# Impact of monthly changes of rainfall erosivity and cover management factors on soil loss estimation for Crete Island, Greece

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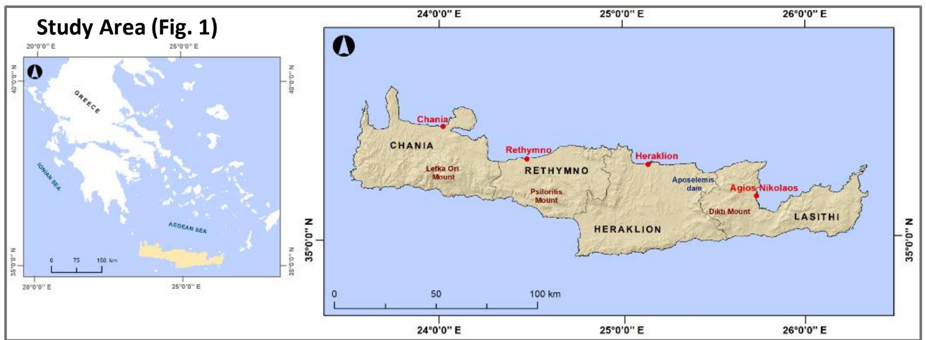
**Abstract:** Soil erosion is a major environmental process caused by water or wind. It is a growing problem in Greece and particularly in the island of Crete, the biggest Greek island with great agricultural activity. The advances in geospatial technologies such as geographic information systems (GIS) and remote sensing, as well as the wide spreading of use of corresponding data, has significantly accelerated the development of several methods/models over time enabling the assessment of soil erosion loss. Nowadays, a number of different models is detected in the relative research studies. In the majority of them, data representing the soil erosion-influencing conditions of a given region like its climate, topography, soil regime, and surface coverage are analyzed. On this basis, an empirical model namely Revised Universal Soil Loss Equation (RUSLE) was developed. By a GIS-based implementation, RUSLE model integrates a number of water erosion factors for estimating soil loss rate. According to the type of primary data used for their creation, these factors are separated to the following five: rainfall erosivity (R-factor), soil erodibility (K-factor), slope length and steepness (LS-factor), cover management (C-factor), and support practice (P-factor). The present study has as main objectives: (a) to estimate the soil loss rate by water-caused erosion for the island of Crete between January and December for the years 2016 and 2019, as a result of RUSLE model implementation, and (b) to explore the impact and the correlation of intra-annual variability of C and R-factors and their temporal interactions on estimated soil loss rate, by handling these factors as monthly changing and the others (K, LS and P-factors) as static during the whole year. In this frame, sensitivity analysis was performed in order to check the sensitivity of model to changing environmental factors. The five key factors of model were generated by using GIS and remote sensing-based techniques and data. Specifically, rainfall data at a high temporal scale resolution for R-factor, soil data for K-factor, digital elevation model (DEM) of 30 m spatial resolution for LS-factor, satellite (Landsat-8 OLI) imagery data of 30 m spatial resolution for C-factor and land cover data for P-factor were exploited. The estimated rates were cartographically visualized as maps presenting the spatio-temporal patterns of soil loss for the study area on a monthly basis.

**Study Area (Fig. 1)**




❖ **RUSLE (Revised Universal Soil Loss Estimation)** is an empirical equation that enumerates the average annual soil erosion in tons /ha/year.

$A = R*K*LS*C*P$

where, A estimated average annual soil erosion (ton/$ha^{-1}$/$year^{-1}$),
R rainfall erosivity factor ((MJ mm ha-1 $h^{-1}$ $year^{-1}$),
K = soil erodibility factor (t $MJ^{-1}$ $ha^{-1}$ $mm^{-1}$),
L slope length factor (dimensionless),
S slope steepness factor (dimensionless),
C cover management factor (dimensionless),
P supporting practices (dimensionless),

