Assessment of different methods for the quantification of soil erosion risk after fire: A case study from Geraneia Mt., central Greece.

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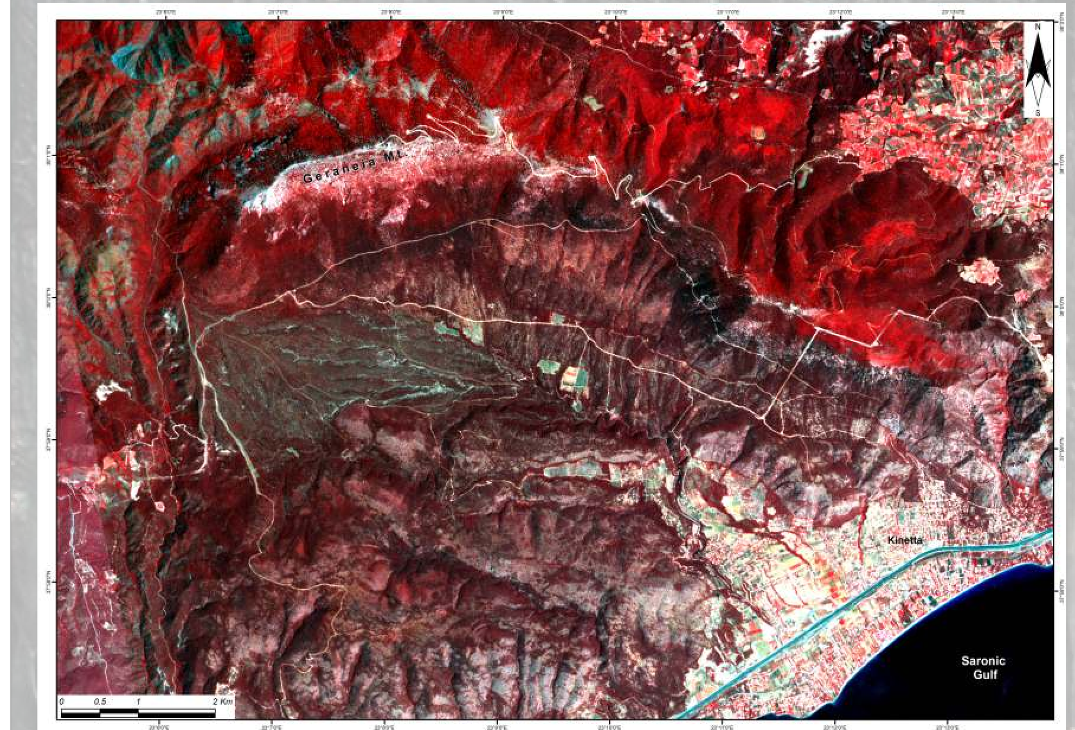
ABSTRACT

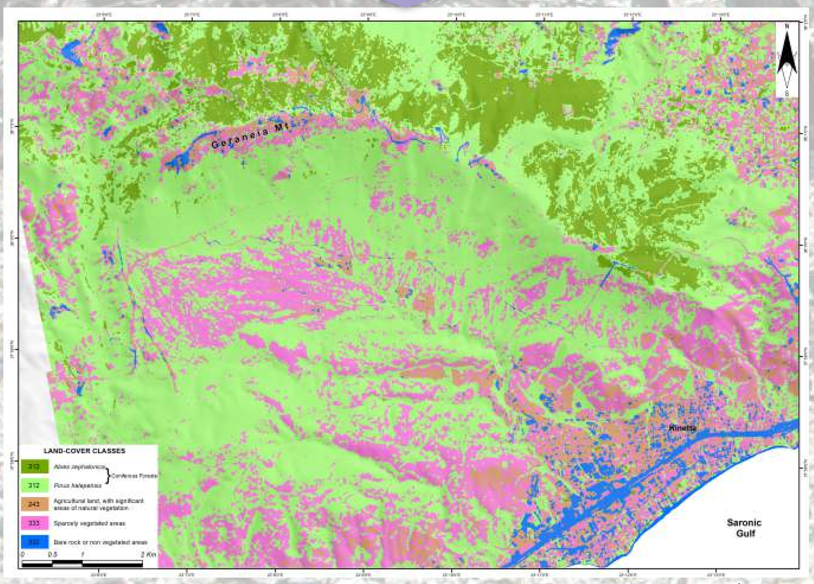
The quantification of the amount of the expected eroded material that will migrate towards lower elevations after a forest fire is one of the most crucial and practical information needed from the local authorities, in order to design post-fire stabilization measures and actions. It is one of the greatest challenges in natural resources and environmental planning and computer simulation models are becoming increasingly popular in predicting soil loss for various land use and management practices. Quite a few models along with their modifications are being developed aiming to fulfil the need for accurate quantification of soil erosion risk. Depending on the availability and the quality of the spatial data, which have to be imported into the various models as parameters, different methodologies are followed.

