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Supplementary material

Predicting wildfire spread and behaviour in Mediterranean landscapes

Michele Salis[A,B,I], *Bachisio Arca*[C], *Fermin Alcasena*[D], *Margarita Arianoutsou*[E], *Valentina Bacciu*[B], *Pierpaolo Duce*[C], *Beatriz Duguy*[F], *Nikos Koutsias*[G], *Giorgos Mallinis*[E], *Ioannis Mitsopoulos*[E], *José M. Moreno*[H], *José Ramón Pérez*[H], *Itziar R. Urbieta*[H], *Fotios Xystrakis*[G], *Gonzalo Zavala*[H] *and Donatella Spano*[A,B]

[A]University of Sassari, Department of Science for Nature and Environmental Resources (DIPNET), Via Enrico De Nicola 9, 07100, Sassari, Italy.

[B]Euro-Mediterranean Center on Climate Change (CMCC), Impacts on Agriculture, Forests and Ecosystem Services (IAFES) Division, Via De Nicola 9, 07100, Sassari, Italy.

[C]National Research Council (CNR), Institute of Biometeorology (IBIMET), Traversa La Crucca 3, 07100, Sassari, Italy.

[D]University of Lleida, Agriculture and Forest Engineering Department (EAGROF), Alcalde Rovira Roure 191, 25198, Lleida, Spain.

[E]University of Athens, School of Sciences, Faculty of Biology, Department of Ecology and Systematics, Panepistimiopolis, 15784, Athens, Greece.

[F]University of Barcelona, Department of Evolutionary Biology, Ecology and Environmental Sciences, Avinguda Diagonal 643, 08028, Barcelona, Spain.

[G]University of Patras, Department of Environmental and Natural Resources Management, G. Seferi 2, 30100, Agrinio, Greece.

[H]University of Castilla–La Mancha, Department of Environmental Sciences, Avenida Carlos III, 45071, Toledo, Spain.

[I]Corresponding author. Email: miksalis@uniss.it

Table S1. Weather conditions observed during the day of the fire ignition, for all case studies. The weather data were obtained from the weather stations closest to the fire events

Case Study	Tmin (°C)	Tmax (°C)	RH min (%)	RH max (%)	Average Wind Speed (km h^{-1})	Main Wind Direction
Alexandroupoli	21	34	17	64	18	NE
Attica	25	30	29	42	33	NE
Budoni	22	28	29	61	35	WNW
Collado	16	29	24	70	7	SW
Fresnedoso de Ibor	15	26	31	85	5	WSW
Hurdes	11	36	9	80	4	SSW
Lochiri	21	41	19	91	30	SW
Monte Doglia	11	22	41	84	30	WNW
Navalmoral	21	38	20	57	5	SSE
Nuoro	21	41	12	83	35	SW
Penteli	22	28	32	55	19	NE
Vall de Gallinera	23	38	32	81	13	NE-E

Table S2. Overview of fuel types, main species and fuel model codes used for the custom and standard fuel model simulations of FARSITE, for each case study

CASE STUDY	FUEL TYPE	MAIN SPECIES	CUSTOM FUEL MODEL	STANDARD FUEL MODEL
Alexandroupoli	Dense shrublands	*Quercus coccifera L., Pistacia lentiscus L.*	CMA1	SH7
	Very low seasonal shrubs	*Quercus coccifera L., Pistacia lentiscus L.*	CMA2	SH5
	Grasslands		CMA3	GR1
	Agricultural areas		CMA4	GR4
*Attica**	Grasslands		FM1	FM1
	Pinus halepensis stands without shrub layer	*Pinus halepensis Mill.*	FM3	FM3
	Quercus coccifera maquis and Pinus halepensis stands	*Quercus coccifera L. and Pinus halepensis Mill.*	FM4	FM4
	Juniperus spp. shrublands	*Juniperus spp.*	FM5	FM5
	Pinus stands with moderate dense Quercus shrubs	*Pinus halepensis Mill. and Quercus coccifera L.*	FM6	FM6
	Pinus stands with tall and dense Quercus shrubs	*Pinus halepensis Mill. and Quercus coccifera L.*	FM7	FM7
	Agricultural areas	*Permanent crops*	GS2	FM2
Budoni	Grasslands		FM1	FM1
	Low load maquis	*Cistus monspeliensis L., Calycotome spinosa L.*	CMB1	SH2
	High load maquis	*Olea europea L. var. oleaster, Pistacia lentiscus L., Myrtus communis L.*	CMB2	SH7
Collado	Agrostis grasslands	*Agrostis castellana Boiss. & Reut.*	FM1	FM1
	Holcus grasslands	*Holcus lanatus L.*	FM2	FM2
	High Cytisus scoparius shrubs	*Cytisus scoparius L.*	FM4	FM4
	High Cytisus multiflorus shrubs	*Cytisus multiflorus (L'Hér.) Sweet*	CME5	FM5
	Medium heigth Cytisus scoparius shrubs	*Cytisus scoparius L.*	FM6	FM6
	Medium heigth Cytisus multiflorus shrubs	*Cytisus multiflorus (L'Hér.) Sweet*	FM7	FM7
	High load Pinus unnderstory	*Pinus pinaster Aiton*	FM9	FM9
Fresnedoso de Ibor	Holcus grasslands	*Holcus lanatus L.*	FM2	FM2
	High Cistus ladanifer shrubs	*Cistus ladanifer L.*	FM4	FM4
	High Cytisus multiflorus shrubs	*Cytisus multiflorus (L'Hér.) Sweet*	CME5	FM5
	Medium heigth Cistus ladanifer shrubs	*Cistus ladanifer L.*	FM6	FM6
	Quercus shrubs	*Quercus ilex L. and Quercus suber L.*	FM7	FM7
	Low load Pinus understory	*Pinus pinaster Aiton*	FM8	FM8

