Inputs for fire Risk Management

Emilio Chuvieco

Universidad de Alcalá

GOFC-GOLD Fire IT – 20-23 November 2017

Risk concepts in Natural Hazards

- Danger: probability of occurrence in a determined space and time.
- Vulnerability: "The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard" (UNISDR, 2009).
  - Value of affected resource: Value * Recovery time.

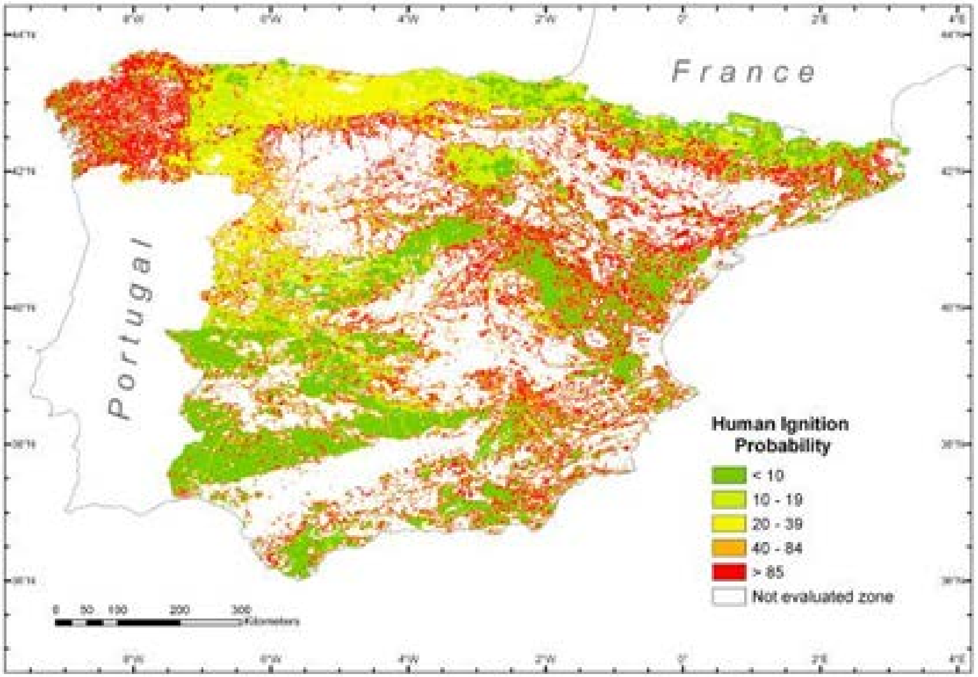
Risk = Danger * Vulnerability

Fire Risk

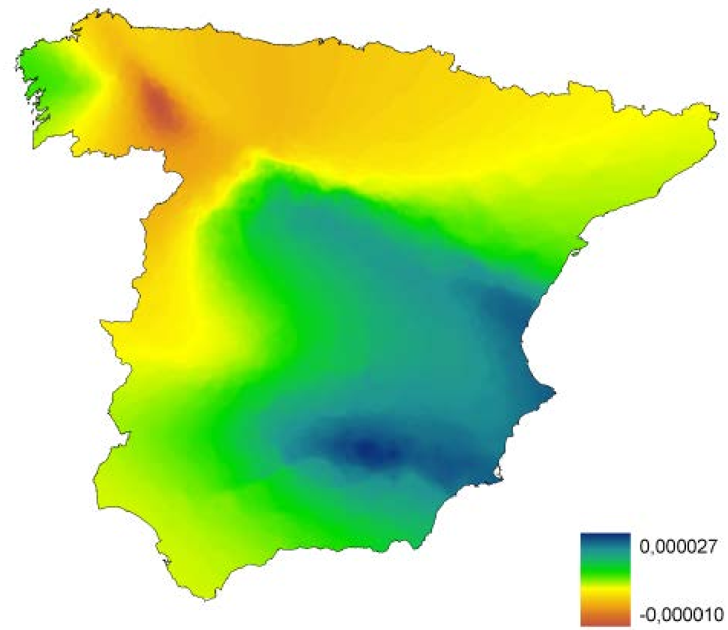
Risk = Danger * Vulnerability

- Danger:
  - Fuel load (partial)
  - FMC (dead only)
  - Wind speed-direction.
  - Slope.
  - Lightning prob.
  - FMC of live fuels.
  - Human factors.
- Vulnerability:
  - Human values
  - Ecosystem values.