Geraneia Mt is an extended mountain range at the west outskirts of Attica, central Greece, reaching the altitude of 1351 m, part of which has been designated as Natura 2000 site and is characterized by almost vertical slopes of carbonate rocks. The mountain was almost completely burned by a wild fire in late July 2018, which consumed most of its *Pinus halepensis* forests. The ridge of the protected area, covered by endemic fir *Abies cephalonica* forest was also affected by the fire. The soil covers carbonate rocks which comprise the higher elevations and the vertical slopes of the mountain as debris and loose deposits crop out at the south-facing mountain front which was greatly affected by the fire.

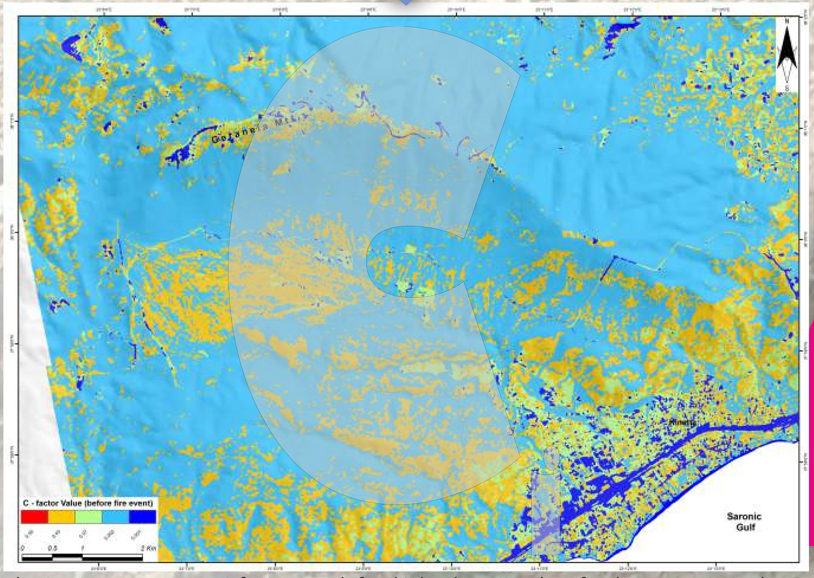
Several erosion risk spatial models (*here only the RUSLE is presented)* were applied on the protected area of Geraneia Mt in order to compare the sensitivity of their results and evaluate the risk of the affected habitats to be deteriorated. For each model, the most sensitive model parameters were calibrated and predicted soil loss amounts were compared. A qualitative and quantitative estimation was achieved and the advantages and disadvantages of each model had been identified.



Pre-fire pseudocolor satellite image (NIr,R,G/R,G,B) acquired on June 30th 2018 by Planetscope constellation, with spatial resolution of 3 m. Dense vegetation prevailing on Geraneia Mt. is presented in red color.