Hurdes	High Cytisus scoparius shrubs	*Cytisus scoparius L.*	FM4	FM4
	High Cytisus multiflorus shrubs	*Cytisus multiflorus (L'Hér.) Sweet*	CME5	FM5
	Medium heigth Cytisus scoparius shrubs	*Cytisus scoparius L.*	FM6	FM6
	Low load Pinus understory	*Pinus pinaster Aiton*	FM8	FM8
	High load Pinus unnderstory	*Pinus pinaster Aiton*	FM9	FM9
Lochiri	Open pastures		CMS1	FM2
	Garrigue	*Cistus spp., Myrtus communis L.*	CMS2	SH2
	Med. maquis	*Olea europea L. var. oleaster, Pistacia lentiscus L., Cistus spp.*	CMS3	FM4
	Grasslands		CMS4G	FM1
	Orchards		CMS4O	FM1
	Pinus stands	*Pinus radiata L.*	CMS5	FM7
	Broadleaf	*Quercus suber L., Quercus ilex L.*	CMS6B	FM7
Monte Doglia	High and close maquis	*Pistacia lentiscus L., Myrtus communis L., Rosmarinus officinalis L., Cistus monspeliensis L.*	CMM1	SH7
	Medium height and open maquis	*Calycotome spinosa L., Chamaerops humilis L.*	CMM2	SH2
Navalmoral	Agrostis grasslands	*Agrostis castellana Boiss. & Reut.*	FM1	FM1
	Holcus grasslands	*Holcus lanatus L.*	FM2	FM2
	Cytisus multiflorus shrubs	*Cytisus multiflorus (L'Hér.) Sweet*	CME5	FM5
Nuoro	Open pastures		CMS1	FM2
	Garrigue	*Cistus spp., Myrtus communis L.*	CMS2	SH2
	Med. maquis	*Olea europea L. var. oleaster, Pistacia lentiscus L., Cistus spp.*	CMS3	FM4
	Grasslands		CMS4G	FM1
	Orchards		CMS4O	FM1
	Pinus stands	*Pinus halepensis Mill.*	CM_SAR5	FM7
	Broadleaf	*Quercus suber L., Quercus ilex L.*	CMS6B	FM7
	Mixed woods	*Quercus suber L., Quercus ilex L., Pinus spp.*	CMS6W	FM7
Penteli	Dense shrublands	*Quercus coccifera L., Pistacia lentiscus L.*	CMP1	SH7
	Sparse shrublands	*Quercus coccifera L., Pistacia lentiscus L.*	CMP2	SH5
	Understory of Pinus stands	*Pinus halepensis Mill., Quercus coccifera L.*	CMP3	TU5
	Grasslands		CMP4	GR1
Vall de Gallinera	Agricultural areas with significant natural vegetation	*Ulex parviflorus Pourr, Cistus monspeliensis L., Cistus albidus L., Rosmarinus officinalis L., Erica multiflora L., Brachypodium retusum (Pers.) P.Beauv.*	GS1	GS1
	Irrigated agricultural areas and fruit trees		GR1	GR1
	Shrublands with sparse trees (Pinus and Quercus)	*Ulex parviflorus Pourr, Cistus monspeliensis L., Cistus albidus L., Rosmarinus officinalis L., Erica multiflora L.; sparse Pinus halepensis Mill., sparse Quercus ilex L. subsp. ballota*	SH5	SH5
	Low density shrublands	*Ulex parviflorus Pourr, Cistus monspeliensis L., Cistus albidus L., Rosmarinus*	CMV1	SH2

