Generalitat de Catalunya
Departament de Territori i Sostenibilitat

Servei Meteorològic de Catalunya

UNIVERSITAT DE BARCELONA

European Geosciences Union | Vienna | Austria | 8-13 April 2018

Wind gust thresholds related to social impact in Catalonia: analysis by regions based on 10 years of report requests (2006-2015)

Barbería L. *(1)*, Amaro J. *(1)*, Cañas M. *(1)*, Aran M. *(1)* and Llasat M.C. *(2)*

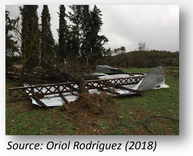
(1) Meteorological Service of Catalonia, Barcelona. Spain; (2) Dept. Applied Physics, Univ. Barcelona. Spain

Correspondence to: L. Barbería (lbarberia@meteo.cat)

1. QUICK OVERVIEW

Strong wind events cause remarkable economic losses

AT WHICH GUST VALUES DAMAGE BEGINS HAPPENING?



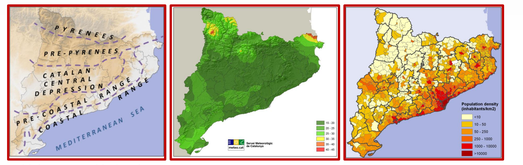
Source: Oriol Rodriguez (2018)

- Studies conducted under the HYMEX project (*Drobinski et al., 2014)* established that **report requests** connected to **insurance claims** that are received in meteorological services are a **good proxy indicator of the social impact of severe weather events** (*Amaro et al., 2010, Barbería et al., 2014*).

Average of 4362 report requests per year (2006-2015) in the SMC

- **Wind gust values** provided in **reports requested during 2006-2015** in the Meteorological Service of Catalonia (SMC) have been **analysed by county** due to geographical heterogeneity.
- **Results will be contrasted with current warning thresholds** (*Protecció Civil, 2017*).

GEOGRAPHICAL HETEROGENEITY



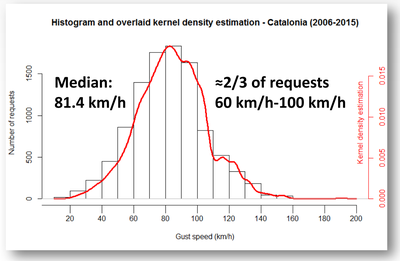
Major geographical regions

P98 daily maximum gust speed values (m/s) AWS of the SMC (2007-2015)

Population density (inh./km²) 2015 Data source: Idescat

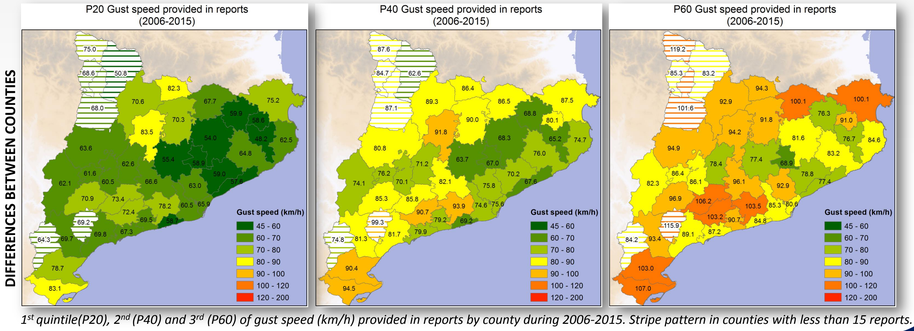
2. GUST VALUES RELATED TO REQUESTS

10211 wind gust values analysed



Mapping of gust speed quintiles obtained from each county's distribution. The gust values have been collected from requests.