Human factors of fire ignition



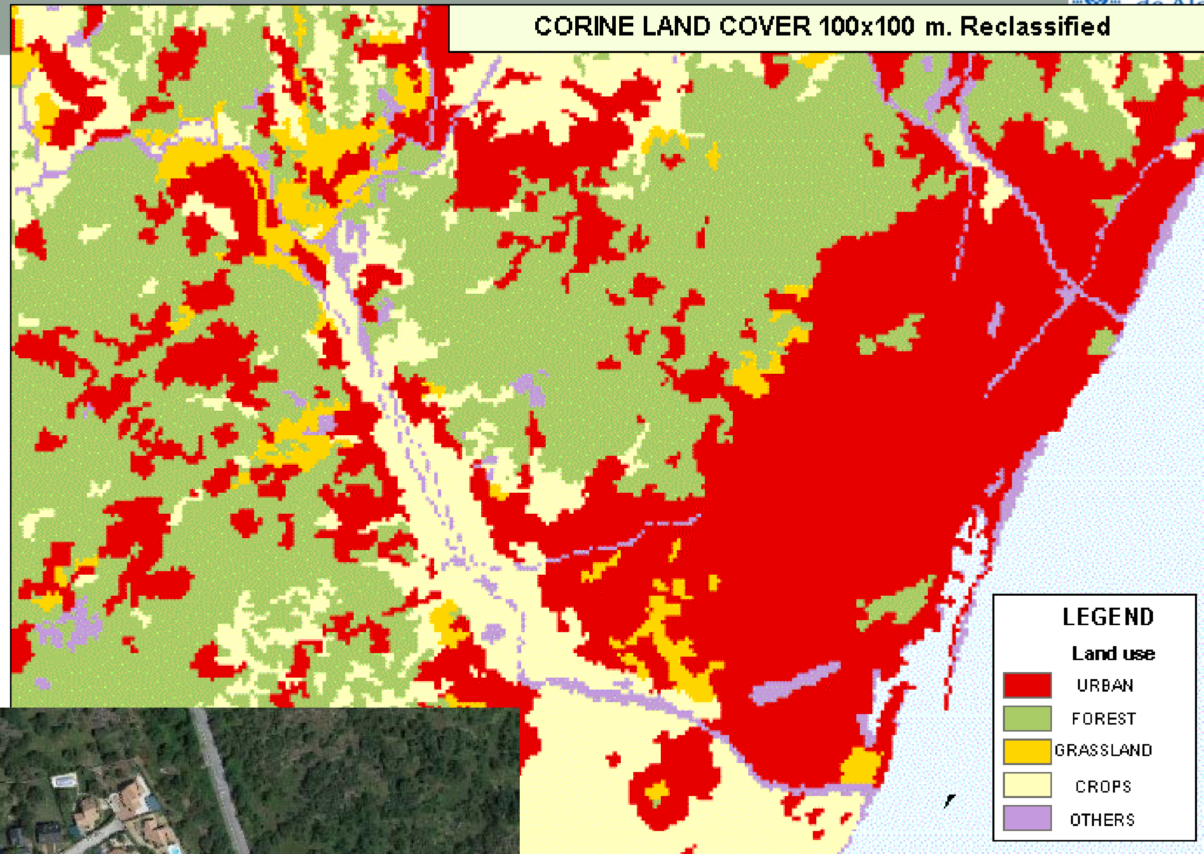
Chuvieco et al., 2014, IJWF



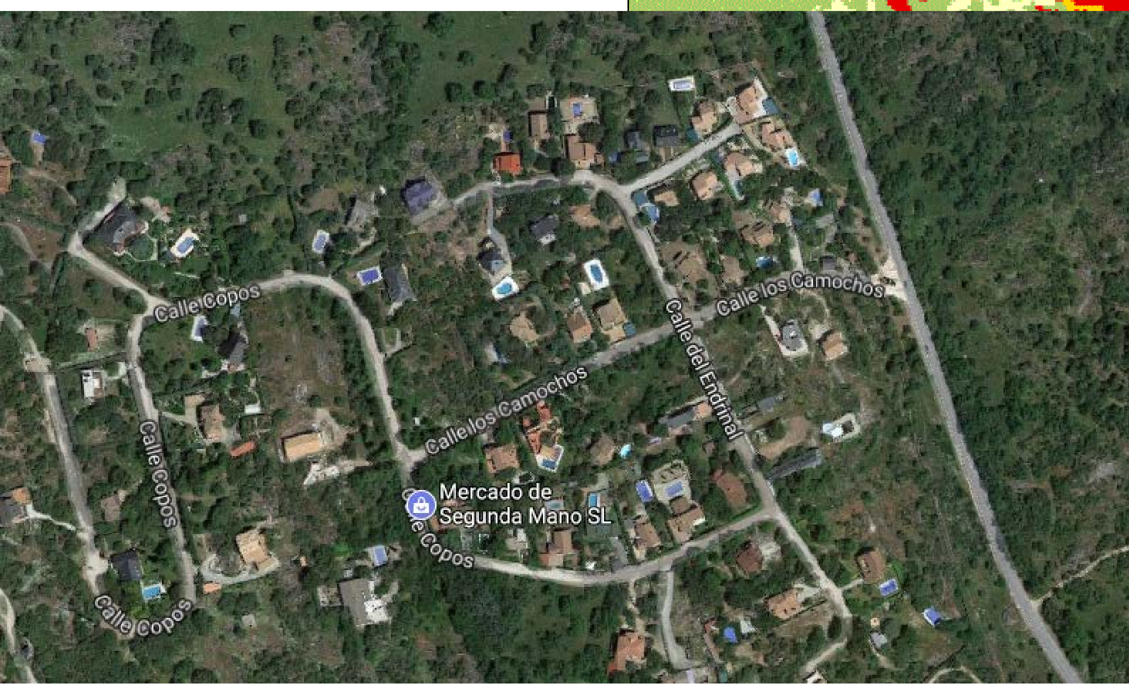
Urban-forest interface
Geographical regression

