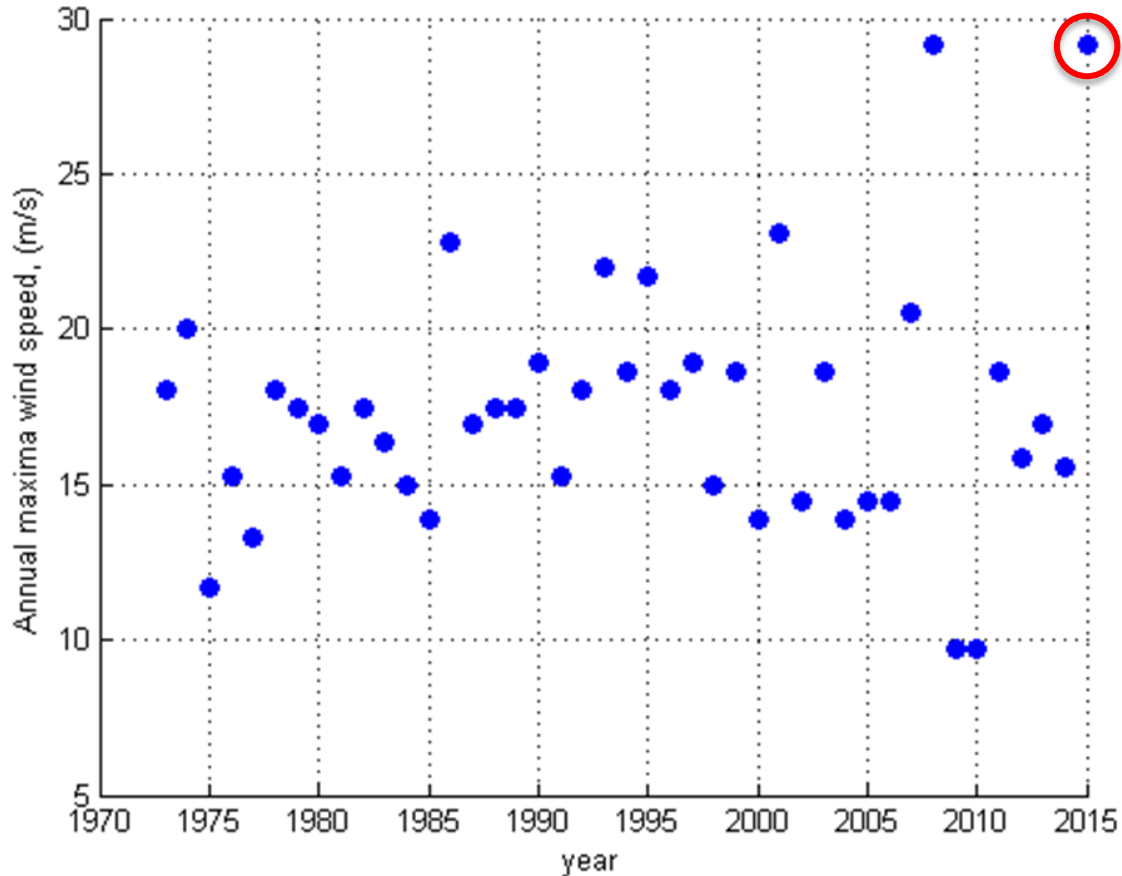
Annual maxima of wind speed at Pisa airport weather station

Wind speed – Pisa airport annual maxima elaboration

Basic wind velocity

$$v_b = v_{b,0} \qquad \text{per } a_s \leq a_0$$
$$v_b = v_{b,0} + k_a (a_s - a_0) \quad \text{per } a_0 < a_s \leq 1500 \text{ m}$$