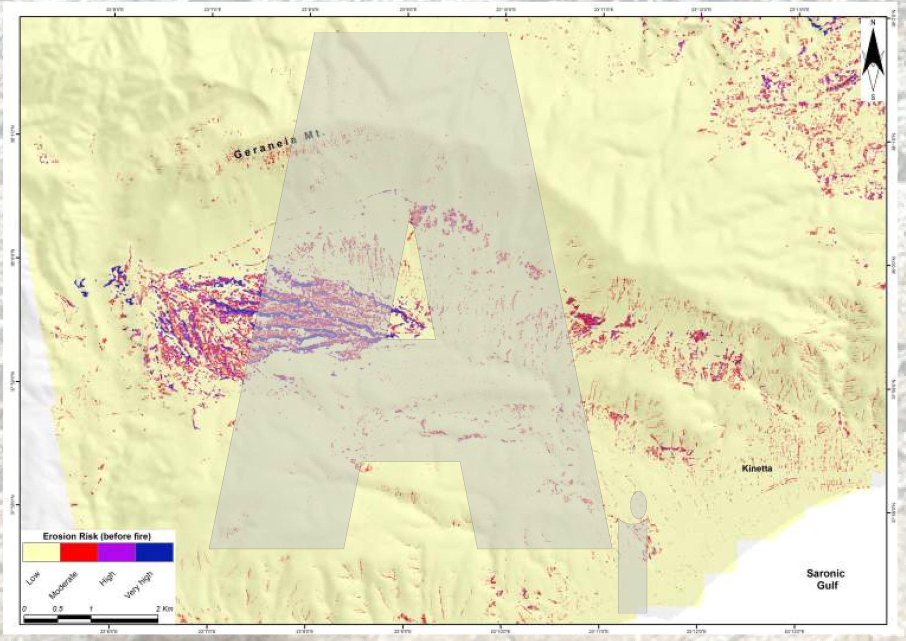
We used the classification of the satellite image acquired before the fire (June 30th 2018), based on CORINE land use classes.



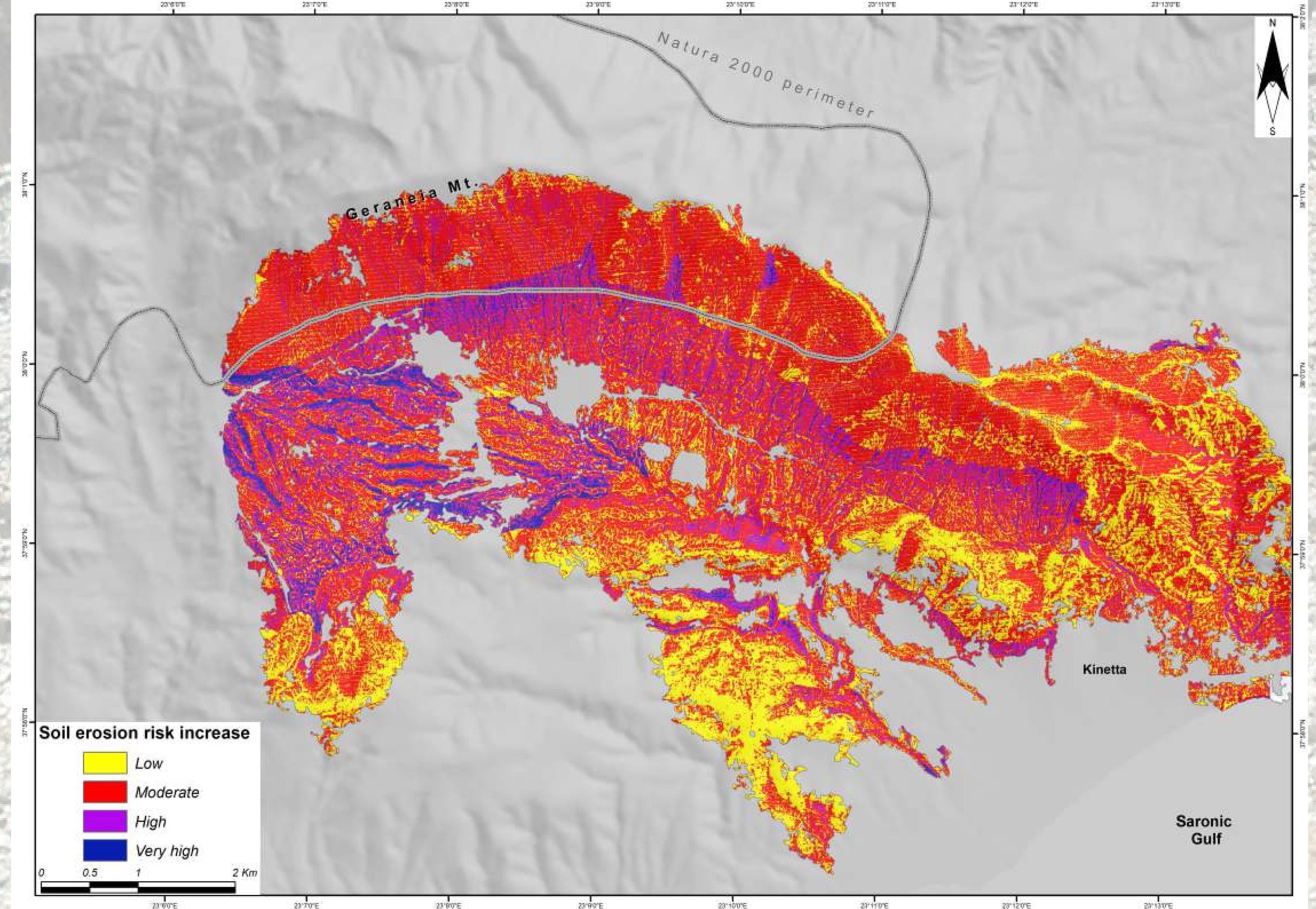
The Cover Management **C-factor** stands for the land cover. Values for the respective unburnt land cover types have been obtained from available literature, hence the pre-fire Ci is produced.

