10.1071/WF22145
International Journal of Wildland Fire

Supplementary Material

Testing simple approaches to map sediment mobilisation hotspots after wildfires

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Supplementary material 1:

Road density in Águeda catchment

To obtain the road density within the boundary of Águeda catchment we used the OpenStreetMap dataset (https://download.geofabrik.de/europe.html, for more information about this dataset please visit: https://www.openstreetmap.org/#map=9/40.5107/-8.1711). Tracks have the highest density inside the catchment (40% of total road density) followed by residential (14%) and tertiary (13%) roads (**Table S1**). Additionally, if we consider the mean road density per land use / land cover type as in **Table S2**, Forest of *Eucalyptus globulus* and other natural areas have relatively high road densities (from 17 to 22 km/km^2), comparable to that of agriculture (39 km/km^2).

Table S1. Road types within the boundary of Águeda catchment considering the OpenStreetMap dataset (https://www.openstreetmap.org/#map=9/40.5107/-8.1711). Also, the total length (km) and the density road (km/km^2) considering each type of road are presented.

Type of road	Total length (km)	Density road (km/km^2)
Tertiary	196.239	51.001
Primary	25.812	6.708
Track	605.373	157.332
Secondary	67.860	17.636
Motorway_Link	4.277	1.111
Unclassified	205.342	53.367
Motorway	35.363	9.191
Residential	210.336	54.665
Steps	0.454	0.118
Service	49.210	12.789
Path	42.675	11.091
Footway	5.268	1.369
Track_Grade2	31.950	8.303
Track_Grade3	20.874	5.425
Track_Grade4	21.460	5.577
Track_Grade5	0.321	0.083
Pedestrian	0.289	0.075
Bridleway	1.140	0.296
Cycleway	1.840	0.478

Table S2. Mean road density (km/km^2) within the boundary of Águeda catchment according to land use/land cover type and considering the OpenStreetMap dataset (https://www.openstreetmap.org/#map=9/40.5107/-8.1711).

Land use/Land cover type	Area (km^2)	Mean road density (km/km^2)
Agriculture	0.359	38.523
Forest of *Pinus pinaster*	0.626	21.365
Forest of *Eucalyptus globulus*	1.979	16.839
Forest of other Broadleaf	0.357	20.931
Shrubs and natural vegetation	0.403	18.722
Urban	0.123	115.874

Supplementary material 2:

Land use/land cover management in Portugal: a brief description

Since the end of the 19th century, Portugal experienced an increase of approximately 35% of forest, replacing agricultural areas (Valente *et al.* 2013). The forest growth is resulted from the investment of the government, private owners and producers, mainly in an unorganized manner and without proper spatial planning (Valente *et al*. 2015*b*). In addition, the last Portuguese agricultural census (INE 2021) indicates a sharp slowdown in the decrease of agricultural areas since 2009 (–26.6% between 1999 and 2009 and –4.9% during the last decade), even tending to some stabilization; for example, this has been observed in the *Beira Litoral* region, where a decrease of –10.5% was registered, and where farms have on average less than 3 hectares. Also, the depopulation since the 1950s (everywhere except in the northern and central coastline municipalities) led to the abandonment of agricultural areas and a reduction in the size of herds, with a subsequent decrease in the amount of forest fuels consumed by grazing and gathering firewood (Nunes *et al.* 2016; Valente *et al*. 2015*b*). Additionally, this situation accelerated the disruption of agricultural system (Fernandes *et al.* 2014).

