Empirical models for spatio-temporal live fuel moisture content estimation in mixed Mediterranean vegetation areas using Sentinel-2 indices and meteorological data

José M. Costa-Saura, Ángel Balaguer-Beser*, Luis A. Ruiz, Josep E. Pardo-Pascual and José L. Soriano-Sancho
*Correspondence: abalague@mat.upv.es

SUPPLEMENTARY MATERIAL

Figure S1: Forest area burned (total area in ha) in the province of Valencia (Spain) in each month of the year during the period 1986-2015.

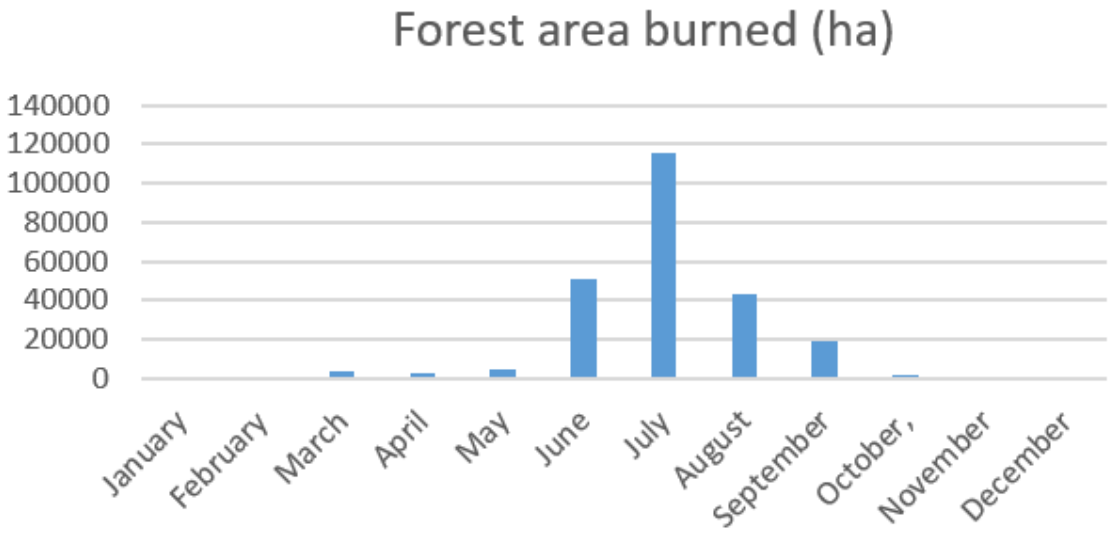

Figure S2: Comparison between the time series of LFMC_WAS (left axis) and NDMI (right axis) in plot number 7. The NDMI_filter values were obtained after using the Savitzky-Golay filter.