$A_i = R \times K \times LS \times C_i$

Aspect of a slope in the burned Aleppo pine forest. Picture taken a few months after fire. Despite the fact that vegetative regeneration of understorey shrubs has already started, because of the scarcity of the shrubs, signs of soil degradation are apparent.



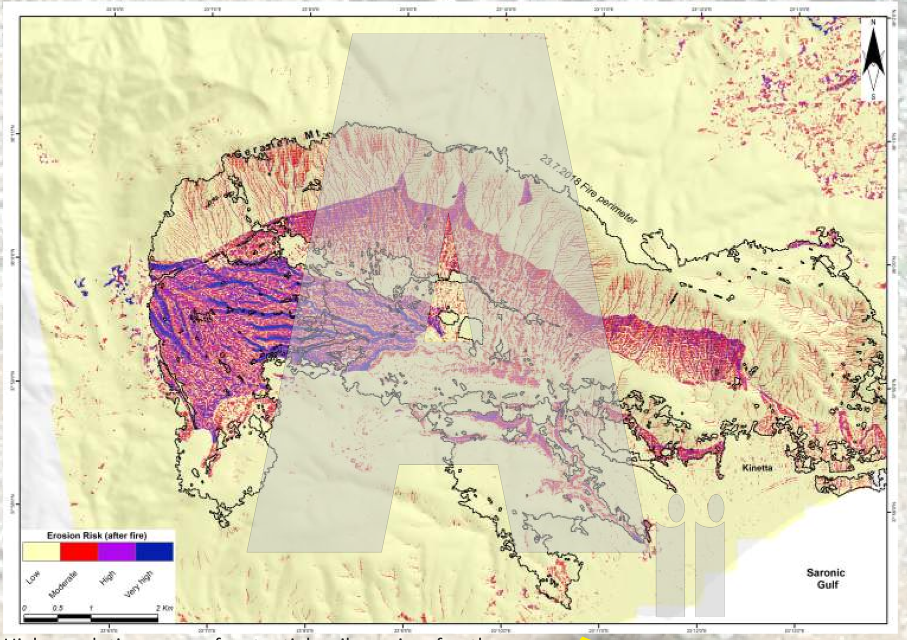
High resolution map of potential soil erosion for the Geraneia Mt, before the fire that happened on July 29th 2018, as calculated with the application of the Revised Universal Soil Loss Equation (RUSLE) method.
The Supporting Practices **P-factor** in the study area equals 1, as no measures to prevent soil loss have been taken after fire.



The two maps resulted from the application of RUSLE method, before and after the fire, were compared at the burnt area, in order to quantify the increase of the erosion risk and delinate the areas of High and Very high risk for soil loss.
It is worthy to note that the summit of the mountain, which is part of the Natura 2000 site is expected to have moderate and high erosion risk.