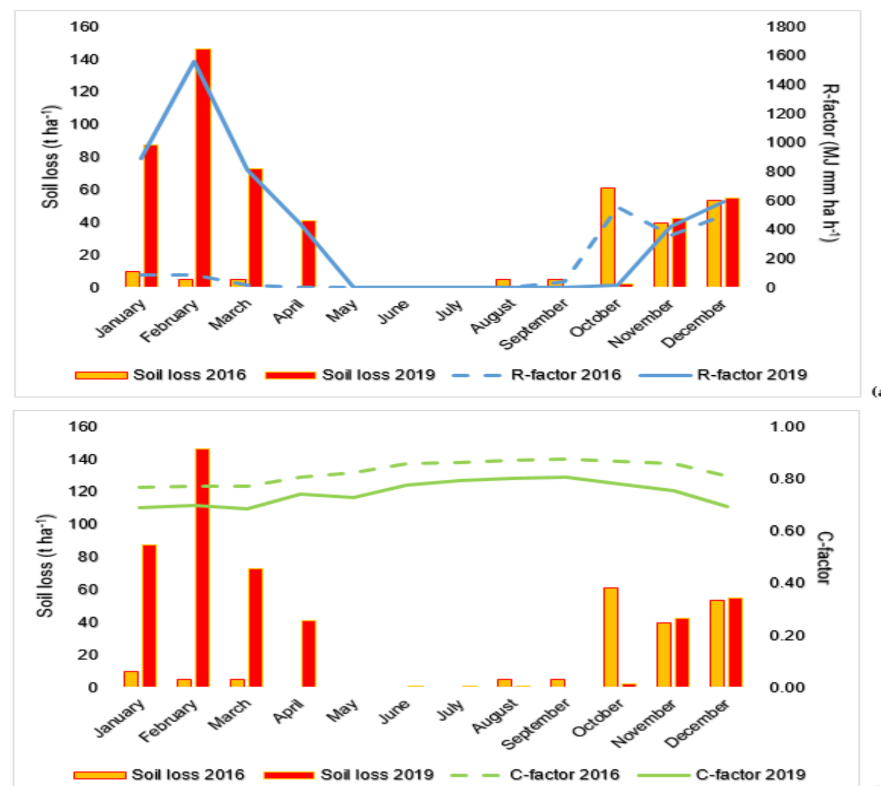



**Figure 4.** Monthly variation of mean soil loss rate in 2016 and 2019 compared to this one of: (a) mean rainfall erosivity (R-factor); (b) mean cover management (C-factor).