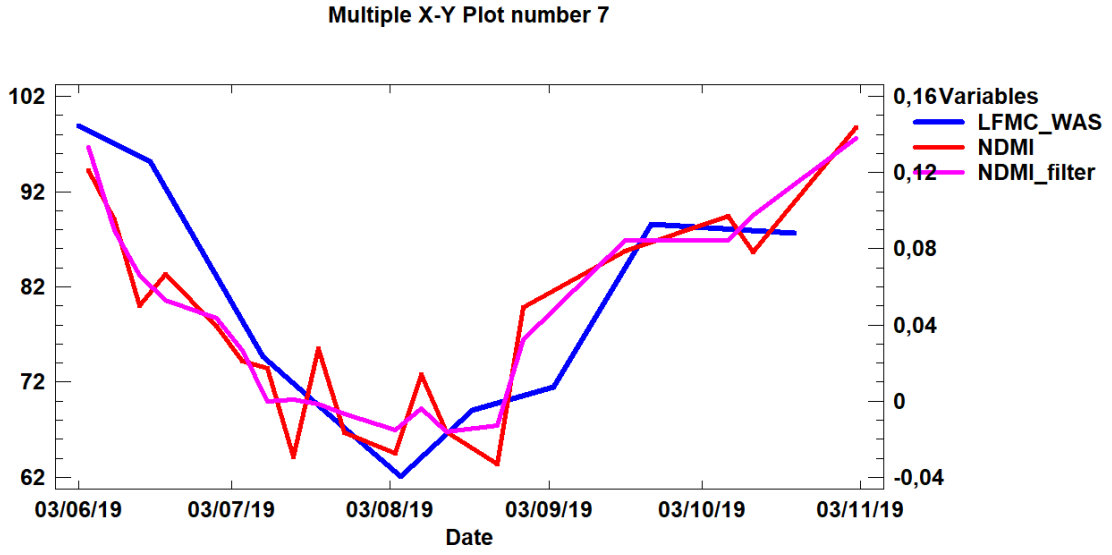

Figure S3: Plot of LFMC_WAS versus the date of data collection in plots of zones F and G.

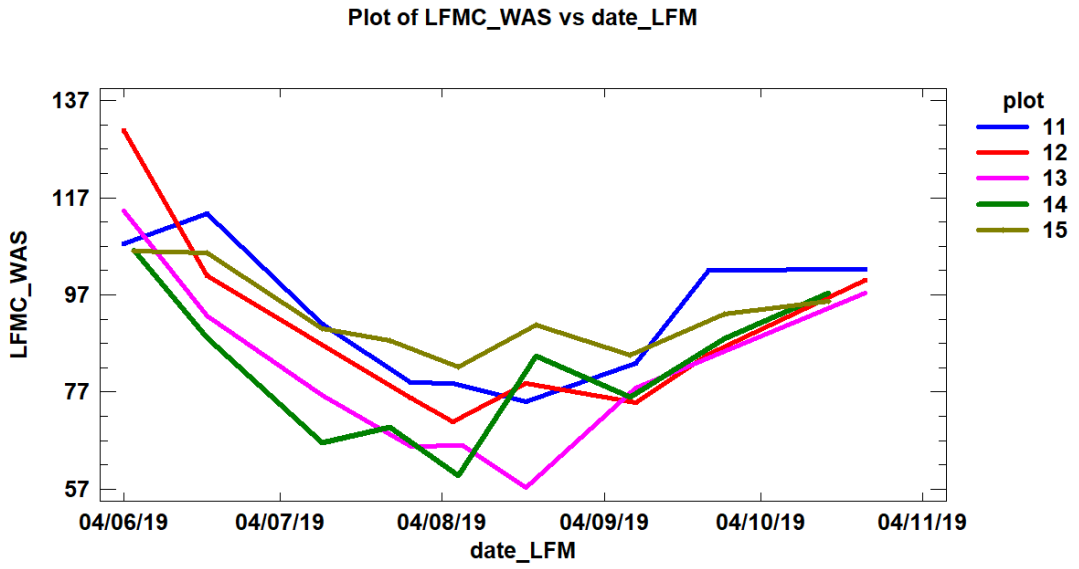

Table S1: Individual site regressions between LFMC_WAS and NDMI: coefficients of each regression model ($LFMC\_WAS_{ij} = \alpha_j + \beta_j$ SI_{ij}) P-values of those coefficients, R^2, RMSE and MAE.