Rodrigues et al., 2014

WUI

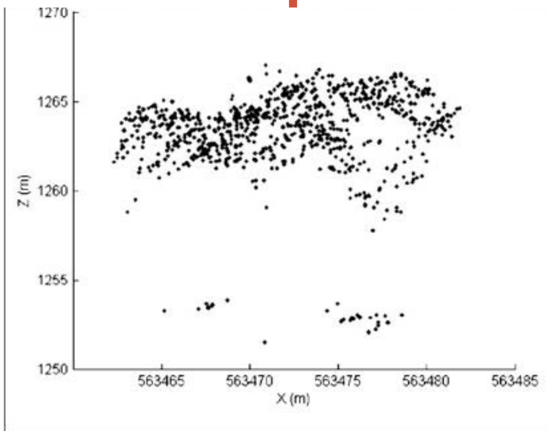


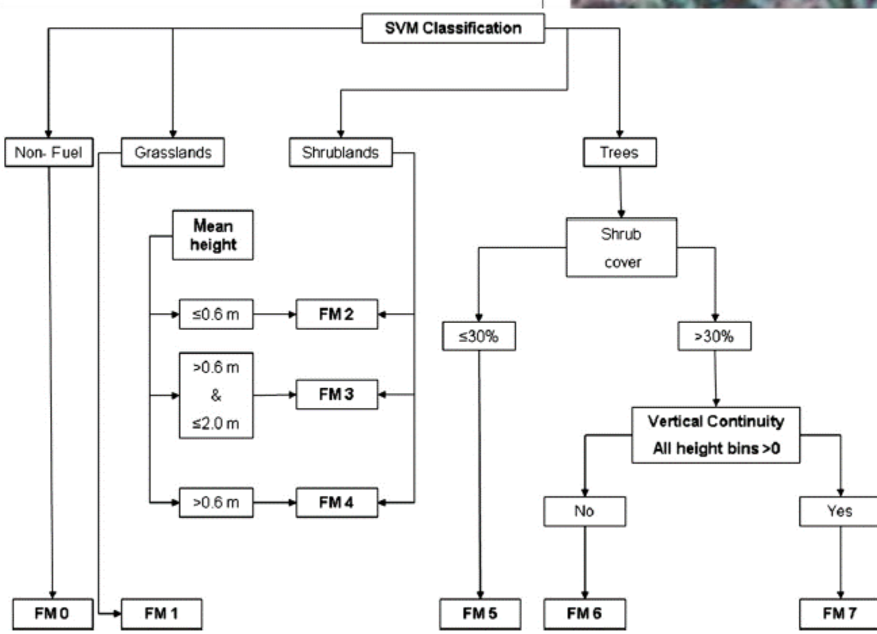
CORINE 100X100 m

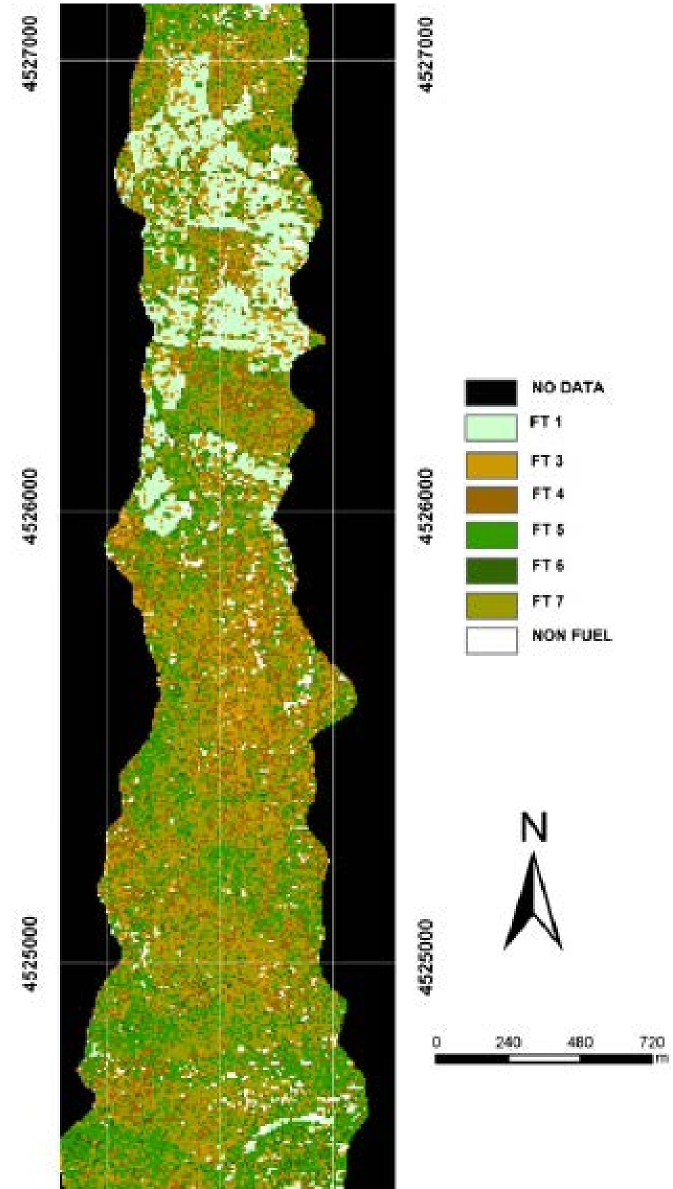


vember 2017

Fuel type mapping from the integration of active-passive sensors

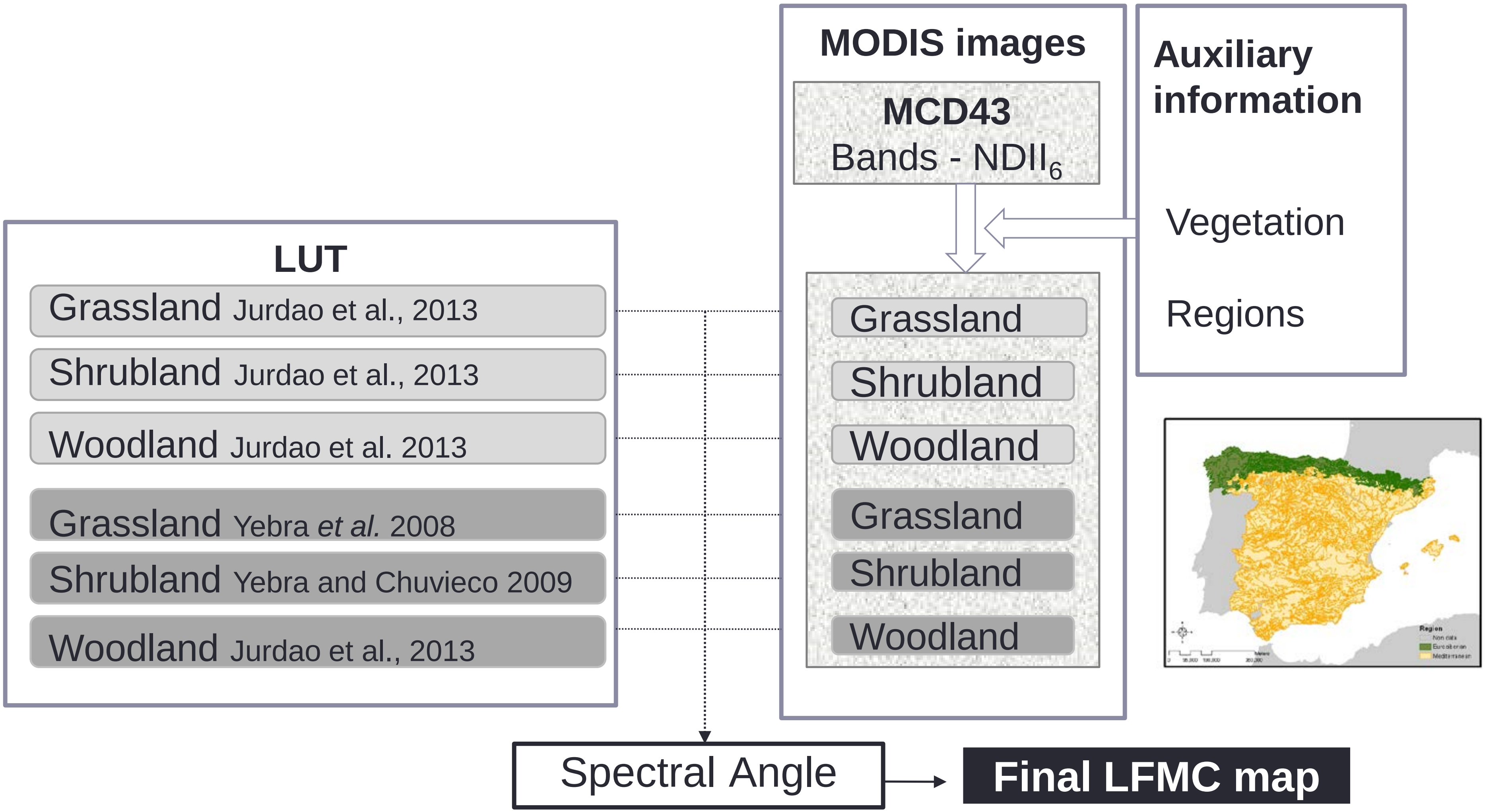