	officinalis L., Erica multiflora L., Brachypodium retusum (Pers.) P.Beauv.		
Dense shrublands	*Ulex parviflorus Pourr, Cistus monspeliensis L., Cistus albidus L., Rosmarinus officinalis L., Erica multiflora L., Brachypodium retusum (Pers.) P.Beauv.*	CMV2	SH7

*The custom fuel model simulation differs from the standard one only for the use of GS2 vs. FM2 for agricultural areas.

Table S3. Overview of the fuel models used for the custom fuel simulations

FD = fuel depth (m); DFL = dead (1, 10 and 100 h) fuel load (Mg ha^{-1}); LFL = live fuel load (Mg ha^{-1}); SAVD = surface area to volume ration of dead fuel (m^{-1}); SAVL = surface area to volume ratio of live fuel (m^{-1}); DHC = dead fuel heat content (kJ kg^{-1}); LHC = live fuel heat content (kJ kg^{-1}); DFM = dead 1h fuel moisture (%); LFM = live fuel moisture (%); ME = moisture of extinction (%)

Case Study	Fuel Model	FD	DFL	LFL	SAVD	SAVL	DHC	LHC	DFM	LFM	ME
Alexandroupoli	CMA1	2.0	15.11	7.60	1656	4141	18000	20000	12	110	35
	CMA2	1.0	7.91	3.31	1656	4141	18000	20000	12	110	35
	CMA3	0.3	3.92	4.10	1115	2446	18000	19000	35	120	20
	CMA4	0.2	2.41	0.89	1115	2446	18000	19000	35	130	25
Attica	FM1	0.5	1.83	0.00	11400	5900	18600	18600	3	0	11
	FM3	0.8	7.44	0.00	4900	5900	18600	18600	3	75	25
	FM4	3.0	27.23	12.38	6500	4900	18600	18600	3	75	20
	FM5	1.0	3.71	4.94	6500	4900	18600	18600	3	100	20
	FM6	3.0	14.83	0.00	5700	4900	18600	18600	3	100	25
	FM7	3.0	11.12	0.91	5000	4900	18600	18600	3	75	40
	GS2	0.5	2.47	3.95	6500	5900	18600	18600	3	75	14
Budoni	FM1	0.3	1.83	0.00	11400	5900	18620	18620	5	0	20
	CMB1	0.5	6.39	2.05	2000	4500	18620	18620	8	70	35
	CMB2	1.8	16.60	12.08	2400	5700	18620	18620	8	70	35
Collado	FM1	0.3	1.83	0.00	11400	5900	18620	18620	5	0	20
	FM2	0.3	8.65	1.24	9800	4900	18620	18620	5	100	15
	FM4	2.0	27.23	12.38	2023	5214	20756	20203	8	85	20
	CME5	1.5	19.80	4.94	2023	5214	20756	20203	8	85	20
	FM6	1.2	14.83	0.00	2023	5214	20756	20203	8	85	25
	FM7	0.8	11.12	0.91	2023	5214	20756	20203	8	85	40
	FM8	0.1	12.36	0.00	6562	5249	18608	18594	4	75	30