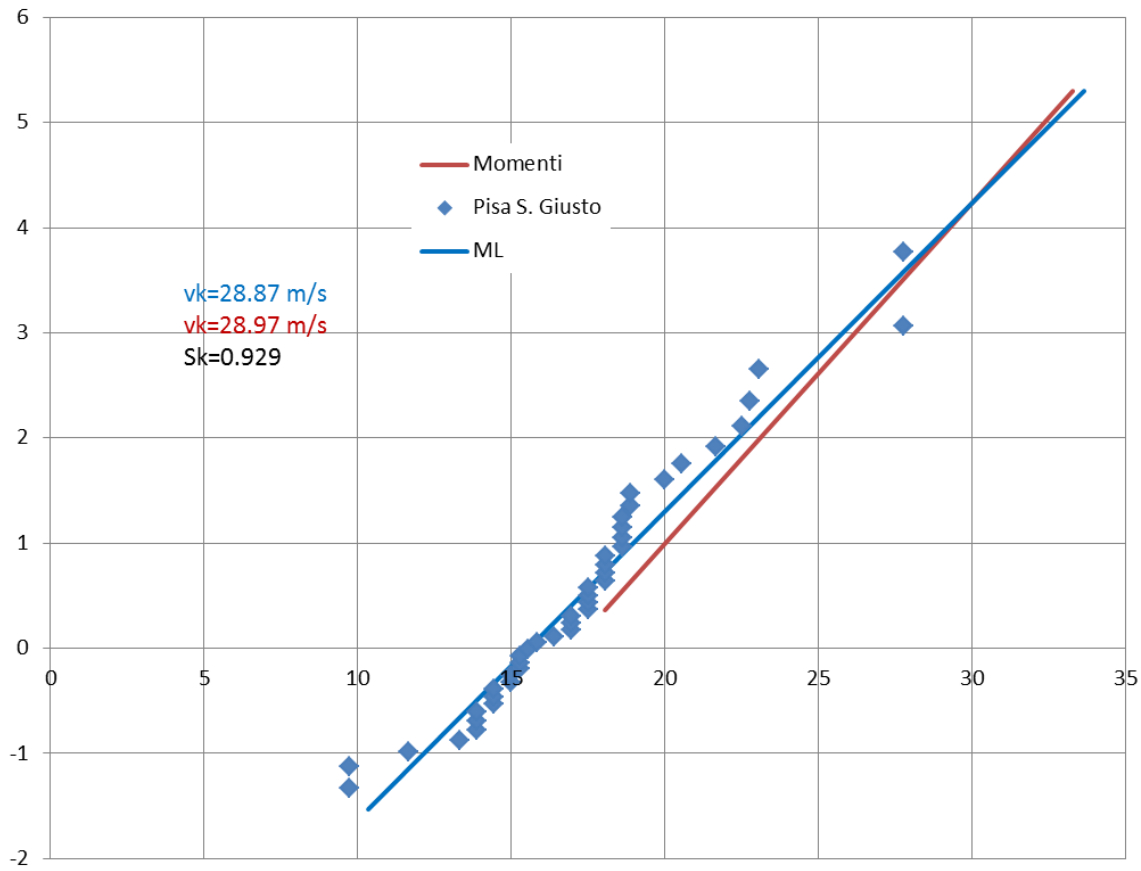| Zone	Description	$v_{b,0}$ [m/s]	a_0 [m]	k_a [1/s]
1	Valle d'Aosta, Piemonte, Lombardia, Trentino Alto Adige, Veneto, Friuli Venezia Giulia except the province of Trieste	25	1000	0,010
2	Emilia Romagna	25	750	0,015
3	Toscana, Marche, Umbria, Lazio, Abruzzo, Molise, Puglia, Campania, Basilicata, Calabria	27	500	0,020
4	Sicilia e province of Reggio Calabria	28	500	0,020
5	Sardegna (zone east of the line connecting Capo Teulada with Isola di Maddalena)	28	750	0,015
6	Sardegna (zone west of the line connecting Capo Teulada with Isola di Maddalena)	28	500	0,020
7	Liguria	28	1000	0,015
8	Province of Trieste	30	1500	0,010
9	Islands (except Sicilia and Sardegna) and open sea	31	500	0,020