Plot Number	Coefficients of the regression model	P-Values	R^2	RMSE	MAE
1	$\alpha_1 = 81.64, \beta_1 = 174.53$	<0.0000, 0.0202	0.56	6.92%	5.23%
2	$\alpha_2 = 84.29, \beta_2 = 256.14$	<0.0000, 0.0117	0.62	9.06%	7.04%
3	$\alpha_3 = 94.32, \beta_3 = 250.64$	<0.0000, 0.1107	0.32	16.39%	13.04%
4	$\alpha_4 = 87.30, \beta_4 = 302.91$	<0.0000, 0.0186	0.57	12.58%	9.67%
5	$\alpha_5 = 81.64, \beta_5 = 308.41$	<0.0000, 0.1327	0.29	10.82%	7.99%
6	$\alpha_6 = 81.03, \beta_6 = 190.85$	<0.0000, 0.0093	0.64	9.84%	7.51%
7	$\alpha_7 = 70.21, \beta_7 = 220.82$	<0.0000, 0.0004	0.85	5.48%	3.82%
8	$\alpha_8 = 86.58, \beta_8 = 172.74$	<0.0000, 0.0283	0.52	7.83%	5.54%
9	$\alpha_9 = 81.08, \beta_9 = 304.81$	<0.0000, 0.0056	0.69	8.85%	6.87%
10	$\alpha_{10} = 71.80, \beta_{10} = 161.50$	<0.0000, 0.0042	0.71	6.38%	4.76%
11	$\alpha_{11} = 93.57, \beta_{11} = 308.31$	<0.0000, 0.0020	0.77	7.39%	4.69%
12	$\alpha_{12} = 62.01, \beta_{12} = 590.98$	<0.0000, 0.0090	0.71	11.81%	8.01%
13	$\alpha_{13} = 88.52, \beta_{13} = 290.67$	<0.0000, 0.0187	0.57	12.58%	8.52%
14	$\alpha_{14} = 51.73, \beta_{14} = 330.58$	<0.0030, 0.0297	0.51	11.25%	9.04%
15	$\alpha_{15} = 67.86, \beta_{15} = 125.61$	<0.0165, 0.2827	0.16	8.26%	5.62%

Figure S4: Scatterplot between LFMC_WAS and P60 considering all dates and plots.

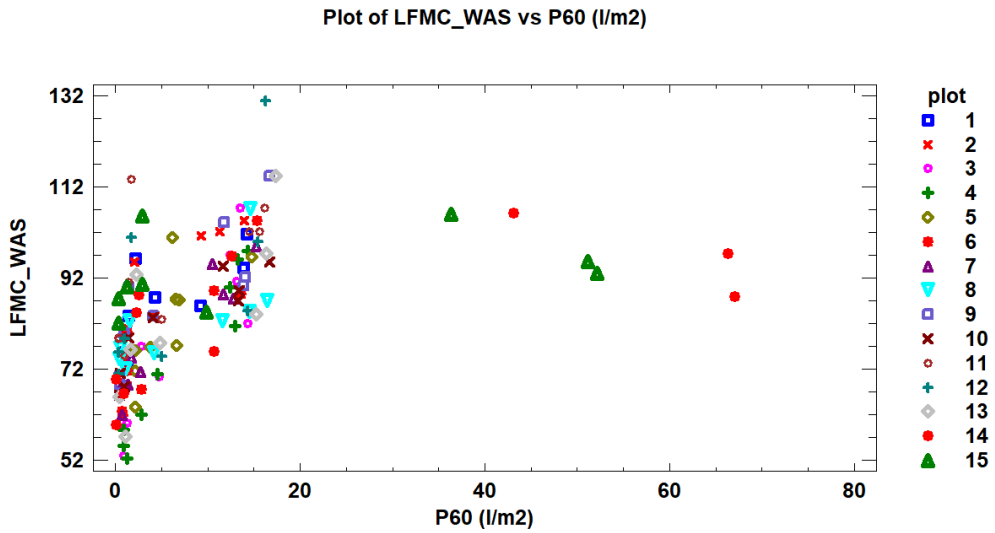

Figure S5: Box plot of W7 (Km/h) values.