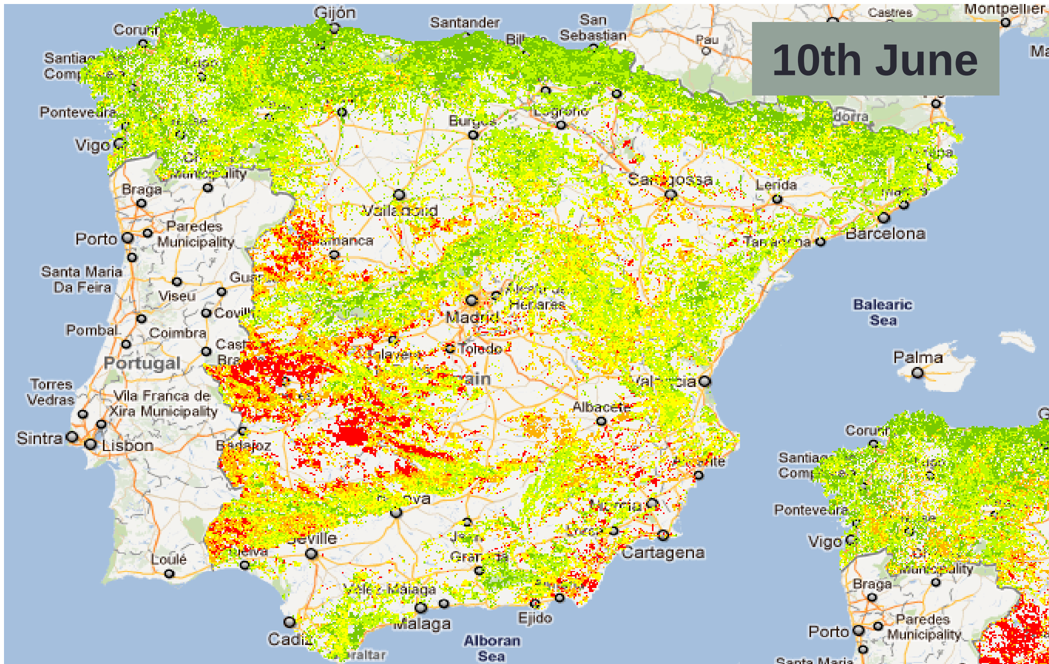


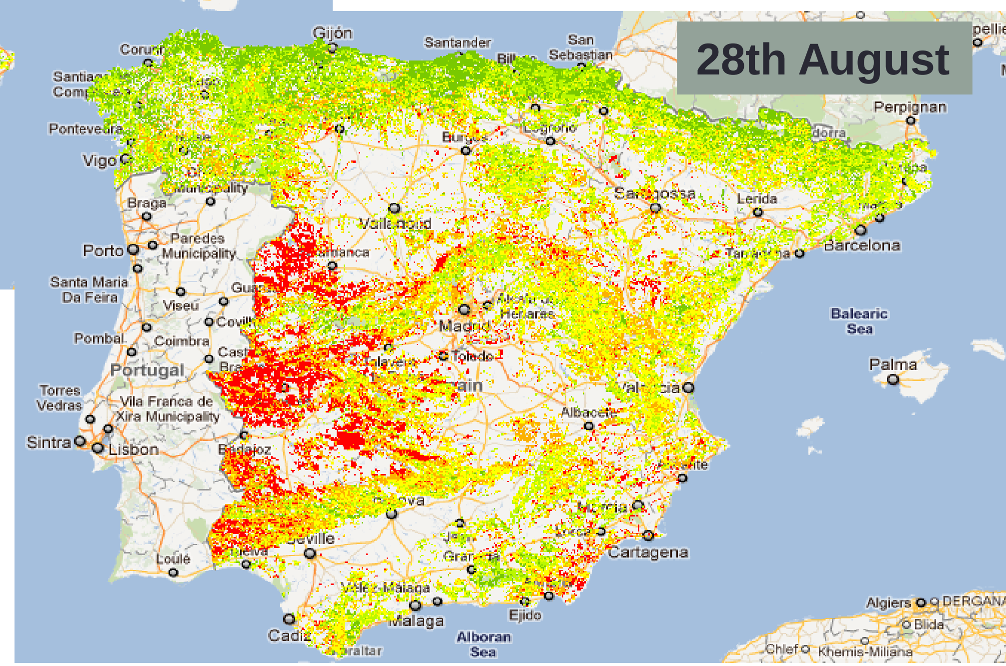
Garcia et al., 2011, RSE

Semi-operational LFMC estimation



Examples of FMC maps





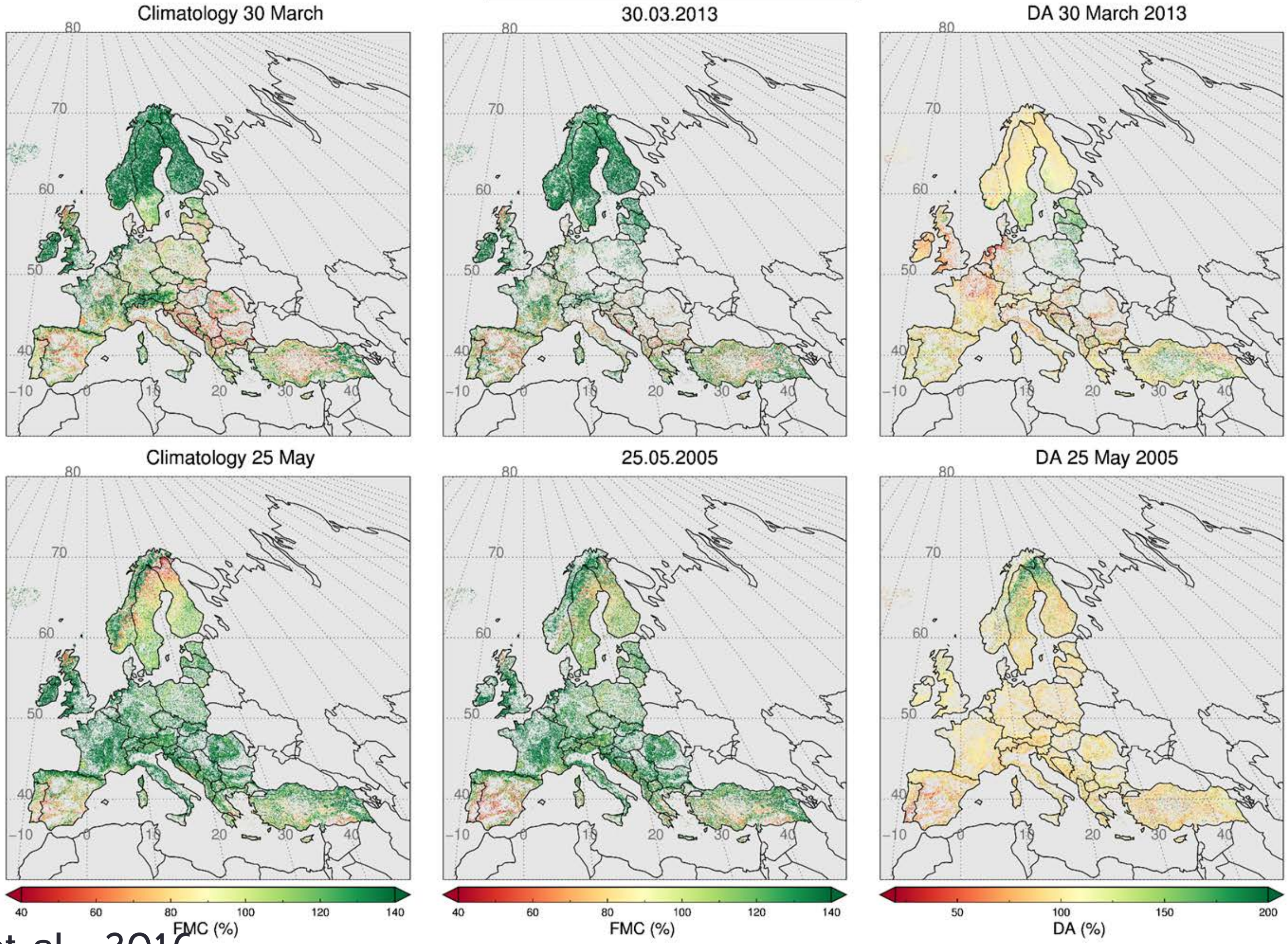
- < 35
- 35 - 70
- 71 - 105
- 106 - 140
- > 140
- Zona no evaluada