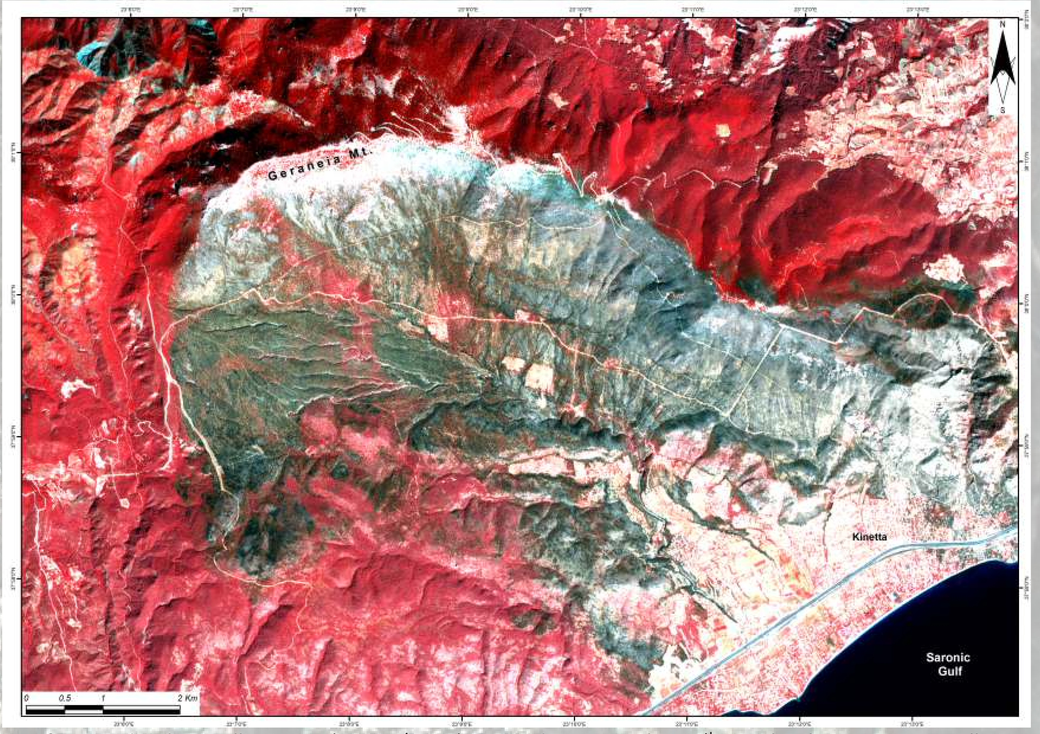
This part of the protected area is covered by the endemic tree *Abies cephalonica* which forms an open forest. Natural post-fire regeneration of the Greek fir is a very slow process. The understorey shrubby vegetation is rather scarce throughout the forests of the mountain, hence the potential vegetative post-fire regeneration which could halt soil erosion risk is at the minimum.

Aspect of the summit area where low erosion risk is calculated and high erosion risk at the burnt foothills of Geraneia Mt.

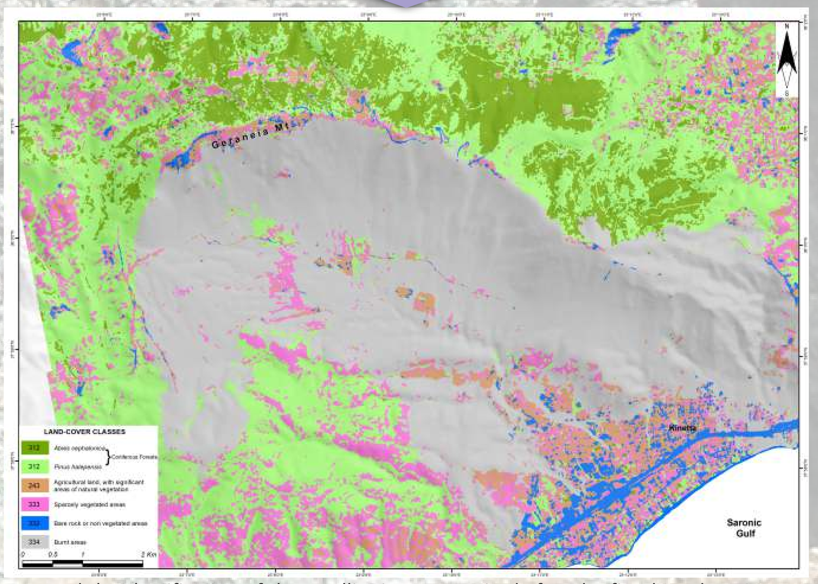


High resolution map of potential soil erosion for the Geraneia Mt, right after the fire event of July 29th, 2018, as calculated with the application of the Revised Universal Soil Loss Equation (RUSLE) method.
The Supporting Practices **P-factor** in the study area equals 1, as no measures to prevent soil loss have been taken after fire.