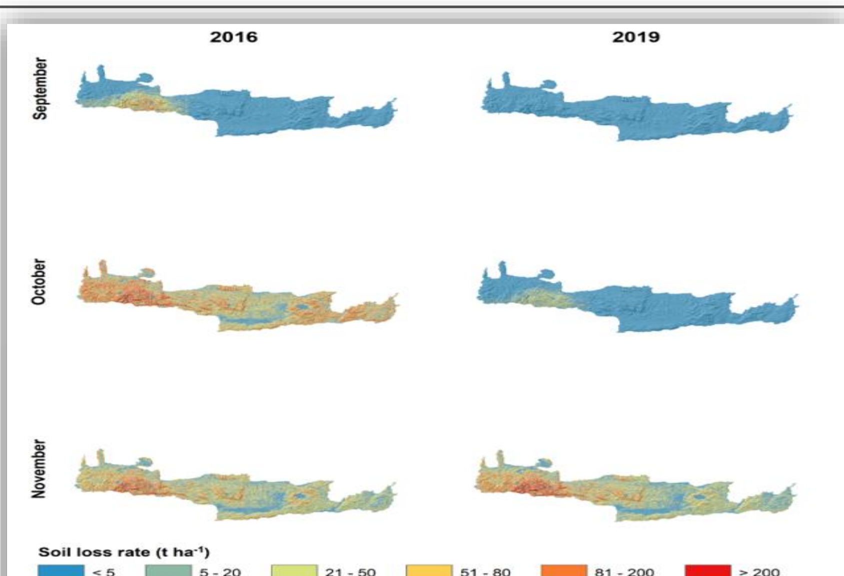



**Figure 2.** Monthly spatial distribution of soil loss rate for Crete Island in 2016 and 2019.

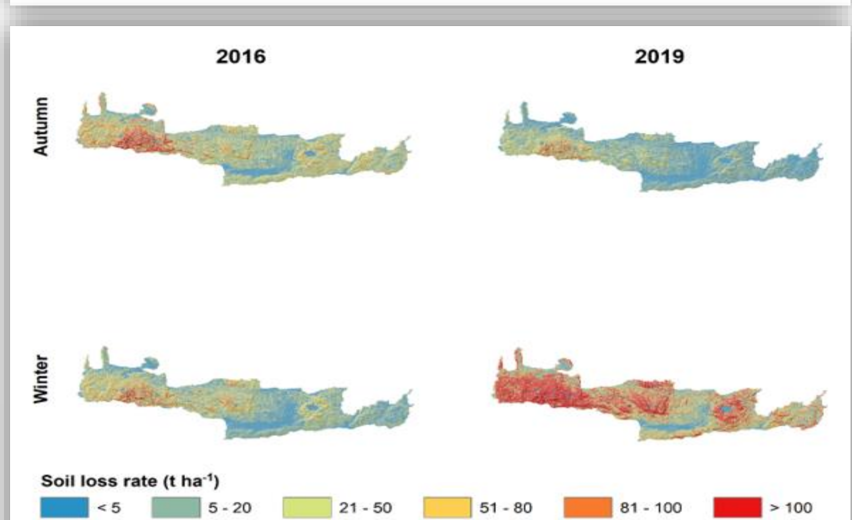



**Figure 3.** Seasonal spatial distribution of soil loss rate for Crete Island in 2016 and 2019.

❖ **Results/Conclusions:**

- Figures 2 and 3 visualize the spatial distributions of estimated monthly and seasonal, respectively, soil loss rates for Crete Island in 2016 and 2019. In 2016, the period from October to December was identified as the most erosive, with monthly mean soil loss rates greater than 39 t $ha^{-1}$. Within this period, October was found to have the highest soil loss (mean rate of about 61 t $ha^{-1}$), followed by December (mean rate of about 53 t $ha^{-1}$). None influence by water-induced soil erosion was observed at the period from April to July, with monthly mean rates equal to 0 t $ha^{-1}$. On a seasonal basis, autumn was shown as the most erosive season, with mean soil loss rate equal to about 35 t $ha^{-1}$. In contrast, summer was the least erosive season, with mean rate equal to 0.22 t $ha^{-1}$. Both monthly and seasonally, the areas most affected by soil erosion were mainly detected in the west-southern, central and eastern parts of island.

- In 2019, the period from January to March revealed the highest influence by erosion, with monthly mean soil loss rates greater than 70 t $ha^{-1}$. Among these months, February presented the highest soil loss, with mean rate equal to 146 t $ha^{-1}$. None influence by erosion (mean rate of 0 t $ha^{-1}$) was found in September and May. Among seasons, winter was the most erosive (mean rate of about 96 t $ha^{-1}$), whereas summer the least erosive (mean rate of 0.25 t $ha^{-1}$). The areas most affected by soil erosion were mainly observed in the west-southern, central and eastern parts of island.

- The monthly variations of R and C-factors compared with the corresponding soil loss rates were plotted in Figure 4 for evaluating the impact of these variations on soil erosion. Between 2016 and 2019, two converse tendencies expressed by an increase in the values of R-factor and a decrease in those of C-factor were found (Figure 4). However, each of the two factors presented similar intra-annual variation from one year to the other. R-factor revealed intense fluctuations over the months in both years (especially in 2019), whereas C-factor showed a quite stabilized tendency.

- Significant differences were observed in terms of the temporal distribution of high soil loss rates. By an intra-annual perspective (among the months of each year), October in 2016 and February in 2019 were recognized as the most erosive months. Because of the high contribution of these months, and, to a lesser degree, of their temporally closest months (directly previous and next), the relative seasons of autumn in 2016 and winter in 2019 were shown as the most erosive

❖ **Future work:** Future work could focus on monthly and seasonal soil loss estimations for smaller regions contained in the island (for instance, watersheds) by using data of higher spatial resolution.

**"5DARE" research project**

Websites: https://www.ims.forth.gr/en/project/view?id=193;

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