geogra.uah.es/fireglobe

LFMC estimation from MODIS RTM modelling

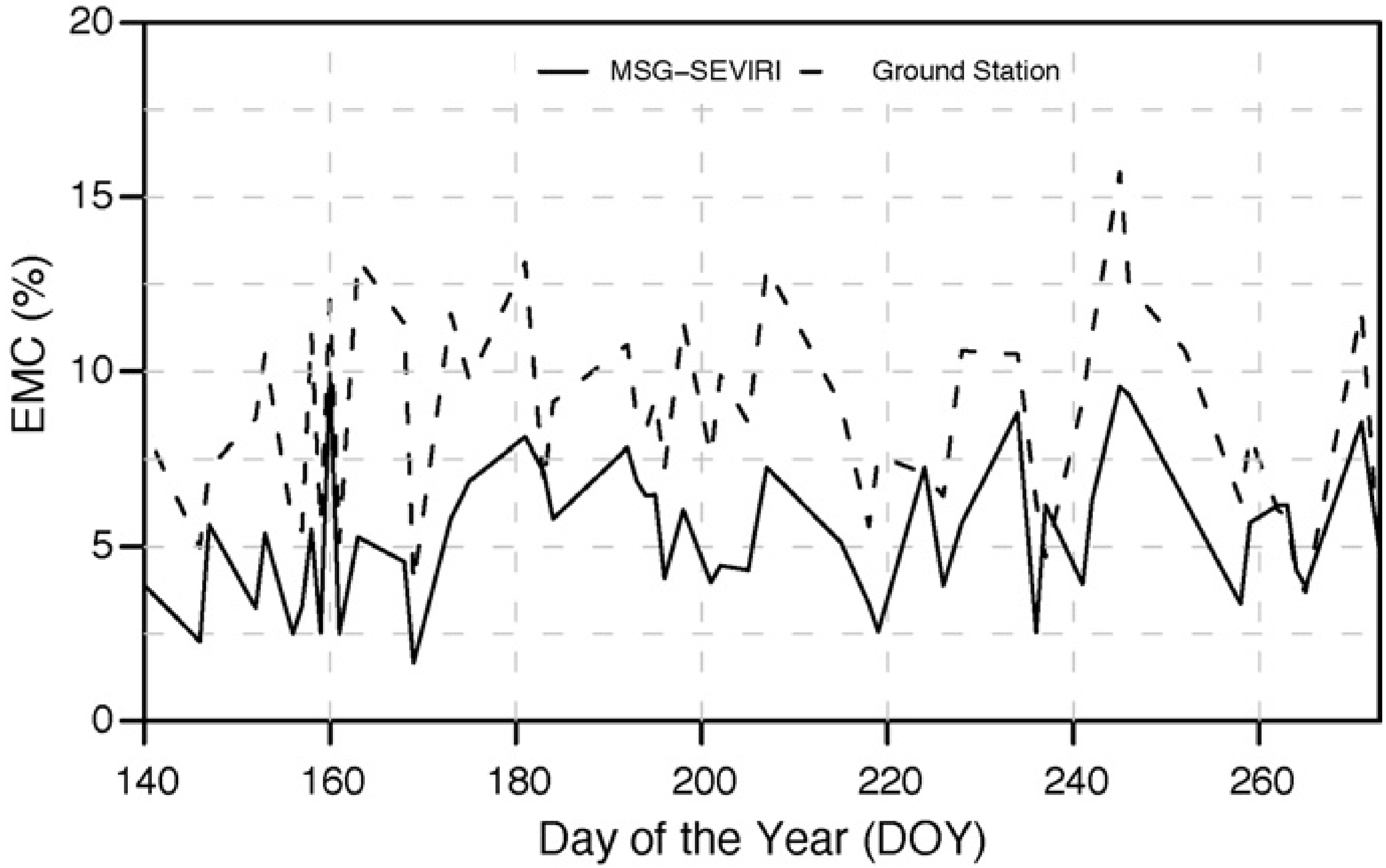
WET

DRY



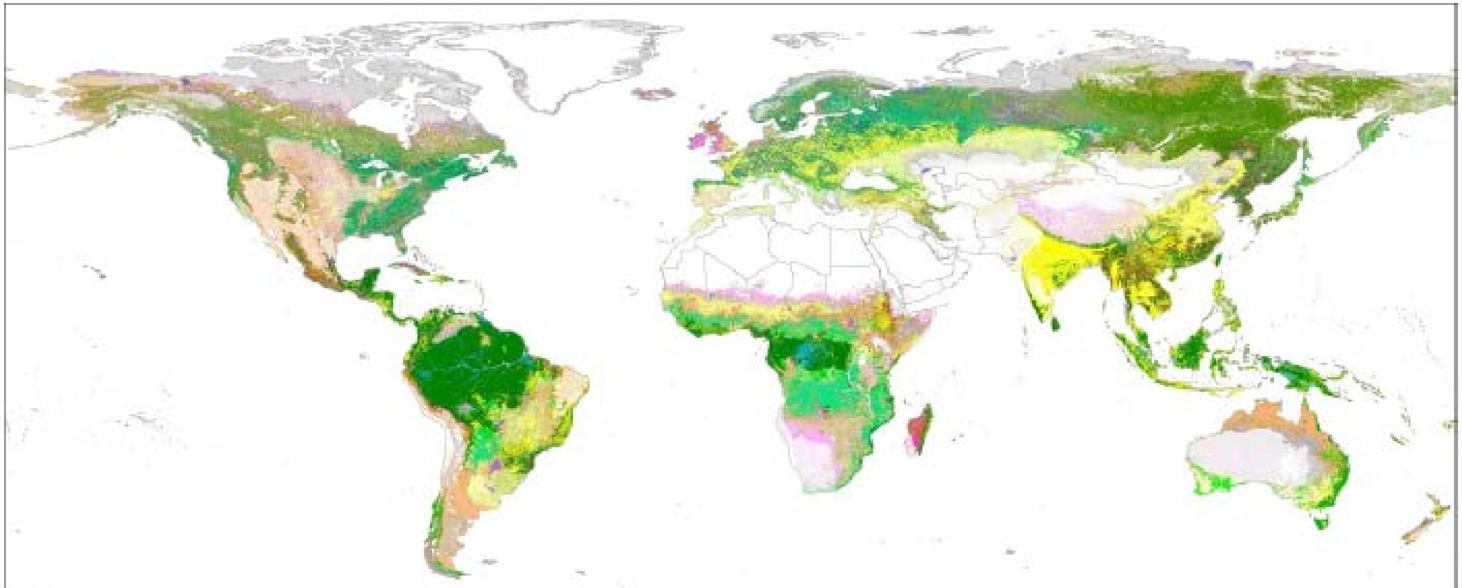
Yebra et al., 2016

Estimation of EMC from MSG Seviri



Nieto et al., 2010, AFM

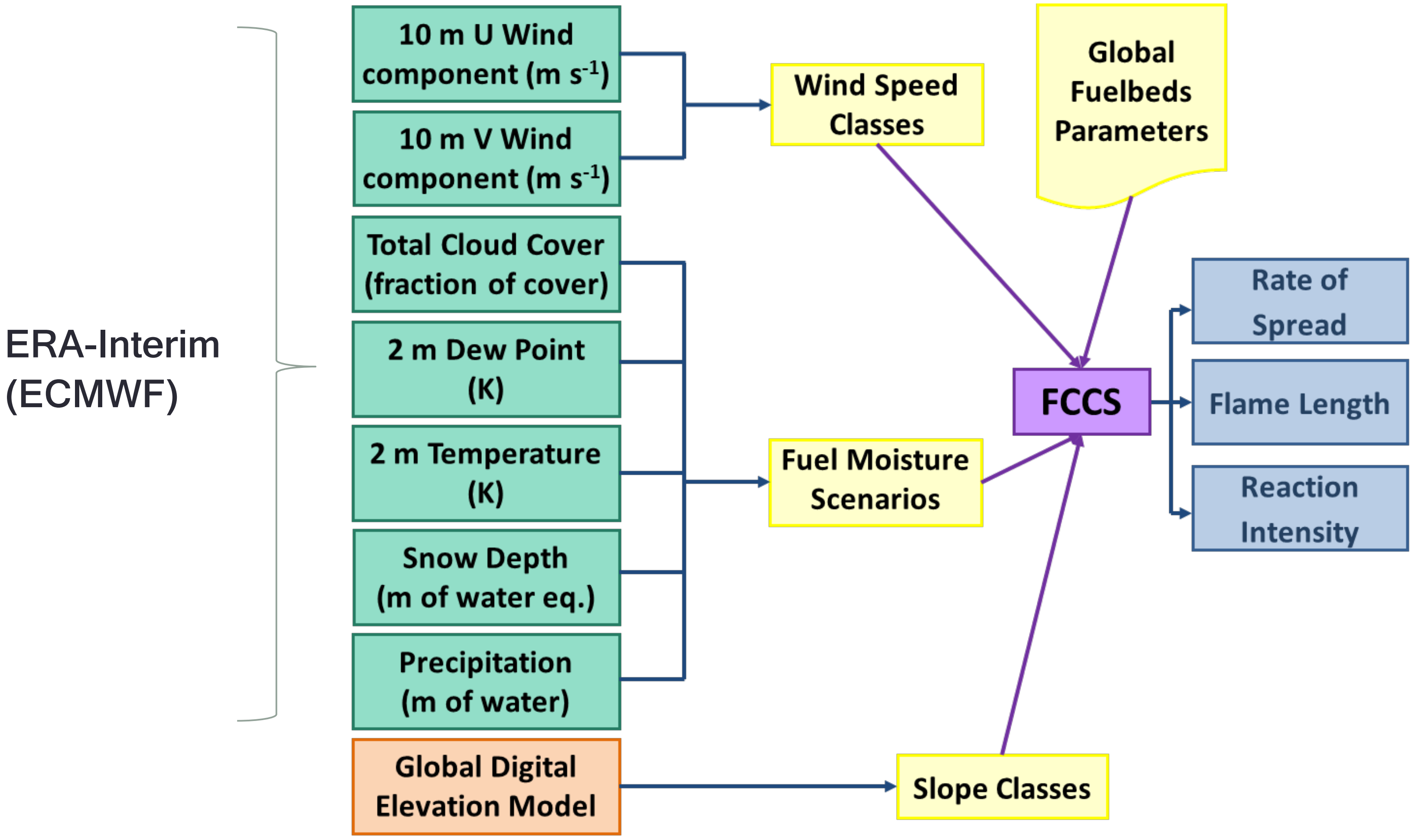
Global Fuel type characterizaton



Land Cover \ Biomes	T/S Moist Broadleaf Forests	T/S Dry Broadleaf Forests	T/S Coniferous Forests	Temperate Broadleaf and Mixed Forests	Temperate Coniferous Forests	Boreal Forests/Taiga	T/S Grasslands, Savannas and Shrublands	Temperate Grasslands, Savannas and Shrublands	Tundra	Mediterranean Forests, Woodlands and Scrub	Desert and Xeric Shrublands	Mangroves
Cropland	1010 to 1019	2010 to 2015		4010 to 4018	5010 - 5012		7010 to 7018	8010 to 8019		12010 to 12018	13010 to 13017	14011
Mosaic Cropland (50-70%) / Vegetation (20-50%)	1020 to 2019	2020 to 2029	3022	4020 to 4028	5020 - 5022		7020 to 7029	8020 to 8029		12020 to 12028	13020 to 13026	14021
Mosaic Vegetation (50-70%) / Cropland (20-50%)	1030 to 1039	2030 to 2039	3032	4030 to 4037	5030 to 5035		7030 to 7039	8030 to 8039		12030 to 12036	13030 to 13037	14031