The Portuguese Forest is owned by several parties: the state (central state, municipalities, parishes), *baldios* (community areas), large forest product companies, other diverse entities (e.g., church), and non-industrial private forest owners, who are responsible for more than 75% of the forest (Baptista and Santos 2006; Ribeiro *et al.* 2014). One of the major constraints of forest management is the small size of forest properties, which most of the times results from inheritance partitioning, especially in north and central Portugal (Ribeiro *et al.* 2014; Valente *et al.* 2013) where plots have areas of less than 10ha (Valente *et al*. 2015*b*). Currently these small-scale forest owners are less attached to their forest lands and more urbanized than in the past (Feliciano *et al.* 2017). Baptista and Santos (2006) suggested that only a part of the forest owners invest in their land, while the remainder only carry out at least one productive intervention. Additionally, only a minority keeps track of their forests with a record that allows the quantification of management organization. One example of investments and non-investments are the small-scale forest holdings in the north and central regions, where many of the owners perceive that the only viable option is no intervention in their properties (Valente *et al*. 2015*b*; Valente *et al.* 2013). This situation is caused by, on one hand, opposing views of forest management, as private forest owners do not always align with forest management services (Feliciano *et al.* 2017); and on the other hand, insufficient financial mechanisms and incentives to support forest interventions on private lands, which hinders the implementation of forest policy (Valente *et al*. 2015*b*). This situation undermines the effectiveness of any measure to prevent forest fires and mitigate their impacts (Ribeiro *et al.* 2014).

Agricultural holdings are still managed by individual producers (94.5%), although there was a notorious increase of agriculture societies in the last decade (+115.5%) (INE, 2021). Additionally, the last Portuguese agricultural census indicates: (i) agriculture holdings now cover 55.5% of Portugal, an increase of more 4.3% compared to 2009; (ii) arable land has decreased by 11.6%, while permanent crops and grassland have increased by 24.6% and 14.9%, respectively; (iii) 77.4% of agricultural holdings are covered by agricultural production and 18.9% by shrubs and forests without agricultural use; (iv) arable land covers 50.2% of the agricultural area used in *Beira Litoral* (the region where the Agueda catchment is located); and (v) fallow and horticultural areas increased in *Beira Litoral*.

Land use/land cover management in Portugal and fire risk management: a brief description

Wildfires play a key role in certain forest ecosystems and species evolution (Nunes *et al.* 2016); however, they are also a major constraint to forest/landscape management, and this is already a social perception, as a succession of forest fires can be seen on a yearly basis (Valente *et al.* 2015*a*).

In Portugal, forest intervention zones (ZIF) were created as a measure to prevent forest fires and support forest management. These areas comprise a continuous and bounded area, where the main land use is forest, and can include private land, *baldios* and public land. Nowadays, the central region is covered by 75 ZIF with 299,000 ha, which means that the medium size of each ZIF is less than 4,000 ha (Valente *et al.*, 2013).

Forests in Portugal are mainly composed by: *Eucalyptus globulus* (26%), *Quercus suber* (23%), *Pinus pinaster* (23%), *Quercus ilex* (11%), *Pinus pinea* (6%), and other broadleaf and conifer species (17%) (Valente *et al.* 2015*b*). From these species the most prone fire are eucalyptus and maritime pine trees, and the main reforestation species are: *Pinus pinaster Ait*., which requires extensive fuels treatment to avoid high-severity fires (Fernandes *et al.* 2014); and *Eucalyptus globulus Labill*. This latter specie is the most important in the forests of the central and north regions (Valente *et al.* 2015*b*). Additionally, pine plantations have been converted into eucalyptus plantations in the post-fire period by the landowners in these regions (Hawtree *et al.* 2015).