Basic wind velocity

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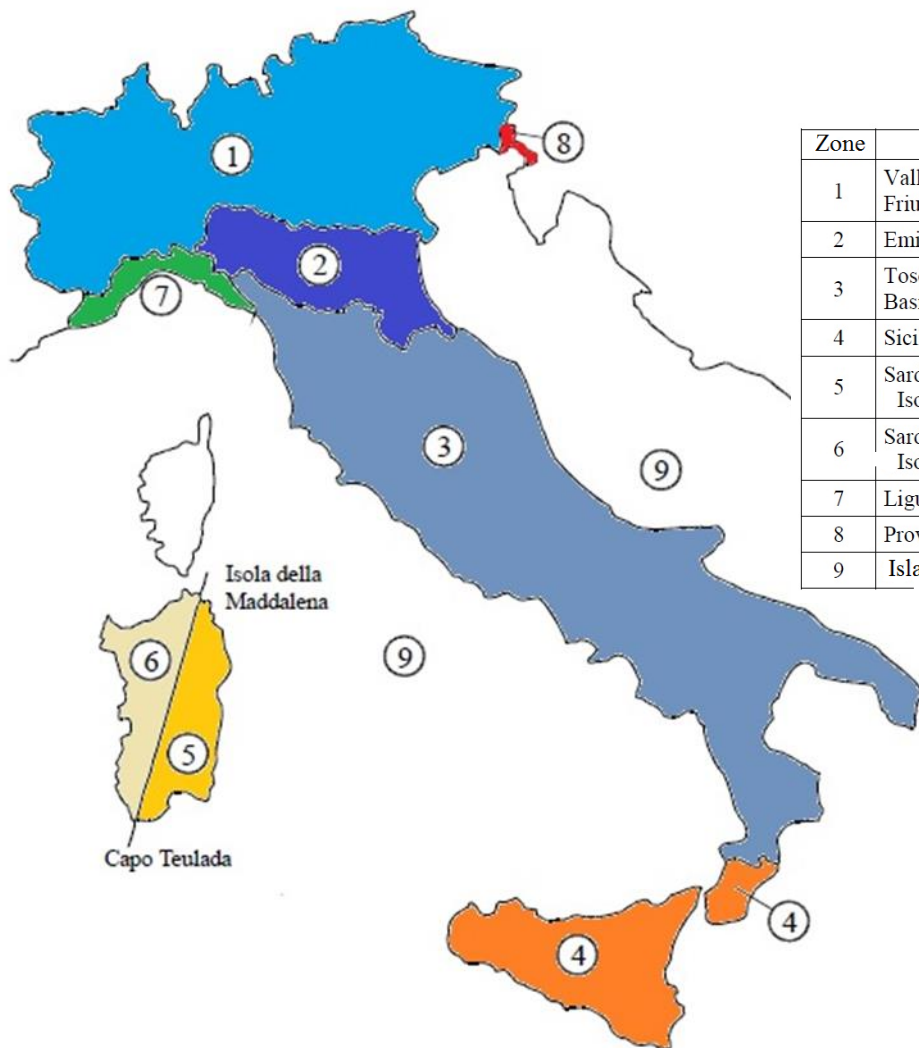| Zone	Description	$v_{b,0}$ [m/s]	a_0 [m]	k_a [1/s]
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Isola della Maddalena

Capo Teulada

Terrain roughness

Terrain roughness	Description
A	Urban areas with not less of 15% of surface is covered by buildings whose height is bigger than 15 m
B	Urban areas not belonging to class A, suburban, industrial and wooden areas
C	Area with dispersed obstacles (trees, buildings, walls, fences …); areas with roughness not belonging to classes A, B, D
D	Areas woth no obstacles (open land, airports, agricultural areas, pastures, wetlands or sandy lands, surfaces covered by snow or ice, open sea, lakes …)

$$c_e(z) = k_r^2\, c_t \ln(z/z_0)\,[7 + c_t \ln(z/z_0)] \qquad \text{per } z \geq z_{min}$$

$$c_e(z) = c_e(z_{min}) \qquad \text{per } z < z_{min}$$

Exposure category	k_r	z_0 [m]	z_{min} [m]
I	0,17	0,01	2
II	0,19	0,05	4
III	0,20	0,10	5
IV	0,22	0,30	8
V	0,23	0,70	12