Broadleaved evergreen or semi-deciduous forest	1040	2040	3040	4040 - 4043	5040		7040 - 7043	8040 - 8043		12043		
Broadleaved deciduous forest	1061	2061	3061	4061	5061	6061	7061	8061	11061	12061	13061	
Needleleaved evergreen forest	1091	2091	3091	4091	5091	6091	7091	8091	11091	12091	13091	
Needleleaved deciduous forest				4092	5092	6092		8092	11092			
Broadleaved/Needleleaved evergreen mixed forest				4100	5100	6100	7100	8100	11100	12100		
Broadleaved/Needleleaved deciduous mixed forest				4102		6102			11102			
Mosaic Forest -Shrubland (50-70%) / Grassland (20-50%)	1110	2110	3110	4110 - 4112	5110 - 5112	6110 - 6112	7110 - 7113	8110 to 8113	11110 - 11112	12110 - 12113	13110 - 13113	
Mosaic Grassland (50-70%) / Forest -Shrubland (20-50%)	1120	2120	3120	4120 to 4123	5120 - 5122	6120 - 6122	7120 - 7123	8120 to 8123	11120 - 11122	12123	13120 - 13123	
Shrubland	1130	2130	3130	4130 - 4133	5130	6130	7130 - 7133	8130 - 8133	11130	12130 - 12133	13130 - 13133	
Grassland	1140	2140	3140	4140	5140	6140	7140	8140	11140	12140	13140	
Sparse vegetation				4150	5150	6150	7150	8150	11150	12150	13150	
Broadleaved forest regularly flooded (fresh-brackish water)	1160						7160					
												14170
						6180	7180	8180	11180			

