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Supplement of

The relationship between precipitation and insurance data for floods in a Mediterranean region (northeast Spain)

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SUPPLEMENTARY MATERIAL**TABLES****Table S1: Basin aggregation**

ALL BASINS		BASINS	
CODE	BASIN NAME	CODE	JOIN
001	Tec, el	1001 (001; 002; 030)	El Tec; Rieres litorals Muga; La Muga
002	Rieres litorals Muga	1002 (003; 040)	Rieres litorals Fluvià; El Fluvià
003	Rieres litorals Fluvià	006	El Daró
006	Daró, el	1003 (015; 852)	El Gaià; Rieres Tarragona Centre
015	Gaià, el	019	Riera de Riudecanyes
019	Riera de Riudecanyes	1004 (025; 970)	La Sénia; Rieres litorals Ebre Sud
025	Sénia, la	050	Tordera, la
030	Muga, la	060	Besòs, el
040	Fluvià, el	070	Foix, el
050	Tordera, la	080	Francolí, el
060	Besòs, el	090	Garona, eth
070	Foix, el	100	Ter, el
080	Francolí, el	200	Llobregat, el
090	Garona, eth	300	Segre, el
100	Ter, el	400	Ebre, l'
200	Llobregat, el	500	Rieres Costa Brava Nord
300	Segre, el	600	Rieres Costa Brava Centre
400	Ebre, l'	618	Rieres Costa Brava Sud
500	Rieres Costa Brava Nord	700	Rieres del Maresme
600	Rieres Costa Brava Centre	774	Torrents de l' Àrea Metropolitana de Barcelona
618	Rieres Costa Brava Sud	789	Rieres litorals Llobregat
700	Rieres del Maresme	800	Rieres del Garraf
774	Torrents de l' Àrea Metropolitana de Barcelona	833	Rieres Tarragona Nord
789	Rieres litorals Llobregat	900	Rieres Tarragona Sud
800	Rieres del Garraf	913	Rieres Meridionals de Tarragona
833	Rieres Tarragona Nord	944	Rieres litorals Ebre Nord
852	Rieres Tarragona Centre		
900	Rieres Tarragona Sud		
913	Rieres Meridionals de Tarragona		
944	Rieres litorals Ebre Nord		
970	Rieres litorals Ebre Sud		

Table S2: Warning zones aggregation

ALL WARNING ZONE		WARNING ZONE	
CODE	WARNING ZONE NAME	CODE	WARNING ZONE NAME
694304	Litoral sur de Tarragona	694304	Litoral sur de Tarragona
694302	Cadena prelitoral de Tarragona	694302	Cadena prelitoral de Tarragona
694301	Depresión central de Tarragona	694301	Depresión central de Tarragona
694303	Litoral norte de Tarragona	694303	Litoral norte de Tarragona
690804	Prelitoral de Barcelona	690804	Prelitoral de Barcelona
692503	Depresión central de Lleida	692503	Depresión central de Lleida
690803	Prelitoral de Barcelona	690803	Prelitoral de Barcelona
690802	Depresión central de Barcelona	690802	Depresión central de Barcelona
691704	Litoral sur de Girona	691704	Litoral sur de Girona
691702	Prelitoral de Girona	691702	Prelitoral de Girona
691703	Ampurdán	691703	Ampurdán
690801	Prepirineo de Barcelona	690000 (690801; 691701)	Prepirineo de Barcelona, pirineo de Lleida y Llivia
692502	Pirineo de Lleida	692502	Pirineo de Lleida
691701	Pirineo de Girona y Llivia	692501	Valle de Arán
692501	Valle de Arán		

Table S3: Parameters of the logistic model and RA values for the basin level with 40 mm/24 h maximum precipitation threshold. Number of flood cases: 331

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-3.62	0.83	0.60
	DPC	-6.83	1.56	0.67
	DPW	-7.16	1.63	0.68
60	D	-5.11	1.06	0.63
	DPC	-7.79	1.67	0.69
	DPW	-8.68	1.87	0.71
70	D	-6.06	1.17	0.65
	DPC	-9.05	1.84	0.71
	DPW	-8.88	1.80	0.71
80	D	-9.19	1.73	0.72
	DPC	-10.73	2.07	0.74
	DPW	-9.74	1.85	0.73
90	D	-10.47	1.82	0.74
	DPC	-11.48	2.03	0.74
	DPW	-13.76	2.52	0.80

Table S4: Parameters of the logistic model and RA values for the basin level (without taking into account mountain basins: basin 090, 100, 200 and 300, according to Table 1 in supplementary material) with 40 mm/24 h maximum precipitation threshold. Number of flood cases: 247.