	FM9	0.1	17.76	0.00	5905	4593	18608	18594	3	50	25
Fresnedoso de Ibor	FM1	0.3	1.83	0.00	11400	5900	18620	18620	5	0	20
	FM2	0.3	8.65	1.24	9800	4900	18620	18620	5	100	15
	FM4	2.0	27.23	12.38	2023	5214	20756	20203	8	85	20
	CME5	1.5	19.80	4.94	2023	5214	20756	20203	8	85	20
	FM6	1.2	14.83	0.00	2023	5214	20756	20203	8	85	25
	FM7	0.8	11.12	0.91	2023	5214	20756	20203	8	85	40
	FM8	0.1	12.36	0.00	6562	5249	18608	18594	4	75	30
	FM9	0.1	17.76	0.00	5905	4593	18608	18594	3	50	25
Hurdes	FM1	0.3	1.83	0.00	11400	5900	18620	18620	5	0	20
	FM4	2.0	27.23	12.38	2023	5214	20756	20203	8	85	20
	CME5	1.5	19.80	4.94	2023	5214	20756	20203	8	85	20
	FM6	1.2	14.83	0.00	2023	5214	20756	20203	8	85	25
	FM7	0.8	11.12	0.91	2023	5214	20756	20203	8	85	40
	FM8	0.1	12.36	0.00	6562	5249	18608	18594	4	75	30
	FM9	0.1	17.76	0.00	5905	4593	18608	18594	3	50	25
Lochiri	CMS1	0.7	2.00	0.00	6700	0	18600	18600	7	0	20
	CMS2	1.0	7.00	6.00	2200	4700	18600	18600	9	70	25
	CMS3	2.0	15.00	12.50	2200	4700	18600	18600	9	70	25
	CMS4G	0.3	1.00	0.00	6700	0	18600	18600	7	0	20
	CMS4O	0.2	1.00	0.00	6700	0	18600	18600	9	0	20
	CMS5	0.5	10.00	1.00	5200	4700	18600	18600	9	85	25
	CMS6	0.5	12.00	2.00	2200	4700	18600	18600	9	85	25
Monte Doglia	CMM1	1.7	18.18	12.76	2400	5500	18000	20000	12	110	35
	CMM2	0.8	14.54	10.48	2400	5500	18000	20000	12	110	35
Navalmoral	FM1	0.3	1.83	0.00	11400	5900	18620	18620	5	0	20
	FM2	0.3	8.65	1.24	9800	4900	18620	18620	5	100	15

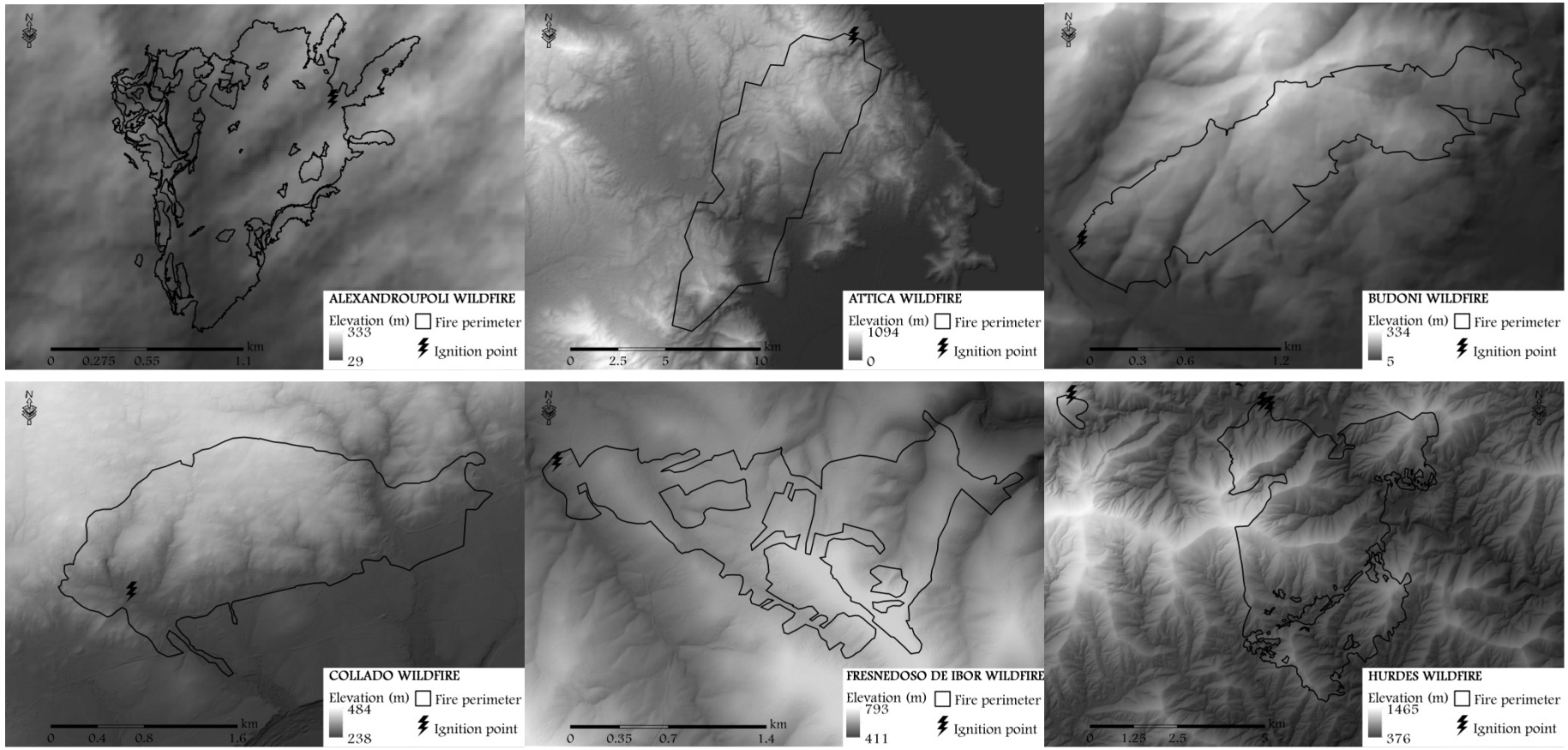
	CME5	1.5	19.80	4.94	2023	5214	20756	20203	8	85	20
Nuoro	CMS1	0.7	2.00	0.00	6700	0	18600	18600	7	0	20
	CMS2	1.0	7.00	6.00	2200	4700	18600	18600	9	70	25
	CMS3	2.0	15.00	12.50	2200	4700	18600	18600	9	70	25
	CMS4G	0.3	1.00	0.00	6700	0	18600	18600	7	0	20
	CMS4O	0.2	1.00	0.00	6700	0	18600	18600	9	0	20
	CMS5	0.5	10.00	1.00	5200	4700	18600	18600	9	85	25
	CMS6B	0.5	12.00	2.50	2200	4700	18600	18600	9	85	25
	CMS6W	0.5	12.00	2.00	2200	4700	18600	18600	9	85	25
Penteli	CMP1	2.0	13.81	6.60	1656	4141	18000	20000	10	90	35
	CMP2	1.0	4.31	2.31	1656	4141	18000	20000	10	90	35
	CMP3	1.5	8.15	5.10	1656	4141	18000	20000	10	90	35
	CMP4	0.3	5.51	1.89	1115	2446	18000	20000	10	110	20
Vall de Gallinera	GS1	0.3	0.49	2.84	4940	4446	18600	18600	7	100	15
	GR2	0.3	0.25	2.47	4940	4446	18600	18600	7	100	15
	SH5	1.8	14.08	7.17	1853	3952	18600	18600	7	100	15
	CMV1	0.6	3.12	2.88	6500	5000	18600	18600	7	100	15
	CMV2	1.0	15.40	6.60	6500	5000	18600	18600	7	100	25