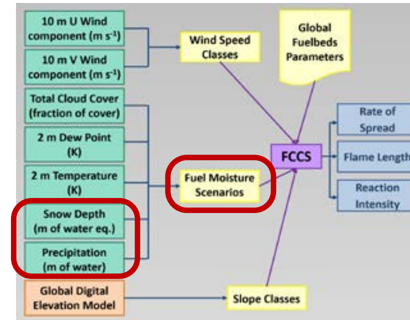
Pettinari et al., 2016, Biogeosciences

Estimation of fire danger parameters

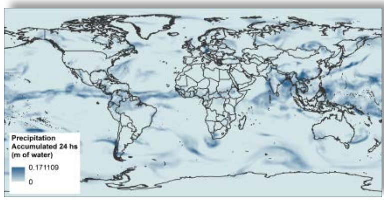


Pettinari & Chuvieco, 2017, Forests

Fuel moisture scenario maps

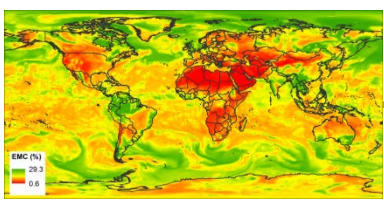


Precipitation

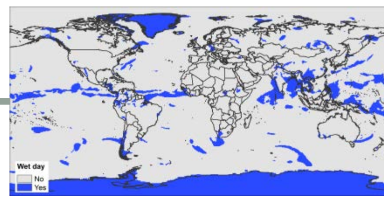


Snow Depth

EMC

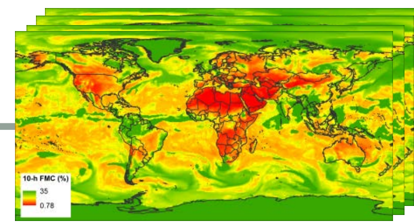


Fuels Wet

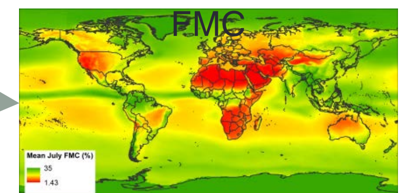


Wet: 10-h FMC = 35 %
Dry: 10-h FMC = 1.28 * EMC

10-h FMC

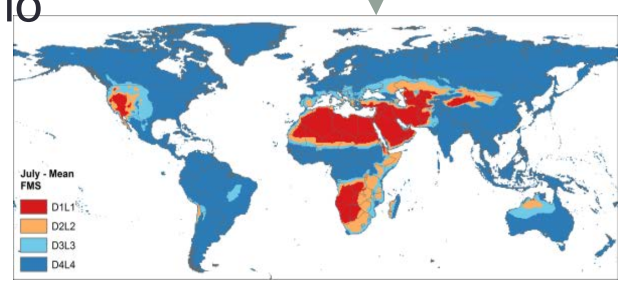


Mean July 10-h FMC



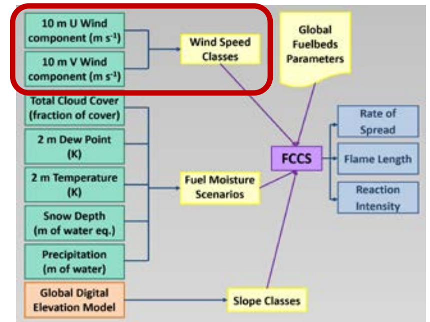
July Mean Fuel Moisture Scenario

- D1L1: 10-h FMC < 5.5%
- D2L2: 5.5% <= 10-h FMC < 8.5%
- D3L3: 8.5% <= 10-h FMC < 10.5%
- D4L4: 10-h FMC >= 10.5%

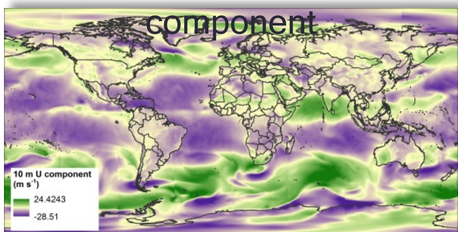


Pettinari & Chuvieco, 2017, Forests

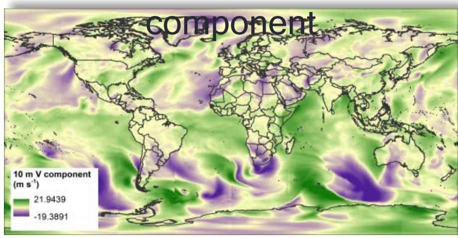
Wind speed



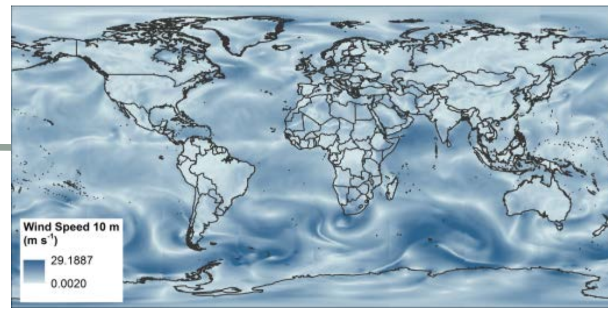
10m U wind component

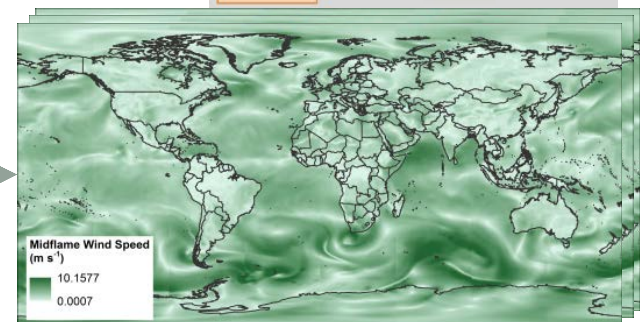


10m V wind component



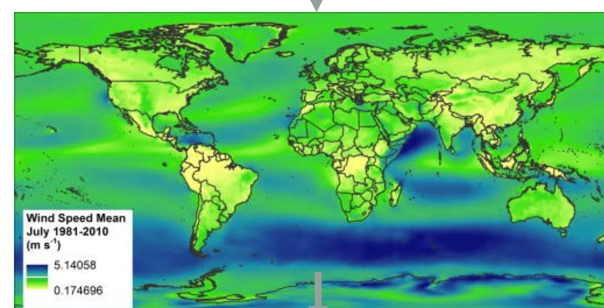
$$10\ m\ Wind\ Speed = \sqrt{W_U{}^2 + W_V{}^2}$$

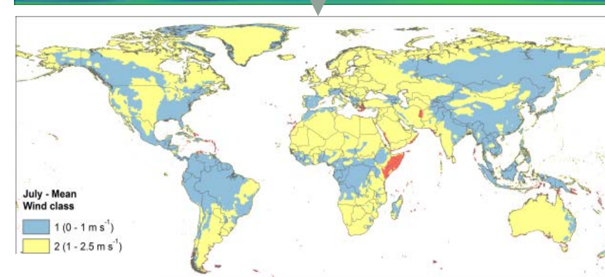




Wind adjustment factor: 0.348 (intermediate between sheltered and unsheltered fuels)

$$Midflame\ Wind\ Speed = Wind\ Speed * 0.348$$



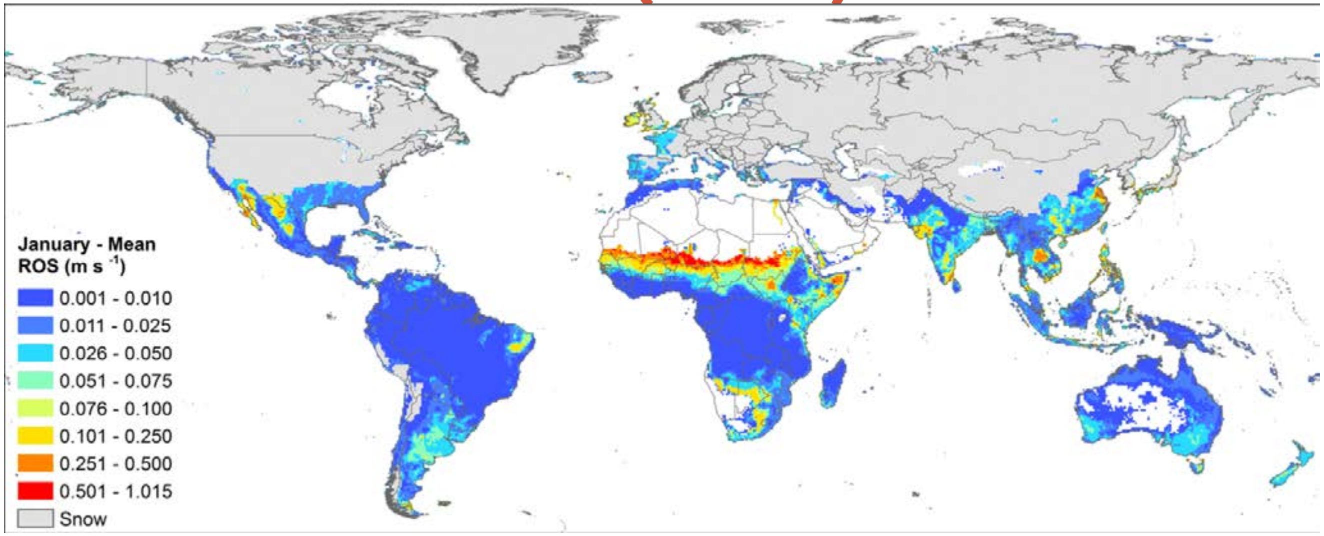


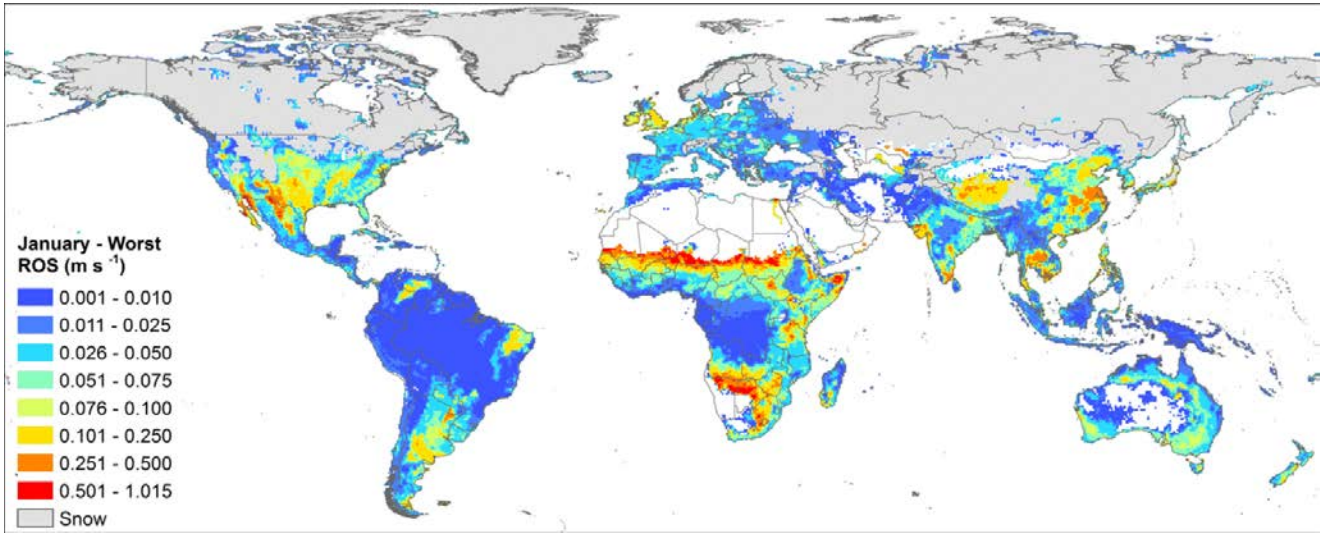
July Mean Wind Class

- Class 1: 0 – 1.0 m s^{-1} (0 – 2.24 mph)
- Class 2: 1.0 – 2.5 m s^{-1} (2.24 – 5.59 mph)
- Class 3: 2.5 – 5 m s^{-1} (5.59 – 11.18 mph)