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-3.95	0.91	0.6
	DPC	-6.53	1.51	0.65
	DPW	-7.13	1.65	0.66
60	D	-6.71	1.45	0.66
	DPC	-7.39	1.6	0.66
	DPW	-7.87	1.71	0.67
70	D	-7.37	1.49	0.66
	DPC	-10.31	2.15	0.72
	DPW	-8.88	1.83	0.70
80	D	-10.26	2.01	0.73
	DPC	-12.43	2.49	0.76
	DPW	-10.46	2.05	0.73
90	D	-10.62	1.89	0.72
	DPC	-10.83	1.94	0.72
	DPW	-13.45	2.5	0.79

Table S5: Parameters of the logistic model and RA values for the basin level (without taking into account mountain basins: basin 090, 100, 200 and 300, according to Table 1 in supplementary material) with 60 mm/24 h maximum precipitation threshold. Number of flood cases: 171.

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-6.51	1.44	0.63
	DPC	-9.19	2.03	0.66
	DPW	-11.08	2.45	0.69
60	D	-10.06	2.13	0.69
	DPC	-10.28	2.17	0.67
	DPW	-10.25	2.16	0.68
70	D	-10.94	2.21	0.69
	DPC	-13.54	2.78	0.73
	DPW	-11.07	2.24	0.7
80	D	-11.15	2.13	0.7
	DPC	-10.3	1.95	0.69
	DPW	-10.65	2.02	0.7
90	D	-12.37	2.21	0.71
	DPC	-10.9	1.9	0.68
	DPW	-13.52	2.45	0.73

Table S6: Parameters of the logistic model and RA values for the basin level with 40 mm/24 h average precipitation threshold. Number of flood cases: 177.

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-5.38	1.29	0.61
	DPC	-10.32	2.48	0.68
	DPW	-10.16	2.44	0.68
60	D	-5.89	1.31	0.61
	DPC	-10.70	2.46	0.69
	DPW	-9.48	2.17	0.68
70	D	-8.25	1.76	0.66
	DPC	-13.10	2.90	0.73
	DPW	-9.78	2.12	0.68
80	D	-11.75	2.44	0.73
	DPC	-11.86	2.46	0.71
	DPW	-9.96	2.02	0.67
90	D	-12.22	2.35	0.72
	DPC	-13.13	2.56	0.73
	DPW	-14.99	2.98	0.77

Table S7: Parameters of the logistic model and RA values for the basin level with 60 mm/24 h average precipitation threshold. Number of flood cases: 100. * Indicates no significance (p-value>0.05).

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-6.02*	1.37*	0.61*
	DPC	-14.99	3.42	0.72
	DPW	-13.70	3.13	0.71
60	D	-7.95	1.71	0.64
	DPC	-17.43	3.87	0.75
	DPW	-16.95	3.76	0.75
70	D	-11.76	2.47	0.69
	DPC	-13.61	2.89	0.72
	DPW	-13.44	2.85	0.70
80	D	-9.04*	1.73*	0.64
	DPC	-15.51	3.17	0.73
	DPW	13.68	2.77	0.71
90	D	-10.20*	1.80*	0.67
	DPC	-15.75	3.02	0.74
	DPW	-12.99	2.42	0.69

Table S8: Parameters of the logistic model and RA values for the warning zone level with 40 mm/24 h maximum precipitation threshold. Number of flood cases: 243.

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-2.73	0.62	0.6
	DPC	-6.79	1.53	0.7
	DPW	-6.81	1.54	0.7
60	D	-4.05	0.82	0.63
	DPC	-7.54	1.59	0.71
	DPW	-7.21	1.52	0.71
70	D	-4.82	0.89	0.63
	DPC	-8.25	1.64	0.73
	DPW	-9	1.8	0.74
80	D	-7.35	1.31	0.7
	DPC	-9.67	1.81	0.76
	DPW	-10.65	2.03	0.78
90	D	-8.92	1.46	0.73
	DPC	-11.04	1.9	0.79
	DPW	-11.62	2.02	0.81

Table S9: Parameters of the logistic model and RA values for the warning zone level with 60 mm/24 h maximum precipitation threshold. Number of flood cases: 180. * Indicates no significance (p-value>0.05).

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-2.13*	0.46*	0.58*
	DPC	-6.54	1.41	0.66
	DPW	-6.52	1.41	0.67
60	D	-2.08*	0.36*	0.55*
	DPC	-7.07	1.43	0.68
	DPW	-6.94	1.4	0.67
70	D	-3.64*	0.6*	0.58*
	DPC	-8.06	1.54	0.7
	DPW	-10.04	1.96	0.75
80	D	-3.9*	0.54*	0.56*
	DPC	-10.04	1.83	0.75
	DPW	-10.01	1.82	0.74
90	D	-8.44	1.32	0.71
	DPC	-10.61	1.76	0.75
	DPW	-10.57	1.75	0.75

Table S10: Parameters of the logistic model and RA values for the MAB level with 20 mm/30 min maximum precipitation threshold. Number of flood cases: 21. * Indicates no significance (p-value>0.05).