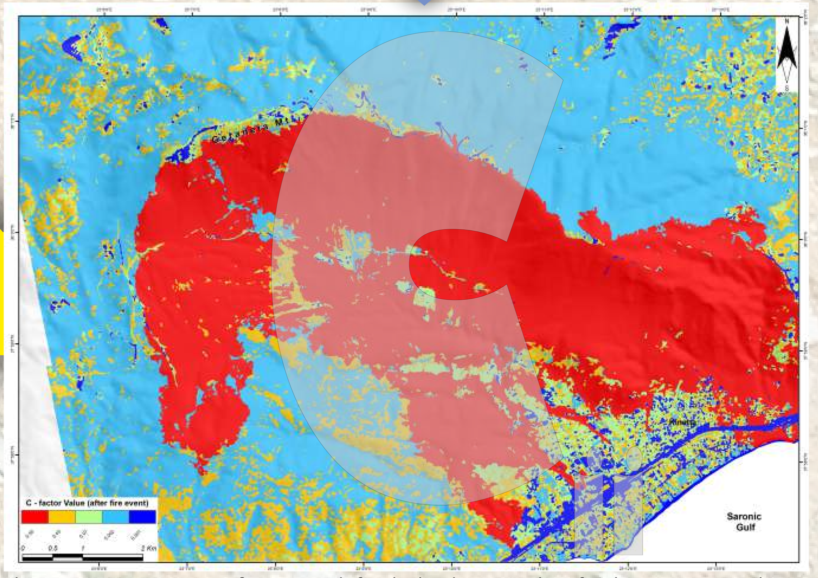
$A_{ii} = R \times K \times LS \times C_{ii}$



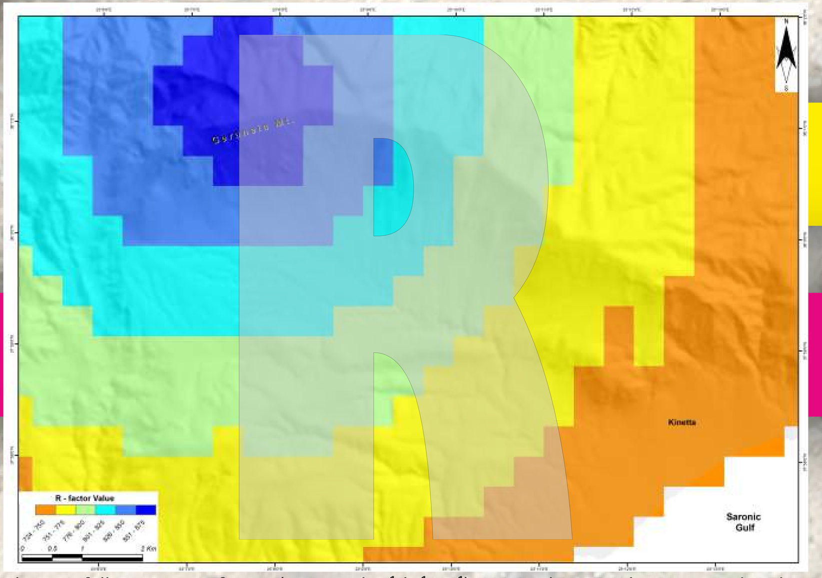
Post fire pseudocolor satellite image (NIr,R,G/R,G,B) acquired on September 24th 2018 by Planetscope constellation, with spatial resolution of 3 m.