Wind map at sea level - Italy

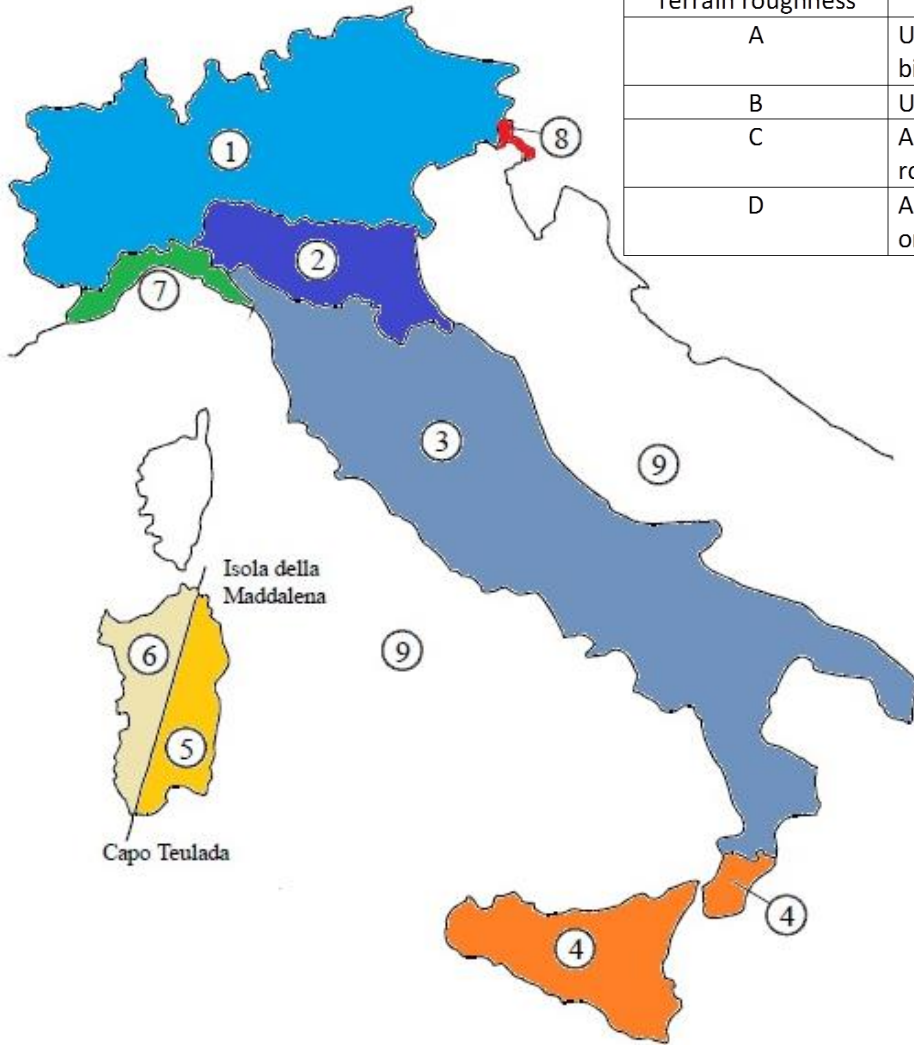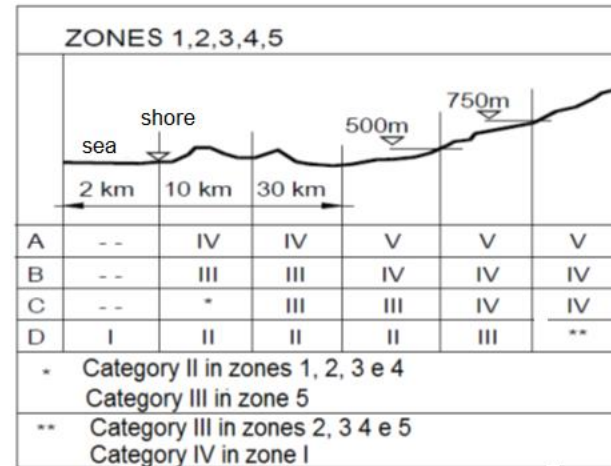| Terrain roughness	Description
A	Urban areas with not less of 15% of surface is covered by buildings whose height is bigger than 15 m
B	Urban areas not belonging to class A, suburban, industrial and wooden areas
C	Area with dispersed obstacles (trees, buildings, walls, fences ...); areas with roughness not belonging to classes A, B, D
D	Areas woth no obstacles (open land, airports, agricultural areas, pastures, wetlands or sandy lands, surfaces covered by snow or ice, open sea, lakes ...)