PERCENTILE	DAMAGE	β_0	β_1	RA
50	D	-42.27	12.28	0.94
	DPC	-42.27	12.28	0.94
	DPW	-34.04	9.81	0.91
60	D	-75.09	11.66	0.95
	DPC	-26.47	11.66	0.95
	DPW	-33.68	11.66	0.95
70	D	-27.89	7.23	0.92
	DPC	-27.89	7.23	0.92
	DPW	-27.89	7.23	0.92
80	D	-16.25	4.05*	0.82
	DPC	-16.25	4.05*	0.82
	DPW	-16.25	4.05*	0.82
90	D	-6759.73	1727.74*	1*
	DPC	-6759.73	1727.74*	1*
	DPW	-6759.73	1727.74*	1*

Table S11: Damage percentiles for all the damage indicators, precipitation indicators and levels. Damage (D) is in euros, damage per capita (DPC) in euros/population and damage per wealth (DPW) in euros/GDP.

PERCENTILE	DAMAGE	BASINS		WARNING ZONES		MAB	
		40 mm/24h	60 mm/24h	40 mm/24h	60 mm/24h	10 mm/30min	20 mm/30min
50	D	76534	91732	180148	228677	191222	332437
	DPC	0.40	0.48	0.33	0.54	0.06	0.11
	DPW	20	27	15	26	2	4
60	D	142642	177573	288708	342690	253197	439954
	DPC	0.66	0.96	0.61	0.82	0.09	0.14
	DPW	36	57	31	48	3	5
70	D	244098	280868	465357	601829	446198	1754684
	DPC	1.25	1.97	1.12	1.60	0.14	0.56
	DPW	71	97	60	94	5	19
80	D	512063	798412	800506	1203333	1394559	2992793
	DPC	3.15	4.14	2.38	2.76	0.45	0.93
	DPW	141	200	132	164	13	29
90	D	1670401	2377659	2504096	3191660	3414333	10680483
	DPC	7.97	13.15	5.28	6.35	1.07	3.57
	DPW	380	591	301	417	35	103