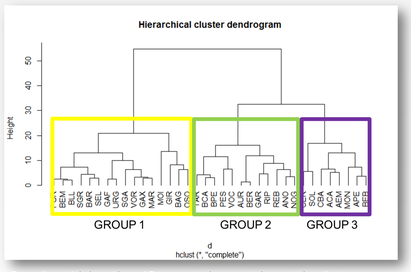
DIFFERENCES BETWEEN COUNTIES



1st quintile(P20), 2nd (P40) and 3rd (P60) of gust speed (km/h) provided in reports by county during 2006-2015. Stripe pattern in counties with less than 15 reports.

3. CLUSTER ANALYSIS

Hierarchical cluster dendrogram: 3 groups



Counties with less than 15 requests have not been taken into account

- **To obtain groups with similar behaviour**

Based on P20, P40 and P60 of gust speed values related to requests

P80 and P100 omitted as we focus on the values that begin causing damage

Results could be biased* by:

1) Few requests in some counties => OVERESTIMATION OR SUBESTIMATION
2) Many requests related to the same event = same gust value repeatedly in the histogram, sometimes shaping a peak => usually OVERESTIMATION
3) Differences within a county: in some cases, the territory within a county is not homogeneous, and the histogram has two peaks, according to the two different responses => OVERESTIMATION in the areas with lower values

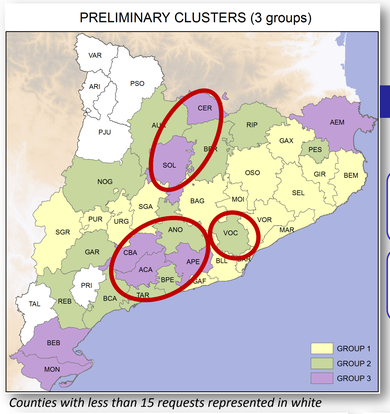
For 2 and 3, counties' individual histograms can be checked

GROUP 1: lowest values of the gust speed, highly populated areas (see section 1)

GROUP 2: medium speeds, high speeds in high altitudes, not populated

GROUP 3: high values of gust speed in populated areas

PRELIMINARY CLUSTERS (3 groups)



Counties with less than 15 requests represented in white

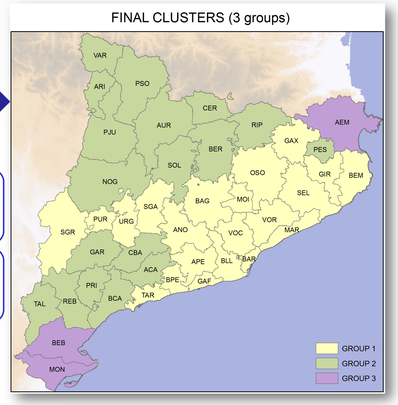
*To avoid erroneous results:

Supervision and readjustment

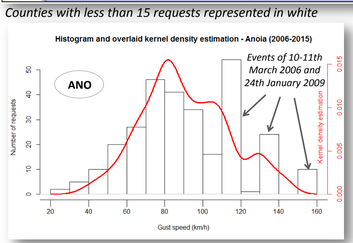
Counties with less than 15 requests (white colour in the map) assigned to the most similar cluster

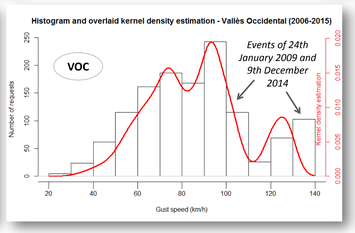
Anomalies (marked in red) checked by revising histograms and reassigned to another group if necessary

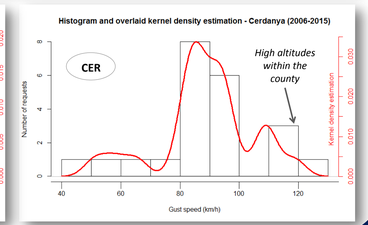
FINAL CLUSTERS (3 groups)