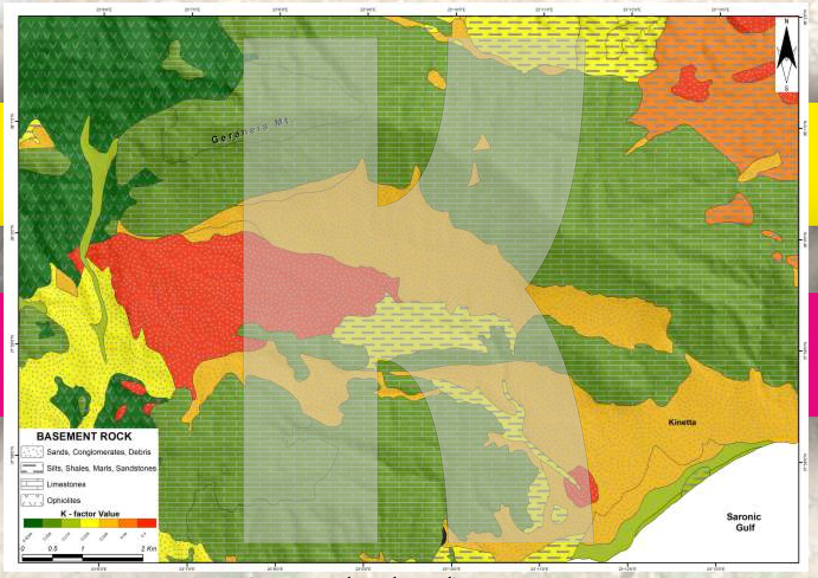
We used the classification of the satellite image acquired after the fire, based on CORINE land use classes including the Burnt areas (334).



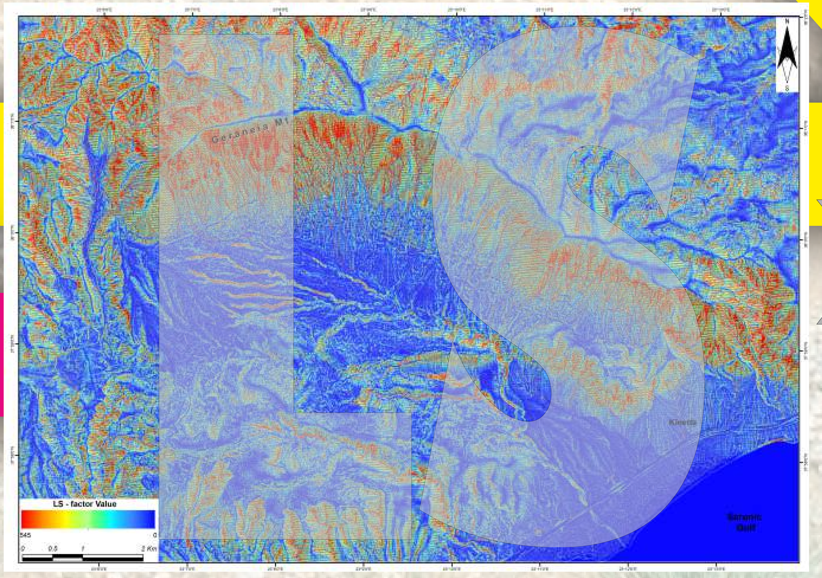
The Cover Management **C-factor** stands for the land cover. Values for the respective unburnt land cover types have been obtained from available literature, hence the post-fire Cii is produced.



The Rainfall Erosivity **R-factor** (MJxmmxha-¹xh-¹xyr-¹), is a multi-annual average index that measures rainfall's kinetic high intensity energy and intensity to describe the effect of rainfall on sheet and rill erosion. In this study we used the Tuscany equation to calculate the distribution of the R-factor throughout the area of interest ($R = a \times P$), where *P* represents the mean annual rainfall (in mm) and *a* is the correlation coefficient depending on the meteorological stations of which the rainfall data were used (equals to 1.3 for the Attica region).



The Soil Erodibility **K-factor** (txhaxhxha-¹xMJ-¹xmm-¹), represents both susceptibility of soil to erosion and the amount and rate of runoff, as measured under the standard unit plot condition. As a basic dataset we used the published geological map of the area and the maternal basement rock type. Following we related the various rock types with literature references for already published K-factor values and used them for the calculations.



The Slope Length and Slope Steepness **LS-factor** is a dimensionless number describing the effect of topography on soil erosion. L is the slope length factor, representing the effect of slope length on erosion and S is the slope steepness which represents the way slope steepness affects erosional processes.

Landsat-7ETM+ image of Western Attica (321/RGB), acquired on 13/5/2009. The vertical lines depict the 2018 fire event. The map on the right shows the location of the Landsat image in the mainland Greece.

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