FIGURES

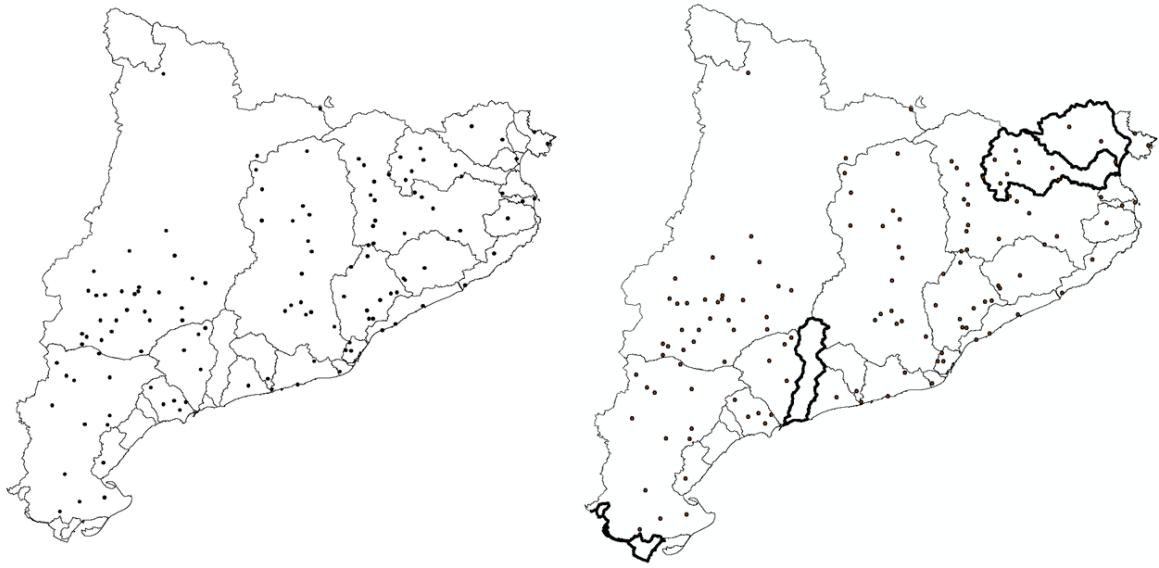


Figure S1. Basins aggregation

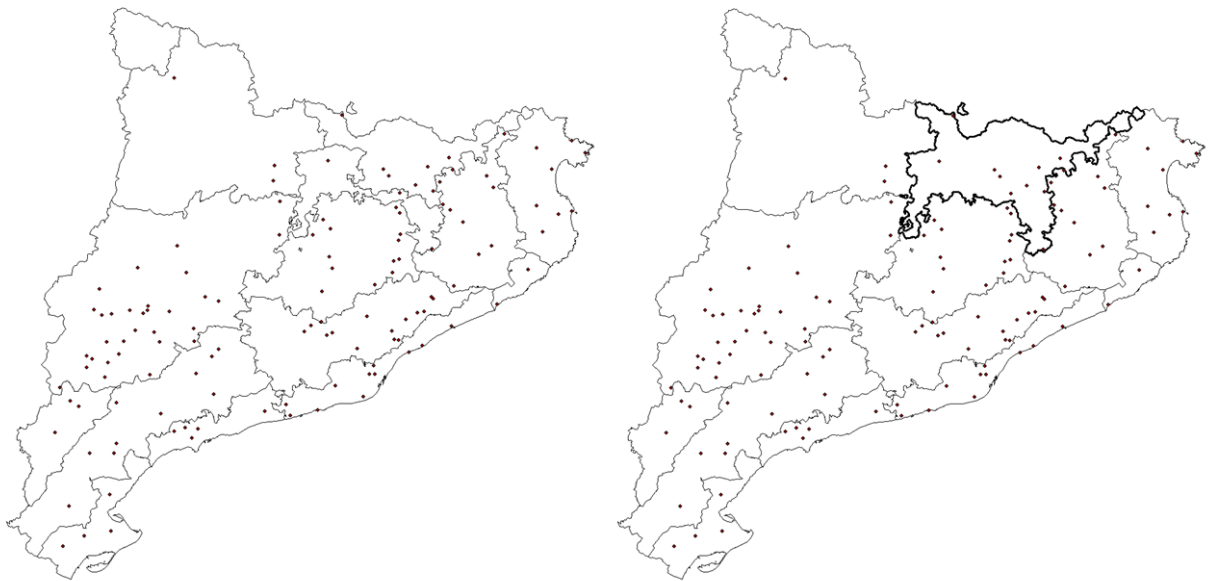


Figure S2. Warning zones aggregation

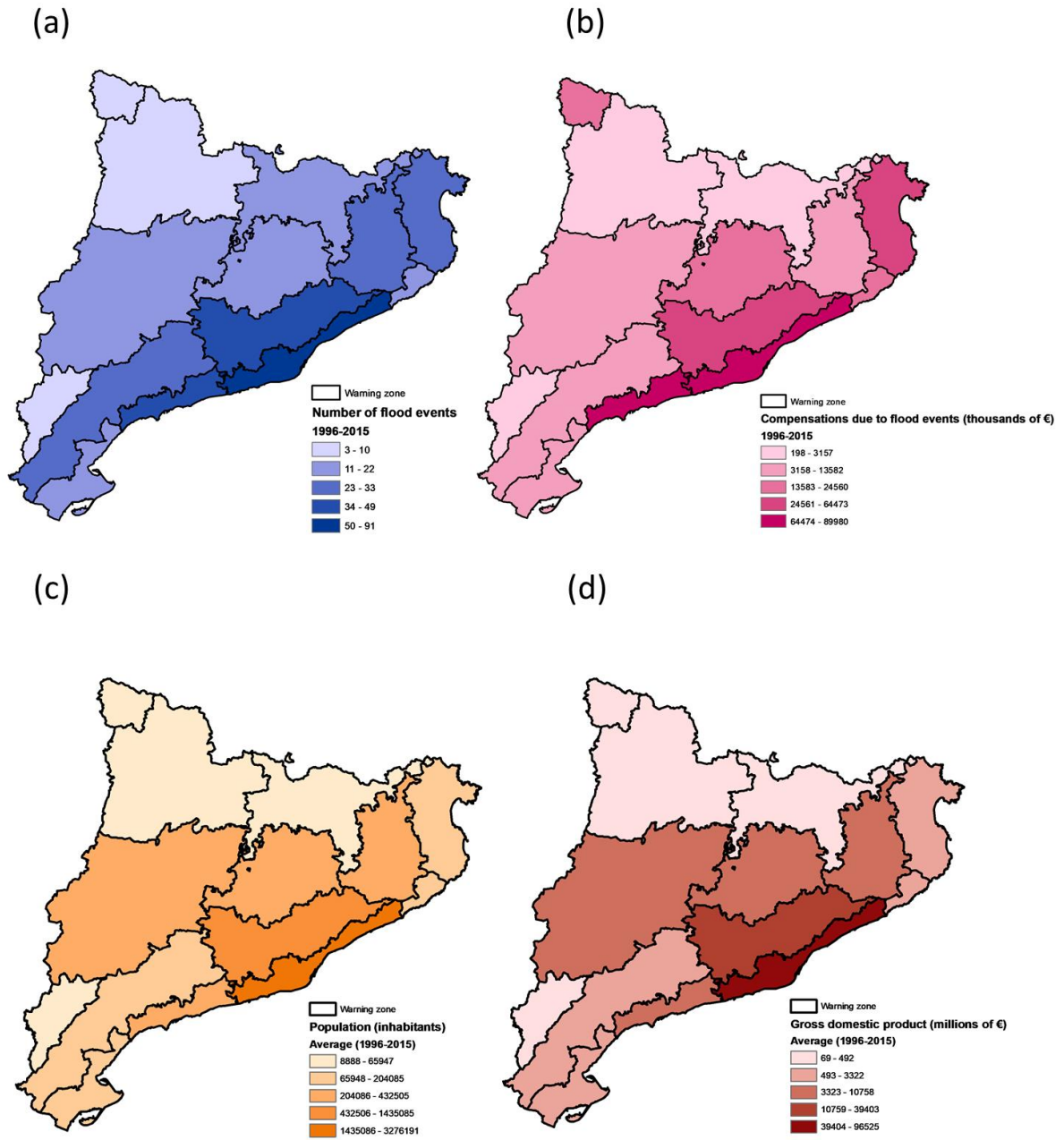


Figure S3. (a) Warning zone distribution of flood events (1996-2015); (b) total insurance compensations for floods made by CCS (1996-2015); (c) average total population; and (d) average gross domestic product.

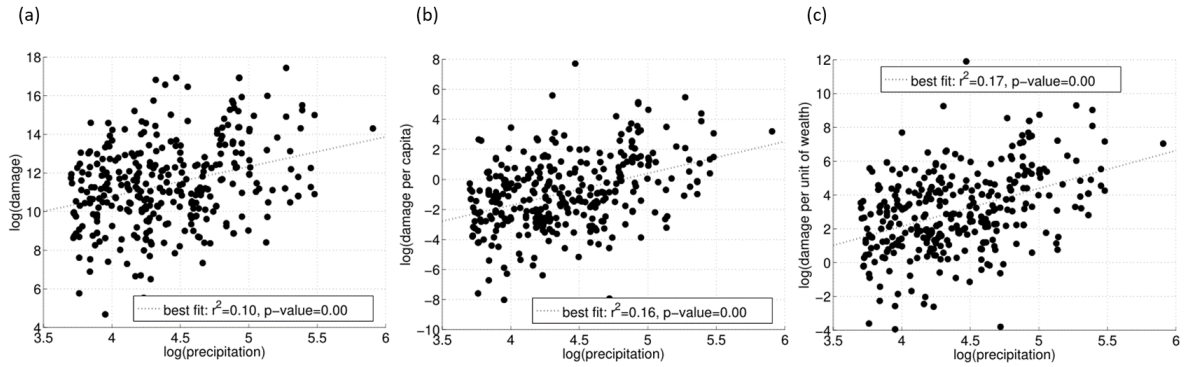


Figure S4: Scatter plot showing maximum precipitation in 24 h (mm) and (a) total damages (D); (b) damage per capita (DPC); and (c) damage per unit of wealth (DPW), for flood events recorded in Catalonia between 1996 and 2015 (log-transformed values; damage are given in