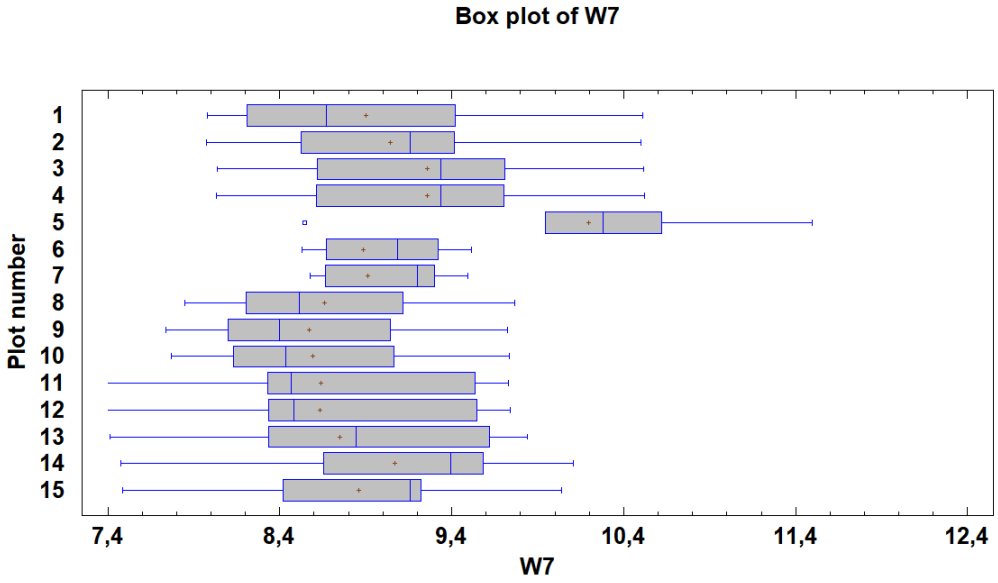

Table S2: Pearson correlation coefficients between LFMC_WAS, some spectral indices and several meteorological variables considering all dates and plots. P15 (P30 and P60) is the cumulative precipitation for the last 15 days (30 and 60 days). T15 (T30 and T60) is the average of daily mean temperatures calculated in the previous 15 (30 and 60) days. RH3 (RH7 and RH15) is the average of daily minimum relative humidity calculated in the 3 (7 and 15) days prior to the date of LFMC_WAS collection in the field. W7 (W15) is the average of the mean wind speed for 10' of the maximum daily wind gusts for the previous 7 (15) days.