Pettinari & Chuvieco, 2017, Forests

Estimation of fire danger parameters from forecasted data (RoS)





Pettinari & Chuvieco, 2017, Forests

Universidad de Alcalá

Global fire vulnerability

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2014) **23**, 245–258

RESEARCH PAPER

Integration of ecological and socio-economic factors to assess global vulnerability to wildfire

Emilio Chuvieco[1]*, Susana Martínez[2], María Victoria Román[3], Stijn Hantson[1] and M. Lucrecia Pettinari[1]

[1]*Environmental Remote Sensing Research Group, Department of Geography and Geology, Universidad de Alcalá, Colegios 2, 28801 Alcalá de Henares, Spain,* [2]*GI-TB Lab. Botánica y Biogeografía, IBADER, Campus de Lugo, Universidad de Santiago de Compostela, 27002 Lugo, Spain,* [3]*Department of Economics, Universidad de Alcalá. Colegios 2, 28801 Alcalá de Henares, Spain*

ABSTRACT

Aim This paper presents a map of global fire vulnerability, estimating the potential damage of wildland fires to global ecosystems.

Location Global scale at 0.5° grid resolution.

Methods Three vulnerability factors were considered: ecological richness and fragility, provision of ecosystem services and value of houses in the wildland–urban interface. Each of these factors was estimated from existing global databases. Ecological values were estimated from biodiversity relevance, conservation status and fragmentation based on Olson's ecoregions. The ecological regeneration delay was estimated from adaptation to fires and soil erosion potential. The former was assessed by comparing actual land cover with fire-off simulations based on a dynamic global vegetation model (ORCHIDEE). The annual loss of ecosystem

Present Marginal Loss (PML)

$$PML = ML * \frac{1-(1+r)^{-\log n}}{r}$$

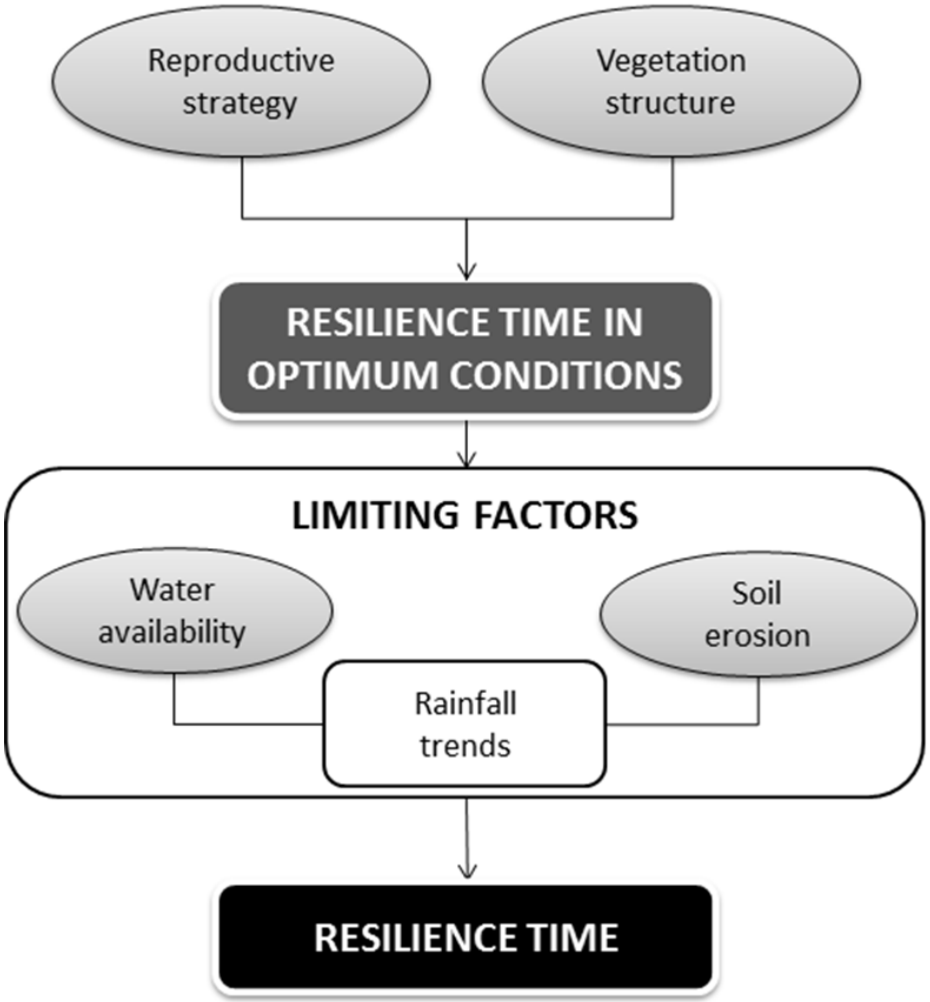
- ML = $V_1 - V_0$
- V_0 = Initial value of resource, related to economic assessment
- V_1 = Value after fire, related to fire behavior.
- **n: number of years to regenerate, related to ecological conditions and fire behavior.**
- r: Discount rate (2%).

Assumed

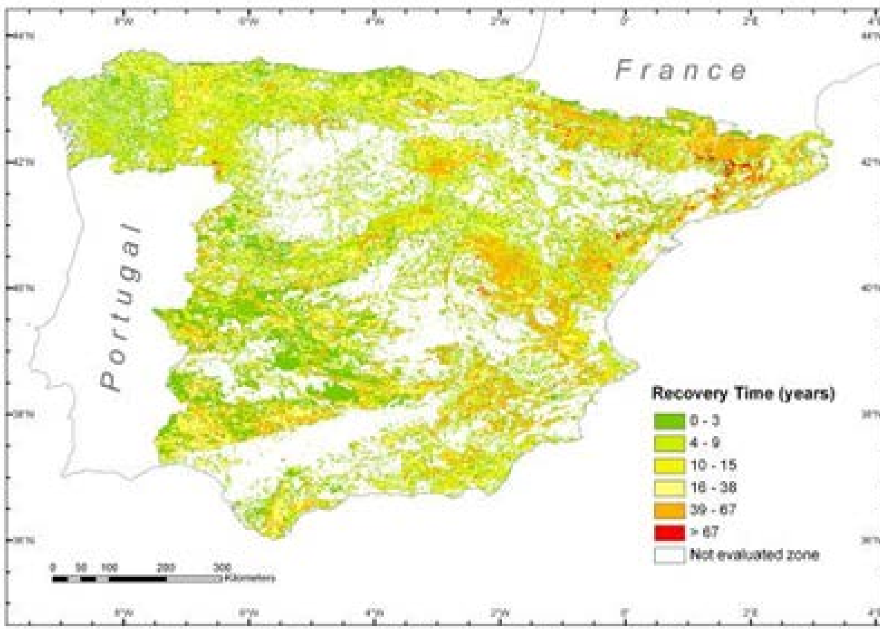
Estimated

Chuvieco et al., 2014, IJWF

Recovery time (n)



Rodrigues et al., 2014, PPG



Chuvieco et al., 2014, IJWF

RS in Fire risk assessment

- Improve methods to generate input datasets:
  - Fuel types.
  - Fuel moisture content.
  - Human factors.
- Better link RS data to ignition and propagation models.
- Consider both danger and vulnerability:
  - Mitigating risks.