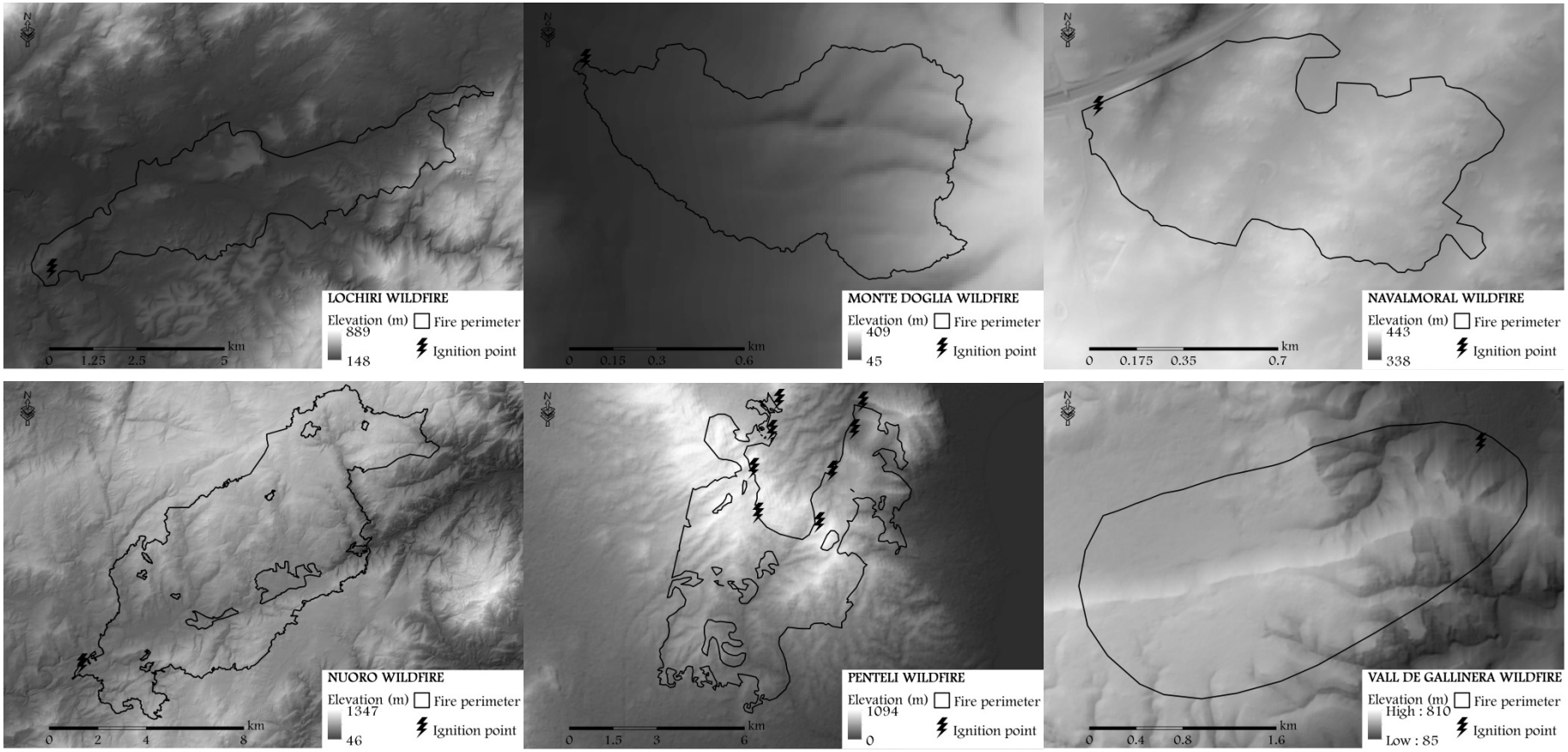
Table S4. Overview of the ground and aerial forces that participated to the wildfire suppression and assistance operations during the whole wildfire event, for each case study. The data were provided by the local fire management agencies