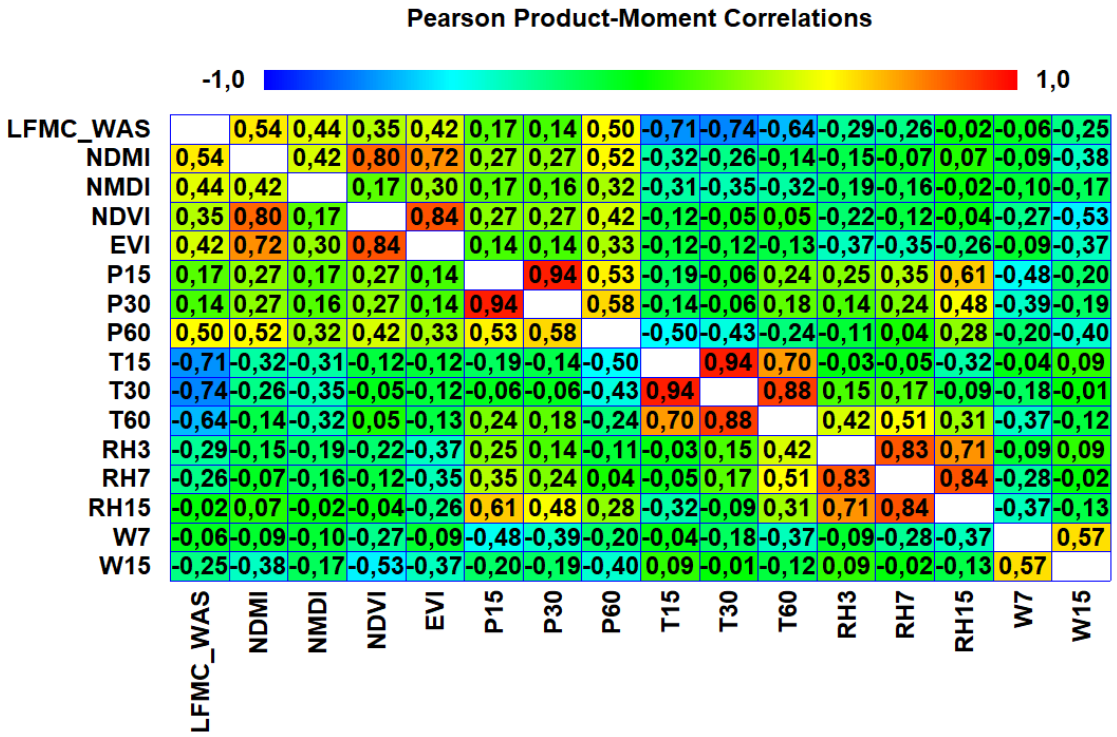

Table S3: Other empirical models fitted: formulation, P-values of each coefficient, adjusted R^2 (R^2_{adj}) , root mean square error (RMSE) and mean absolute error (MAE). $RH3_{ij}$ ($RH15_{ij}$) is the average of daily minimum relative humidity calculated in the 3 days (15 days) prior to the date of LFMC_WAS collection in the field. $P15_{ij}$ is the cumulative precipitation for the last 15 days.

Formulation	**P-values**	**R^2_{adj}**	**RMSE**	**MAE**
$LFMC\_WAS_{ij} = 162.23 + 70{,}27\ \mathrm{NDMI}_{ij} - 2.88\ \mathrm{T30}_{ij} - 0{,}21\ \mathrm{RH3}_{ij}$	<0.0000, <0.0000, <0.0000, 0.0030	0.68	8,30%	6,40%
$LFMC\_WAS_{ij} = 173{,}69 + 66{,}528\ \mathrm{NDMI}_{ij} - 3{,}05\ \mathrm{T30}_{ij} - 0{,}38\ \mathrm{RH15}_{ij} + 0{,}064\ \mathrm{P15}_{ij}$	<0.0000, <0.0000, <0.0000, 0.0015 0.0115	0.69	8.26%	6.25%

Table S4: Multiple regression models for LFMC_WAV (LFMC Weighted Average in all Vegetation species), weighted using their %FCC per plot given in table 1. The columns represent: Spatial resolution of predictors, formulation, P-values of each coefficient, adjusted R^2 (**R^2_{adj}**), root mean square error (RMSE) and mean absolute error (MAE).

Spatial Resolution of predictors	**Formulation**	**P-values**	**R^2_{adj}**	**RMSE**	**MAE**
1 Sentinel-2 pixel	$LFMC\_WAV_{ij} = 148.195 + 51.493\ \mathrm{NDMI}_{ij} - 2.61\ \mathrm{T30}_{ij}$	<0.0000, <0.0000 <0.0000	0.58	8.38%	6.22%
1 Sentinel-2 pixel	$LFMC\_WAV_{ij} = 174.815 - 74.9895\ \mathrm{Average\_NDMI}_{j} + 113.834\ \mathrm{NDMI}_{ij} - 2.317\ \mathrm{T60}_{ij} - 4.01\ \mathrm{W7}_{ij}$	<0.0000, <0.0000, 0.0007, <0.0000, <0.0000	0.66	7.55%;	5.66%

3x3 pixels	Sentinel-2	$LFMC\_WAV_{ij} = 174.639 - 92.07\ \text{Average\_NDMI}_j + 131.578\ \text{NDMI}_{ij} - 2.2742\ \text{T60}_{ij} - 4.11\ \text{W7}_{ij}$	<0.0000, <0.0000, <0.0000, <0.0000 <0.0000	0.69	7.19%;	5.34%
9x9 pixels	Sentinel-2	$LFMC\_WAV_{ij} = 176.02\ - 125.387\ \text{Average\_NDMI}_j + 144.64\ \text{NDMI}_{ij} - 2.26\ \text{T60}_{ij} - 4.25\ \text{W7}_{ij}$	<0.0000, <0.0000 <0.0000, <0.0000, <0.0000	0.66	7.53%	5.61%