euros). Each point represents the compensation series (D, DPC or DPW) and the maximum 24 h precipitation for each basin. The dashed line indicates the fit based on a linear regression model. ($P_0=40$ mm/24 h).

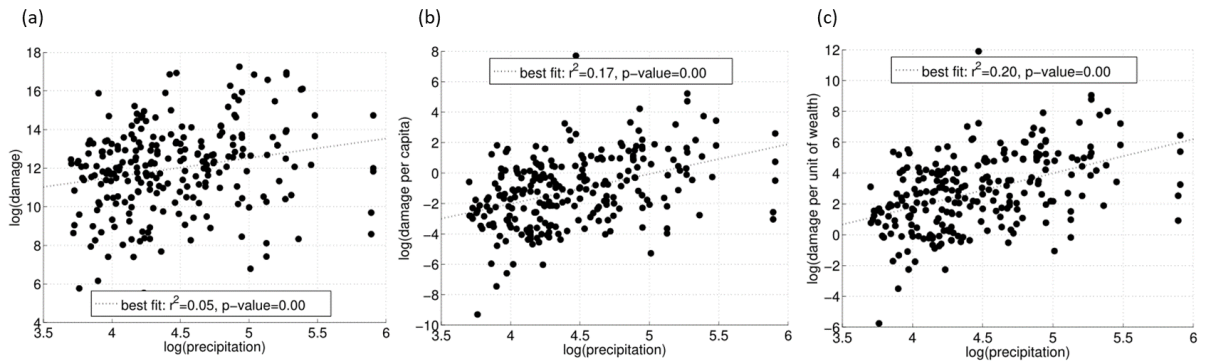


Figure S5: Scatter plot showing maximum precipitation in 24 h (mm) and (a) total damages (D); (b) damage per capita (DPC); and (c) damage per unit of wealth (DPW), for flood events recorded in Catalonia between 1996 and 2015 (log-transformed values; damage are given in euros). Each point represents the compensation series (D, DPC or DPW) and the maximum 24 h precipitation for each warning zone. The dashed line indicates the fit based on a linear regression model. ($P_0=40$ mm/24 h).