ZONES 1,2,3,4,5

	2 km	10 km	30 km	500m	750m	
A	- -	IV	IV	V	V	V
B	- -	III	III	IV	IV	IV
C	- -	*	III	III	IV	IV
D	I	II	II	II	III	**

* Category II in zones 1, 2, 3 e 4
Category III in zone 5

** Category III in zones 2, 3 4 e 5
Category IV in zone I
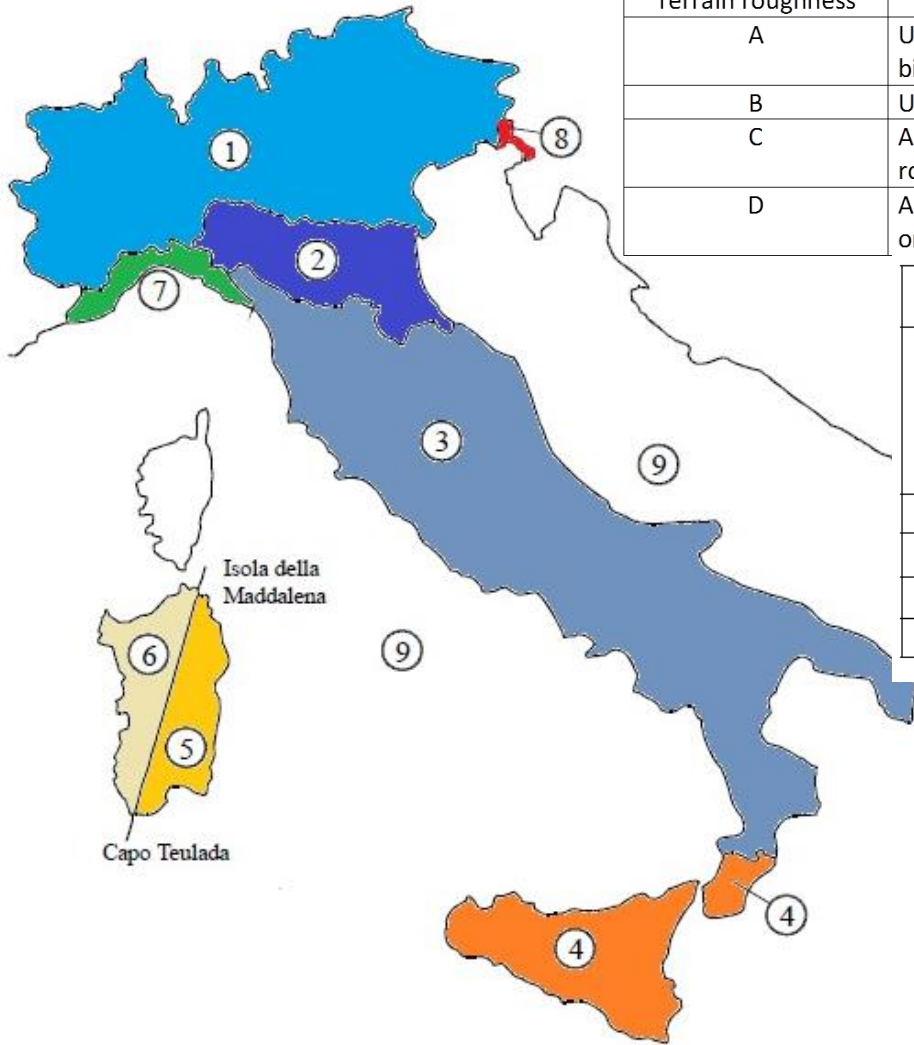
Isola della Maddalena

Capo Teulada

Wind map at sea level - Italy

Terrain roughness	Description
A	Urban areas with not less of 15% of surface is covered by buildings whose height is bigger than 15 m
B	Urban areas not belonging to class A, suburban, industrial and wooden areas
C	Area with dispersed obstacles (trees, buildings, walls, fences …); areas with roughness not belonging to classes A, B, D
D	Areas woth no obstacles (open land, airports, agricultural areas, pastures, wetlands or sandy lands, surfaces covered by snow or ice, open sea, lakes …)

ZONE 9

	sea	shore
A	- -	I
B	- -	I
C	- -	I
D	I	I

ZONE 6

	sea	shore 2 km	10 km	30 km	500m
A	- -	III	IV	V	V
B	- -	II	III	IV	IV
C	- -	II	III	III	IV
D	I	I	II	II	III

ZONES 7,8

	sea 1.5 km	0.5 km	shore
A	- -	- -	IV
B	- -	- -	IV
C	- -	- -	III
D	I	II	*

* Category II in zone 8
Category III in zone 7

Thank you for your attention