EXAMPLES OF CHECKED HISTOGRAMS



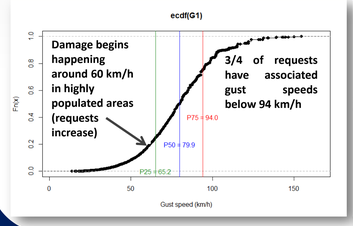




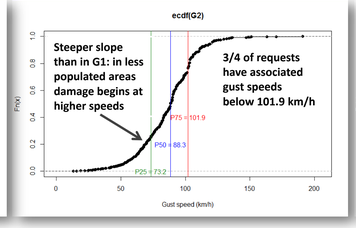
4. THRESHOLDS PROPOSED

Empirical cumulative distribution function of gust speed values related to requests for each group

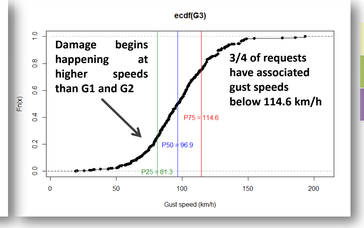
GROUP 1 (G1)



GROUP 2 (G2)



GROUP 3 (G3)



3 levels for each group:

- **P25 (L1) → Connected to first damages**
- **P50 (L2), P75 (L3) → Connected to more severe damage**

Rounded values to 0 or 5

Cluster	L1 (km/h)	L2 (km/h)	L3 (km/h)
G1	65	80	95
G2	75	90	100
G3	80	95	115

Current first warning thresholds in the SMC (SMP1): 72 km/h, 90 km/h and 108 km/h (also 3 groups of counties). Higher thresholds than L1

! However, the SMP does not take into account vulnerability and exposure factors

5. VERIFICATION

2016 wind events have been used (1 090 requests)

REQUESTED DATES ⟷ **CROSSED** ⟷ **DATES THRESHOLDS OVERCOME**

Number of times that a date has been requested (in red the highest number of requests)

Indicated with a black square

Often, the date is not completely known, so an approximate period of time is requested.

Dates crossed for all the counties

Example of table for Barcelonès (BAR) county

Dates requested vs dates thresholds overcome (L1, 65 km/h, black square)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JAN	5	3	3	4	9	13	14	12	12	18	19	16	10	6	3	2	1	2	1		1	1	1	1							
FEB	1	1	1	1	2	2	3	3	4	5	4	5	4	4	3	2	2				1	1	1	1	2	7	10	7	8		
MAR	6	15	7	4	4	3	3	3	3	3	4	5	5	5	4	4	3	3	2	2	2	2	2	2	2	1	1	1	1	1	
APR	1	1	1							1	1	1	1	1	1	2	1	1	1												
MAI																2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	
JUN	1	1	1	1	1					2	2	2	3	3	3	2															
JUL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
AUG																															
SEP	1	1	1	1	1					1	2	3	9	11	2	2	2	2	3	3	3	3	1	1	1			1			
OCT	1	1	1							1	1	1	1	1	1	1				1	1	1	1								
NOV	1	2	2	1	2	2	2	7	17	4	1																				
DEC																				2	1										

Remarkable number of requests (damaging event) but no threshold exceedance

All the exceedances of L1 (65 km/h, black square) had at least one request

Few requests for a highly populated area

Table for Barcelonès county crossing requested dates and dates when L1 (65 km/h) was overcome during 2016

How to evaluate the adequacy of thresholds?

2 requirements

NOT TOO HIGH

The events that had a high number of requests should be matched with the exceedance of the threshold

NOT TOO LOW

The exceedance of the threshold should be corresponded with some requests

Indexes suggested

$R_1 = (NRe / NRt)*100$

NRt = total number of events with requests > P90

NRe = number of NRt when the wind gust threshold was exceeded

$R_2 = (Ner / Net)*100$

Net = total number of days when the threshold was exceeded

Ner = number of Net that coincide with at least one request

0 ----------100

Adequacy

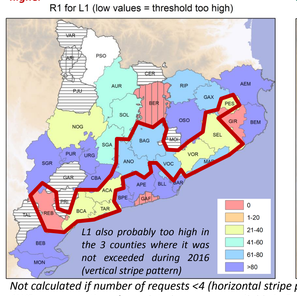
VALUES NEAR 100 REJECT THAT THE THRESHOLDS ARE TOO HIGH (R_1) OR TOO LOW (R_2)