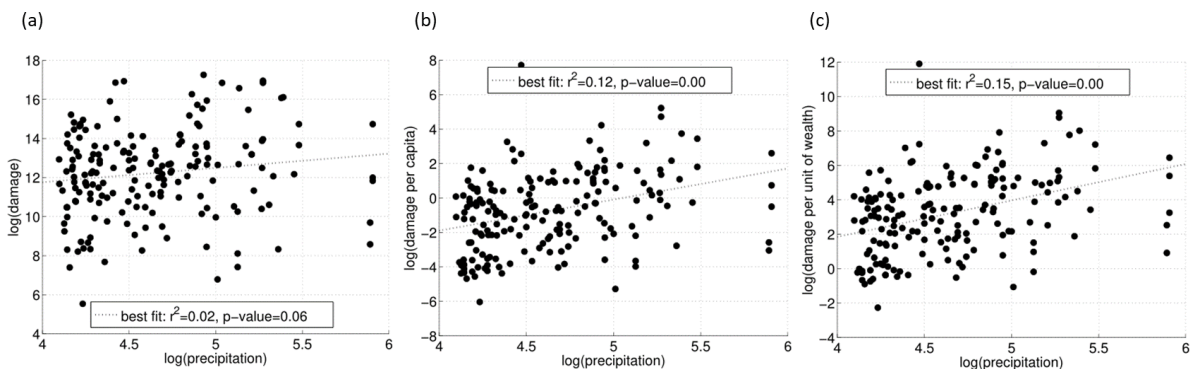


Figure S6: Scatter plot showing maximum precipitation in 24 h (mm) and (a) total damages (D); (b) damage per capita (DPC); and (c) damage per unit of wealth (DPW), for flood events recorded in Catalonia between 1996 and 2015 (log-transformed values; damage are given in euros). Each point represents the compensation series (D, DPC or DPW) and the maximum 24 h precipitation for each warning zone. The dashed line indicates the fit based on a linear regression model. ($P_0=60$ mm/24 h).

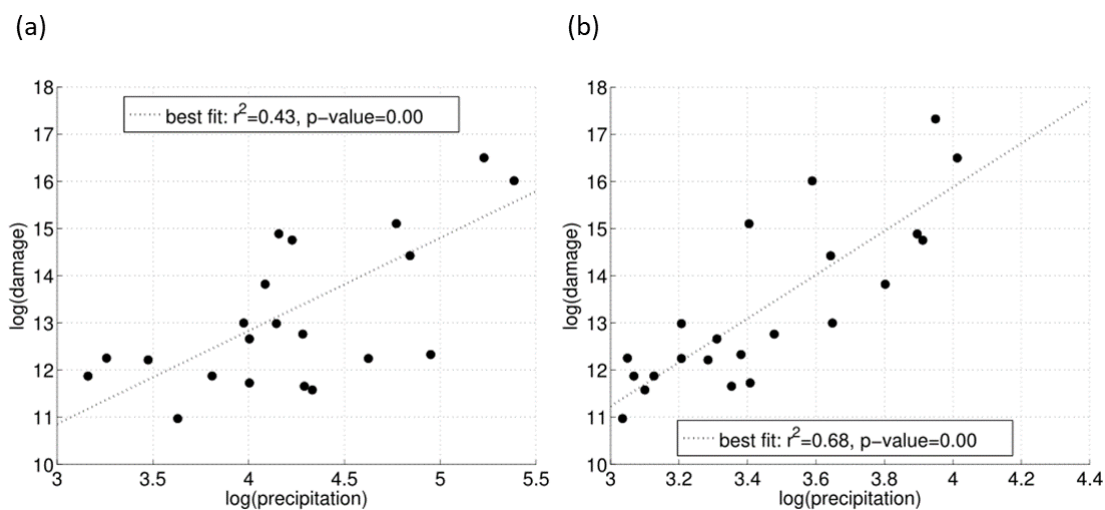


Figure S7: scatter plot (a) damages (D) versus 24 h precipitation ($P_0=20$ mm/24 h) and (b) damages (D) versus 30 minute precipitation ($P_0=20$ mm/30 min) for the MAB (unit: log(mm)).