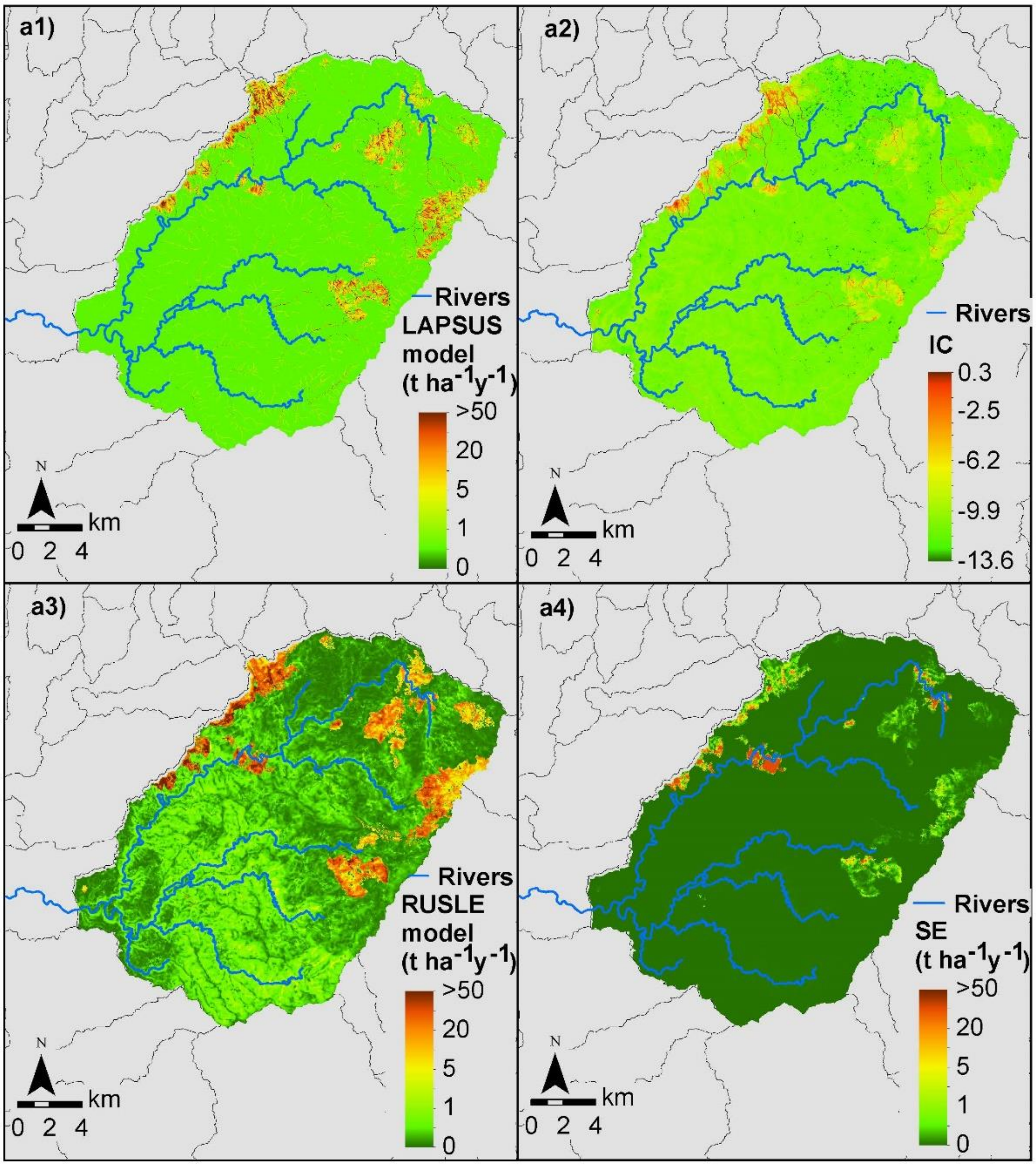
Land use/land cover management in Águeda catchment: a brief description

The Águeda catchment is the clear representation of land use/land cover changes of the last decades that occurred through the north-central region of Portugal described above. Since the end of the 19th century, the most significant forest transitions on this region were from rural agro-silvopastoral and shrublands to plantation tree species such as Pinus pinaster and Eucalyptus globulus (Hawtree 2019; Hawtree *et al.* 2015). The latter is cultivated primarily for use in the paper pulp industry and constitute a mosaic of stands in different rotation cycles (Boulet *et al.* 2015). The Eucalyptus plantation typically involves 2-3 cuts of 12-15 years each, after which a new stand is planted (Wahren *et al.* 2016), following deep ground operations such as rip ploughing and bench terracing to remove existing root systems (Boulet *et al.* 2015). The topographic characteristics of the Águeda catchment contain a dissected and rugged relief with rectilinear slopes mostly from 15 to 25 degrees (Doerr *et al.* 1996), valley-side slopes with typically with 20 degrees (Wahren *et al.* 2016), and stony and shallow soils (< 0.5 m) (Hawtree 2019).