Example of R_1 and R_2 calculated for L1

Best results in general for G1 and G3 (blue colour in the maps), even though L1 could be too high in some counties. Comparison between the 2 indexes:

R1 < R2: L1 more likely to be too high than too low: L1 could be more adequate than current warning thresholds in the SMC (SMP1), as the SMP1 is even higher

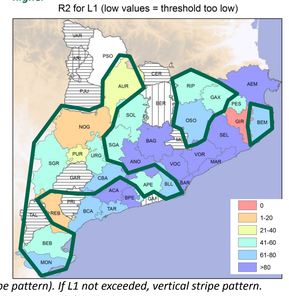
R1 for L1 (low values = threshold too high)



L1 also probably too high in the 3 counties where it was not exceeded during 2016 (vertical stripe pattern)

R2 < R1: L1 more likely to be too low than too high: current warning thresholds in the SMC (SMP1) could be more adequate than the L1, as the SMP1 is higher

R2 for L1 (low values = threshold too low)



Not calculated if number of requests <4 (horizontal stripe pattern). If L1 not exceeded, vertical stripe pattern. AWS representative of populated areas not available in Pallars Sobirà (PSO).

6. CONCLUSIONS

- Gust speed values connected to social impact have been analysed using as proxy data report requests received during 2006-2015 in the Meteorological Service of Catalonia (SMC).
- Global results show a median of 81.4 km/h, and about 2/3 of requests have associated gust speeds between 60 km/h and 100 km/h.
- Cluster analysis has been performed to group counties with similar behaviour regarding the first damaging gusts. 3 groups have been suggested: G1 corresponds to lowest values of the gust speed in highly populated areas; G2: medium speeds and high speeds in high altitudes, not populated; G3: high values of gust speed in populated areas.
- Three levels of thresholds (L1, L2 and L3) have been proposed for each group, based on P25, P50 and P75. L1 could be associated with first damages. For G1, L1 is 65 km/h, for G2 is 75 km/h and for G3 is 80 km/h.
- Verification of L1 has been carried out using 2016 wind events. Requested dates and the dates when L1 was exceeded have been crossed for each county.
- 2 indexes have been suggested for evaluating the adequacy of thresholds, according to 2 criteria: they shouldn't be too high (high number of requests => exceedance of the threshold) and they shouldn't be too low (exceedance of the threshold => requests).
- In some counties, especially in the inland, the L1 could be too low, so the current warning thresholds in the SMC (SMP1), which are higher than the L1, are probably more adequate.
- On the contrary, for other counties, especially in the coastal and precoastal range, the L1 is probably more adequate than the SMP1. It is necessary to highlight that the SMP1 does not take into account vulnerability and exposure factors, so this methodology is a useful tool to evaluate social impact.

7. REFERENCES

Amaro, J., Gayà, M., Aran, M. and Llasat, M.C. (2010): **Preliminary results of the Social Impact Research Group of MEDEX: the request database (2000–2002) of two Meteorological Services**, Nat. Hazards Earth Syst. Sci., 10, 2643-2652

Barbería L, Amaro J, Aran M, Llasat MC (2014):**The role of different factors related to social impact of heavy rain events: considerations about the intensity thresholds in densely populated areas**. Natural Hazards and Earth System Sciences, **14**, 1843-1852. doi:10.5194/nhess-14-1843-2014.

Drobinski, P. et al (2014).: **HyMeX: A 10-Year Multidisciplinary Program on the Mediterranean Water Cycle** , Bulletin Am. Meteorol. Soc., Volume 95, Number 7, p.1063

Protecció Civil (2017): **Pla especial d'emergències per risc de vent a Catalunya (VENTCAT)**, 44-46, http://interior.gencat.cat/web/.content/home/030_arees_dactuacio/proteccio_civil/plans_de_proteccio_civil/plans_de_proteccio_civil_a_catalunya/documents/Document_Pla_VENTCAT.pdf