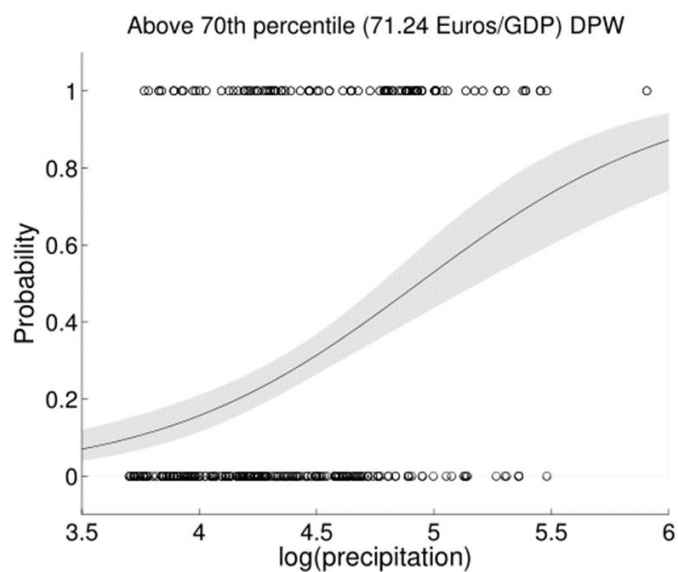


Figure S8: Example of logistic regression result to model DPW damages above the 70th percentile as a function of precipitation (log-transformed of the precipitation given in mm) for basin level. The solid line indicates the best estimate while the shaded band indicates the 95% confidence interval. Open circles along the horizontal axis show the events that are above (top) and below (bottom) the 70th percentile. ($P_0=40$ mm/24 h).

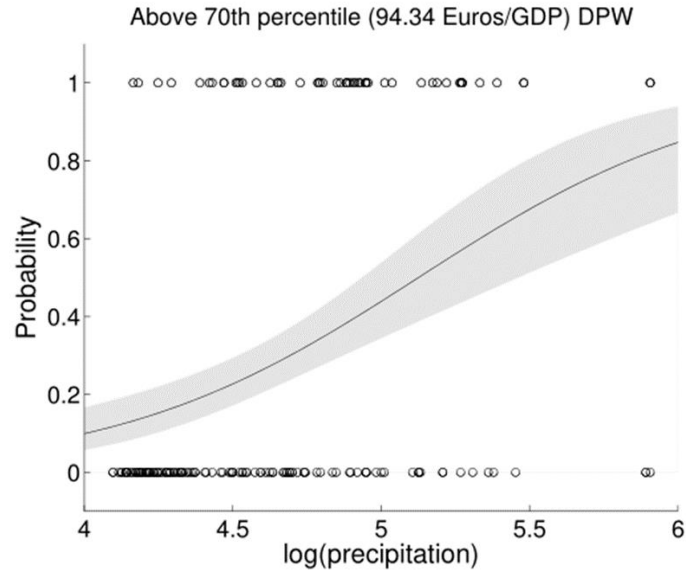


Figure S9: Example of logistic regression result to model DPW damages above the 70th percentile as a function of precipitation (log-transformed of the precipitation given in mm) for warning zone level. The solid line indicates the best estimate while the shaded band indicates the 95% confidence interval. Open circles along the horizontal axis show the events that are above (top) and below (bottom) the 70th percentile. ($P_0=60$ mm/24 h).

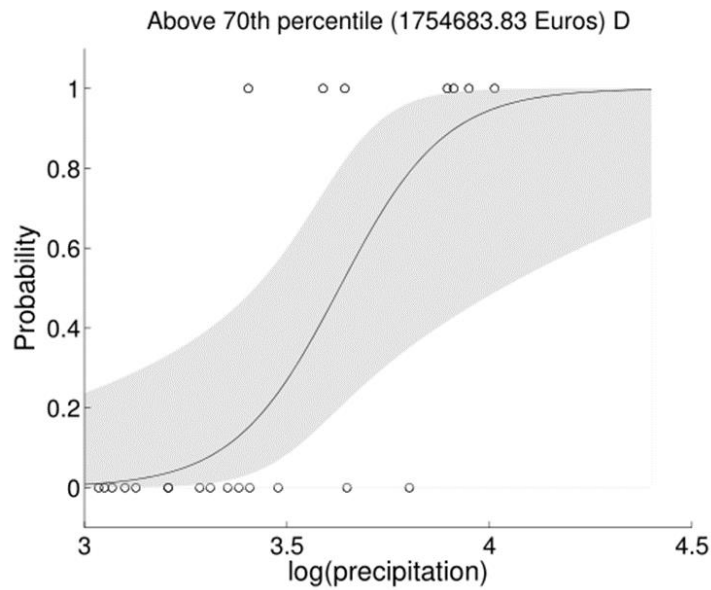


Figure S10: Example of logistic regression result to model D damages above the 70th percentile as a function of precipitation (log-transformed of the precipitation given in mm) for the MAB. The solid line indicates the best estimate while the shaded band indicates the 95% confidence interval. Open circles along the horizontal axis show the events that are above (top) and below (bottom) the 70th percentile. ($P_0=20$ mm/30 min).