Supplementary material 3:

Figures to support the Results section.

a)



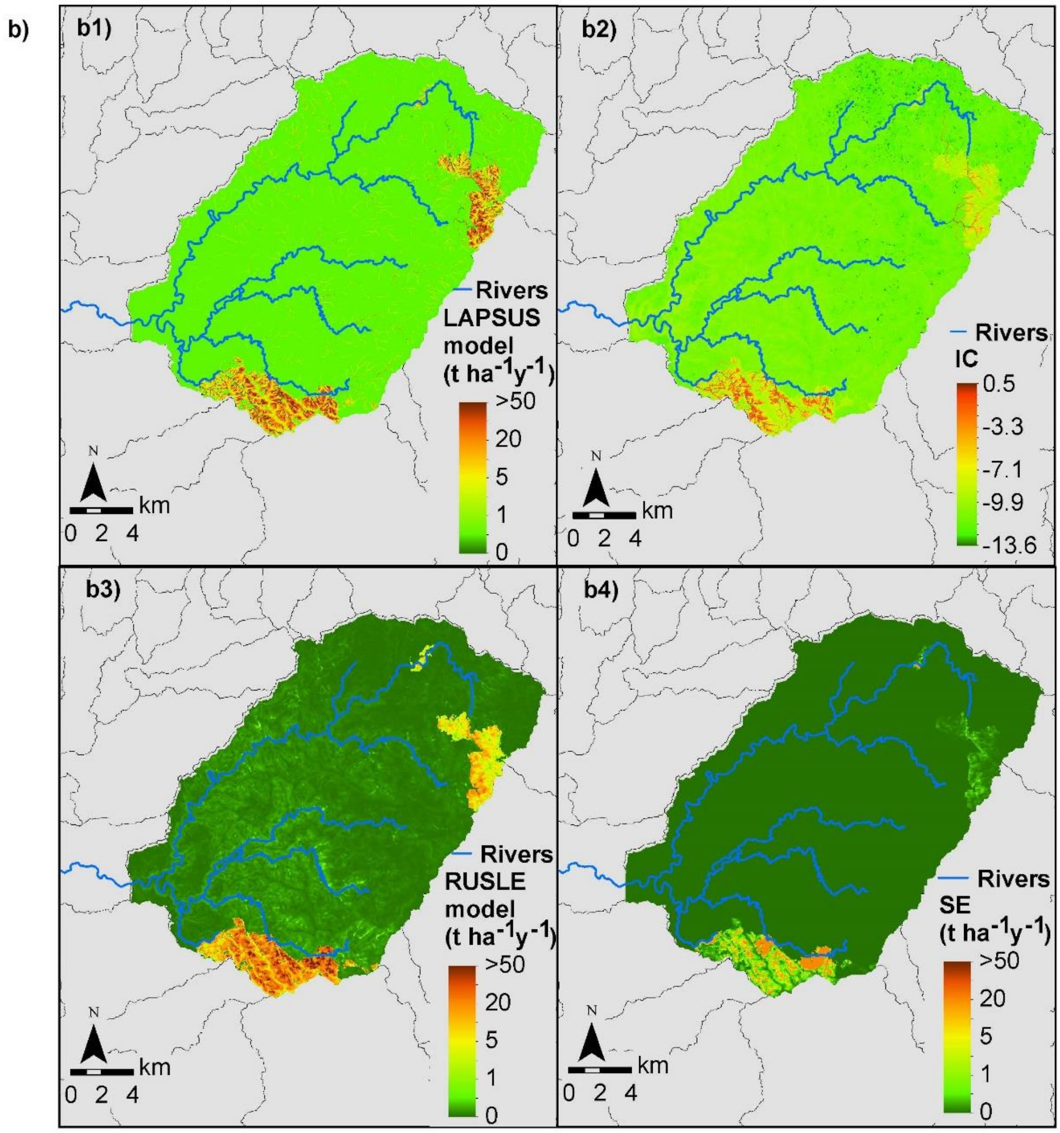


Figure S1. Outputs of the four approaches used in this study for the years 1985 (a) and 2005 (b): (a1 and b1) LAPSUS (Landscape Process Modelling at Multi-dimensions and Scales) model; (a2 and b2) Index of Connectivity (IC); (a3 and b3) Revised version of Universal Soil Loss Equation (RUSLE model); and (a4 and b4) Sediment Export (SE). All the maps have indicated the main rivers of the catchment in a blue line.

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