Case Study	Fire Size (ha)	Number of Firefighters and Volunteers	Number of Ground Vehicles	Number of Airplanes	Number of Helicopters
Alexandroupoli	124	40	15	5	1
Attica	7040	406	120	12	8
Budoni	141	149	17	2	2
Collado	373	45	4	2	4
Fresnedoso de Ibor	201	90	16	2	7
Hurdes	3092	>500	24	8	15
Lochiri	2520	283	22	4	3
Monte Doglia	70	61	14	1	2
Navalmoral	86	55	6	0	3
Nuoro	7460	344	67	9	7
Penteli	3720	406	120	12	8
Vall de Gallinera	591	NA	NA	NA	NA

Fig. S1. Photos of the shrubland types for which we used custom fuel models in this work (from left to right, and from top to bottom, respectively: Alexandropouli: CMA1 and CMA2; Budoni: CMB2 and CMB1; Lochiri and Nuoro: CMS3 and CMS2; Monte Doglia: CMM1 and CMM2; Penteli: CMP1 and CMP2; Val de Gallinera: CMV2 and CMV1; Collado, Fresnedoso de Ibor, Hurdes and Navalmoral: CME5).

Fig. S2. Maps of the terrain elevation of the study areas, along with the observed fire perimeters and ignition point(s) location (from left to right, and from top to bottom, respectively: Alexandropouli, Attica, Budoni, Collado, Fresnedoso de Ibor, Hurdes, Lochiri, Monte Doglia, Navalmoral, Nuoro, Penteli, Val de Gallinera).




LOCHIRI WILDFIRE
Elevation (m)
889
148
Fire perimeter
Ignition point
km
0 1.25 2.5 5
MONTE DOGLIA WILDFIRE
Elevation (m)
409
45
Fire perimeter
Ignition point
km
0 0.15 0.3 0.6
NAVALMORAL WILDFIRE
Elevation (m)
443
338
Fire perimeter
Ignition point
km
0 0.175 0.35 0.7
NUORO WILDFIRE
Elevation (m)
1347
46
Fire perimeter
Ignition point
km
0 2 4 8
PENTELI WILDFIRE
Elevation (m)
1094
0
Fire perimeter
Ignition point
km
0 1.5 3 6
VALL DE GALLINERA WILDFIRE
Elevation (m)
High : 810
Low : 85
Fire perimeter
Ignition point
km
0 0.4 0.8 1.6