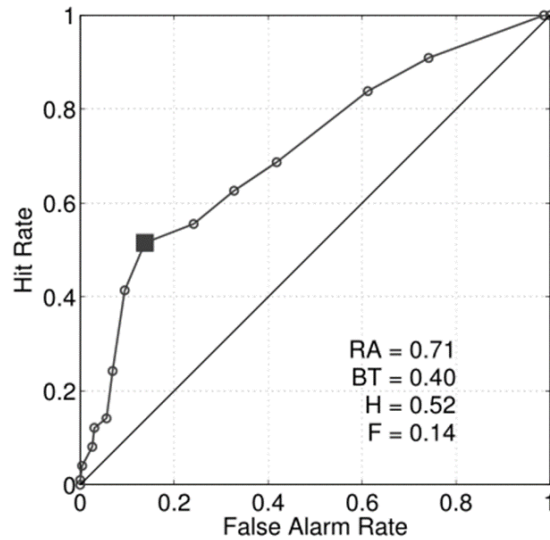


Figure S11: Relative operating characteristic (ROC) diagram for above 70th DPW predictions for basin level using the logistic regression of Eq. (1) ($P_0=40$ mm/24 h). The open dots indicate a set of probability forecasts by stepping a decision threshold with 5% probability through the modelling results. The numbers inside the plots are the ROC Area (RA) and the Best Threshold (BT), here defined as the threshold that maximise the difference between the hit rate (H) and the false alarm rate (F).

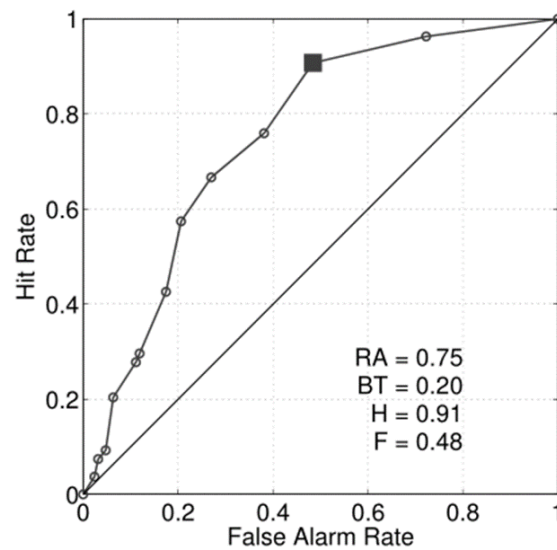


Figure S12: Relative operating characteristic (ROC) diagram for above 70th DPW predictions for the warning zones using the logistic regression of Eq. (1) ($P_0=60$ mm/24 h). The open dots indicate a set of probability forecasts by stepping a decision threshold with 5% probability through the modelling results. The numbers inside the plots are the ROC Area (RA) and the Best Threshold (BT), here defined as the threshold that maximise the difference between the hit rate (H) and the false alarm rate (F).

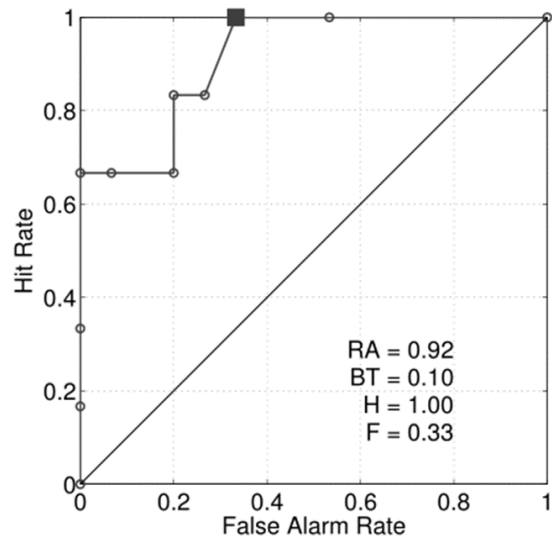


Figure S13: Relative operating characteristic (ROC) diagram for above 70th D predictions for the MAB using the logistic regression of Eq. (1) ($P_0=20$ mm/30 min). The open dots indicate a set of probability forecasts by stepping a decision threshold with 5% probability through the modelling results. The numbers inside the plots are the ROC Area (RA) and the Best Threshold (BT), here defined as the threshold that maximise the difference between the hit rate (H) and the false alarm rate (F).